Request for Information
from the Candidate
SKA Sites

Australia–New Zealand
SKA Coordination Committee
15 September 2011
This response to the Square Kilometre Array (SKA) Siting Group (SSG) Request for Information from the Candidate SKA Sites (dated 25 June 2011) has been prepared for, and approved by, the Australia–New Zealand SKA Coordination Committee (ANZSCC), on behalf of the Australian Government, New Zealand Government and Government of Western Australia. It was submitted to the SSG on 15 September 2011.

Confidentiality of the response

Consistent with the advice of the Chair of the SSG regarding the confidentiality of responses to the Request for Information from the Candidate SKA Sites, the ANZSCC requests that all material in this response be held in confidence for the duration of the process that ends with the submission of a preferred site recommendation to the SKA Governing Board.

Further, the ANZSCC advises that the material is provided solely for the purpose of making the recommendation and any subsequent process leading to an SKA site decision. Use of the material for any other purpose requires the written approval of the ANZSCC.

The ANZSCC advises that none of the material in the response is considered commercial-in-confidence.
Dr Vernon Pankonin  
Chair, SKA Siting Group  
Jodrell Bank Centre for Astrophysics  
Rm 3.115, Third Floor, Alan Turing Building  
The University of Manchester  
Oxford Road  
Manchester M13 9PL United Kingdom

Dear Dr Pankonin

On behalf of the Australian Government, the New Zealand Government and the Government of Western Australia we are pleased to present this response to the Request for Information (RFI) from the SKA Siting Group.

Our governments are of the view that this region offers an opportunity for the international community to locate the Square Kilometre Array (SKA) on a site that would ideally serve the long term interests of the science of radio astronomy.

As potential hosts of this major global scientific instrument we undertake to work closely and co-operatively with the international project partners to ensure that the SKA delivers the best outcomes for the global science community.

The plan to build this ambitious instrument, and to maximise the science outcomes it delivers, has our full and enthusiastic support. In this response to the RFI we demonstrate how the SKA can be built to provide for exceptional science at an affordable cost in Australia and New Zealand.

We share a ‘big picture’ vision for the SKA, and offer an exceptionally radio-quiet core area for maximum sensitivity, coupled with a long base-line spanning 5,010 kilometres to optimise resolution and array performance.

Australia and New Zealand have the physical characteristics and political will to support such a vision. We have the advantage of a sparsely populated interior and an extensive continental fibre-optic network that can link remote array stations.

Australia and New Zealand are stable countries with robust institutions and governance traditions. This is perhaps the least volatile region in the world: politically, economically and
socially. The ‘sovereign risk’ for the partners operating here will be as low as could be provided anywhere in the world.

The SKA will generate some of the most exciting and important scientific discoveries likely to be made in the coming decades; indeed it is no doubt likely to yield benefits which we cannot yet imagine.

The Australian, New Zealand and Western Australian Governments look forward to being part of that journey. We thank you for considering our candidature.

The Hon Julia Gillard
Prime Minister
Australia
8 September 2011

Rt Hon John Key
Prime Minister
New Zealand
6 September 2011

The Hon Colin Barnett
Premier
Western Australia
12 September 2011
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Executive Summary
Overview

The governments and astronomy communities in Australia and New Zealand have identified supporting and hosting the SKA project as a priority and wish to strongly indicate their willingness, as hosts, to provide the best possible opportunity for the project to succeed.

This response to the Request for Information seeks to detail the features that this region offers the project; features the Australia and New Zealand SKA Coordination Committee (ANZSCC) considers are well suited to meeting the highly specific and demanding requirements of the SKA. The ANZSCC also wishes to convey the strong and broad support the project enjoys with government, the public, the science community and the wide range of organisations and institutions prepared to contribute their resources and expertise to help make the SKA happen for the benefit of all partners. In Australia, this builds on a track record of over half a century in supporting radio astronomy as part of a global endeavour.

The Square Kilometre Array (SKA) project is one of the most visionary and potentially discovery-rich undertakings in astronomy. The SKA represents a significant investment for funders and presents many unique challenges in terms of the scale and complexity of the infrastructure requirement, the need to operate in remote radio-quiet locations and the expected longevity of the facility. It is also being developed in a period of global financial constraint, which only serves to heighten sensitivity to project risk.

It is therefore crucial to the feasibility and success of the project that the partners identify a host region that has both the necessary science and technical characteristics to enable exceptional science outcomes and a societal environment that will afford the project a high level of support and long-term stability and surety.

This response to the Request for Information details why the ANZSCC considers that Australia and New Zealand meet these requirements to a high degree. In summary, Australia and New Zealand do so by providing:

- An intrinsically radio-quiet site that will reduce cost and maximise array sensitivity
- A robust and sustainable radio-quiet protection regime
- Benign climatic conditions over the full array and highly suitable flat terrain in the core region
- A 5,000 km baseline that will give the SKA exceptional resolution
- Access to a mature, integrated and well-regulated communications infrastructure that provides the SKA with a low risk, high reliability, low cost data transport infrastructure solution
- Access to other infrastructure including a power station with a high renewable energy component, and support buildings at the Murchison Radio-astronomy Observatory, Geraldton and Perth
- One of the most politically stable and well governed regions in the world, able to provide a seamless operating environment across the entire instrument and a high level of insulation from sovereign risk
- An open, transparent and effective regulatory and business environment providing ready access to skilled labour and services, skilled migration programs, efficient bureaucracy and world-class infrastructure
- Safe, vibrant and well-serviced communities for SKA employees and their families to live in — with quality, secure housing, world-class education and health services and attractive lifestyle opportunities, and
- A high level of government investment in science and innovation, with a high priority given to radio astronomy for more than 50 years.
This response also deals with the critical issue of cost and implementation feasibility. We demonstrate that an implementation of the SKA infrastructure that is compliant with the Request for Information is technically feasible in Australia and New Zealand — and in detail how it could, indicatively, be achieved.

The detailed costings presented show that the component costs associated with the infrastructure required for this compliant model are significant enough to raise questions about whether the model is financially viable from the viewpoint of funders.

We have therefore developed a motivated alternative model that demonstrates it is possible to build a practical, financially feasible, staged infrastructure solution in Australia and New Zealand, while fulfilling the scientific requirements of the SKA. Crucially, the Australia–New Zealand motivated alternative retains key features of the compliant model, including the long baselines, which would utilise the existing Australian and New Zealand academic/research broadband networks to provide an easy to implement, cost-effective solution to the SKA’s long haul data transport requirements.

Science and technical factors

Australia and New Zealand offer several highly attractive features that will enable the SKA to be an instrument of maximum discovery. They include: an intrinsic level of radio-quiet that guarantees the SKA will be able to make the most sensitive observations possible; a 5,000 km baseline that guarantees excellent resolving power; a practical and robust legislative regime, that is already in operation, to protect the exceptional radio-quietness; benign environmental conditions across the full east–west configuration, and ideal flat terrain in the core region.

Radio-quiet zone protection

Intrinsic radio-quietness

Australia and New Zealand offer the SKA a superbly radio-quiet environment:

- The proposed SKA core area, the Murchison Radio-astronomy Observatory (MRO), is located 320 km from Geraldton, the nearest major population centre.
- The Murchison region has an extremely low population density (0.002 people/km²). Land use is predominantly limited to low-level pastoral activity within 70 km of the centre of the MRO. The MRO is located within the 3850 km² Boolardy Station that is operated by CSIRO in a radio-quiet compliant manner.
- All proposed Australian and New Zealand SKA sites are compliant in this response and sited in areas of acceptably low incidental and transmitted radio emissions.

Robust and sustainable radio-quiet protection

The Australian and Western Australian governments are already operating, with the involvement of regulatory agencies and stakeholders, a robust and sustainable radio-quiet protection regime for the SKA and precursor projects. The key features are:

- Apparatus-licensed transmissions within 260 km of the centre of the MRO are protected by a Radiocommunications Assignment Licensing Instruction under the Australian Government Radiocommunications Act.
- Within 150 km of the centre of the MRO enhanced protection is provided by the Radiocommunications Act Mid-West Radio-Quiet Zone Frequency Band Plan, with radio-astronomy being identified as the primary user of spectrum within 70 km of the MRO centre.
- Further protection is afforded by the Australian Communications and Media Authority (ACMA) from class licence and spectrum licence devices.
• The State Government of Western Australia has introduced a Radio Telescope Mineral Resource Management Area within 70 km of the MRO centre and section 19 exemptions under the WA Mining Act to provide further protection from mining activity
• CSIRO holds and manages the lease of Boolardy Station to control pastoral activity within this region
• Robust regulation of radio spectrum across Australia is managed by a single government agency, the ACMA, an agency with a long history of making effective provision for radio astronomy spectrum use, under a single nationally applicable Radiocommunications Act.

Physical characteristics of the site
The atmospheric conditions and climate across the proposed 5,000 km wide primarily east–west array configuration provides an excellent physical environment for the array, while the flatness and stability of the core area make it ideal for SKA deployment:
• The SKA array-stations are not exposed to the volatile regions of the tropics and are located in the desert and grassland regions of Australia. The more extreme desert regions are avoided.
• The core site enjoys a low average rainfall (215 mm annually), moderate–high mean maximum monthly temperature (19–38 ºC), low–moderate day-time humidity (mean monthly 3 pm ranges from 19–44 per cent) and low wind speed (annual mean 15 km/h)
• The core site is also flat over an extensive area, with stable soil types and a high degree of seismic stability
• Corrosion risks are low: the closest saltpans are 375 km from the MRO.

Other selection factors
Australia and New Zealand offer the SKA project the opportunity to be based in a region where long-term stability and security, high living standards and sound regulatory and economic conditions can effectively be guaranteed. The ‘sovereign’ risk factors from operating in this region are as low as can be offered anywhere in the world.

Political, socio-economic and financial
Australia and New Zealand provide the political stability, effective governance, conducive business environment, security and high quality of life required for a long-term project seeking to attract and retain the best people from around the world:
• Australia and New Zealand are democracies, with excellent institutions and human rights records. They are ranked the 6th and 5th most ‘democratic’ countries on an international index. They also rank 2nd and 3rd respectively on the United Nations Human Development Index, a measure of overall national well-being.
• Both rank highly in ‘ease of business’ and ‘country risk measures’ (for example 10th and 3rd in the World Bank’s Ease of Business Index and in Tier 1 of the Eurobank’s country risk index). Both invest heavily in research and development and support a large science sector. Australia increased expenditure on science and innovation by 43% over the past three years and ranks 6th in OECD for publically financed research and development.
• The current economic conditions and forecasts are notably good for both countries – with projected growth rates of 3 percent per annum, with low levels of inflation and very low public debt.

Customs and excise
Both Australia and New Zealand have open economies, with efficient and transparent customs processes, and competitive taxation systems with particularly low consumption and fuel taxes.
In addition:

- Goods imported by the SKA organisation would be tariff free and GST on imported goods would be a claimable business expense through an efficient deferral scheme
- Funding provided by partner governments is not likely to be subject to GST.

**Legal**

Principles such as the rule of law, procedural fairness, judicial precedent and the separation of powers are fundamental to the legal systems in Australia and New Zealand. In particular:

- Both countries have highly professional and well-resourced judicial and non-judicial dispute resolutions systems and are party to international law and dispute resolution agreements
- There are a range of options available for acquiring a legal status for the SKA organisation
- Transparent and robust processes exist to acquire the sites required for the SKA.

**Security**

The security requirements for the SKA project in Australia and New Zealand would be low key and cost effective, given the relative isolation of the core area and the good law and order environment in the region. In particular:

- The remote, low-crime core area provides a natural level of security
- Standard, low-cost, low-profile measures will be sufficient to secure project assets and personnel
- Employees and families would live in safe, welcoming communities with no extraordinary security measures required.

**Employment**

Australia and New Zealand provide an outstanding environment for the SKA project to recruit employees both locally and globally:

- The domestic workforce is skilled and productive with 49% in higher skill occupations, while 56% of the working age population have a tertiary qualification
- Australia has EU-levels of productivity with 1.7% growth per annum and low levels of industrial action
- Both countries have highly effective and successful skilled migration programs; there is access to a range of visa options to suit circumstances
- The spouses/partners of all skilled migrants are eligible to find employment.

**Working and support environment**

Australia and New Zealand are desirable places to work, live and raise families and can offer SKA employees many professional and personal advantages:

- The operations model enables SKA workers and families to live predominantly in Geraldton or Perth, both of which are safe, healthy, cohesive and highly ‘liveable’ communities with access to a wide range of recreation and community involvement options
- High education standards in safe school environments
- Perth ranked as 8th most liveable city in the world by The Economist’s liveability ranking.
Implementation and cost

The infrastructure cost for the Model SKA proposed is €1 b with annual operating expenses of €131 m/yr. The ANZSCC has also developed a motivated alternative model, aiming to reduce cost while minimising the science impact. The motivated alternative model delivers 13 out of the 14 SKA design reference missions. The model incorporates a novel ‘snowflake’ to significantly reduce reticulation costs. It retains the long baselines, but reduces the number of remote array stations to 12. The infrastructure cost for this motivated alternative configuration is €480 m with annual operating expenses of €76 m/yr. In addition, over €55 m of existing or funded SKA-related infrastructure is available in both models.

Data communications

Australia and New Zealand have an extensive optical fibre network throughout both countries. The academic broadband research networks have extensive reach to provide low-risk, cost-effective bandwidth to the SKA. Key features are:

- Flat terrain and availability of state-of-the-art optical fibre laying services for optimal deployment of dedicated optical fibre network in the intermediate region
- Existing optical fibre connectivity from Perth to the MRO for both SKA Phase 1 and SKA Phase 2, and the required capacity for international connectivity will be available for SKA Phase 1 and SKA Phase 2
- Affordable network traffic rates predominantly using a single national research carrier
- A total cost of €153 m for the compliant configuration and €89 m for the motivated alternative configuration.

Electrical power

A range of power supply options exist for both the SKA Phase 2 core and remote stations including grid, gas pipeline and on-site renewables. In addition:

- Power for SKA Phase 1 will be provided by the expansion of the already funded MRO power station, which has a significant renewable component
- A total cost of €331 m for the compliant configuration and €167 m for the motivated alternative configuration.

Other infrastructure

Australia’s extensive experience in large-scale infrastructure programs in remote regions, and in the operation of radio astronomy facilities, provide an excellent basis for a comprehensive infrastructure costing and detailed operational models in both the compliant configuration and the motivated alternative configuration. Key features are:

- Pre-fabricated modular construction methods available to simplify remote deployments
- Substantial investment (over €13 m) has already been made in existing buildings at MRO, Geraldton and Perth that can be utilised by the SKA
- A total cost of €520 m for the compliant configuration and €223 m for the motivated alternative configuration.

The ANZSCC views this response to the Request for Information as an important part of a robust and transparent process that it strongly supports. With this response, the ANZSCC commends Australia and New Zealand to you as willing and able hosts of the SKA project. The ANZSCC looks forward to working with the international community in bringing the site decision process to not only a timely conclusion, but one that maximises the benefit for the project and its partners as a whole.
Science and Technical Factors

The Galactic All-Sky Survey, conducted with the CSIRO Parkes radio telescope. Image by N McClure-Griffiths (CSIRO) et al.
Radio-Quiet Zone Protection
Report Summary: Radio-Quiet Zone Protection

Both the selection of radio-quiet locations, and then the robust regulatory protection of radio-quiet, are required to ensure an adequate observing environment for the SKA over its 50-year lifetime. It is also essential to develop a well-informed cooperative coexistence regime with other stakeholders in the area. The Australian radio astronomy community has built on its 50-year history of maintaining good relations with spectrum neighbours, and of working constructively with the Australian regulator, the Australian Communications and Media Authority (ACMA), to establish the Mid West Radio-Quiet Zone (RQZ).

We have:

- Selected a site for the core of the SKA, in consultation with local industry, that is exceptionally radio-quiet over the whole SKA frequency range
- Implemented early and effective radio-quiet controls to demonstrate capability and to gain experience in managing the issues arising in the region
- Agreed, in close collaboration with governments and mining parties, a balanced and effective coexistence regime, backed up by well defined dispute resolution arrangements and an intergovernmental Memorandum of Understanding outlining the agreed policy framework
- Prepared instruments to consolidate the early protections in place since 2005, and to provide greater regulatory certainty to the Mid West Radio-Quiet Zone. The RQZ is now protected by a Frequency Band Plan and class and spectrum licence controls, in addition to earlier measures
- Introduced processes to monitor the Mid West Radio-Quiet Zone implementation and to consider any other measures necessary to ensure the Governments’ policy objectives are met
- Continued to provide input into ACMA discussion documents, as appropriate, to ensure high visibility for the Mid West Radio-Quiet Zone.

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<td>Radiocommunications Act</td>
<td>Broad scope to create RQZ regulations Australia wide</td>
<td>Legislation needs implementation of regulations under the Act to be effective</td>
<td>Progressive implementation of regulations, such as Band Plan, Class Licence conditions, spectrum licence conditions and RALI</td>
</tr>
<tr>
<td>regime</td>
<td>RQZ extends to 260 km radius</td>
<td>Embedded in national spectrum management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Section 19 exemptions under Western Australian Mining Act</td>
<td>Ability to match regulations to requirements</td>
<td>Protection against incompatible mining activity</td>
<td>Refine section 19 size once all sites established</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Negative reaction from stakeholders if controls more than necessary</td>
<td></td>
</tr>
<tr>
<td>Local control</td>
<td>Purchase of Boolardy Station pastoral lease</td>
<td>Immediate land use control to ensure radio-quiet compliance</td>
<td>expectation management amongst other pastoralists</td>
<td>Good communication</td>
</tr>
<tr>
<td>Consultation measures</td>
<td>Memorandum of Understanding and Management Framework</td>
<td>Clarifies expectations and process for consultation</td>
<td>Behaviours may evolve with experience over time</td>
<td>Good communications with stakeholders</td>
</tr>
<tr>
<td>Australia’s spectrum environment</td>
<td>ACMA management of spectrum</td>
<td>Experienced, transparent and robust processes in place</td>
<td>Need good international communication links for SKA</td>
<td>AARNet international links</td>
</tr>
<tr>
<td>Geographic isolation</td>
<td>RQZ controls only need to apply to Australia and New Zealand</td>
<td>Facilitates establishment and maintenance of radio-quiet locations</td>
<td>Access to support infrastructure inland</td>
<td>Optimum balance possible in site selection depending on budget, other infrastructure and radio-quiet requirements</td>
</tr>
<tr>
<td>Low population density in inland regions for remote array-stations</td>
<td>Facilitates establishment and maintenance of radio-quiet locations</td>
<td>Access to support infrastructure inland</td>
<td>Optimum balance possible in site selection depending on budget, other infrastructure and radio-quiet requirements</td>
<td></td>
</tr>
</tbody>
</table>
Introduction

The Australia–New Zealand SKA Coordination Committee (ANZSCC) recognises the critical importance of radio-quiet protection to the construction cost and long term operational potential of the SKA. The SKA’s sensitivity to radio frequency interference (RFI) comes from a combination of large collecting area, sensitive wide bandwidth receivers and high dynamic range, and the requirement to observe over wide frequency ranges outside those identified by the International Telecommunication Union (ITU) as being for radio astronomy use.

The geographical distribution of SKA array-stations, fairly closely packed over 180 km and then extending with decreasing density to over 3,000 km, poses the additional challenge of ensuring adequate radio-quiet over a very large area.

Achieving the most radio-quiet environment is very important, both scientifically and technically. At a technical level, lower RFI power levels can enhance the system dynamic range and enable a significantly less expensive design of the system. Power consumption by the electronics throughout the data processing chain can also be lower, up to a halving of power consumption at the receptors themselves. It is even more important to be able to ensure that the levels of narrow band RFI are such that the effects of compression and spurious product generation do not contaminate the RFI-free spectrum.

From a science perspective, there are significant cost savings and opportunities gained if observations can be conducted from the most radio-quiet location. More parts of the spectrum are opened up to useful scientific observations, survey time is decreased, survey sensitivity increased, and the discovery potential from transient and variable astrophysical sources is greatly enhanced. In addition, a reduced need for RFI mitigation in data processing leads directly to increased computing capability for science.

The two essential strategies for robust RFI protection of the core and remote SKA sites are:

- ‘Self-protection’, selection of locations for the core and remote array-stations where demands for active use of the radio spectrum are at a minimum (this also mitigates risk from future spectrum deregulation)
- Implementing a thorough and robust protection regime with the cooperative engagement of regulators, the local community and economic enterprises.

The Murchison Radio-astronomy Observatory (MRO) site offers superb radio-quiet because of extremely low population density and geographic isolation. The other important economic activities in the region surrounding the central site, grazing and mining, are compatible with preserving radio-quietness for SKA. Neither industry is an aggressive user of spectrum.

Local stakeholders have been supportive of the SKA bid and have been working to maintain an adequate radio-quiet regime since 2005. There are only 11 pastoral homesteads within 70 km of the MRO. There is only one town within 180 km of the MRO site: Cue, with a population of 320 people.

Mining in Western Australia is subject to extensive stakeholder consultation prior to a rigorous approvals process. In addition to the regulatory framework on radio-quiet under which mining has operated, in 2011, a coexistence regime on radio-quiet, comprising a Memorandum of Understanding (MOU) and Management Framework [1], has been agreed between the Australian and Western Australian Governments in consultation with mining industry parties in the Mid West of Western Australia, the Australian Communications and Media Authority (ACMA) and CSIRO. The regime supports the requirements of radio astronomy projects through processes to facilitate the implementation of mutually satisfactory solutions that minimise RFI in the region.

The ACMA is scheduled to consider, on 6–7 July 2011, proposed arrangements to enhance the existing regulatory framework for radio-quiet in the Mid West Radio-Quiet Zone (RQZ). This package of regulatory measures follows public consultation in October 2010, consideration of the diverse comments of stakeholders on the proposal and further targeted consultation on revisions to the package of measures. The revised, proposed regulatory framework was developed cognisant of the MOU and Management Framework agreed between the Australian and Western Australian Governments and would provide a greater level of regulatory formality and certainty to arrangements in the RQZ.
As requested, the Australia–New Zealand SKA Coordination Committee has focused this report on establishment of the Radio-Quiet Zone around the core site of the SKA. However, the Committee also recognises the enhanced science capability offered by remote array-stations in Australia and New Zealand, with New Zealand a core partner to ensuring an exceptionally long baseline for the SKA. Recognising this, information on New Zealand’s legislative and regulatory environment has been provided for context and to provide information on the option of extending the SKA baseline beyond the required 3,000 km to 5,500 km incorporating array-stations in New Zealand.

The remote array-stations in an Australia–New Zealand SKA realisation are mainly sited in inland Australia – the famous ‘outback’ – primarily along the Australian Academic Research Network (AARNet) national research optical fibre backbone that crosses the continent east-west and north-south. AARNet provides access to high bandwidth optical fibre even in areas that are very remote and radio-quiet. Access to the New Zealand academic research network, KAREN, can enable a cost effective extension of the SKA into New Zealand. This enables the radio-quiet standards required for the remote array-stations to be achieved in an affordable and science focused implementation. Other remote stations are close to existing Telstra-owned fibre, which could be accessed as part of Australia’s National Broadband Network program. Figure 1 indicates a full configuration option for SKA in Australia together with a population density map, indicating the extremely low population density of Australian SKA sites. Figure 1 also shows the same configuration with locations of licensed (not necessarily operational) transmitters from the ACMA database. It is informative to note the sharp drop-off in transmitter density away from Perth. Western Australia has a total population of 2.3 million, with 1.7 million of those people living in Perth itself. The population density is so low in rural Western Australia that it is not commercially viable to provide many radio frequency services.

Australia and New Zealand’s geographic isolation from other countries is a further advantage with respect to the establishment of a radio-quiet zone. The geographic isolation of the SKA facility in Australia and New Zealand means that national controls will be consistent with the requirements of neighbouring countries.

In the sections below, we describe the stages and the outcomes of the introduction of radio-quiet protection for the SKA in Australia and New Zealand. The work builds on over 50 years experience in protection of radio-quiet for radio astronomy within CSIRO, and the Australian Government regulatory agencies, since the Parkes radio telescope was established.
This map of Australia shows population density and proposed indicative locations for SKA array-stations.

This map of Australia shows locations of licensed (not necessarily operational) transmitters (from the ACMA database) and proposed indicative locations for SKA array-stations.

Figure 1 – Maps of Australia indicating population density (top), locations of licensed (not necessarily operational) transmitters from the ACMA database (bottom), and proposed indicative locations for SKA array-stations.
Legislation

Describe the way the RQZ is based in local and national laws, how it will be enforced, and the mandates and roles of local and national authorities and the SKA organisation in maintaining and overseeing the RQZ. At what level of government can a decision be made to amend or overturn the legislation governing the RQZ for the SKA? All relevant official documents issued by the site proponent and authorities shall be included in the Annex to the report.

Table 1 below shows the different regulatory instruments and other mechanisms in place or proposed for the Mid West Radio-Quiet Zone. The role of the various legislative and regulatory protections is outlined. Instruments proposed to be presented to the ACMA on 6–7 July for consideration or updating, and the protection they afford, are shown by ‘*’. Mechanisms proposed to be recommended to the relevant Minister by the ACMA after 15 July, and the protection they afford, are shown by ‘#’. The measures are explained in detail in the sections below.

Table 1 – Instruments and measures in place (and proposed to be considered by the ACMA on 6–7 July) for the Mid West Radio-Quiet Zone. The measures are explained in detail in the sections below.

<table>
<thead>
<tr>
<th>Protection mechanism</th>
<th>Zone size</th>
<th>Protection offered</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Australian Government</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiocommunications Act 1992 [2]</td>
<td>As required</td>
<td>Contains mechanisms to create protection from licensed transmissions to protect the radio-quiet of the MRO and SKA (for example, sections 66, 107, 108, 133)</td>
</tr>
<tr>
<td>Embargo 41 (ACMA) * [3] (made for the purposes of the ACMA’s spectrum planning responsibilities under the Radiocommunications Act 1992) (implemented 2005, updated 2007, proposed to be replaced by Band Plan, July 2011)</td>
<td>100 km radius for 230 MHz to 25.25 GHz</td>
<td>Restricted zone</td>
</tr>
<tr>
<td></td>
<td>150 km radius (100 MHz to 230 MHz)</td>
<td>No new apparatus licensed assignments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exceptions considered on case by case basis</td>
</tr>
<tr>
<td>Radiocommunications Assignment Licensing Instruction MS 32 * [4] (made for the purposes of the ACMA’s spectrum planning responsibilities under the Radiocommunications Act 1992) (implemented 2007, proposed to be modified to be consistent with Band Plan, July 2011)</td>
<td>Up to 260 km radius (see Table 2)</td>
<td>From 100 MHz to 25.25 GHz, provides for coordination to ensure no harmful radio-frequency interference on the MRO (Proposed that lower frequency be 70 MHz when updated in July 2011)</td>
</tr>
<tr>
<td>Spectrum Licence controls (under the Radiocommunications Act 1992) #</td>
<td>Up to 160 km radius for 2.3 GHz spectrum licence offerings</td>
<td>Spectrum licence devices not permitted to cause harmful interference</td>
</tr>
<tr>
<td>150 km x 150 km excision from allocations proposed for 700 MHz and 2.5 GHz and future spectrum licences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class licence controls (under the Radiocommunications Act 1992)*</td>
<td>70 km radius for restricted zone</td>
<td>Conditions to ‘not cause interference’ proposed to be placed in licences where required. Many licences already contain provisions to not cause interference 70 MHz to 25.25 GHz</td>
</tr>
<tr>
<td>Mid West Radio-Quiet Zone Frequency Band Plan (under the Radiocommunications Act 1992)* (to be presented to ACMA Authority on 6–7 July 2011)</td>
<td>Radio astronomy service primary within 70 km Coexistence regime to minimise RFI from 70 to 150 km</td>
<td>70 km radius restricted zone</td>
</tr>
<tr>
<td></td>
<td>150 km radius for coordination zone</td>
<td>70 MHz to 25.25 GHz</td>
</tr>
<tr>
<td>MRO Indigenous Land Use Agreement (under the Native Title Act 1993 (Australian Government))</td>
<td>MRO (12,674 hectares)</td>
<td>Wajarri Yamatji people agree to not produce harmful radio frequency interference on MRO Applies to any and all radio-quietness requirements of the MRO</td>
</tr>
<tr>
<td>Protection mechanism</td>
<td>Zone size</td>
<td>Protection offered</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>MRO management (user agreements)</td>
<td>MRO (12,674 hectares)</td>
<td>Users of site need to comply with radio-quiet requirements 70 MHz to 25.25 GHz for licensed and incidental emissions</td>
</tr>
<tr>
<td>Boolardy Station sublease</td>
<td>Boolardy Station pastoral lease (346,000 hectares)</td>
<td>Managers of pastoral station agree to comply with radio-quietness requirements 70 MHz to 25.25 GHz for licensed and incidental emissions</td>
</tr>
<tr>
<td>2011 Memorandum of Understanding and Management Framework [1] (jointly agreed between Australian and Western Australian Governments)</td>
<td>Mid West RQZ, to 260 km radius</td>
<td>Provides a framework for managing RFI issues within the RQZ with commercial interests Applies from 70 MHz to 25.25 GHz</td>
</tr>
<tr>
<td>New Zealand Government</td>
<td>To be determined</td>
<td>A combination of three different types of controls are expected to be used as below</td>
</tr>
</tbody>
</table>

**Land ownership controls**
Agreements with immediate and, if necessary, adjacent landowners to restrict siting of new radio communications services without assessment and approval by SKA manager

**Resource Management Act controls**
Definition of RQZ in Territorial Local Authority (Council) District Plan (under Resource Management Act)

**Radiocommunications Act and Radiocommunications Regulations**
Application of policies to prevent new licences (or to limit potential affect of new licences within RQZ)

**Western Australian Government**

Radio Telescope Mineral Resource Management Area administered by Western Australian Department of Mines and Petroleum

70 km radius circle from MRO centre

All mining activity on granted tenements must have an approved Radio Emissions Management Plan developed in consultation with MRO Entity

Section 19 Reserves under the Mining Act 1978 (Western Australia) [5]

Total area = 1,714,094 hectares

No mining tenements can be granted within the area

**Australian Government legislation**

Australian spectrum planning and allocation is based on requirements set out in the International Telecommunication Union’s (ITU’s) Radio Regulations. Australia is a signatory to the Constitution and Convention of the ITU. Article 4 of the ITU Constitution states that the provisions of the Constitution and the Convention are complemented by those of the Administrative Regulations (including the Radio Regulations) which shall be binding on all Member States. Australia is a member state.

The Australian Radiofrequency Spectrum Plan¹ (the Spectrum Plan) is based on Article 5 of the Radio Regulations. The Spectrum Plan, and a number of other mechanisms for the planning and allocation of spectrum are created under, and/or are guided by, the Radiocommunications Act 1992 (the Act) [2].

The objects of the Act include providing for management of the radiofrequency spectrum in order to maximise the overall public benefit. Section 21 of the Act specifies that the Act applies to a radio emission in connection with making astronomical or meteorological observations in the same way as it applies to a radiocommunication. Radio emissions, as defined in the Act (section 8), include those from astronomical objects. The Act includes the ability to prepare a spectrum

plan and frequency band plans (sections 30 and 32), and introduce measures to provide restrictions (for example, in frequency or geographic area) on how the radio spectrum can be used (for example, sections 66, 107, 108, 133).

The Spectrum Plan (made under section 30 of the Act) divides the Australian radiofrequency spectrum into a number of frequency bands and specifies the general purposes for which the bands may be used. This process is referred to as the allocation of frequency bands to radio communications services. Chapter 2 of the Spectrum Plan (which includes the Table of Frequency Allocations) binds the ACMA in making decisions about use of the radiofrequency spectrum (however there is some flexibility in section 10 of the Spectrum Plan).

Frequency band plans specify the purposes for which bands may be used, and may provide for the reservation of parts of the spectrum for public or community services. Frequency band plans are prepared for parts of the spectrum where there is a clear need arising from government policy initiatives or community demand.

Embargoes and Radiocommunications Assignment Licensing Instructions (RALIs) are planning tools used to facilitate orderly spectrum planning. Officers authorised to assess applications for licences for radio communications equipment are required to consider an Embargo and/or RALI in the course of their work. Embargoes provide notice of the ACMA’s intention to restrict the allocation of new licences in a band, pending its replanning. By putting in place an Embargo, the ACMA informs of its intention not to grant apparatus licences for particular services, frequencies and geographic areas, creating a more ‘stable’ planning environment. Embargoes are used in conjunction with other administrative and planning tools.

A RALI provides guidance for coordination of radio communications and may include criteria in relation to interference protection and may also embargo spectrum. Details such as permitted frequency channelisation, antenna performance characteristics and coordination arrangements are often prescribed in RALIs.

Under sections 46 and 47 of the Radiocommunications Act 1992, generally a person must not operate, or have in his or her possession for the purpose of operation, a radio communications device otherwise than as authorised by a spectrum or apparatus or class licence. Penalties apply.

**Spectrum licences**

Spectrum licences are a tradeable, spectrum access right for a fixed term of up to 15 years. This means that the licence is not limited to any particular technology, system or service. Instead of authorising the use of a specific radio communications device at a fixed site, spectrum licences give licensees the freedom to deploy devices anywhere within their licence area, provided that the devices are compatible with the core conditions of the licence, and the technical framework for the bands and (generally) the devices are registered. Spectrum licences can be suspended or cancelled in certain circumstances (Chapter 3, Part 3.2, Division 3 of the Act). The Minister may, after consultation with the ACMA, give to the ACMA a written notice designating a specified part of the spectrum to be allocated by issuing spectrum licences (section 36 or 153B, the Act).

The ACMA keeps a Register of Radiocommunications Licences (the Register), which (in relation to spectrum licences) includes such details as the ACMA determines, in writing, about radio communications devices that are operated under spectrum licences (as well as other information described in section 144 of the Act). Under section 145 of the Act, the ACMA may refuse to include in the Register details of a radio communications transmitter that is proposed to be operated under a spectrum licence (and thereby effectively refuse to permit its operation) if the ACMA is satisfied that operation of the transmitter could cause an unacceptable level of interference to the operation of other radio communications devices under that or any other spectrum licence, or any other licence. Under subsection 145(4) of the Radiocommunications Act 1992, the ACMA may determine, by written instrument, what are unacceptable levels of interference for the purposes of this section.

**Apparatus licences**

Apparatus licences authorise radio communications devices under specific technical conditions of use such as frequency, power and geographical area. Spectrum use under apparatus licences is typically site-specific, but there are instances of nomadic Australia-wide use and area-wide systems use. Licences are usually issued over the counter at prices set administratively, but may be auctioned when there is competing demand. Apparatus licences are the most
widely used form of licences. Apparatus licences can be issued in most of the usable radiofrequency spectrum (unless specifically cleared for spectrum licensing).

There are currently 21 apparatus licence types with the licence specifying the category of service (including land mobile, fixed services, aircraft, amateur, broadcasting, maritime, defence, space, scientific and Earth station services). However, most apparatus licences are either for land mobile or fixed point-to-point services. Apparatus licences can be issued for periods of up to five years, but licensees typically opt for one-year licences that are renewed annually.

An apparatus licence is subject to conditions specified in the Act, including an obligation for licensees to comply with the Act; a condition that any radio communications device operated under the licence must comply with all the standards applicable to it; conditions specified in the Radiocommunications Licence Conditions (Apparatus Licence) Determination 2003 and any other determinations made by the ACMA under paragraph 107(1)(f) of the Act; conditions specified in the licence; and any further conditions imposed by the ACMA under section 111 of the Act. However, section 107 of the Act does not apply to transmitter licences issued under sections 101A, 101B, 101C, 102, 102A or datacasting transmitter licences. Apparatus licences can be suspended or cancelled in certain circumstances (Chapter 3, Part 3.3, Division 6 of the Radiocommunications Act 1992). Issuance of apparatus licenses can be subject to conditions in RALIs and Embargos as described above.

**Class licences**

Class licences provide general access to spectrum on a shared basis. They create public access where anybody may operate equipment covered by the licence as long as they comply with the conditions as specified. Class licences involve minimal administration as they are not issued to individuals, device registration is not required, and no licence fees are payable. Devices authorised under class licences are typically low power transmitters providing short-range communications that do not require individual frequency coordination for interference management purposes.

A total of 12 class licences are currently in force. Millions of devices are operated under the authorisation of these licences. Examples of such devices are remote control devices, citizen band radio, cordless telephones, mobile phone handsets and ‘spread spectrum’ devices.

The broad categories of communications services that typically operate under the provisions of a class licence include:

- Short range devices
- High-power services operating on standard (shared) frequencies
- Devices associated with an apparatus licensed service.

There are a myriad of short-range devices operating under class licences. This is spectrum sharing on the basis that harmful interference is unlikely, usually due to the low radiated power of these devices. Where interference occurs it is typically intermittent, has limited effects on the service provided, or the source is close and probably owned by the same user. These devices are typically low interference potential devices such as TV remote controls, Bluetooth and Wi-Fi devices, and keyless entry remotes for cars.

**Interference disputes**

The ACMA encourages the users of spectrum to negotiate their mutual use of spectrum. It is desirable for spectrum users, to the extent possible, to self-manage their spectrum-sharing arrangements and in the first instance put in place arrangements to manage interference. With this in mind, if parties use the consultation processes outlined in the MOU and Management Framework, the ACMA would take the outcomes of those processes into account when making its decisions about regulatory matters, including the resolution of interference disputes.

Should ACMA involvement be required to assist in the resolution of interference disputes in the RQZ, the ACMA may invoke conciliation arrangements under Part 4.3 of the Radiocommunications Act 1992. It may, as a result of a conciliation process, issue directions to settle the dispute. Any such decisions would be made in accordance with the ACMA approach to regulatory decision making including principles of administrative law, and in the context of all relevant circumstances surrounding the dispute.
Enforcement

Under the Radiocommunications Act 1992 there are criminal and administrative sanctions for non-compliance with the Act. For example, if a licensee breaches the conditions of the licence, the ACMA has powers to suspend or cancel the licence. Applicable criminal penalties include ‘penalty units’ under the Criminal Code Act 1995 which amount to a monetary penalty and/or imprisonment if pursued through the courts. Alternatively, section 315 of the Act provides, in some circumstances including a breach of licence conditions, for a smaller penalty to be paid instead of prosecution. Fines vary depending on the offence and whether the offence has been committed by an individual or a body corporate.

The ACMA adopts a graduated and strategic risk-based approach to compliance and enforcement. The approach recognises the importance of co-regulation and engaging with the regulated community to obtain, to the greatest extent possible, voluntary compliance. Any action taken is commensurate with the seriousness of the conduct, which includes consideration of the consequences of the conduct and any detriment or damage caused.

If information is laid before a magistrate alleging that an ACMA inspector suspects on reasonable grounds that there may, for example, be anything in respect of which an offence against the Act has been committed, the magistrate may issue a search warrant authorising an ACMA inspector to (in certain circumstances) enter (section 269, the Act), search; and seize anything suspected to be connected with the offence (section 272, the Act).

Mid West Radio-Quiet Zone protection measures implemented under the Radiocommunications Act 1992

The ACMA implemented administrative measures under the Radiocommunications Act 1992 to implement the Mid West Radio-Quiet Zone through RALI MS 32 (issued September 2007) and Embargo 41 (issued April 2005). The current arrangements are outlined below.

RALI MS 32

The control of individually licensed (‘apparatus licensed’) radio transmitters in the Mid West Radio-Quiet Zone is defined in Radiocommunications Assignment and Licensing Instruction (RALI) MS 32, ‘Coordination of Apparatus Licensed Services within the Mid West Radio Quiet Zone’ (24 September 2007) [4]. It describes both ‘restricted’ zones and ‘coordination’ zones.

The restricted zone, which matches the area covered by Embargo 41, is the area within 100 km of the central site (150 km for frequencies from 100 to 230 MHz) where no new apparatus licences are allowed at any emission level, apart from exceptional circumstances which must be approved on a case by case basis. The low population density of the area means that emergency services and normal pastoral activities are still able to continue without threatening the high quality of the Mid West Radio-Quiet Zone.

Beyond the restricted zone, a coordination zone is defined as a function of frequency (from 260 km at the lowest frequencies to 120 km at 2.3–6 GHz). Above 6 GHz, the 100 km restricted zone is sufficient and no coordination zone is required. The control on new apparatus licences in the coordination zone is based on an estimation of power spectral density levels as received at the core of the site, rather than on limits of emission at the source. Power spectral density is evaluated from transmitter characteristics and a three knife edge diffraction model. The threshold values defining acceptable emission levels are defined in Table 2, in the ‘Technical properties’ section, below. MS 32 specifies that a license applicant should consult with CSIRO (as the current MRO Entity) regarding measures, if required, to reduce the RFI impact of their proposed transmission activity to below acceptable threshold levels prior to seeking a licence from the ACMA.

Embargo 41

RALI MS 32 is accompanied by Embargo 41 (issued April 2005; revised November 2005 and April 2007) [3]. The embargo prohibits new assignments to apparatus licensed transmitters, coordinated terrestrial transmitters, and earth stations in the frequency band 100 MHz to 25.25 GHz, within the restricted zone as defined above. Existing licensed services may continue to operate, but proposals to expand or modify existing services are subject to the embargo. As
with the RALI, exceptions may be allowed on a case by case basis after a technical evaluation to determine the impact on the Mid West RQZ.

**Roles in maintaining and overseeing Embargo 41 and RALI MS 32**

As an independent statutory authority, the ACMA acts in accordance with the objects of the *Radiocommunications Act 1992*, principles of administrative law and the ACMA’s Spectrum Management Principles.² The objects of the *Radiocommunications Act 1992* include supporting the communications policy objectives of the Australian Government. In deciding whether to issue an apparatus licence, the ACMA must have regard to all matters that it considers relevant, including the effect on radio communications of the proposed operation of the radio communications devices that would be authorised under the licence (section 100), the effect of the proposed transmission on the Mid West RQZ, and the Government policy regarding the RQZ.

The ACMA has responsibility for maintaining and overseeing the implementation of RALI MS 32 and Embargo 41, including assessing, before issue of a licence, whether the conditions of the RALI and Embargo have been met by the licence applicant. The ACMA has managed the radio-quiet protection measures for radio astronomy in Australia for many years, and has built up a sophisticated knowledge base of radio astronomy requirements. The ACMA’s intention to provide adequate protection to the Mid West Radio-Quiet Zone is clearly articulated in its Five-year Spectrum Outlook 2011–2015³ as well as through the individual measures that have been implemented to protect the Mid West RQZ. The strongly stated Government policy in the 2011 MOU, including the December 2010 intergovernmental communiqué, further clarifies the ACMA’s mandate to effectively protect the Mid West RQZ.

MS 32 specifies that a license applicant should consult with CSIRO (as the current MRO Entity) regarding measures, if required, to reduce the RFI impact of their proposed transmission activity to below acceptable threshold levels. An authorised ACMA assigner often makes the first contact with CSIRO regarding a licence application and then, if required, puts the licence applicant directly in contact with CSIRO. The ACMA has responsibility for deciding whether to grant an apparatus licence, in light of the conditions of the RALI.

**New arrangements for the Mid West Radio-Quiet Zone**

The ACMA is scheduled to consider on 6–7 July 2011 the following proposed arrangements to enhance regulatory protections for radio-quiet in the RQZ. This package of regulatory measures follows public consultation in October 2010, consideration of the diverse comments of stakeholders on the proposal and further targeted consultation on revisions to the package of measures. Stakeholders to the consultation were generally supportive of the SKA project, with concerns focused on ensuring that radio-quiet protections did not unduly restrict other activities in the region. The revised, proposed regulatory framework was developed cognisant of the Memorandum of Understanding and Management Framework agreed between the Australian and Western Australian Governments (see further under ‘Other RQZ Protection Measures’).

While the Authority retains complete discretion regarding whether to make the proposed enhancements to the regulatory regime, the ACMA has previously stated publicly its intent to ensure that the RQZ has appropriate protection to provide world class facilities for radio astronomy.

**Band plan**

The ACMA will consider, on 6–7 July 2011, the introduction of a Mid West RQZ frequency band plan that would replace Embargo 41. The express purpose of the proposed band plan is to establish a radio-quiet zone to prevent harmful interference to radio astronomy services.

Chapter 2 of the *Radiocommunications Act 1992* provides for the ACMA to make plans that govern the allocation of spectrum under the three licensing systems (spectrum, apparatus and class). The Spectrum Plan covers the entire spectrum that is regulated under the *Radiocommunications Act 1992*, while a frequency band plan covers particular parts

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of the spectrum in more detail. A band plan is made by the ACMA to identify the purposes for which a frequency band may be used.

Currently, Embargo 41 and RALI MS 32 are administrative documents that provide certainty and stability for stakeholders by clarifying the policy position of the ACMA with respect to the RQZ. The introduction of a band plan would not substantially change the technical nature of protections that have been in place in the RQZ for several years. The ACMA would continue to consider licence applications in light of the need to protect radio-astronomy services as it has done to date and continue to encourage constructive dialogue between the MRO and other spectrum users in the region to develop mutually acceptable technical solutions. However, the introduction of a band plan would elevate the status of the regulatory arrangements from administrative to legislative.

A band plan is a legislative instrument under Part 2.1 of the Act. It is a disallowable instrument and must therefore be tabled in, and be subject to disallowance by the Australian Parliament. Any variations to band plans are also disallowable instruments. The ACMA can make or alter band plans as required. However, section 33 of the Act requires that if the ACMA proposes to make a new band plan or amend an existing band plan, it must consult for at least one month on its proposal and publish a notice in the Gazette providing details about the consultation process. The ACMA must consider any representations it receives in the consultation and may then alter the draft band plan accordingly before making it.

The proposed band plan, therefore, would provide a greater level of regulatory formality and certainty to arrangements in the RQZ. It outlines the purposes for which spectrum in the frequency range 70 MHz to 25.25 GHz may be used within defined geographic zones:

- **Restricted zone** — Within 70 km of the MRO, radio astronomy services would effectively be the primary services in the zone, with other services deemed to be secondary
- **Coordination zone** — The new outer zone will operate within a radius of 70–150 km from the MRO. Proposed licence applicants must consult with the MRO Entity (currently CSIRO) to determine practical and cost effective technical solutions that minimise RFI to acceptable levels.

RALI MS 32 will continue to operate from 150–260 km radius.

**Roles in maintaining and overseeing implementation of the band plan**

In both zones, the proposed band plan requires applicants for new apparatus licences to consult with the MRO Entity before applying for a licence. The intent of the requirement to consult with the MRO Entity is that the licence applicant and the MRO Entity would come to an agreement about appropriate technical solutions to ensure that radio astronomy services are protected from harmful interference while maximising the opportunities for other spectrum users to use the spectrum in the RQZ. The ACMA would consider all relevant circumstances, including the consultation that has been undertaken, when considering whether to grant an apparatus licence. In the event of a failure to come to an agreement, the ACMA will make a decision in light of all the circumstances.

The Management Framework is recognised by the Australian and Western Australian Governments as the agreed process by which industry applicants consult with the MRO Entity (or any future SKA Entity as described in the Management Framework) as required under current (and future) radio-quiet regulations. While it is open to negotiating parties under the proposed band plan to develop other standing or ad hoc consultation arrangements, the CSIRO (as the MRO Entity) will operate consistently with the Management Framework in performing its functions.

Should the Authority decide to replace the Embargo 41 with the proposed band plan on 6–7 July, the ACMA would also review and make amendments to RALI MS 32 to reflect the changed regulatory arrangements, including the changed geographic area of the inner (restricted) zone and the lowered frequency boundary.

**New licence conditions**

Compliance with conditions imposed on a licence, whether it is an apparatus, class or spectrum licence, is required under the Act. Information about these licence types is available on the ACMA’s website. It is an offence to operate a radio communications device other than in accordance with a licence.
Class licences

In general, class licences are issued on a ‘no interference, no protection’ basis, meaning that it is intended that class-licensed services should not cause interference to other services, nor can they claim protection from interference from other services. Most of the class licences already contain sufficient protections for other radio communications services. However, to ensure that appropriate protections are in place where relevant, the ACMA will consider, on 6–7 July, varying three class licences to ensure that appropriate conditions exist on the operation of services under these class licences within the RQZ to protect the MRO from harmful interference:

- Radiocommunications (Communication with Space Object) Class Licence 1998
- Radiocommunications (Low Interference Potential Devices) Class Licence 2000
- Radiocommunications (Citizen Band Radio Stations) Class Licence 2002

Apparatus licences

Under the proposed enhanced arrangements, potential licensees in the RQZ would be required to consult with the MRO before applying to the ACMA for an apparatus licence. As part of the ACMA’s consideration of whether to issue a licence and the conditions it imposes on that licence, the ACMA expects that relevant technical arrangements negotiated and agreed between the licence applicant and the MRO will be applied to the apparatus licence as a licence condition.

Spectrum licences

To continue to protect the RQZ and support the SKA bid, spectrum licences granted in areas in and around the RQZ will be subject to a licence condition designed to prevent harmful interference to radio-astronomy services at the site. It is intended that these conditions will generally reflect the terms of RALI MS 32, as amended.

The ACMA also intends to exclude a 150 km by 150 km area around the proposed core SKA site at the centre of the RQZ from all new spectrum licences that are granted on a nationwide basis (see Figure 2). This will preserve options surrounding apparatus licensing of radio-astronomy receivers at the centre of the site. This approach is reflected in the current consultation processes around the introduction of spectrum licensing in the 700 MHz and 2.5 GHz bands.

Roles in maintaining and overseeing implementation of the licence controls

The ACMA is responsible for decisions regarding issuance of licences, including any geographic constraints. The ACMA is responsible for managing disputes regarding interference between radio communications services.

New Zealand Government legislation

In New Zealand, three types of controls are anticipated, depending on the location of the site and RQZ requirements.

These are landowner agreements, activity restrictions in District Plans established under the Resource Management Act and specific controls under licences granted under the Radiocommunications Act and Regulations.

District Plans allow designation of geographic areas where land use activities of an undesired type are either prohibited or controlled by a specified approval process. Such land use activities can include establishment of radio transmitting facilities.

The radiofrequency spectrum is managed by the Ministry of Economic Development (MED) through the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001.

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5 Available at: http://www.comlaw.gov.au/Details/F2009C00545
6 Available at: http://www.comlaw.gov.au/Details/F2011C00307
7 Available at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_312542
New Zealand MED uses three types of licences: radio licences, spectrum licences, and general user licences, which correspond to the apparatus, spectrum and class licences, respectively, used in Australia. New Zealand remote array-stations will be protected under the New Zealand legislative framework as appropriate, once array-station locations are confirmed. Where Management Rights are recorded there is also an ability to provide licences to ‘have no harmful interference’ to protect receivers. Such licences need to be taken into account when any party creates new transmitting licences.

**Western Australian Government legislation**

The State Government radio-quiet protection for the Mid West Radio-Quiet Zone is provided by measures under the administration of the *Mining Act 1978* (Western Australia).

**Radio telescope mineral resource management area**

The Government of Western Australia has created a Radio Telescope Mineral Resource Management Area applicable to a 70 km radius centred on the MRO (see Figure 3), within which new tenements will have conditions requiring all mining and exploration activities to be conducted according to a Radio Emissions Management Plan (REMP).

The REMP requires that, prior to commencement of any exploration or mining activity, an assessment of its potential radiofrequency interference at the centre of the MRO is to be completed. If any interference is potentially above the levels to protect the radio-quietness, the activities and/or equipment will need to be modified to reduce interference to acceptable levels. The operator will be required to commit to compliance with the REMP and any breaches of such compliance could result in penalties being imposed including forfeiture of the tenement. The Radio Telescope Mineral Resource Management Area has been in operation since 2008. Detailed guidelines, drawing on experience from the development of the first few REMPs, are currently being drafted by the Western Australian Department of Mines and Petroleum, in collaboration with CSIRO, and can be provided for review at a later date.

**Section 19 exemption area protection**

The section 19 exemptions under the *Mining Act 1978* (Western Australia) prevent the granting of exploration and mining titles in the areas exempted. These areas cover the proposed central site and the areas indicated in Figure 3.

**Roles in maintaining and overseeing the Western Australian Government controls**

The Director-General of the Western Australian Government Department of Mines and Petroleum is responsible for overseeing the approval of Radio Emission Management Plans. The MRO Entity, currently CSIRO, provides advice to the Department of Mines and Petroleum and to companies wishing to develop Radio Emission Management Plans regarding the radio-quiet implications of the Management Plans.

Section 19 exemption zones under the *Mining Act 1978* are approved by the relevant Western Australian Minister and are administered by the Western Australian Department of Mines and Petroleum.
This map shows the zone sizes for the Australian Government Radio-quiet Zone controls, existing and due for consideration by the ACMA on 6–7 July, and in relation to the spectrum licence excision zone by the Minister after 15 July. The indicative configuration is overlaid for context. Town populations are indicated.

Figure 2 – A map of the Mid West region of Western Australia showing the Australian Government Radio-Quiet Zone.
This map shows the zone sizes for the Western Australian State Government Radio-quiet Zone controls provided under the Mining Act 1978 and the size of Boolardy Station pastoral lease, for which CSIRO is the current leaseholder. Proposed rail infrastructure route and town populations are also indicated.

Figure 3 – A map of the Mid West region of Western Australia showing the Western Australian State Government Radio-Quiet Zone.
Other RQZ protection measures

Memorandum of Understanding and Management Framework

A Memorandum of Understanding (MOU) on radio-quiet matters relating to the MRO and SKA has been signed between the Australian and Western Australian Governments. This includes a Management Framework [1]. Together the documents agree on the roles and responsibilities of parties, and mechanisms for developing agreement on radio-quiet issues within the Mid West Radio-Quiet Zone. This provides an agreed process for enabling coexistence of radio astronomy and industry, and non-regulatory processes within which government, industry and CSIRO will work.

MRO self-compliance standards

CSIRO is managing the MRO, an area of land of over 12,674 hectares, under lease from the Government of Western Australia. CSIRO is implementing strict radio-quiet controls to ensure any RF emissions by astronomers and other visitors to the site are maintained at levels below the relevant ITU thresholds [6]. Compliance assures that ITU standards of radio-quiet are met. All equipment that is planned to be used and left on site needs to be tested prior to deployment and a spectral fingerprint given to the MRO Manager. This not only assures compliance, but in the event of faults developing, will assist in tracking down the problems.

Signage on roads and information to pastoralists

Murchison Shire Council (MSC) erected signs in support of the RQZ in 2008. CSIRO staff regularly attend Council meetings in order to keep pastoralists informed of radio-quiet issues. MSC is responsible for road signage. Pastoral operations are subject to the ACMA regulatory framework.

Agreements with the Wajarri Yamatji people

The access protocol that forms part of the Indigenous Land Use Agreement (ILUA) for the MRO specifies that the Wajarri Yamatji people, in their use of the land ‘comply with any and all radio-quietness requirements of the MRO’. An ILUA Liaison Committee, including members of the Wajarri Yamatji community and CSIRO, meets regularly to discuss matters including community education on radio-quiet. The Australian Government Office of Native Title is responsible for administration of ILUAs.

At what level of Government can a decision be made to amend or overturn the legislation governing the RQZ?

The Radiocommunications Act 1992 provides the legislative backbone for the Mid West RQZ and could only be amended or overturned though a motion to the full Parliament of the Australian Government.

A frequency band plan is a legislative instrument under Part 2.1 of the Radiocommunications Act 1992. It is a disallowable instrument and must therefore be tabled in, and be subject to disallowance by the Australian Parliament. Any variations to band plans are also disallowable instruments. The ACMA can make or alter frequency band plans as required. However, section 33 of the Radiocommunications Act 1992 requires that if the ACMA proposes to make a new band plan or amend an existing band plan, it must consult for at least one month on its proposal and publish a notice in the Gazette providing details about the consultation process. The ACMA must consider any representations it receives in the consultation and may then alter the draft band plan accordingly before making it.

Embargo 41 and RALI MS 32 are administrative documents that provide certainty and stability for stakeholders by clarifying the policy position of the ACMA with respect to the RQZ. They may be amended as required by senior ACMA staff. The ACMA follows best practice regulation processes in respect of any amendments including consultation with stakeholders as appropriate.

Section 19 exemption zones under the Mining Act 1978 are approved by the relevant Western Australian Minister.

The self-compliance rules on the MRO are currently built into site service agreements between CSIRO and the user, under which users are permitted access to the site.
Timelines

The timeline for establishing the RQZ, identification of phases if applicable, and a summary of items remaining to be done to establish the RQZ in practice. Note that the target lifetime of the SKA facility and the associated RQZ is 50 years from commencement of operation.

The establishment of the Mid West Radio-Quiet Zone involves three phases.

Phase 1: Establishment of a robust legislative framework enabling creation of the Radio-Quiet Zone (1999–2001)

A robust legislative framework is provided in Australia for licensed transmissions through the Radiocommunications Act 1992. Further protection against incidental emissions from mining is provided through processes under the Mining Act 1978 (Western Australia), within the Radio Telescope Mineral Resource Management Area. Further information on these legislative instruments is presented above in the section ‘Legislation’.

The Radiocommunications Act 1992 contains the powers required to create a Radio-quiet Zone to protect Australia’s candidate SKA site from licensed transmissions, including powers to restrict radio emissions to required levels in geographic regions. This has enabled a coherent approach to the creation of the Mid West Radio-Quiet Zone using a well-established legislative framework, together with an experienced regulator. Similar national legislation exists in New Zealand for regulation of spectrum.

At a State level, the Western Australian Government recognised the need to effectively manage the coexistence of mining activities and radio astronomy. The Western Australian Mining Act 1978 provides the powers to place appropriate conditions and restrictions on mining activity when granting tenements.

Phase 2: Initial protection for the Mid West RQZ (2001–2011)

Government action

Since 2001, both the Australian and Western Australian governments have introduced and enforced radio-quiet protections over the Mid West region of Western Australia in the vicinity of Australia’s candidate SKA site.

In 2001, the then Western Australian Minister for State Development placed exemptions over areas of land at the core SKA site and surrounding areas under section 19 of the Mining Act 1978 (Western Australia). The exemptions prevent the granting of exploration and mining titles within the S19/157 and S19/158 zones [5]. The areas were identified after detailed investigation by the Geological Survey of Western Australia, in collaboration with CSIRO, and have been selected because of the then perceived low mineral and petroleum prospectivity of the areas (see Figure 3). In addition, the Government of Western Australia created, in 2008, a Radio Telescope Mineral Resource Management Area (of 70 km radius) surrounding the MRO, to ensure that any mining activity within the area is conducted in a radio-quiet manner (see Figure 3).

The protection measures implemented by the ACMA include Embargo 41 (established April 2005) and Radiocommunications Assignment Licensing Instruction MS 32 (established September 2007).

Both CSIRO and the ACMA have worked with industry groups (including mining companies) and individuals on affected license applications since 2005 and have begun to establish a database of technical guidelines to help license applicants understand the radio-quiet regime and develop technical solutions that minimise any radio-frequency impact of their activities on the MRO. This will streamline future planning and processing of requests for advice from stakeholders within the Mid West Radio-Quiet Zone. Technical Advisory Guidelines also assist mining parties to develop Radio Emission Management Plans within the Radio Telescope Mineral Resource Management Area to control both licensed and incidental emissions.
The work with stakeholders in implementation and enforcement of regulations prior to SKA site choice has been undertaken for a number of reasons:

- The Radiocommunications Act 1992 and Mining Act 1978 legislation provide the framework, but for the SKA to become a valued part of a community and a ‘good neighbour’ over its lifetime requires development of consultation processes between stakeholders in the interpretation and implementation of radio-quiet controls. The MOU and Management Framework provides for such processes.
- Early regulations in place prevent the establishment of activities that may later prove to be incompatible with radio astronomy.
- The establishment of a radio-quiet regime demonstrates to the SKA community the power and ability in practice to implement such regulations. Without evidence of effective implementation, the SKA project would face significant risk that any legislative framework would not be converted into a workable implementation regime with the cooperation of surrounding stakeholders.

**Initial site selection for the Mid West Radio-Quiet Zone**

The Australian site selection process has identified a site remote from centres of population. There have also been collaborative efforts to ensure coexistence with mining interests in Western Australia. This led to the relocation, in 2007, of the core site from Mileura to Boolardy and diversion of proposed mining rail infrastructure to ensure a minimum 70 km separation from the rail line and the MRO. The diversion of the proposed rail infrastructure corridor is strong evidence of the willingness of industry and government to achieve coexistence of mining activity and radio astronomy and support the development of an effective radio-quiet zone.

**Ownership control of immediate activity**

CSIRO, using funds provided by the Government of Western Australia, acquired the 346,000 hectare (855,000 acres) Boolardy Station pastoral lease in mid 2009. The MRO is sited within the Boolardy Station pastoral lease. This enables CSIRO to effectively control the radio-quiet of the Boolardy Station pastoral activity.

The 12,674 hectares of land for the MRO was excised from the Boolardy Station pastoral lease and leased to CSIRO by the Western Australian Government in November 2009. CSIRO manages the MRO as an international facility for radio astronomy, including enforcing stringent radio-quietness standards on operational activities on site. An Indigenous Land Use Agreement was signed with the Native Title Claimants of the area of, and surrounding, the MRO in July 2009 and registered with the National Native Title Tribunal in November 2009. In an Access Protocol that forms part of the Indigenous Land Use Agreement, the Wajarri Yamatji people agree to respect the radio-quiet requirements of the MRO.

**Phase 3: Creating a collaborative implementation regime (2011 onwards)**

In 2007, the Australian Government and the Western Australian Government signed an intergovernmental Memorandum of Understanding (2007 MOU) in relation to Australia’s bid for the SKA project. The MOU covered a broad range of issues in relation to the project to ensure that the two governments were aligned in their approaches. The MOU confirmed that a government priority is to maintain the quality of the candidate SKA site, especially its radio-quietness. The governments agreed to establish and safeguard a radio-quiet zone in the Mid West of Western Australia, with appropriate development and other controls.

In December 2010, the commitment to implement effective controls to protect radio-quiet, and facilitate coexistence with surrounding activity, was confirmed in a joint communiqué issued by the Australian and Western Australian governments.

In June 2011, the Australian and Western Australian governments signed an additional intergovernmental radio-quiet specific Memorandum of Understanding (2011 MOU) [1], supported by a Management Framework, providing the policy context for coexistence between radio astronomy and adjacent industry in the Mid West. This has been the culmination of work throughout 2010 and 2011 between the governments, the ACMA, CSIRO, the local community and mining stakeholders in the Mid West region of Western Australia.
The ACMA has developed a new regulatory framework, to be considered for introduction and implementation on 6–7 July 2011. The proposed regulatory framework was developed cognisant of the 2011 MOU and Management Framework. The technical specifications for the new regulatory framework are provided in the section ‘Technical properties’ below, and further details are provided in the section ‘Legislation’ above.

In addition, the Government of Western Australia has continued to provide assistance, for example, through strengthening the protection under the section 19 zones of the *Mining Act 1978* by increasing the size of the zone when it has become able to do so. Some examples of these increases include:

- November 2005: S19/158 was extended by 448 km²
- January 2007: S19/157 and S19/158 were joined and S19/158 was extended 40 km to the west. This increased the exemption zones by 362 km²
- May 2007: An additional 592 km² was added to the west and northwest of S19/158 when tenements applications were withdrawn
- February 2011: S19/158 extended to new tenement boundaries to the northwest, providing an additional 27 km² of protection.

The zones provide one of a number of potential mechanisms for managing remote array-stations as their locations are confirmed.

**Technical properties**

A full multi-dimensional matrix of frequency range, maximum allowed emission levels as a function of frequency, and, if applicable, location within the RQZ. Note exceptions if applicable.

**Matrix**

The new regulatory framework, due to be considered by the ACMA on 6–7 July 2011, builds on a strong existing framework of radio-quiet protection in the Mid West region of Western Australia. The defined maximum emission levels for the Mid West Radio-Quiet Zone are currently as defined in the Radiocommunications Assignment Licensing Instruction MS 32 (RALI MS 32) (see Table 2), and are based on recommendations from SKA Memo 73. The new proposed framework extends the lower frequency from 100 MHz to 70 MHz, as now requested for the SKA, and establishes, in a legislative basis, radio astronomy as the primary user of spectrum within 70 km radius of the MRO. The levels for the extension to 70 MHz will not be available until after the ACMA has considered the new measures on 6–7 July 2011. The new regulatory framework is expected to propose that RALI MS 32 be modified to adopt the extended levels, as will the other measures that protect the Mid West RQZ. Table 2 (below) summarises the restricted and coordination zones for the Mid West Radio-Quiet Zone along with the power spectral density limit for the coordination zone, as a function of frequency. It should be noted that the thresholds in Table 2 refer to power spectral density levels as received at the core of the site, rather than the level of emission at a source. Within the restricted zone, no new licence assignments are allowed except on a case by case consideration basis. Consistent with the Management Framework, in the coordination zone, the applicant must consult with the MRO Entity (currently CSIRO) to determine technical solutions that minimise RFI to acceptable levels. Acceptable levels can include emissions above the RALI MS32 thresholds (for example, through spectrum coordination) if agreed under the Management Framework.

<table>
<thead>
<tr>
<th>Frequency range (MHz)</th>
<th>Restricted Zone radius (km)</th>
<th>Coordination Zone radius (km)</th>
<th>Threshold (dBm/Hz)</th>
</tr>
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<tbody>
<tr>
<td>100–230</td>
<td>150</td>
<td>260</td>
<td>-214</td>
</tr>
<tr>
<td>230–400</td>
<td>100</td>
<td>180</td>
<td>-222</td>
</tr>
<tr>
<td>400–520</td>
<td>100</td>
<td>165</td>
<td>-224</td>
</tr>
<tr>
<td>520–820</td>
<td>100</td>
<td>190</td>
<td>-224</td>
</tr>
<tr>
<td>Frequency range (MHz)</td>
<td>Restricted Zone radius (km)</td>
<td>Coordination Zone radius (km)</td>
<td>Threshold (dBm/Hz)</td>
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<td>-------------------------------</td>
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</tr>
<tr>
<td>820–1,000</td>
<td>100</td>
<td>145</td>
<td>-228</td>
</tr>
<tr>
<td>1,000–2,300</td>
<td>100</td>
<td>140</td>
<td>-230</td>
</tr>
<tr>
<td>2,300–6,000</td>
<td>100</td>
<td>120</td>
<td>-232</td>
</tr>
<tr>
<td>6,000–10,000</td>
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</tr>
<tr>
<td>10,000–25,250</td>
<td>100</td>
<td>Not required</td>
<td>-236</td>
</tr>
</tbody>
</table>

Figures 2 and 3 illustrate the various regulatory instruments and zone sizes. Table 1 indicates frequency coverage and zone size.

**Protection for remote array-station sites**

The configuration is most tightly constrained by the science requirements within the 180 km radius intermediate zone. As required by the SKA Program Development Office (SPDO), the Australian site team has applied internationally developed electromagnetic interference (EMI) masks appropriate for incidental emissions to ensure that, in this region, array-stations are sited in areas of acceptably low risk from incidental emissions.

All array-stations (and the core site) in an Australia–New Zealand siting of the SKA will be sited outside appropriate EMI buffer zones from existing infrastructure. In addition, CSIRO will continue to work with the Western Australian Government to identify possible future areas of high mineral and petroleum prospectivity, so that these can be avoided in siting array-stations.

Given that the internationally determined buffer zone required around typical farmsteads is of the order of 10 km radius in the intermediate region, only areas with extremely low population density can be compliant with the SKA EMI mask in the region of the core. Siting of the core and intermediate array-stations in the Mid West of Western Australia, in an environment of very low population density, is effective risk mitigation to ensure that the SKA can coexist with its ‘spectrum neighbours’ and reach its scientific potential over its entire lifetime.

In addition, SPDO has defined acceptable threshold limits to ensure that transmitters do not ‘saturate’ receivers for SKA receptors. The Australia–New Zealand team has created appropriate buffer zone maps around relevant transmitters and all Australian and New Zealand sites for array-stations (and, of course, the core) will be located outside buffer zone areas for acceptable receiver threshold levels. It should be noted that the receiver threshold buffer zone size is independent of distance from the core and is often the most stringent radio-quietness constraint for remote array-stations.

The work to confirm sites for the remote array-stations that are compatible with radio-quiet requirements and to provide adequate future protection for these sites will proceed once the SKA requirements are determined and remote array-station numbers can be confirmed. RQZ protection will use lessons learnt from establishment of the core site. It is important to note that most array-stations in Australia are sited in the very sparsely populated interior, where there is lower risk of radio-quiet compliance issues. Potential array-station sites in New Zealand will also be placed at locations fully compliant with the radio-quiet requirements.
Spectrum management

The ‘quality’ of the RFI environment generally, and of the RQZ for the SKA specifically, is influenced both in critical and in subtle ways by the spectrum management regimes in place for the host country and any other countries where remote stations of SKA2 are situated. Please provide information on the following topics:

a) Organisation of spectrum management by applicable administrations. Describe the way spectrum management is handled in the applicable country(ies).

In Australia, the ACMA is responsible for the regulation of radio communications as well as broadcasting, the internet, and telecommunications. The ACMA lists ‘managing access to the radiofrequency spectrum’ as one of their four main responsibilities. The ACMA is a statutory authority within the Australian Government portfolio overseen by the Minister for Broadband, Communications and the Digital Economy. The ACMA acts in accordance with the objects of the Radiocommunications Act 1992, principles of administrative law and the ACMA’s Spectrum Management Principles.

The Australian legislation defining the radio spectrum management is contained in the Radiocommunications Act 1992 and the Broadcasting Services Act 1992. The ACMA, as regulator of the radio spectrum in Australia, has been involved in the Mid West RQZ planning for the Australian SKA site since its inception in the 1990s. It has been supportive and proactive in designing standards and regulatory and legislative measures to protect the RQZ, and has worked with CSIRO and other organisations in both the technical and the regulatory aspects. In public forums, it has made strong commitments to the protection of the SKA project and the RQZ. Under the Radiocommunications Act 1992, all radiocommunication transmitters in Australia are required to be licensed. Three types of licences are issued by the ACMA, as outlined in the section ‘Legislation’ above.

In addition to management of licensed spectrum, successful maintenance of the Mid West Radio-Quiet Zone for the SKA requires effective control of incidental emissions from mining and exploration activity within 70 km of the MRO. Management of the generation of incidental emissions from mining and exploration within 70 km of the site is under the control of the Western Australian Government Department of Mines and Petroleum through the Radio Telescope Mineral Resource Management Area.

The Australian Government will consider further regulatory protection if necessary, including legislation to protect against incidental emissions.

In New Zealand, the radiofrequency spectrum is managed by the Ministry of Economic Development (MED) through the Radiocommunications Act 1989 and the Radiocommunications Regulations 2001. New Zealand MED uses three types of licences: radio licences, spectrum licences, and general user licences, which correspond to the apparatus, spectrum and class licences, respectively, used in Australia. New Zealand remote array-stations will be protected under the New Zealand legislative framework as appropriate.

b) Empowerment of the SKA. Describe how, and to what degree, the SKA organisation will be able to manage the quality of the RQZ in case of violations, or if there is pressure from other parties to compromise that quality in any way.

Earlier sections of this report have outlined the various measures thus far implemented to protect the radio-quietness of the Mid West Radio-Quiet Zone. The regulatory measures refer to expert advice provided to the regulatory authorities by the MRO Entity, currently CSIRO. CSIRO has successfully assisted in radio-quiet zone processes for radio astronomy in Australia and New Zealand.
Australia since the establishment of the Parkes radio telescope in the 1960s. CSIRO has indicated its willingness to continue to work closely with the ACMA and the Government of Western Australia regarding the Mid West Radio-Quiet Zone.

Whether CSIRO continues with the roles assigned to it currently, or these roles are transferred to an SKA Entity if the SKA is hosted in Australia, would be the subject of negotiations over hosting arrangements. It is the intention of the governments that spectrum management, including the Mid West RQZ, will remain under national management and that the Management Framework (and any agreements between the MRO Entity and industry reached under, or relating to, the Framework) would apply to the SKA Entity.

One of the legislative objects under which the ACMA manages spectrum is to support Government communications policy. It is required to take all relevant factors into account in its administration of spectrum. The government’s commitment to adequately protect the Mid West RQZ is articulated in the 2011 MOU.

Australia has a strong tradition of support for radio astronomy, and a well organised astronomy community. Astronomy is one of the three ‘super sciences’ identified by the Government as deserving of priority support in Australia. The tradition and expertise in Australia in support for radio astronomy and especially in spectrum management in support of radio-quietness for radio astronomy, is important in mitigating the long term risk for the SKA. This well established and robust tradition means that the SKA, through the Australian astronomy community as well as directly, will have an effective voice to work to ensure the continued protection of the RQZ.

c) Specific measures of radio interference protection. Describe any specific, dedicated measures already taken or considered to improve the RFI/EMI environment both within the RQZ and outside.

As noted in the sections above, a number of measures are already in place to provide protection from RFI. The most substantial of these is the new regulatory framework which will be considered by the ACMA on 6–7 July. This framework will update the Spectrum Plan, introduce a new Band Plan for the Mid West Region, provide new licence conditions for Spectrum and Class Licences and update RALI MS 32 and Embargo 41. This will ensure consistency with the 2011 MOU and Management Framework, and consistency between Australian and Western Australian regulatory arrangements, creating a robust regulatory framework for radio-quiet into the future.

As well as the regulations that have been implemented, CSIRO, in collaboration with governments and industry stakeholders, is undertaking a number of other measures to ensure the balanced maintenance of radio-quiet on the MRO:

- Coordination of assignment of FM frequency bands and other radio communications signals between stakeholders in the region. This is possible because of the distance between towns and the sparse population between towns, which results in only low power transmitters being deployed in the area, which will not interfere with each other
- Development of Technical Advisory Guidelines for mining companies and pastoralists detailing acceptable equipment to use within the Mid West RQZ
- Development of technical solutions in collaboration with particular companies to ensure that any radio emissions do not cause unacceptable RFI
- Careful placement of array-stations to ensure full compliance with EMI and receiver threshold buffer zone masks
- Creation of no-fly zones over the MRO, as already exist over CSIRO’s radio astronomy national facilities on the east coast of Australia
- Community and stakeholder education, including with Murchison Shire Council and pastoral stakeholders, and other surrounding Councils
- Managing the Boolardy Station pastoral activity and working with other pastoralists to ensure radio-quiet compliant operations
- Road signage for the 4–5 vehicles per day that use the roads within 50 km of the RQZ.
d) Remote stations. Describe plans and prospects for the establishment of radio protection zones around remote stations (size, frequencies, etc).

As described above, the ACMA has indicated its willingness to consider introducing required measures to protect the sites of remote array-stations, on the understanding that remote array-stations will be sited initially in adequately radio-quiet areas.

The remote array-station locations in Australia and New Zealand will be selected to be compliant with both EMI and receiver threshold buffer zones.

The remote array-stations in an Australian SKA realisation will be sited in the Australian interior, primarily along the AARNet national research optical fibre backbone. This enables the radio-quiet standards required for the remote array-stations to be achieved in an affordable and scientifically optimised implementation.

Work to provide the required protection for remote array-stations in Australia and New Zealand will proceed once the SKA requirements are better understood and remote array-station sites can be confirmed, and will use lessons learnt from the protection of the core site.

Spectrum usage

A Radio Quiet Zone also concerns a localised management of the radio interference environment. Influences from remote areas will be felt inside the RQZ. Therefore current and future spectrum usage is a very relevant aspect of the environment for the SKA. The RFI measurement campaign carried out at the core locations, roughly in the middle of the RQZs, has provided a snapshot of that environment in 2010. An assessment of future trends in spectrum usage is therefore important.

Describe the local and national plans for licensed and unlicensed use of the spectrum in terms of foreseeable introduction of new services or devices, termination of services. The introduction of digital, and phasing out of analogue, broadcasting is an example.

In Australia, the ACMA continually monitors future spectrum developments. The ACMA has identified a number of planned changes in radio spectrum usage over the coming years. These are described in comprehensive detail in the Five-year Spectrum Outlook, issued annually. The open and transparent planning processes adopted by the ACMA not only assist industry in Australia, but are very useful for the SKA community to develop a comprehensive picture of future spectrum trends in Australia.

The following issues from the 2011–2015 Spectrum Outlook are relevant to the protection of the RQZ:

- Support for radio astronomy
  
  From section 5.8.2: 2011–2015

  “The Australian proposed SKA site is in a remote area which provides a naturally radio-quiet environment. To further support Australia’s bid, a radio-quiet zone (RQZ) has been established in Western Australia. The ACMA consulted on the proposed Radiocommunications (Mid West Radio-Quiet Zone) Frequency Band Plan in 2010. The intended purpose of the proposed band plan is to protect the operation of radio astronomy services within the identified geographic area.

  The proposed arrangements allow for the operation of other services in the area, provided the services are able to coexist and do not cause interference to the SKA. The CSIRO has developed consultation mechanisms and


processes that interested applicants can use to approach the CSIRO with their intended applications, before submission with the ACMA.

Within the RQZ, the Murchison Radio-astronomy Observatory is currently the location of the Australian SKA Pathfinder (ASKAP) radio telescope, the Murchison Widefield Array (MWA) radio telescope being constructed by a consortium of national and international institutions and other radio astronomy projects. These will help demonstrate the suitability of the proposed SKA site in Western Australia. The introduction of the SKA, if hosted by Australia, is the most significant foreseeable change in radio astronomy and spectrum requirements for the RAS."

From section 5.8.4: Beyond 2015

"The SKA is expected to become operational between 2015 and 2020, although at this stage it is not known whether the SKA will be built in Australia or South Africa. In any case, the radio-quiet environment established by the development of the RQZ in Australia will ensure that it continues to remain an appropriate place for the deployment and future development of radio astronomy activities."

- Digital television transition

Australia is currently in transition to digital television. Digital broadcasting is now available across Australia, and the process of shutting down the analog transmission has already commenced in some regional centres. By 31 December 2013, all analog television transmission will have ended. Once the analog stations have been cleared, the digital channels will be restacked into adjacent frequency channels, with five sets of six channels each available for different areas. In general, six VHF channels will be used in major cities, and six UHF channels will be used in regional and remote areas. However, the ACMA have indicated a willingness to work with the SKA Entity to determine whether VHF or UHF would be preferable for towns in remote Western Australia within the RQZ.

New Zealand is also in transition to digital television with a Digital Switch Over date having been confirmed for 30 November 2013. Digital services in the UHF band will have a population coverage of approximately 86.5 percent (analog is presently up to 99.95 percent) with satellite services available nationwide. Currently three digital licence networks are in use, with several other networks anticipated as television services develop. These will all be within the UHF Band IV and V.

VHF spectrum (Band III) will be unused after Digital Switch Over until further policy decisions are made by Government.

- Digital dividend and mobile broadband

The digital television transition will make more efficient use of the spectrum, and consequently, the Australian Government has announced that 126 MHz (694–820 MHz) will be re-allocated for other applications. While the decision is yet to be finalised, it is expected that two bands of 45 MHz each (703–748 and 758–803 MHz) will be auctioned as spectrum licences. It is expected that these licences will support mobile broadband services. This aligns with regional plans for this frequency band, and will leave a mid-band gap of 10 MHz and guard bands (694–703 and 803–806 MHz).

The band 806–820 MHz is currently the subject of a discussion paper; this could be used to extend the 900 MHz mobile telephony spectrum, identified for public protection and disaster relief services, or be used for some other purpose.

The ACMA has estimated that mobile broadband services in Australia will need an additional 300 MHz by 2020, and is considering additional frequency bands to provide this capacity. Two portions of the 2.5 GHz band (2500–2570 MHz and 2620–2690 MHz) are being considered for spectrum licences to facilitate new uses such as wireless access services. There is also a review of the 900 MHz band to improve efficiency and facilitate new technologies. It is expected that this review will, among other things, facilitate the changeover from second-generation mobile telephony to third- or fourth-generation mobile communications.
It is proposed that spectrum licences in areas around the RQZ will be subject to a licence condition designed to prevent harmful interference to radio astronomy services at the site, as discussed in earlier sections. It is intended that these conditions will also apply to any future spectrum licences in the SKA frequency range.

New Zealand will be allocating spectrum in the 700–800 MHz range in the next few years and it is expected to be deployed for mobile broadband purposes.

- National Broadband Network

The National Broadband Network (NBN) is an Australian Government initiative to deliver high capacity broadband services to all Australians. The NBN will provide optical fibre connectivity to at least 93 percent of Australian homes, schools and businesses. The remaining premises will be connected via 4G wireless access and Ka band satellite services. As well as driving innovative digital services for the whole country, the NBN will provide a new, world class optical fibre network across the country, and in some areas can relieve radio frequency spectrum pressure by providing a fibre alternative to some fixed wireless applications.

The ACMA also envisions that, as the demand for mobile broadband grows, a major component of the solution will be 60 GHz wireless femtocells within homes and businesses, connected to an indoor station which is then connected to the fibre network.

In the remote locations of SKA array-stations and the core, it is likely that service will be provided via satellite. It is possible that provision of SKA optic-fibre may facilitate nearby communities moving to optical fibre provision.

New Zealand is deploying a fibre-based Ultra Fast Broadband network in urban areas. In rural areas a Rural Broadband Initiative will use fibre to link to new and additional cellular sites with deployment of 900 MHz cellular services (wideband CDMA) to provide 3G voice and data services. In due course use of 700 MHz services for 4G will be deployed.

- 400 MHz review

The 403–520 MHz band (the 400 MHz band) is one of the most heavily used parts of the radiofrequency spectrum. It is used by industry to support a range of transport and dispatch activities and by government to deliver vital services to the public, including emergency services such as police, fire and ambulance. The band is congested in urban areas but is widely used in regional and remote areas of Australia as well.

The ACMA has been reviewing the arrangements for this band since early 2008, to support harmonisation of government services and relieve congestion, particularly in densely populated areas. These new arrangements provide harmonised spectrum in 403–470 MHz to support interoperable radio communications between national security, law enforcement and emergency services. There are also improvements to underlying technical arrangements in the entire 400 MHz band, including a reduction in channel bandwidths and an increase in the technology options supported in the band. Changing the frequency duplex arrangements in the 450–470 MHz band and changing the channelling scheme opens up options for new technologies.

The ACMA is also reforming arrangements for the Citizen Band Radio Service in the UHF band. This primarily involves increasing the number of channels available through a reduction in channel bandwidth. It is expected that new arrangements will be in place across Australia by the end of 2018, and by 2015 in high- and medium-density areas.

**Relevant activities**

Describe the way the site proponent interacts with spectrum management bodies, such as ITU, WP7D, CRAF, IUCAF, RAFCAP, other.

CSIRO, as a key stakeholder in the Australia–New Zealand SKA bid, has been active in ITU for several decades, particularly in the work of ITU-R Study Group 7 (Science Services), Working Party 7D (Radioastronomy) and Study Group 3 (Radiowave Propagation). Dr Tasso Tzioumis of CSIRO is currently the Chairman of ITU-R WP 7D (since
September 2009), responsible for leading ITU activities in spectrum management issues for radio astronomy. Mr Richard Jacobsen of CSIRO was the rapporteur to WRC-97 and WRC-2000 for the chapter on science services, including radio astronomy topics, and in this role was responsible for achieving consensus among numerous stakeholders on the science service material in the Conference Preparatory Meeting (CPM) report. Mr Jacobsen was also Vice-Chairman of ITU-R Study Group 7 from 2000 to 2007. Mrs Carol Wilson of CSIRO has been Chairman of ITU-R Working Party 3M (Propagation prediction for fixed and satellite services and interference analysis) since 2002 and Vice-Chairman of Study Group 3 since 2007. Mrs Wilson is also active in WP 7D and is the rapporteur for developing a report on radio-quiet zones.

Dr Tzioumis, Mr Jacobsen and Mrs Wilson have also been active participants in ITU-R World Radiocommunications Conferences over the past decade. They are also very active in national spectrum management activities including the development of the Australian position to international meetings. In all these roles, Australia and CSIRO have contributed significantly to spectrum management decisions in support of radio astronomy and in improving the prediction of interference between radio systems.

IUCAF was set up by the URSI, IAU and COSPAR as the Inter Union Commission on the Allocation of Frequencies, and operates as an international organisation with representatives from all three Unions. It provides independent expertise and advocacy on spectrum management for passive science services like radio astronomy, earth exploration science and space science. CSIRO has been involved in IUCAF from its inception and Dr Tzioumis of CSIRO has been an active member representing URSI since 1999.

CRAF, CORF and RAFCAP are committees similar to IUCAF but acting regionally. RAFCAP was set up in 2001 and represents radio astronomy spectrum management interests in the Asia–Pacific region. CSIRO has been very active in RAFCAP. Dr Tzioumis was the inaugural Secretary of RAFCAP for the period 2001–2008 and has been the Chairman since 2008. RAFCAP also liaises closely with its sister organisations in Europe (CRAF), USA (CORF) and internationally (IUCAF). CSIRO is also active in frequency management and protection forums in URSI and IAU. Dr Tzioumis has been an active member of URSI Commission J since 1993 and represents URSI on IUCAF. Dr Tzioumis was the Chairman of the IAU Working Group on RFI mitigation for the period 2000–2009 and remains an active member of this group.

It is further demonstration of Australian Government support for spectrum protection for radio astronomy that the CSIRO officers involved in national and international spectrum management activities are adequately supported in their positions of responsibility. In many countries around the world it is becoming harder to persuade governments to provide this essential support, which is a service to the international community, as well as being in the national interest.

Conclusions

Human use of the radio frequency spectrum is accelerating. The resulting scarcity of free spectrum is increasing commercial pressure on spectrum regulators, and is leading to deregulation of spectrum management in some areas. Looking forwards over the likely greater than 50-year lifetime of the SKA, it is the view of the ANZSCC that only through selection of an SKA site that is extremely remote from these pressures can the RFI risk be adequately mitigated for SKA throughout its long lifetime.

It is also essential to develop and implement an effective legislative and regulatory framework to manage spectrum use in the broad vicinity of the SKA sites, and also to develop a cooperative coexistence regime with other interests in the area. Australian radio astronomy facilities have a 50-year history of maintaining good relations with their spectrum neighbours, and the Australian and New Zealand SKA project team is committed to bringing this expertise to bear to ensure the longevity of radio-quiet protection for the SKA in Australia and New Zealand.

We have:

- Selected a site for the core of the SKA in consultation with local industry to ensure compatibility
- Implemented early and effective radio-quiet controls to prevent the development of incompatible activities, to demonstrate capability and to gain experience in managing the issues arising in the region
- Agreed, in close collaboration with governments and mining parties, a balanced and effective coexistence regime, backed up by well defined dispute resolution arrangements and an intergovernmental MOU outlining the agreed policy framework
• Prepared instruments to consolidate the early protections in place since 2005 and to provide greater regulatory certainty to the Mid West Radio-Quiet Zone. These are due to go to the ACMA for consideration on 6–7 July 2011
• Introduced processes to monitor the Mid West RQZ implementation and to consider any other measures necessary to ensure the governments’ policy objectives are met.

The ANZSCC does not underestimate the importance of, or the challenge in, providing adequate radio-quiet protection for the SKA over its greater than 50-year lifetime. Long-term radio-quiet protection is arguably the most important consideration in selecting a host site for the SKA. In a global environment of increasing manmade RFI, the effectiveness of the radio-quiet zone could dramatically affect the scientific potential of the SKA over its lifetime.

Australia has demonstrated that it can provide a site for the SKA that is superbly radio-quiet, and which has a strong and effective radio-quiet zone in place, combining a coherent legislative framework with robust consultative processes. The ANZSCC is fully committed to providing the international SKA community with the support and expertise needed to make the SKA an outstanding success in the 21st century.

List of attachments

Include all official supporting or agreement documents.

The documents listed below are provided as separate attachments:

[1] A Memorandum of Understanding on Radio Quiet Matters Relating to the Murchison Radio-astronomy Observatory and Square Kilometre Array project

Supplementary information

Since submission of this report on 30 June 2011 the enhanced regulatory measures were Registered and Tabled in Parliament, and they are now in operation. Additional official documentation was provided to the expert consultant group in late July, and is provided in this report as Attachments 7, 8 and 9:

[8] ACMA Explanatory Statement on Mid West RQZ Frequency Band Plan
Site Physical Characteristics

One of CSIRO's Australian SKA Pathfinder antennas at the MRO. Photography by Terrace Photographers.
**Report Summary: Site Physical Characteristics**

The Murchison Radio-astronomy Observatory (MRO) core site and surrounding area is sparsely populated, flat and accessible, enabling a cost effective deployment of the infrastructure components. The moderately high and relatively flat terrain leads to a stable climate with low storm and lightning rate, and expected high tropospheric phase stability.

The core location in the Mid West of Western Australia enables a predominantly east–west configuration extending to New Zealand with a maximum baseline of 5,000 km. The longitude of the core enhances astronomical links with telescopes already being built in Asia and can facilitate growth of radio astronomy in the developing southeast Asian economies.

The proposed core site is sufficiently inland to avoid high winds from cyclones and damaging radio-frequency interference (RFI) from the more populated coastal areas, but close enough to the coast to avoid the extreme desert temperatures of the interior. This is made possible by the very sharp decrease in population density away from the coast in Western Australia.

Ready accessibility to the attractive Western Australian coastline improves the social environment for workers and adoption of a ‘turno’ system for work at the site means SKA workers’ families can benefit from the pleasant climate and coastal lifestyle of Geraldton or Perth.

The Mid West of Western Australia is not an area where large changes in temperature or rainfall are predicted as a result of climate change.

Australian industry has a long history of successful deployment of sophisticated infrastructure in the Australian interior and techniques are well developed in infrastructure deployment in inland climates.

<table>
<thead>
<tr>
<th>Component</th>
<th>Feature</th>
<th>Advantage</th>
<th>Potential risk</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Temperature</td>
<td>• Summer temperatures high</td>
<td>• Use appropriate components</td>
<td>• Controlled environments where required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Precipitation</td>
<td>• Rain episodes can temporarily disrupt work and access</td>
<td>• Duplicate access routes, and use occasional air access if required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lightning strike</td>
<td>• Very low strike rate</td>
<td>• Sealed road to site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wind</td>
<td>• Not in high wind area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cloud cover</td>
<td>• Low time lost due to telescope stowage (rain, wind)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High number of cloud free days – potential for solar renewable power supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geophysical</td>
<td>Slope</td>
<td>• Flat core site and surrounding area, cost effective for array deployment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seismic</td>
<td>• Very high degree of seismic stability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ground surface</td>
<td>• Stable soil types and rock at depth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The remote, naturally radio-quiet location of the MRO offers the SKA a number of benefits including a stable, benign climate combined with a predominantly flat and sparsely occupied landscape, which allows for cost effective deployment of widely distributed infrastructure with excellent science outcomes.

This section of the report addresses the environmental categories as listed in the Request for Information. This report has been compiled using statistical information for the central core area surrounding the MRO from Australia’s 2005 site proposal, data from the Australian Bureau of Meteorology (BOM) and Geoscience Australia (GA), as well from CSIRO’s own measurements taken at Boolardy Station and the MRO. Geophysical data have been compiled by Aurecon using information from ASKAP construction and derivation of geophysical mask maps for the core site undertaken during PrepSKA work (see Attachment 10).

The primary source of information is the BOM and is based on the nearest weather stations, located at the settlement of Murchison (70 km west of the core) and Murgoo (70 km south of the core). Where information is not uniformly populated consistently at these weather stations (various statistics collected at Murchison from 1987–2011, Murgoo from 1889–2011) or current for all the required variables, Meekatharra Airport weather station data (180 km east of the core) has been used to populate fields (various statistics collected at Meekatharra Airport from 1944–2011). With further information from Cue weather station (145 km southeast of the core) and Errabiddy weather station (145 km north of the core), this provides statistical analysis spanning the core and the surrounding 180 km region. It should be noted that the variance in results from neighbouring weather stations within the 180 km zone is minimal (mean annual minimum and maximum temperatures vary by +/- 2 °C and mean annual rainfalls varies +/- 35 mm across the entire 360 km zone). Therefore, data sourced from any of the above weather stations provides suitable results. Where available, maps of the continent have been included to display the spatial variation of key factors in relation to the remote stations.

According to the Koeppen Climate Classification System, the entire array is located in grassland and desert regions, including the more distant remote stations (as shown in Figure 1). Generally the Australian climate can be classified as hot and dry and, using the modified Koeppen Climate Classification System, can be further broken down into the areas as highlighted in the Figure.

The SKA array-stations in Australia are located in desert and grassland regions not exposed to volatile tropical weather.
Environmental

Air temperature information for each month of the year

The most significant factor in determining the general pattern of temperature distribution across Australia is proximity to the equator. Areas to the north of the country are warmer than areas to the south. The daily mean temperature map (Figure 2) shows that the effect of elevation is also significant, with higher areas exhibiting cooler temperatures.

Mean and range

The mean daily maximum and minimum air temperature for the central region, shown for each month, have been calculated over all years of recording.

Table 1 – Mean and range of maximum temperature at the MRO.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<th>Sep</th>
<th>Oct</th>
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<tbody>
<tr>
<td>Mean</td>
<td>37.9</td>
<td>37.2</td>
<td>34.3</td>
<td>29.5</td>
<td>23.8</td>
<td>19.9</td>
<td>19.0</td>
<td>20.9</td>
<td>24.7</td>
<td>28.2</td>
<td>32.5</td>
<td>36.1</td>
</tr>
<tr>
<td>Highest monthly mean</td>
<td>40.7</td>
<td>42.5</td>
<td>38.8</td>
<td>33.5</td>
<td>27.7</td>
<td>22.9</td>
<td>23.6</td>
<td>23.8</td>
<td>28.4</td>
<td>33.7</td>
<td>36.1</td>
<td>39.3</td>
</tr>
<tr>
<td>Lowest monthly mean</td>
<td>32.5</td>
<td>32.7</td>
<td>28.4</td>
<td>25.3</td>
<td>20.2</td>
<td>16.9</td>
<td>16.2</td>
<td>17.9</td>
<td>21.1</td>
<td>24.5</td>
<td>29.1</td>
<td>32.9</td>
</tr>
</tbody>
</table>

Table 2 – Mean and range of minimum temperature at the MRO.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>22.3</td>
<td>22.4</td>
<td>20.4</td>
<td>16.0</td>
<td>11.1</td>
<td>8.0</td>
<td>6.6</td>
<td>7.3</td>
<td>9.7</td>
<td>12.6</td>
<td>16.5</td>
<td>19.6</td>
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<td>Highest monthly mean</td>
<td>26.0</td>
<td>26.9</td>
<td>25.6</td>
<td>19.7</td>
<td>14.4</td>
<td>11.5</td>
<td>10.1</td>
<td>10.8</td>
<td>14.4</td>
<td>17.1</td>
<td>21.6</td>
<td>23.0</td>
</tr>
<tr>
<td>Lowest monthly mean</td>
<td>18.7</td>
<td>18.2</td>
<td>15.4</td>
<td>13.9</td>
<td>7.9</td>
<td>4.9</td>
<td>3.6</td>
<td>3.8</td>
<td>6.9</td>
<td>9.6</td>
<td>12.6</td>
<td>15.7</td>
</tr>
</tbody>
</table>

Minimum and maximum over the days in the month

Table 3 – Maximum daily temperature at the MRO (2010).

<table>
<thead>
<tr>
<th>Day</th>
<th>Statistic</th>
<th>2010 (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>1st</td>
<td>41.3</td>
<td>43.7</td>
</tr>
<tr>
<td>2nd</td>
<td>38.7</td>
<td>41.7</td>
</tr>
<tr>
<td>3rd</td>
<td>40.3</td>
<td>35.8</td>
</tr>
<tr>
<td>4th</td>
<td>42.3</td>
<td>33.4</td>
</tr>
<tr>
<td>5th</td>
<td>43.8</td>
<td>41.8</td>
</tr>
<tr>
<td>6th</td>
<td>43.5</td>
<td>37.5</td>
</tr>
<tr>
<td>7th</td>
<td>44.4</td>
<td>37.5</td>
</tr>
<tr>
<td>8th</td>
<td>44.3</td>
<td>42.0</td>
</tr>
<tr>
<td>9th</td>
<td>44.3</td>
<td>36.4</td>
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<td>10th</td>
<td>43.9</td>
<td>38.7</td>
</tr>
<tr>
<td>11th</td>
<td>41.1</td>
<td>40.2</td>
</tr>
<tr>
<td>12th</td>
<td>40.0</td>
<td>41.9</td>
</tr>
<tr>
<td>13th</td>
<td>38.9</td>
<td>41.7</td>
</tr>
<tr>
<td>Day</td>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>1st</td>
<td>23.7</td>
<td>29.3</td>
</tr>
<tr>
<td>2nd</td>
<td>27.7</td>
<td>25.9</td>
</tr>
<tr>
<td>3rd</td>
<td>25.5</td>
<td>24.6</td>
</tr>
<tr>
<td>4th</td>
<td>25.6</td>
<td>21.5</td>
</tr>
<tr>
<td>5th</td>
<td>27.7</td>
<td>23.6</td>
</tr>
<tr>
<td>6th</td>
<td>26.8</td>
<td>25.8</td>
</tr>
<tr>
<td>7th</td>
<td>29.4</td>
<td>21.1</td>
</tr>
<tr>
<td>8th</td>
<td>28.3</td>
<td>22.2</td>
</tr>
<tr>
<td>9th</td>
<td>28.9</td>
<td>28.5</td>
</tr>
<tr>
<td>10th</td>
<td>30.2</td>
<td>23.6</td>
</tr>
<tr>
<td>11th</td>
<td>26.6</td>
<td>24.1</td>
</tr>
<tr>
<td>12th</td>
<td>24.7</td>
<td>26.8</td>
</tr>
<tr>
<td>13th</td>
<td>24.9</td>
<td>24.2</td>
</tr>
<tr>
<td>14th</td>
<td>25.6</td>
<td>28.7</td>
</tr>
<tr>
<td>15th</td>
<td>28.1</td>
<td>27.5</td>
</tr>
</tbody>
</table>

**Table 4 – Minimum daily temperature at the MRO (2010).**
each month of the year, using the first day of the month as an indicator. In addition to these data tables we provide a daily variation in temperature experienced in a typical day at the MRO for:

Table 5 – Variance of the maximum daily temperature at the MRO.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest daily</td>
<td>47.8</td>
<td>46.7</td>
<td>44.9</td>
<td>41.1</td>
<td>34.7</td>
<td>29</td>
<td>30</td>
<td>35</td>
<td>40.6</td>
<td>40.2</td>
<td>43</td>
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</tr>
<tr>
<td>Lowest daily</td>
<td>25.3</td>
<td>25</td>
<td>20</td>
<td>17.9</td>
<td>14.5</td>
<td>13.4</td>
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<td>14.3</td>
<td>15.8</td>
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</tr>
<tr>
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<td>21.7</td>
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<td>20.2</td>
<td>15.6</td>
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<td>24.8</td>
<td>24.6</td>
<td>25.6</td>
<td>22.5</td>
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</table>

Table 6 – Variance of the minimum daily temperature at the MRO.

<table>
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<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<td>Highest daily</td>
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<td>29.7</td>
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<td>15.3</td>
<td>16.7</td>
<td>20</td>
<td>24.7</td>
<td>27.5</td>
<td>29.7</td>
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<tr>
<td>Lowest daily</td>
<td>11.7</td>
<td>13.9</td>
<td>8.5</td>
<td>5.6</td>
<td>0.6</td>
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<td>-1.7</td>
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<td>21.2</td>
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<td>21.6</td>
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<td>18.3</td>
<td>23</td>
<td>20.8</td>
<td>20.8</td>
</tr>
</tbody>
</table>

In addition to these data tables we provide a daily variation in temperature experienced in a typical day at the MRO for each month of the year, using the first day of the month as an indicator.
optical fibre backbone provider, indicate typical components do not have a shorter lifetime in the Australian desert than they have in more temperate areas if suitable enclosures are used. It has been assumed that any Australian conditions.

Lower power, field-mounted active electronic components will be suitably housed in sealed enclosures. The analog no cooling and have proven to operate reliably. Similar solutions would be appropriate for the SKA AA-low receptors. Beamformers used by the Murchison Widefield Array (MWA) are mounted on the receptor tiles in sealed enclosures with

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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</thead>
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<td>14.9</td>
<td>19.7</td>
<td>20.4</td>
<td>27.9</td>
</tr>
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<td>1:00 am</td>
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<td>25.4</td>
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<td>12.8</td>
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<tr>
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<td>15.7</td>
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<td>26.7</td>
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<tr>
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<td>18.6</td>
<td>22.2</td>
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<td>32.4</td>
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<td>10:00 pm</td>
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<tr>
<td>11:00 pm</td>
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<td>10.9</td>
<td>17.7</td>
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<td>28.2</td>
<td>26.5</td>
<td>15.0</td>
<td>24.7</td>
<td>24.8</td>
<td>25.8</td>
<td>29.5</td>
<td>36.6</td>
</tr>
<tr>
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<td>23.8</td>
<td>23.3</td>
<td>21.3</td>
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<td>11.5</td>
<td>17.1</td>
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<td>9.7</td>
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<td>6.9</td>
<td>15.5</td>
<td>13.3</td>
<td>8.7</td>
<td>12.1</td>
<td>14.8</td>
</tr>
</tbody>
</table>

All mechanical structures, electrical supply infrastructure and electronic systems installed in external environments in Australia must comply with Australian Standards and the Building Code of Australia requirements, which are based on international best practice (ANSI, BSi and ISO).

Statistics of ‘mean time between failure’ from the Australian Academic Research Network (AARNet), Australia’s research optical fibre backbone provider, indicate typical components do not have a shorter lifetime in the Australian desert regions than they have in more temperate areas if suitable enclosures are used. It has been assumed that any vulnerable active components for SKA would be housed in air conditioned spaces or would have dedicated cooling. Lower power, field-mounted active electronic components will be suitably housed in sealed enclosures. The analog beamformers used by the Murchison Widefield Array (MWA) are mounted on the receptor tiles in sealed enclosures with no cooling and have proven to operate reliably. Similar solutions would be appropriate for the SKA AA-low receptors.

Global and local engineering firms have undertaken numerous large scale remote projects in physical locations similar to those proposed by the ANZSCC and are experienced in the timely and appropriate deployment of equipment for Australian conditions.
This map shows the spatial variance of mean temperature for the individual remote array stations, which indicates consistency and suitability of the deployment environment over the entire baseline. The majority of SKA array-stations are not placed in the hottest regions of the continent.

Figure 2 – Average daily mean temperature (annual), overlaid with SKA array stations.

**Humidity**

The BOM provides information on the mean relative humidity levels at 9 am and 3 pm. The 9 am relative humidity levels in Table 8 reduce quickly as the temperature generally rises 4–7 degrees from 9 am to noon (Table 7) and the 3 pm relative humidity levels are seen throughout the majority of the day. The core has excellent relative humidity averages, well below 50 percent most of the time.

**Mean**

Table 8 – Mean relative humidity at the MRO.

<table>
<thead>
<tr>
<th>Relative humidity</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean 9 am relative</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Range (average of maximum to minimum over the month)**

Table 9 – Range of mean relative humidity at the MRO.

<table>
<thead>
<tr>
<th>Relative humidity</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>All years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of mean 9 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Range of mean 3 pm</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>relative humidity</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Average minimum and maximum over the month

Table 10 – Average minimum and maximum of mean relative humidity at the MRO.

<table>
<thead>
<tr>
<th>Relative humidity</th>
<th>All years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Average minimum</td>
<td>19</td>
</tr>
<tr>
<td>mean relative humidity</td>
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<td>Average maximum</td>
<td>40</td>
</tr>
<tr>
<td>mean relative humidity</td>
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</tr>
</tbody>
</table>

Absolute minimum and maximum over the month

Table 11 – Minimum and maximum of mean relative humidity at the MRO.

<table>
<thead>
<tr>
<th>Relative humidity</th>
<th>All years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Minimum mean 9 am</td>
<td>27</td>
</tr>
<tr>
<td>relative humidity</td>
<td></td>
</tr>
<tr>
<td>Maximum mean 9 am</td>
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</tr>
<tr>
<td>relative humidity</td>
<td></td>
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<tr>
<td>Minimum mean 3 pm</td>
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</tr>
<tr>
<td>relative humidity</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>relative humidity</td>
<td></td>
</tr>
</tbody>
</table>

This map shows the spatial variance of relative humidity for the remote array-stations.

The humidity levels at proposed SKA sites across Australia would not negatively impact on the infrastructure components or the operation of the SKA in Australia. Australian siting avoids high dry regions. This minimises the risk of electronic equipment failure due to static electrical discharge.

Figure 3 – Average daily relative humidity (annual), overlaid with SKA array stations.
Rainfall information for each month

The annual mean rainfall in the 180 km region surrounding the core site is 215 mm, with the highest recorded annual maximum being 563 mm (in 1975). Most rain falls from February to July. The spring months of September to November are particularly dry with only 6 mm of rain on average each month. There is an average of 36 rain days per calendar year. Climate change modelling does not indicate a significant increase or decrease in rainfall for the region. In 2011 there has been an atypical, prolonged period of rain in the Mid West. Some delays in ASKAP’s construction have been encountered due to the currently unsealed road to the site being periodically closed to heavy vehicles. An all-weather road in to the SKA site is proposed as part of the Basic Infrastructure Component response to mitigate this risk.

Mean per day

Table 12 – Mean rainfall at the MRO.

<table>
<thead>
<tr>
<th>Statistics</th>
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<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
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</thead>
<tbody>
<tr>
<td>Mean rainfall</td>
<td>17.2</td>
<td>22.0</td>
<td>21.6</td>
<td>17.0</td>
<td>25.4</td>
<td>35.8</td>
<td>29.0</td>
<td>19.9</td>
<td>6.7</td>
<td>5.2</td>
<td>5.9</td>
<td>9.9</td>
<td>215.7</td>
</tr>
<tr>
<td>Highest rainfall</td>
<td>110.7</td>
<td>188.6</td>
<td>190.2</td>
<td>204.1</td>
<td>134.5</td>
<td>123.4</td>
<td>144.4</td>
<td>105.2</td>
<td>44.2</td>
<td>70.0</td>
<td>74.7</td>
<td>98.4</td>
<td>563.0</td>
</tr>
<tr>
<td>Lowest rainfall</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22.1</td>
</tr>
<tr>
<td>Highest daily rainfall</td>
<td>101.1</td>
<td>145.0</td>
<td>160.0</td>
<td>122.7</td>
<td>80.8</td>
<td>50.3</td>
<td>38.8</td>
<td>47.2</td>
<td>32.5</td>
<td>32.6</td>
<td>45.0</td>
<td>70.0</td>
<td>160</td>
</tr>
<tr>
<td>Mean number of days of rain</td>
<td>2.0</td>
<td>2.4</td>
<td>2.6</td>
<td>2.5</td>
<td>4.1</td>
<td>6.0</td>
<td>6.1</td>
<td>4.4</td>
<td>2.1</td>
<td>1.4</td>
<td>0.9</td>
<td>1.5</td>
<td>36.0</td>
</tr>
</tbody>
</table>

Absolute maximum daily rainfall over the month

Table 13 – Absolute maximum daily rainfall over each month at the MRO.

<table>
<thead>
<tr>
<th>Daily rainfall</th>
<th>2010 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>Jan</td>
</tr>
<tr>
<td>1st</td>
<td>0</td>
</tr>
<tr>
<td>2nd</td>
<td>0</td>
</tr>
<tr>
<td>3rd</td>
<td>0</td>
</tr>
<tr>
<td>4th</td>
<td>0</td>
</tr>
<tr>
<td>5th</td>
<td>0</td>
</tr>
<tr>
<td>6th</td>
<td>0</td>
</tr>
<tr>
<td>7th</td>
<td>0</td>
</tr>
<tr>
<td>8th</td>
<td>0</td>
</tr>
<tr>
<td>9th</td>
<td>0</td>
</tr>
<tr>
<td>10th</td>
<td>0</td>
</tr>
<tr>
<td>11th</td>
<td>0</td>
</tr>
<tr>
<td>12th</td>
<td>0</td>
</tr>
<tr>
<td>Date</td>
<td>0</td>
</tr>
<tr>
<td>-------</td>
<td>---</td>
</tr>
<tr>
<td>13th</td>
<td></td>
</tr>
<tr>
<td>14th</td>
<td></td>
</tr>
<tr>
<td>15th</td>
<td></td>
</tr>
<tr>
<td>16th</td>
<td></td>
</tr>
<tr>
<td>17th</td>
<td></td>
</tr>
<tr>
<td>18th</td>
<td></td>
</tr>
<tr>
<td>19th</td>
<td></td>
</tr>
<tr>
<td>20th</td>
<td></td>
</tr>
<tr>
<td>21st</td>
<td></td>
</tr>
<tr>
<td>22nd</td>
<td></td>
</tr>
<tr>
<td>23rd</td>
<td></td>
</tr>
<tr>
<td>24th</td>
<td></td>
</tr>
<tr>
<td>25th</td>
<td></td>
</tr>
<tr>
<td>26th</td>
<td></td>
</tr>
<tr>
<td>27th</td>
<td></td>
</tr>
<tr>
<td>28th</td>
<td></td>
</tr>
<tr>
<td>29th</td>
<td></td>
</tr>
<tr>
<td>30th</td>
<td></td>
</tr>
<tr>
<td>31st</td>
<td></td>
</tr>
<tr>
<td>Highest daily</td>
<td></td>
</tr>
<tr>
<td>Monthly total</td>
<td></td>
</tr>
</tbody>
</table>

**Absolute maximum quantity of rain that can fall in a 30 minute burst in a month**

These data are not currently captured by any source in the area. Rainfall bursts can occur (as can be inferred from the highest daily rainfall statistics) and are caused by the occurrence of a broken down cyclone system dissipating through the area (refer to Severe Weather Events section for further information), or by isolated thunderstorm activity. As indicated by the 2010 daily statistics (above) and the historical mean annual rainfall statistics in Table 12, they are not common.
This map shows the spatial variance of average annual rainfall for the individual remote array-stations. Low rainfall at the SKA sites is not likely to impact significantly on construction programs, infrastructure deployment and subsequent operation of the SKA in Australia.

**Figure 4 – Average rainfall (annual), overlaid with SKA array stations.**

**Dewpoint temperatures (derived information)**

The dewpoint is a measure of the moisture content of the air and is the temperature to which air (at constant atmospheric pressure) must be cooled in order for dew to occur. It is derived theoretically from dry- and wet-bulb temperatures, with a correction made for the site's elevation. Dewpoint temperatures are presented below for the core site for 9 am and 3 pm during a calendar month or year, averaged over the period of record. It can be seen that, in this region, the ambient temperature rarely falls below the dewpoint temperature. The standard practice of housing all vulnerable active electronic components in either air conditioned spaces or in sealed enclosures, and using appropriately sealed electrical connectors, will adequately protect against dew formation. These measures are a proven solution, routinely implemented at other Australian radio telescope facilities.

**Table 14 – Dewpoint temperatures at the MRO.**

<table>
<thead>
<tr>
<th>Dew-point temp</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean 9 am dewpoint temperature</td>
<td>12.6</td>
<td>14.1</td>
<td>13.1</td>
<td>12.2</td>
<td>10.0</td>
<td>7.9</td>
<td>7.6</td>
<td>7.1</td>
<td>7.5</td>
<td>9.0</td>
<td>10.8</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Mean 3 pm dewpoint temperature</td>
<td>9.5</td>
<td>12.0</td>
<td>10.8</td>
<td>10.5</td>
<td>8.2</td>
<td>6.6</td>
<td>6.0</td>
<td>4.8</td>
<td>4.2</td>
<td>4.7</td>
<td>5.7</td>
<td>7.0</td>
<td>7.5</td>
</tr>
</tbody>
</table>

**Occurrence of ice formation, hail and pooling of water**

None of the proposed array station sites are in an alpine or sub-alpine region, so snow and ice loading is not a design consideration for Australian-based SKA buildings and associated infrastructure.

Hail events are rare, as indicated by the low rate of thunder days.

The core site is on the high ground (watershed) between two river systems. The surrounding relatively flat terrain can allow temporary pooling of water after heavy rain, but any such pools are shallow (a few centimetres) and short-lived.
Cloud cover

The average number of cloudy days in a calendar month or year has been calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is recorded as eight oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as one okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as seven oktas. A cloudy day is recorded when the mean of the 9 am and 3 pm cloud observations is greater than, or equal to, six oktas.

Table 15 – Cloud cover at the MRO.

<table>
<thead>
<tr>
<th>Cloud Cover</th>
<th>All years (oktas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean 9 am cloud cover</td>
<td>1.7</td>
</tr>
<tr>
<td>Mean 3 pm cloud cover</td>
<td>2.6</td>
</tr>
</tbody>
</table>

The lack of cloud cover (and the large number of clear days) indicates good potential for renewable solar energy generation and is representative of very stable weather patterns.

Wind information for each month

Wind speed is generally measured at a height of 10 metres above the surface and is averaged over the ten minutes leading up to the time of observation.

Speed, mean

Table 16 – Mean wind speed at the MRO.

<table>
<thead>
<tr>
<th>Wind speed mean</th>
<th>All years (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean wind speed</td>
<td>16.9</td>
</tr>
</tbody>
</table>

Speed, average monthly

Table 17 – Average maximum wind speed at the MRO.

<table>
<thead>
<tr>
<th>Wind speed average</th>
<th>All years (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Average maximum wind speed</td>
<td>28.8</td>
</tr>
</tbody>
</table>

Speed, absolute maximum over the month

Table 18 – Absolute maximum wind speed at the MRO.

<table>
<thead>
<tr>
<th>Absolute maximum wind speed</th>
<th>All years (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Absolute maximum wind speed</td>
<td>67.0</td>
</tr>
</tbody>
</table>
Gust (<10 s duration), absolute peak over the month

A gust is any sudden increase of wind speed of short duration: typically a three second time period is used. The maximum wind gust for a day is measured from midnight to midnight. If, for some reason, an observation is unable to be made, the next observation is recorded as an accumulation. It can be seen that, even though there have been peak wind gusts of up to 148 km/h (in 1968) these are rare: the annual mean wind speed is only 15.2 km/h.

Table 19 – Maximum wind gusts at the MRO.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. wind gust</td>
<td>148</td>
<td>109</td>
<td>106</td>
<td>95</td>
<td>121</td>
<td>85</td>
<td>91</td>
<td>87</td>
<td>84</td>
<td>115</td>
<td>141</td>
<td>115</td>
</tr>
</tbody>
</table>

It should be noted that on average Boolardy experiences less than 0.3 days a month of gale force winds, and between 0.5 and 2.4 windy days per month, as can be seen in Table 25.

For the ASKAP antennas currently being assembled at the MRO, the wind tolerance for normal operations is 45 km/h. Therefore the down time for ASKAP antennas caused by high wind is anticipated to be less than one percent of the time.

Direction and speed histograms, over each month

Wind roses summarise the occurrence of winds at the core, showing their strength, direction and frequency. The percentage of calm conditions is represented by the size of the centre circle – the bigger the circle, the higher the frequency of calm conditions.

Each branch of the rose represents wind coming from that direction, with north represented at the top of the diagram. Eight directions are indicated. The branches are divided into segments of different thickness and colour, which represent wind speed ranges from that direction. Speed ranges of 10 km/h are used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction. Refer to Attachment 11 to view the monthly (January – December) wind rose diagrams at a better scale.
Figure 5 – Direction/speed histograms.
The wind speeds at the SKA sites are low and not likely to significantly impact construction. They would also have little impact on the proposed infrastructure and operation of the SKA.

This map shows the spatial variance of summer wind speeds for the individual remote array-stations. Wind speeds are generally stronger through the summer months in coastal regions.

![Figure 6 – Wind speeds during summer months, overlaid with SKA array stations.](image1)

This map shows the spatial variance of winter wind speeds for the individual remote array stations. Wind speeds are generally weaker through the winter months particularly on the coastal regions.

![Figure 7 – Wind speeds during winter months, overlaid with SKA array stations.](image2)
The map shows the classification of the Australian continent into wind regions for the purpose of structural design (according to Australian Standard AS1170.2.2011).

While winds can be strong at two South Australian remote station locations, this map indicates all SKA array stations fall into wind region A (from AS1170.2.2011), which is the most benign classification possible for structural design.

Figure 8 – Classification of the Australian continent into wind regions, from the Australian Standards File 1170.2:2011.

Solar radiation, daily solar exposure information per month

The average amount of daily solar energy reaching a specific location on the Earth’s surface in a calendar month or year has been calculated over the period of record. The solar exposure provided in these statistics has been estimated from satellite imagery and is measured in megajoules per square metre (MJ/m²).

Mean, minimum and maximum solar exposure

Table 20 – Mean, minimum and maximum solar exposure at the MRO.

<table>
<thead>
<tr>
<th>Solar exposure</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>29.4</td>
<td>26.3</td>
<td>23.0</td>
<td>18.2</td>
<td>14.7</td>
<td>12.8</td>
<td>13.6</td>
<td>16.9</td>
<td>21.7</td>
<td>26.2</td>
<td>29.2</td>
<td>30.3</td>
</tr>
<tr>
<td>Highest monthly mean</td>
<td>31.8</td>
<td>28.8</td>
<td>25.8</td>
<td>20.8</td>
<td>17.1</td>
<td>14.3</td>
<td>14.8</td>
<td>18.9</td>
<td>23.5</td>
<td>27.6</td>
<td>31.2</td>
<td>32.4</td>
</tr>
<tr>
<td>Lowest monthly mean</td>
<td>26.4</td>
<td>22.9</td>
<td>18.5</td>
<td>15.5</td>
<td>12.0</td>
<td>10.6</td>
<td>11.1</td>
<td>13.3</td>
<td>19.7</td>
<td>22.7</td>
<td>26.7</td>
<td>28.6</td>
</tr>
</tbody>
</table>

There is good potential at the site for generating renewable power from solar technology. The MRO power station is already funded to be a hybrid power station with up to 50 percent renewable generation, most likely through solar technologies.
This map shows the spatial variance of solar exposure for the individual remote array stations. Australia has consistent solar exposure across the country. The relatively uniform solar exposure levels across the SKA sites would have little impact on the proposed infrastructure or the operation of the SKA in Australia, and provides good potential for generation of renewable power from solar energy.

**Airborne particles (such as dust and sand)**

While weather stations in the area don’t collect these data, work on the MRO has demonstrated that the core site and 180 km region are not in a dusty environment, as the undisturbed ground surface is typically coarse sand or gravel. Finer particles are generally washed to lower levels and there is plant cover sufficient to stabilise the soil surface. Dust storms are not typical.

**Airborne chemicals (such as salt)**

There are approximately 20 salt lakes in Australia, seven are in Western Australia. The nearest salt lakes to the core are Lake Macleod (375 km northwest of the core) and Lake Barlee (375 km southeast of the core). The SKA is isolated from saltpan areas that could increase corrosion of equipment. There are no known airborne chemicals that would affect the 180 km zone.

**Animals, insects and birds from which protection is required or special measures taken**

Australia and New Zealand contain no land predators to humans that present any kind of safety risk. There is also a very low communicable disease risk (due to a wide range of factors such as high standards of health, effective control of mosquito populations and low population density). Standard occupational, health and safety (OH&S) measures will be put in place for on site personnel, including procedures to minimise risk from workers inadvertently placing exposed limbs in any danger of being bitten by venomous snakes or spiders. For safety reasons, it is proposed maintenance crews for the remote unstaffed array-stations work in pairs. Note that the risk of serious injury from bites from venomous snakes and spiders in Western Australia is extremely low.

**Identify any restrictions due to indigenous use, ownership, or customs, or due to any legislated protection of flora or fauna**

Commonwealth and State environmental, heritage, land access and native title approvals will be required for placement of infrastructure. These procedures have been followed for existing facilities at the MRO, and the optical fibre cable between the MRO and Geraldton, and have not hindered the deployment of infrastructure. The evidence from large scale mining in Western Australia is that such matters can be satisfactorily managed.

**Wildfires**

Destructive bushfires have occurred in Australia’s southeast and southwest, where there are eucalypt and acacia forests. The very sparse scrub-like vegetation in the desert and marginal farming regions of inland Western Australia, the Northern Territory and South Australia where array-stations are located makes bushfires a rarity in these regions.
Historically, any fires in the central area have been small grass fires, which occurred in years where there was above average rainfall. Property owners maintain a three to four metre firebreak along perimeter fences and keep dedicated emergency water supplies. Maintenance of firebreaks is monitored by local shire councils.

**Seismic stability**

The degree of seismic activity at the core and across all remote stations is low, with only one earthquake of significance recorded anywhere near the core site since 1820. As shown in Figure 10, Australia is subject to very low seismic activity. The low earthquake incidence at the proposed SKA site means there would be no impact on construction or on the subsequent operation of the SKA in Australia.

![Figure 10 – Earthquake epicentre locations across Australia, overlaid with SKA array stations.](image)

**Geotechnical**

**Identification of subsurface strata to depths appropriate for SKA components (dishes, buildings, bunkers, etc), including corrosive minerals such as salt**

Data have been obtained on subsurface strata from a variety of sources:

- A ground penetrating radar survey of a sample site within the MRO
- An EM survey of ASKAP antenna sites
- Test pits from the ASKAP geotechnical surveys
- Contractor reports for the ASKAP antenna foundation excavations
- Trenching logs for the Geraldton to MRO optical fibre installation
- An analysis of geological map data using Geographic Information System (GIS) techniques.

Put together, these sources provide an excellent understanding of the subsurface strata and the consequent influence on trenching and foundation costs, not only for the core site within the MRO, but also for the surrounding 180 km region.

A calculation of the percentage distribution of the surface geology (grouped lithology types) against SKA components has been calculated using GIS data. The locations of SKA components were intersected with the plan geology from the 1:250,000 geological map, the output being a discrete surface geology type for each individual component. Based on our general understanding of the local geology, we have grouped similar lithological types together to form three broad categories and calculated the percentage of components intersecting each category, presented in Table 21.
Table 21 – Percentage distribution of surface geology intersecting the inner core.

<table>
<thead>
<tr>
<th>Surface strata lithology</th>
<th>Percentage distribution of surface geology intersecting the inner core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quaternary unconsolidated</strong></td>
<td>75.5</td>
</tr>
<tr>
<td>Map Sheet SG 50-10 codes: Ql, Qls, Qld, Qa, Qw, Qc and Qs.</td>
<td></td>
</tr>
<tr>
<td>Alluvium, Colluvium, and Eolian clay, silt, sand, gravel and cobble. Gypsiferous and calcareous.</td>
<td></td>
</tr>
<tr>
<td><strong>Quaternary consolidated</strong></td>
<td>7.0</td>
</tr>
<tr>
<td>Map Sheet SG 50-10 codes: Czk, Czc, Czs, Czl, Czz and Czu.</td>
<td></td>
</tr>
<tr>
<td>Alluvium, Colluvium, and Eolian clay, silt, sand, gravel and cobble. Gypsiferous and calcareous.</td>
<td></td>
</tr>
<tr>
<td><strong>Archean bedrock</strong></td>
<td>17.5</td>
</tr>
<tr>
<td>Map Sheet SG 50-10 codes: Agtc, Agwg and Anme.</td>
<td></td>
</tr>
<tr>
<td>Tching Granite, Weiragoo Granite and Meeberrie Gneiss.</td>
<td></td>
</tr>
</tbody>
</table>

At, and adjacent to, the watershed area in the centre of the MRO, where the central core is located, bedrock can be expected to occur close to the surface. A ground penetrating radar survey undertaken for the MWA suggests the depth to bedrock varies between approximately 0.3–0.9 m below the surface. Erosion has exposed the rock at some of these higher locations. Figure 11 below, showing a typical ground profile at the MRO, explains this.

The radar survey data correlate with test pit data undertaken across the MRO for the ASKAP project and provides geotechnical information sufficient for design of the SKA core antennas, correlator room footings and recommendations for the upgrade of the existing access road for SKA.

Based on interpolation from the sampling site and test pits revealing that the depth to bedrock is relatively shallow, we conclude that many of the component locations in the inner core suit footings suitable for bedrock, such as rock anchors. This would indicate that approximately 80 percent of the component locations should be classified as founding on bedrock, with a residual 20 percent founding on consolidated/unconsolidated sedimentary material, as indicated in Table 22.
Table 22 – Identification of subsurface strata to depths appropriate for SKA components.

<table>
<thead>
<tr>
<th>Identification of subsurface strata to depths appropriate for SKA components</th>
<th>Approximate percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>%</td>
</tr>
<tr>
<td>Consolidated/Unconsolidated sedimentary material</td>
<td>20</td>
</tr>
<tr>
<td>Bedrock</td>
<td>80</td>
</tr>
</tbody>
</table>

Current trenching for ASKAP, test pits, and actual excavations for ASKAP antenna foundations, show surface material is compact and stable for footings and trenching and, where rock is shallow, it can be removed from the trench using a hydraulic rock breaker and excavator. Where rock foundation is desired, footing rock anchors will achieve cost effective results.

Moving away from the inner core (watershed area) into areas with more alluvial and colluvial material deposited, the depth to bedrock can be expected to increase. Trench log data from AARNet confirms that, for the complete Geraldton to MRO optical fibre route of approximately 335 km, bedrock was encountered at less than one metre from the ground surface for only 8.5% of the route. Therefore between 20 km and 180 km it would be assumed that the majority of SKA components would be founded on consolidated/unconsolidated sedimentary material. It should be noted that the sandy and gravelly subsurface soils in this region of WA are considered stable and non-reactive.

**Water table – depth, water quality, flow rates**

 Boolardy Station lies in the Upper Murchison River Catchment and receives an average of 215 mm of rain annually. Groundwater is readily available throughout the region. The Boolardy Station Homestead, 30 km from the MRO, obtains all its domestic water and irrigation water from local sources and evidence from Boolardy and surrounding pastoral stations is that throughout the region there is ready access to ground water with quite low salinity and good water quality. All drinking water, and water for ASKAP construction purposes, has been obtained locally.

**Subsurface conductivity profile**

A conductivity survey, also known as an electromagnetic (EM) survey, measures the ability of the soil to conduct an electric current. The electrical conductivity of soils varies depending on the amount of moisture held within the soil’s pore space (the space between soil particles). Consequently, conductivity correlates strongly to pore size, soil particle size and moisture content. In addition, when salts dissolve in the pore water, ions are formed and the solution (the electrolyte) will conduct electricity. As a general rule, the higher the concentration of ions in solution (that is, the higher the salt concentration) the better the solution conducts electricity. In other words, its electrical conductivity increases. Igneous rocks have very low conductivity, sands have low conductivity, silts have a medium conductivity and clays have high conductivity.

An EM survey has been conducted on the MRO. The results agree with what one might expect to find in this semi-arid environment. The near surface geology is likely to contain finer clay-like sediments, which will subsequently have a higher moisture content and/or salt content, resulting in higher conductivity. As the sediment becomes more consolidated/cemented and/or coarser with depth, there is less pore space to contain water, hence the conductivity decreases. Likewise, for an igneous material such as the bedrock at the core, there is little to no pore space for moisture retention (only in weathered material), therefore the conductivity is poor. There are no salt pans in the vicinity.

The earthing system for ASKAP has been designed to meet all applicable electrical safety and lightning protection standards and codes. The system employed uses a combination of earth grids adjacent to and under the antenna foundations, and multiple earth conductor rods placed in shallow vertical bores adjacent to the antennas and buildings. This solution takes advantage of the higher near-surface conductivity typical of the local geology.

**Surface and subsurface (10 cm and 100 cm depth) temperatures**

Terrestrial minimum surface temperature is nominally measured at 9 am and is taken to be the lowest temperature recorded since 6 pm the previous day. It is measured by a thermometer placed close to horizontal and just above the surface of the ground. The overnight temperature, particularly on windless nights, can be lower at ground level than at the level of a Stevenson screen where air temperature is measured. Therefore, the terrestrial minimum temperature gives a more accurate indication of whether frost has occurred.
Monthly maximum and minimum

Table 23 – Mean, minimum and maximum surface temperatures at the MRO.

<table>
<thead>
<tr>
<th>Surface temperature</th>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ground min temp</td>
<td></td>
<td>23.0</td>
<td>22.4</td>
<td>20.0</td>
<td>15.7</td>
<td>10.4</td>
<td>7.1</td>
<td>5.6</td>
<td>6.6</td>
<td>9.7</td>
<td>13.6</td>
<td>17.4</td>
<td>20.7</td>
</tr>
<tr>
<td>Lowest ground temp</td>
<td></td>
<td>12.2</td>
<td>11.7</td>
<td>9.6</td>
<td>3.1</td>
<td>0.0</td>
<td>-2.7</td>
<td>-2.5</td>
<td>-2.0</td>
<td>-0.5</td>
<td>2.2</td>
<td>6.6</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Table 24 – Mean, minimum and maximum subsurface temperatures at 10 cm depth at the MRO.

<table>
<thead>
<tr>
<th>Soil temperature</th>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td>37.5</td>
<td>35.5</td>
<td>32.8</td>
<td>27.2</td>
<td>20.8</td>
<td>16.3</td>
<td>15.3</td>
<td>17.7</td>
<td>22.8</td>
<td>27.9</td>
<td>32.3</td>
<td>35.9</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td>22.0</td>
<td>21.0</td>
<td>18.7</td>
<td>14.0</td>
<td>12.0</td>
<td>7.0</td>
<td>8.0</td>
<td>8.0</td>
<td>12.0</td>
<td>16.0</td>
<td>17.5</td>
<td>24.0</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td>45.0</td>
<td>44.8</td>
<td>42.5</td>
<td>36.4</td>
<td>32.4</td>
<td>22.0</td>
<td>22.3</td>
<td>26.1</td>
<td>31.9</td>
<td>37.3</td>
<td>41.3</td>
<td>45.0</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>23.0</td>
<td>23.8</td>
<td>23.8</td>
<td>22.4</td>
<td>20.4</td>
<td>15.0</td>
<td>14.3</td>
<td>18.1</td>
<td>19.9</td>
<td>21.3</td>
<td>23.8</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Table 25 - Mean, minimum and maximum subsurface temperatures at 100 cm depth at the MRO.

<table>
<thead>
<tr>
<th>Soil temperature</th>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td>33.8</td>
<td>33.6</td>
<td>32.9</td>
<td>30.2</td>
<td>26.2</td>
<td>22.5</td>
<td>20.3</td>
<td>20.1</td>
<td>22.3</td>
<td>25.5</td>
<td>28.8</td>
<td>31.8</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td>29.7</td>
<td>30.0</td>
<td>28.3</td>
<td>26.0</td>
<td>22.0</td>
<td>19.0</td>
<td>16.0</td>
<td>16.0</td>
<td>18.5</td>
<td>21.2</td>
<td>25.0</td>
<td>27.0</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td>36.0</td>
<td>37.0</td>
<td>36.0</td>
<td>34.5</td>
<td>31.0</td>
<td>27.0</td>
<td>23.0</td>
<td>23.0</td>
<td>26.0</td>
<td>29.0</td>
<td>32.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>6.3</td>
<td>7.0</td>
<td>7.7</td>
<td>8.5</td>
<td>9.0</td>
<td>8.0</td>
<td>7.0</td>
<td>7.0</td>
<td>7.5</td>
<td>7.8</td>
<td>7.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Diurnal variation

These data are not directly captured by any source in the area. However, in the above Tables 24 and 25, we have presented the difference of the minimum and maximum average temperatures (range) at 10 cm and 100 cm depths, from which the diurnal variation can be inferred.
Severe weather events
Thunderstorms and associated lightning

Australia is generally subject to low incidences of lightning. The table below shows very low instances of lightning throughout the continent with most occurrences occurring in the eastern state coastal areas and tropical north where there are no array-stations located.

Table 24 – Average annual lightning ground flash density.

<table>
<thead>
<tr>
<th>Area</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central region</td>
<td>1 per sq km/year</td>
</tr>
<tr>
<td>Southwest Western Australia</td>
<td>1 per sq km/year</td>
</tr>
<tr>
<td>Central Australia</td>
<td>1 per sq km/year</td>
</tr>
<tr>
<td>Eastern states</td>
<td>2–3 per sq km/year</td>
</tr>
</tbody>
</table>

This map shows the spatial variance of thunder days for the individual remote array-stations. SKA array-stations are not located in the highest thunder day regions.

Figure 11 – Average annual thunder days, overlaid with SKA array stations.

Figure 11 (above) shows most of the areas where array-stations will be located are subject to less than 20 thunder days per year. Meteorological patterns and statistics indicate that thunder incidence may give an upper bound on all lightning, including sky to sky. Figure 12 (below) gives a graphical representation of spatial variance of lightning ground flash data.
This map shows the spatial variance of annual lightning ground flash density for the individual remote array stations. SKA array-stations are not sited in high lightning strike areas.

Figure 12 – Average annual lightning ground flash density, overlaid with SKA array stations.

The low incidence of lightning and thunder at the SKA core and remote sites is important in minimising maintenance requirements.

**Strong winds (>50 km/h) and tornado or cyclone occurrence**

Cyclone activity in Australia is restricted to the tropical and sub-tropical coastal regions of the continent, usually between the months of November and April. These cyclone areas can be inferred from Figure 11, with reference to the thunder associated with cyclone and storm systems with >60–80+ thunder days. This figure and Figure 8 show there are no array stations in cyclone susceptible areas. Dissipating tropical cyclones can cause strong winds through the Western Australian inland: in March 1999, the dissipating cyclone Vance, which crossed the coastline 600 km north of Boolardy, tracked close to Boolardy and winds near Boolardy reached 106 km/h (Table 19). The highest wind speed recorded in the region was 148 km/h at Meekatharra in January 1968. However, most dissipating cyclones occur further north than the proposed sites for array-stations.

The BOM gathers information on strong winds and classifies the data as windy days (wind speed of 40–63 km/h) and gale force winds (wind speed exceeding 63 km/h). On average Boolardy experiences less than 0.3 days a month of gale force winds, and between 0.5 and 2.4 windy days per month. Similar averages are experienced over the entire 180 km region.

*Table 25 – Average number of strong wind days at the MRO.*

<table>
<thead>
<tr>
<th>Strong wind</th>
<th>Average number of strong wind days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Jan</td>
</tr>
<tr>
<td>Windy days (wind speed 40–63 km/h)</td>
<td>2.4</td>
</tr>
<tr>
<td>Days with gale force winds (wind speed &gt;63 km/h)</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Narrow, localised storm events (storm cells)

The areas being considered to host SKA array stations are generally not in thunderstorm-susceptible regions (as shown in Figure 11). Although severe thunder storms can occur across Australia at any time of the year, they are very rare in the areas under consideration. The storms are usually short in duration as they move through an area.

Large hail events

Over the last 20 years in Western Australia there have been two large hailstone events, but neither have been in regions where it is proposed to site SKA array-stations. The areas being considered as locations for SKA array stations are not in large hail-stone-susceptible regions.

Flooding, flash flood occurrence

The areas being considered to host SKA array stations are not in flood-susceptible regions. The considerations of configuration determination managed under the EU FP7 PrepSKA program included having site proponents create geophysical mask maps of the intermediate region of 180 km radius around the proposed core site. The electromagnetic interference mask and geophysical mask map report for the Australian site is included here as Attachment 10. This shows the inundation areas for the intermediate region and it can be seen that no array-station sites are in areas prone to inundation. The core site is at a high watershed region between two river systems, as such it is not prone to water pooling or flooding.

Dust storms

Dust storms are not typical occurrences in the central area (see section on airborne particles).

Describe whether there are spatial variations in the factors listed above for the following regions

Variation along the spiral arms of the array out to 20 km from the centre

No variation in factors within this region would be encountered.

Variation further along the spiral arms at positions of antenna clumps out to 180 km

Very little variation occurs out to 180 km. Neighbouring weather stations are located across the proposed array and there is very little variance in statistics between these weather stations. For example, mean annual minimum and maximum temperatures vary by +/- 2 °C and mean annual rainfalls varies +/- 35 mm across the entire 360 km zone.

Variation in individual remote sites

Australia-wide spatial variation maps have been included throughout this report to display the physical characteristic variations across the continent. The climate is fairly uniform across the Australian continent, as indicated in the Sections above. Most volatile climate regions are in the far north and there are no array-stations in these regions.

The ANZSCC has proposed a motivated alternative configuration to the configuration of the Model SKA (see Attachment 27). The motivated alternative configuration offers SKA the capacity to build a financially achievable infrastructure solution that still delivers transformational science. The motivated alternative configuration within Australia is predominantly a subset of the compliant configuration, and therefore the physical characteristics will be identical to the Model SKA for the inner 180 km zone with no change in physical characteristics for the remote stations. The array-station in the wettest most northerly site has been removed from the motivated alternative configuration and the array-stations on the coast in the south have been moved inland somewhat away from the coastal region.

The modified alternative configuration also includes an array-station in the south of the South Island of New Zealand. The physical characteristics to be expected in this region are presented in Attachment 12.
Other Selection Factors
Political, Socio-economic and Financial Situations

One of CSIRO’s Australian SKA Pathfinder antennas at the MRO. Photography by T Crawshaw (CSIRO).
Report Summary: Political, Socio-economic and Financial Situations

Australia and New Zealand offer an excellent political, socio-economic and financial environment for the SKA project that ensures the capacity of the people, industry and governments to be valuable partners and hosts.

Australia and New Zealand offer advantages such as:

- Open democracies, ranked 6th and 5th in the world on an international democracy index
- Being well governed, ranking highly on a range of governance indicators, with effective policy and regulatory regimes and negligible corruption. They rank 8th and equal 1st in the world on an international perception of corruption index.
- An excellent business and major project environment, a low level of sovereign risk and excellent country risk ratings. They rank 10th and 3rd in the World Bank’s ease of business index and Australia has the highest possible credit rating.
- Being safe and prosperous, offering high living standards, health and education outcomes and an excellent range of public and private services. They rank 2nd and 3rd on the United Nation’s (UN) human development index.
- A skilled and motivated workforce with a high proportion of tertiary educated workers.
- Giving research and development (R&D) a high priority. Australia is 6th in the OECD for public expenditure on R&D. Astronomy is Australia’s highest impact science discipline.
- Notably strong economic conditions and outlook, growth forecasts of around 3 percent a year and amongst the lowest level of government debt in the world.

Political situation

Overview of the political system

Australia and New Zealand are both constitutional monarchies with a government based on the rule of law. In both countries the government is based on a popularly elected parliament (legislature) with a Prime Minister and a Cabinet of ministers appointed from parliament to conduct executive government. The independence of the judiciary in both countries is of great importance and strongly valued.

The Australian Constitution, which commenced in 1901, establishes a federal system in which legislative, executive and judicial powers are shared or distributed between federal institutions, six States and two Territories. New Zealand is not a federation of states.

Quality of governance

Australia and New Zealand are among the most stable, open and democratic countries in the world. Both have had uninterrupted democratic government for over 100 years. There have been no serious civil disputes in either country during this time.

Australia and New Zealand are both categorised as full democracies by the Economist Intelligence Unit’s Democracy Index 2010 (ranked 6th and 5th), reflecting the presence of free and fair elections, transparent government, flourishing political culture and respect for civil liberties.1

Both countries have strong public sector accountability measures that ensure the transparent, efficient administration of public funds and openness and integrity in government decision making and dealings. Australia and New Zealand have implemented extensive transparency measures including Freedom of Information provisions, independent, statutory auditing and investigation by independent anticorruption bodies with broad powers.

The public sectors in Australia and New Zealand are almost entirely free of corruption, being ranked 8th and equal 1st respectively in Transparency International’s 2010 Corruption Perceptions Index.2 The annual World Bank Group World

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1 The Economist Intelligence Unit, Democracy Index 2010, available at: [http://www.eiu.com/democracy](http://www.eiu.com/democracy)
Governance Indicators rank Australia and New Zealand highly on six indexes measuring quality of governance, voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption.  

There is strong emphasis in both countries on the highest standards of corporate governance, supported by organisations such as the Australian Institute of Company Directors, which provides a professional support network and accreditation, and the Australian Stock Exchange (ASX) Corporate Governance Council whose principles of good corporate governance and best practice recommendations listed companies are expected to adopt.

**Protection of human rights**

**Legislative and institutional protections**

The legal systems of Australia and New Zealand place great importance on the elimination of discrimination on grounds including gender, religion, race, impairment and age.


The Australian Human Rights Commission is an independent statutory authority that investigates complaints of discrimination and promotes the protection of human rights throughout Australia. In April 2010, the Australian Government also launched Australia’s Human Rights Framework which outlines measures to further protect and promote human rights in Australia, including ensuring that federal laws and programs are consistent with Australia’s international human rights obligations.

New Zealand adopted the UN Declaration on Human Rights in 1948 (as has Australia) and has since established legislation to promote and protect human rights. The New Zealand Bill of Rights Act 1990 specifies civil and political rights which arise from the UN International Covenant on Civil and Political Rights. The Human Rights Act 1993 established the Human Rights Commission, which advocates and promotes respect for human rights, encourages harmonious relations between individuals and among groups, monitors equal employment opportunities and helps resolve complaints about discrimination.

**Participation in international conventions and protocols**

Australia and New Zealand are party to the seven core UN human rights treaties and support the Declaration on the Rights of Indigenous Peoples. Latest reports from both countries to the UN’s Universal Periodic Review confirm that they meet, and often surpass, international human rights standards.

**Protection of the rights of Indigenous people**

As well as the protections provided by the other legislation, the special place of Aboriginal and Torres Strait Islanders to Australia’s history and culture is recognised by the Native Title Act 1993. The Act recognises that Indigenous people have a unique affinity with the land (and sea) and provides for a particular form of right over land.

The historic discrimination and injustice suffered by Indigenous people in Australia was recognised in the apology made to indigenous people by the Federal Government on behalf of all Australians in 2008. Australian governments are seeking to address the continuing legacy of injustice.

In New Zealand in 1835, the British Crown and Maori tribes established the Treaty of Waitangi, a formal agreement by which Maori gave the Crown rights to govern and continue settling the country. In return, the Crown guaranteed British citizenship for Maori and full protection of (and tribal authority over) their lands, culture and treasures. The Waitangi Tribunal Act 1975 established a permanent commission of inquiry into breaches of this treaty. The Ministry of Maori

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Development (\textit{Te Puni Kōkiri}) oversees Crown–Maori relationships, advises Government on policy and actively promotes Maori language, business, wellbeing, education and development.

**Positive business environment**

Australia and New Zealand provide a positive business environment with internationally benchmarked regulatory standards and competition policies.

Both countries have implemented extensive economic reforms to open up trade and eliminate inefficiencies. As a result, Australia and New Zealand have amongst the most flexible and resilient economies in the world, as evidenced by their strong performance during the economic downturns of recent years. A recent OECD review of regulatory reform in Australia noted that: “Australia has been one of the most successful OECD countries in weathering the Global Financial Crisis. Mature regulatory settings and a strong fiscal position have worked in Australia’s favour; it was amongst the few OECD countries which did not enter a recession”. The OECD further said Australia’s system for assessing the benefits of new regulation is amongst the most rigorous and comprehensive in the world.\(^6\)

The OECD review also noted that: “\textit{Australian competition law has been effective in establishing robust and competitive markets}”. Some of the key reforms have been: currency and financial market deregulation, reform of public enterprises, decentralisation of the industrial relations system, introduction of strong competition policy, reduction of trade barriers and industry protection, and further opening up of the economies through free-trade agreements. An important feature of the business environment in Australia and New Zealand is the emphasis on open, globally focused government procurement, of which the CSIRO Australian SKA Pathfinder (ASKAP) project is an example.

Both Australia and New Zealand ranks highly in measures of conduciveness of the business environment:

- Australia ranks 10\(^{th}\) and New Zealand 3\(^{rd}\) in the World Bank’s Ease of Business index for 2010\(^7\)
- Australia ranks 9\(^{th}\) and New Zealand 21\(^{st}\) in the 2011 IMD World Competitiveness Scoreboard.\(^8\)

Both Australia and New Zealand rank highly on indexes of sovereign or country risk. They are among the handful of tier one countries in the June 2011 Euromoney Country Risk Index\(^9\). Australia has also earned the highest possible credit ratings from international ratings agencies Standard and Poor’s, and Moody’s.

Australia and New Zealand have a long history of economic integration. The closer economic relationship (CER) Trade Agreement came into effect in 1983 and is widely regarded as one of the most comprehensive frameworks for bilateral economic integration in the world (the Legal report has further details).

**Major project environment**

Australia and New Zealand provide a high quality environment for major projects, in terms of support capacity and policy and regulatory settings. Both countries are characterised by their openness to foreign investment with Australia currently being the 6\(^{th}\) largest recipient of foreign investment in the OECD, reflecting the competitiveness of Australia’s major project environment. Australia is also a regional financial market hub with the 3\(^{rd}\) most developed financial market in the world, according to the World Economic Forum.\(^10\) Australia’s banking sector has been one of the most stable in the world in recent years.

Western Australia is the site of some of the largest projects anywhere in the world, including the €28.7 b Gorgon liquefied natural gas project. In total, resource projects worth more than €133 b are currently underway in the state. Australian companies have a proven capability with large scale complex technology projects and in being part of global supply chains to deliver them. Australia and New Zealand offer a range of companies who could work closely with specialist technology providers to provide project management capability in Australia for the delivery of integrated system-of-systems to meet the requirements of a large international project such as the SKA.

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\(^6\) OECD Directorate for Public Governance and Territorial Development, 2010, \textit{Australia: Towards a Seamless National Economy}, available at: \texttt{http://www.oecd.org/document/63/0,3746,en_2649_34141_44529023_1_1_1_1,00.html}

\(^7\) See: \texttt{http://www.doingbusiness.org/rankings}

\(^8\) Available at: \texttt{http://www.imd.org/research/publications/wcy/}

\(^9\) See: \texttt{http://www.euromoneycountryrisk.com/}

The SKA would have the option of seeking to access the Australian Government’s Major Project Facilitation program. This provides tailored facilitation in relation to Federal and State approval processes. Services include assistance in obtaining approvals and in dealing with other Federal, State and Territory government agencies.

Industry engagement on the SKA

There has been a strong emphasis in SKA project activities in Australia and New Zealand on effective and collaborative engagement with industry. The Australasian SKA Industry Consortium (ASKAIC) brings together companies from various sectors and of various sizes to provide a valuable source of advice, significant prior experience in major projects and a conduit to maximise engagement with, and contribution of, the private sector to the SKA. ASKAIC has made a significant contribution to developing understanding of the non-science benefits of the SKA and in using its international reach to spread that message.

As the SKA’s longest-established industry consortium, ASKAIC has recently taken the lead in the development of strong links to similar clusters and organisations in a number of key stakeholder countries, resulting in the signing of a memorandum of understanding between SKA-focused industry clusters and organisations in July 2011.

A letter, signed by representatives of the member companies of ASKAIC, supporting the Australia–New Zealand candidature to host the SKA, is at Attachment 40.

Socio-economic situation

Australia and New Zealand offer residents high socio-economic standards and are amongst the safest, healthiest, most prosperous countries in the world. The United Nations Development Programme Human Development Index, a composite measure of national wellbeing, ranks Australia and New Zealand as the 2nd and 3rd most highly developed nations globally.11

Outstanding health indicators

Australia and New Zealand rank highly in many health indicators. There are low levels of serious and chronic communicable diseases and violence and both countries offer universal health care operated by efficient health systems. Both also have notably clean environments and high quality supplies of food and drinking water.

Life expectancy for an Australian born in 2010 is 81.9 years, for New Zealand it is 80.6,11 both exceeding the OECD average. Residents of Australia and New Zealand have amongst the lowest rate of mortality from communicable diseases: 18 and 15 respectively per 100,000 of population.12

The universal health care systems of both countries would be available to SKA employees with permanent resident status. A mixture of modern, well funded universal public, and optional private, medical services is available. Australia’s health expenditure as a proportion of GDP is around 8.7 percent, slightly less than the 2008 OECD average.13

High living standards

Australia and New Zealand both have advanced, modern, mixed economies that deliver high levels of material wellbeing and standards of living. Australia’s GDP per capita is €29,950 (higher than the G8 countries) and New Zealand is €17,225.14 Economic equality in both countries is high by international standards.

Cities in Australia and New Zealand fare well in quality of life measures. For example, Perth is rated the world’s 8th most liveable city in the August 2011 Economist Liveability Rankings.15 Other Australian and New Zealand cities are


**Excellent educational attainment and skill development**

Both Australia and New Zealand have an educated, literate workforce capable of being engaged in the type of technical and high skill supporting roles required by the SKA. The United Nations Educational, Scientific and Cultural Organization (UNESCO) figures show both countries have the world's highest school life expectancy rate (the number of years of schooling a child can expect to receive) at 20 years.17

Of the Australian population aged over 25: 35.8 percent have a tertiary qualification, 3.5 percent another post-secondary qualification, 30.7 percent have upper secondary schooling, 22.2 percent lower secondary and only 7.7 have just primary schooling.18

Oceania/Australia also has a high level of e-readiness. The internet penetration rate is 60.1 percent, second only to North America at 78.3 percent.19

**Strong support for science and innovation**

Australia and New Zealand are notably research intensive and focused countries, making them well suited to participating in, and supporting, large global science projects.

Australia's gross expenditure on R&D (GERD) is 2.2 percent of GDP, the 12th highest in the OECD.20 As a result of recent increases in investment (see Australia's 10-year innovation plan, *Powering Ideas: An Innovation Agenda for the 21st Century*21), Australia now has one of the highest annual growth rates in GERD and has recently overtaken countries including France, the UK and Canada. In 2011–2012, for example, GERD will be €6.3b, an increase of 43 percent on 2007–2008 levels.22 And, amongst OECD nations, Australia has the 6th highest level of publicly financed R&D as a percentage of GDP.

In terms of research performance, Australia produces about 3 percent of the world's publications (ranking 9th among OECD countries) and has a citation impact well above world average. The discipline with the highest impact factor is astronomy. Astronomy papers with Australian authors receive, on average, 35 percent more citations per paper than the global average.23

Australia's science and research sector is globally connected, with our premier research grant and fellowship schemes open to international competition. In 2008 the Government announced the internationalisation of Australian Research Council funding, meaning support for international collaboration has been incorporated into the funding schemes of the National Competitive Grants Program.

New Zealand, too, has a strong strategic platform for science and innovation. The 2010 budget included substantial new investment for science and innovation and the Government released its landmark document *Igniting Potential, New Zealand's Science and Innovation Pathway*.24 The restructured funding arrangements and clear strategic priorities for investment places science investment at the heart of the Government's economic agenda.

As in Australia, the New Zealand government is investing heavily in rural broadband and ultrafast broadband projects.

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Support for astronomy in Australia and New Zealand

Astronomy in Australia has strong global connectivity. In the last 10 years, over 85 percent of Australian publications in astronomy were written with at least one international coauthor. International collaboration extends to access to Australian facilities: over 40 percent of users of the entirely Australian-funded Australia Telescope National Facility are from outside Australia and over 60 percent of the ASKAP survey science team members come from outside Australia.

Australia's astronomy facilities are well established and among the best in the world. The Australian Astronomical Observatory (formerly the Anglo-Australian Observatory) is one of the world's highest performing optical telescopes in its class. The Australia Telescope Compact Array is the world's second most prolific radio telescope and the Parkes radio telescope is one of the top three radio astronomy facilities, as measured by citations per paper.

Over the past five years alone, Australia’s Federal Government has contributed over €100 m to international partnerships in astronomy. This included a 6 percent share of the international Gemini Project, a €59 m investment in the Giant Magellan Project, the binational (until 2010) Anglo-Australian Telescope and the International Pierre Auger Project. Through CSIRO and the International Centre for Radio Astronomy Research (ICRAR), Australia has contributed over €6.7 m in staff resources to the PrepSKA phase of the international SKA project.

The Australian astronomy community has grown to over 800 people, an increase of 35 percent over the past five years. There has been a 50 percent increase in the number of students working towards a PhD in astronomy: from 157 in 2005 to 237 in 2010. The Australian astronomy community plans strategically for its future via a decadal planning process and associated mid-term review. The SKA has been identified as the highest priority new infrastructure item for the decade. The SKA has had strong bipartisan support at Federal and State government level over a number of years. Support for the SKA has been unaffected by changes of Federal and Western Australian State governments. During the 2010 Federal election, the Liberal–National coalition, currently the major opposition party in Federal Parliament, expressed its support for the SKA.

Involvement in the international SKA project, and the Australia–New Zealand collaboration, has catalysed the rapid development of radio astronomy in New Zealand, supported by government and the university sector.

Highlights include:

- Dramatic growth in the radio astronomy research community from zero seven years ago to 28 today (including 9 astronomy PhD/MSc students and 10 students specialising in signal processing, interference techniques, electronics or data transfer)
- New Zealand (through Victoria University in Wellington and in partnership with IBM New Zealand) has joined the Murchison Widefield Array radio astronomy consortium, providing high performance computing input
- Auckland University of Technology has invested €1m in a new 12 metre SKA prototype radio telescope, and committed €0.5m to upgrade the existing Warkworth radio telescope
- A significant new astronomy group has been established at the University of Canterbury, which is a partner in the South African Large Telescope Project
- The trans-Tasman eVBLI network demonstrated both the ability of Australian and New Zealand to jointly deliver an operational radio telescope which spanned both countries, and the absence of any legal or infrastructural barriers to the operation of an SKA across Australia and New Zealand.

Financial situation

Favourable economic conditions and outlook

Australia and New Zealand both have notably strong economic conditions and outlook.

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Australia has the 13th largest economy in the world, with GDP of around €2.1 t and two way trade in goods and services valued at €296b (2006–2007). The Australian economy has experienced a real economy average growth rate of 3.2 percent since 1991 and is forecast to grow at an above-trend rate in 2011–2012 and 2012–2013, supported by strong economic conditions in the region.27 Also, Australia did not have a recession during the recent global economic slowdown.

In its latest economic outlook (May 2011), the OECD expects the Australian economy to rebound after disruptions caused by major natural disasters in early 2011, driven by the rebuilding of damaged infrastructure and historically high terms of trade. The OECD forecasts GDP growth will accelerate from 2.9 percent in 2011 to 4.5 percent in 2012.

Australia’s unemployment rate is low compared to most other OECD countries. Nationally, it has been, and remains at, generationally low levels and is forecast to remain low, especially in Western Australia. Inflation has also been low for a number of years and is forecast to remain low.28

New Zealand Treasury forecasts that their economy will grow by an average of three percent over the next three years, boosted by rebuilding work following the Canterbury earthquake. The annual inflation rate is expected to remain within the Reserve Bank’s 1–3 percent target band from mid-2012. Total employment is forecast to rise, particularly in response to growing demand for labour in the construction sector.

Australian and New Zealand Treasury forecasts are at Attachment 13.

**Robust public finances**

Australia and New Zealand have amongst the lowest levels of public debt in the world. In Australia, the expected underlying cash deficit for 2011–2012 is €15.1 b (1.5 percent of GDP) with gross public debt less than 25 percent of GDP. This compares favourably with the forecast average OECD deficit of 6.7 percent of GDP and government debt of 102 percent of GDP in 2011.

Australia is forecast to have a budget surplus of €2.3b (0.2 percent of GDP) in 2012–2013. Treasury notes the return to surplus in two years’ time is expected to be achieved despite the impact of natural disasters and a weaker near term outlook for tax receipts. New Zealand’s current account deficit was €4.4 m in March 2011, which represents 4.3 percent of GDP (Statistics NZ). The Treasury forecasts that the operating balance will return to surplus in 2015.

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Customs and Excise

Signs point to the location of infrastructure at the MRO. Photography by R Hollow (CSIRO).
Report Summary: Customs and Excise

Australia and New Zealand are among the most open economies in the world and have efficient, transparent systems to manage the import and export of goods.

For example:

- Both countries have notably efficient customs processes
- Goods imported by the SKA into Australia are highly likely to be exempt from tariffs
- Personal and household effects brought into Australia by SKA employers will be exempt from tariffs and taxes
- Goods and services tax (GST) on imported items will be claimable as a business expense (through the Deferred GST Scheme, that process can be managed very efficiently)
- There are no import/export restrictions likely to impact on the SKA, though exemptions are available if required.

Australia and New Zealand have efficient and competitive taxation systems that are equitable, transparent and provide long term certainty. Depending on how it is constituted, there are options for the SKA to potentially be exempt from certain taxes.

Customs and excise

Customs

Trade liberalisation policies

As part of an ongoing process of economic reform, Australia and New Zealand have both adopted policies to open up their economies to international trade: they are now amongst the most open economies in the world. In the view of the World Trade Organisation (WTO), Australia’s trade policy framework “continues to be characterised by an unusually high degree of transparency” and that Australia is “one of the most open economies in the world”. They further say Australia has “successfully weathered the global financial crisis without any backsliding on trade liberalisation or action to influence the value of its currency”.¹

Both countries have systematically eliminated or reduced tariffs and other trade or protectionist barriers. More than 96 percent of Australia’s tariff lines are applied at a ‘most favoured nation’ rate of 5 percent or less, with over 46 percent being duty free. Both Australia and New Zealand have a number of free trade agreements, listed in Attachment 14.

Tariffs and tariff concessions on imported goods

Some goods imported into Australia are subject to customs tariff, with an average applied tariff rate of 2.9 percent. However many categories of imported goods are duty free, for example switching, routing and data processing apparatus.

Customs systems and processes in Australia and New Zealand are highly efficient. According to the WTO, Australia’s customs documentation requirements: “have remained minimal and computerised customs clearance has facilitated virtually all imports and exports”¹.

Australia’s customs tariff system also offers a number of general concessions, several of which would likely apply to the SKA. Depending on its legal structure and other factual matters, it is likely that goods imported by the SKA would be duty free, on the basis of one or more of the following concessions:

- Scientific instruments and apparatus to which certain UNESCO agreements apply (Customs Tariff Act 1995, Schedule 4, Item 1D)

• Goods owned by, and for the use of, a foreign government, where the goods are required in accordance with an agreement or arrangement between the Government of Australia and that of another country (Customs Tariff Act 1995, Schedule 4, Item 4). This exemption, where relevant, also provides a GST exemption.

• Goods that are for the official use of an international organisation established by agreement between the Government of Australia and the government of another country or countries (Customs Tariff Act 1995, Schedule, Item 7)

• Goods of a scientific nature that are covered by an agreement or arrangement between the Government of Australia and the government of another country on cooperation in the field of science and technology (Customs Tariff Act 1995, Schedule 4, Item 16).

The Customs Tariff Act 1995 also provides that most personal and household effects imported by individuals and families intending to take up temporary residency are free of duty and not taxable.2

In New Zealand, imports from Australia are not subject to tariffs or restrictions, unless items are specifically prohibited. There is no duty payable on goods imported from other countries for educational, scientific or cultural purposes. Imports of technologically advanced capital equipment avoid import duty if they have greater efficiency and/or higher performance or productivity characteristics than equipment available from New Zealand manufacturers. Other imports of manufactured goods attract duty of 5 percent.3

**GST and excise payable on imports**

In Australia, GST is generally payable on imported goods. Provided the SKA is registered in Australia for the purposes of GST, the GST payable on imports would generally be claimable as an input credit for business expenses. The Australian Taxation Office operates a Deferred GST Scheme through the Australian Customs and Border Protection Service which allows GST liability on imports to be deferred, and usually offset, by input tax credits within the same Business Activity Statement cycle.

A customs tariff equivalent to excise is applied to imports of excisable goods (such as alcohol, tobacco and liquid fuel) and collected at the border. However, it is unlikely that the SKA would import excisable goods.

In New Zealand, all imports are subject to GST of 15 percent of customs value. Excise duties apply to imported alcohol, tobacco, automotive fuels, natural gas, LPG and biodiesel (if blended with motor spirit.)

**Import/export restrictions**

A number of import and export restrictions apply to certain high risk goods entering and leaving Australia and New Zealand. There are no restrictions that are expected to impact on the SKA in Australia or New Zealand. To the extent that the SKA may need to import or export restricted goods, it is generally possible for restrictions to be lifted with approval from the relevant government agency, or if certain conditions are met. However, the use of any asbestos materials should be avoided.

**Taxation and excise system**

The recent review of income tax across the OECD found that, for workers on the average wage, Australia is the seventh lowest taxing OECD nation for a single worker and the fifth lowest for a single income family with two children. New Zealand is the third lowest and the lowest, respectively.4

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2 Available at: [http://www.customs.gov.au/webdata/resources/files/SendingYourPersonalBelongingsToAustraliaAsCargoOrByInternationalMail.pdf](http://www.customs.gov.au/webdata/resources/files/SendingYourPersonalBelongingsToAustraliaAsCargoOrByInternationalMail.pdf)


4 OECD, 2011, *Taxing Wages 2009–10*, available at: [http://www.oecd.org/document/34/0,3746,en_2649_34533_44993442_1_1_1_1,00.html](http://www.oecd.org/document/34/0,3746,en_2649_34533_44993442_1_1_1_1,00.html)
When incorporating all taxes as a percentage of GDP, Australia is the sixth lowest taxing OECD nation and New Zealand is the fourteenth.\(^5\)

According to the recent Henry Review of Australia’s tax system, by OECD standards Australia has a relatively low reliance on consumption tax. Australia’s GST is effectively locked in at 10 percent, below the rate of most other consumption taxes. Australia also has comparatively low fuel taxes.\(^6\)

A general overview of Australian taxation laws is provided at Attachment 15. Note that this overview does not include advice on the potential exemptions that might apply to the SKA, which are considered in the following section.

Businesses established in New Zealand are liable for corporate tax of 28 percent on net profits, a GST of 15 percent on taxable supplies and variable fringe benefit tax on employee ‘perks’ that exceed €629 per year. Corporate tax applies to: registered companies (except for ‘look through’ companies where shareholders are liable for tax on profits), cooperative companies, incorporated societies, portfolio investment entities, specific savings vehicles, unit trusts, statutory producer boards and group investment funds. Personal income tax rates vary from 12.5 to 35 percent.

Australia has taxation treaties with 44 countries to prevent double taxation and tax evasion. New Zealand has double tax agreements with 35 countries.\(^7\)

**Options for taxation status**

The precise taxation status of the SKA will depend on its legal status in Australia (options for which are set out in the Legal Report of this response and other factual matters). The Government is willing to work with the SKA to address the issue of taxation status within the existing legislative and policy framework.

Within Australia’s taxation legislation there are a number of potential exemptions, for example:

- In respect of corporate income tax, bodies which are scientific institutions, charitable institutions or public education institutions may be exempt *(Income Tax Assessment Act 1997 (Cth) ss50–1 and 50–5)*
- Public authorities constituted under an Australian law are exempt from income tax
- Some charitable or not for profit entities are exempt from some State taxes, including (in Western Australia) payroll tax and land tax
- Exemptions available to specific, nominated organisations, including some types of international organisations.

**GST on partner government funding transfers**

The treatment of funding transfers to the SKA in relation to GST is a complex matter that can only be clarified and resolved when the details of the SKA’s legal status, how it will operate and how it will be funded are more clearly known. However, although this will depend on the precise nature of any agreement between the SKA and partner governments, it is likely that funding provided by partner governments to the SKA will not trigger a GST liability for the SKA because any ‘supplies’ made by SKA to partner governments would be treated as non-taxable exports under the GST law.

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One of the phased array feeds for CSIRO’s Australian SKA Pathfinder. Photography by J Sarkissian (CSIRO).
Report Summary: Legal

Australia and New Zealand offer the SKA project a mature and robust legal environment in which to operate:

- Wide range of options available for the legal status of the SKA in Australia and New Zealand
- Transparent and robust process to acquire sites for the SKA
- Seamless cross jurisdiction policy, legal, regulatory and operating environments across the 5,000 km span of the proposed Australia–New Zealand configuration
- Highly professional and well resourced judicial systems and other dispute resolution mechanisms
- Accession to relevant international law and dispute resolution agreements
- Comprehensive laws to protect intellectual property
- Strong support for the SKA project from the collaborating governments

Overview of Australian and New Zealand legal systems

Principles such as the rule of law, procedural fairness, judicial precedent and the separation of powers (especially the independence of the judiciary) are fundamental to the legal systems in Australia and New Zealand. All people are equal before the law and safeguards exist to ensure that people are not treated arbitrarily or unfairly by governments or officials. The common law system, as developed in the United Kingdom, forms the basis of jurisprudence in Australia and New Zealand. In all cases, defendants are considered to be innocent until proven guilty beyond all reasonable doubt. There is no death penalty in Australia or New Zealand.

The SKA and its employees would have access to highly professional and well resourced judicial systems, which have a reputation for dealing with matters fairly and expeditiously, to resolve any civil or criminal legal issues. Both countries also have independent and accessible systems of non-court dispute resolution and administrative review of government decisions.

Further details on separation of powers in the Australian federal system and the legal systems and courts of Australia and New Zealand are provided at Attachment 16.

Access to international law dispute resolution mechanisms

Australia and New Zealand have variously acceded to relevant civil and commercial international law and dispute resolution agreements, providing certainty in resolving disputes that might arise, including in connection with the movement of goods and services across borders. Details of the specific mechanisms available are at Attachment 16.

The Australian and New Zealand governments have signed an Agreement on Trans-Tasman Court Proceedings and Regulatory Enforcement. This Agreement, when in force, will remove many of the procedural barriers to hearing and resolving trans-Tasman disputes by providing simplified processes for serving court documents and subpoenas, hearing interim relief applications, remote appearances and mutual recognition and enforcement of Australian and New Zealand judgments.

Options for the SKA to acquire legal capacity

The Australia–New Zealand SKA Coordination Committee (ANZSCC) has sought preliminary legal advice on the options available for the SKA to acquire legal capacity.
Based on that advice the SKA may have at least the following options for conducting its activities in Australia:

1. Remain a UK-incorporated entity
2. Transfer incorporation to Australia
3. Incorporate a new entity in Australia
4. Be constituted as a statutory corporation
5. Be declared an international organisation under the *International Organisations (Privileges and Immunities) Act 1963* (Cth) (the IOPI Act).

The above options provide the SKA and members with a high degree of flexibility in how they choose to proceed should the Australia–New Zealand site be chosen. The Australian Government is willing to work with the SKA regarding the options to acquire legal capacity.

## Formal arrangements between Australia and New Zealand regarding the SKA project

There has been close collaboration between Australia and New Zealand on the SKA project for a number of years. Prior to formal governmental involvement, Auckland University of Technology was a member of the Australasian SKA Consortium, and has contributed to Australia's subscription to the international Project Office since 2005.

The Australian SKA Coordination Committee (ASCC) was established in 2007 through a memorandum of understanding between the Federal and Western Australian governments as the governance mechanism for Australia's SKA activities and site bid. In August 2009, the Australian and New Zealand governments signed a ministerial level arrangement to develop a scientifically optimal trans-Tasman configuration for the SKA, a joint siting bid and to work in concert to advance the science of radio astronomy. The arrangement integrated New Zealand into what became the ANZSCC, a body which provides an effective, flexible mechanism for high level collaboration and coordination between governments.

The Australian and New Zealand governments are both signatories to the Letter of Intent establishing the SKA Founding Board and are full members. Both have indicated an intention to be full members of the SKA and to commit funding significantly above the minimum required level to support the next phase (preconstruction) of the SKA project.

The Australian Government has indicated an intention to commit new funding of €23 m if the Australia–New Zealand site is selected, and €4.3m if the site is not selected. The New Zealand Government has indicated an intention to commit €3 million if the Australia–New Zealand site is selected, and €1 million if the site is not selected. Given their participation in the SKA program to date and commitments to the next phase of the project, the Australian and New Zealand governments have given strong signals of their intentions to cooperate closely to facilitate the SKA project and to be major partners in the project both jointly and in their own right.

In the event that the decision is made to locate the SKA in Australia and New Zealand, the governments of both countries offer to enter into a joint agreement with the SKA (and/or project partners, as appropriate) regarding the support that will be given by the governments, jointly and separately. They also offer to continue to provide a mechanism for high level collaboration and coordination between the governments.

A joint letter of support and intent in this regard, from the Prime Ministers of Australia and New Zealand, is included in this response as a preliminary document. The letter is also signed by the Premier of the State of Western Australia indicating Western Australia's support for the joint submission.

## Facilitation of cross jurisdictional operation of the SKA

Australia and New Zealand are sovereign, but closely allied, nations with highly integrated economies and collaboration across a range of policy areas. Together Australia and New Zealand are able to offer the SKA a seamless cross
jurisdictional environment in which to operate. Significant progress has also been made towards the establishment of an integrated and jointly regulated telecommunications system across the two countries.

**Within Australia**

Within Australia, the federal system of government is well suited to facilitate the operation of national scale organisations. In particular it should be noted that the Constitution guarantees the free movement of people and goods between States. In addition, Australia’s telecommunications system is regulated at the national level and is operated as a single integrated national market.

There has been significant reform of Federal–State relations in recent years through the Council of Australian Governments (COAG), which operates through a number of ministerial councils charged with enhancing cooperation and harmonising and improving administration across a wide range of areas. For example, there has been reform to standardise legislation and coordinate policy and funding in areas such as: occupational health and safety, the health system, infrastructure, school curriculum, criminal and civil law, competition policy, water, climate change and food standards.

**Trans-Tasman Mutual Recognition Arrangement**

The Trans-Tasman Mutual Recognition Arrangement (TTMRA) is an agreement between the Australian Government, State and Territory Governments and the Government of New Zealand under the *Trans-Tasman Mutual Recognition Act 1997*. The purpose of the TTMRA is to implement mutual recognition principles relating to the sale of goods and the registration of occupations.

These principles, with a few exceptions, state that:

- A good that may be legally sold in Australia may be sold in New Zealand, and a good that may be legally sold in New Zealand may be sold in Australia. This is regardless of differences in standards or other sale related regulatory requirements between Australia and New Zealand.
- A person registered to practise an occupation in Australia is entitled to practise an equivalent occupation in New Zealand, and vice versa, without the need for further testing or examination.

The TTMRA came into force on 1 May 1998.

**Closer Economic Relations Trade Agreement**

Australia and New Zealand have a long history of economic integration. The Closer Economic Relationship (CER) Trade Agreement came into effect in 1983 and is widely regarded as one of the most comprehensive frameworks for bilateral economic integration in the world. The CER provides for a free flow of goods, services and people. Key features of the CER Agreement include the total elimination of tariffs and quantitative restrictions in trade between New Zealand and Australia and the harmonisation of customs procedures. The Agreement allows that, in general, goods and services provided in one country can be provided in the other.

In 2009 the governments agreed to create even stronger economic ties through entry into the Agreement Establishing the ASEAN (Association of Southeast Asian Nations) – Australia – New Zealand Free Trade Area. This provides a framework for trade and investment related cooperation that results in greater market access, transparency and certainty for companies doing business in the region. Australia and New Zealand continue to work closely together to improve market access for businesses and investors. Most recently further CER commitments in respect to business law and investment and the introduction of the Single Economic Market between the two countries have been aimed at removing regulatory barriers to trade in areas such as: company registration, accounting standards, competition policy, consumer protection, securities and insolvency, as well as lower compliance costs, reduction of red tape and improved legal certainty for investors.

Australia and New Zealand also have a common Standards framework.
Intellectual property law

Australia and New Zealand have comprehensive laws designed to protect intellectual property rights including patents, trade marks, designs and copyright. Australia’s common law also covers goods or services that are passed off as those of another. Commonwealth trade practices legislation also prohibits some passing off activities, for example, through prohibiting misleading and deceptive conduct. In addition, Australia's common law protects confidential information and trade secrets in certain circumstances.

IP Australia (part of the Department of Innovation, Industry, Science and Research, but operating independently and reporting directly to the Minister) administers those parts of Australia's trade marks, patents and designs systems having registration formalities, including trademarks, patents and designs.

Further detail on Australia’s intellectual property law framework is in Attachment 17.

Ownership of and access to, or use of, sites

Provision of sites for use by the SKA

Proposed array sites within the 180 km radius intermediate zone of the Australian SKA configuration are, for the most part, on Western Australian Government crown land that is currently leased under the Western Australian Land Administration Act 1997 for the purposes of pastoral activities. A range of options is available for acquiring the necessary interests in those sites, which may vary from site to site. In all cases compensation for acquisitions would be based on reasonable valuations.

The sites are also subject to native title claims made under the Commonwealth Native Title Act 1993. Native title is a pre-existing right in Australia, recognised by the courts, based on indigenous laws, customs and the connection of Indigenous people to the land. Native title is not given or granted by governments. The native title system is based on the principle that recognition of Indigenous peoples’ ongoing connection with their land should, preferably, be resolved by negotiation and mediation.

Although native title rights and interests to land can be compulsorily acquired (and thereby extinguished), the preferred approach is to negotiate an Indigenous Land Use Agreement (ILUA) which provides for the nonextinguishment of native title rights and interests. An ILUA allows people to negotiate flexible, pragmatic agreements to suit their particular circumstances. ILUAs can be tailored to meet the needs of the parties involved and their particular land use issues. It is usual for an ILUA to include some form of compensation commensurate with how the activities impact or restrict native title holders’ ability to exercise their native title rights.

An ILUA has been negotiated with the registered claimants for the native title claim area containing the Murchison Radio-astronomy Observatory (MRO) in relation to the ASKAP and other smaller radio astronomy projects. The same claim group, the Wajarri Yamatji, are the claimants for most of the sites proposed in this response for the intermediate zone. Depending on which sites are eventually required, one or two other claimant areas may also be involved. Similarly most of the sites proposed for the motivated alternative configuration are contained within two pastoral leases, including the Boolardy Station lease held by CSIRO.

The Governments have developed a draft strategy to acquire the relevant interests, which they propose to discuss with the SKA (and/or SKA project member states and organisations) in detail, should the sites be required, including how to resolve the issue of the costs of acquiring land access.

Licences and/or permits required to deploy the SKA

The SKA project would require certain approvals, including:

- All developments in Australia are subject to planning and building compliance legislation, regulation and codes administered through the relevant government authority. The SKA would need to interact with government authorities to obtain, where relevant, the appropriate approvals for infrastructure development, construction, and
where applicable, ongoing operations. Timelines for approvals vary but the Australian and Western Australian
governments will ensure, to the extent possible, that the SKA will be treated as a priority.

- Approval under the Western Australian Mining Act 1978 to ensure that any mining activity in the area is
  compatible with confirmed SKA sites
- Approval under the Heritage of Western Australia Act 1990 to ensure appropriate action is taken to preserve
  important places of cultural heritage significance, including buildings, structures, cemeteries, and archaeological
  sites
- Approval under the Western Australian Aboriginal Heritage Act 1972 to ensure appropriate action is taken to
  preserve important Aboriginal places and objects. Gaining heritage approval would require an Aboriginal
  heritage survey to be undertaken to identify and register important places and objects.

Environmental approvals

The SKA project would be required to comply with relevant Federal and State environment protection legislation, namely:

- The Western Australian Environmental Protection Act 1986 which provides for the prevention, control and
  abatement of pollution and environmental harm, and for the conservation, preservation, protection,
  enhancement and management of the environment in Western Australia. Under this Act, environmental impact
  assessments are required for major projects. Surveys and reports will be required for the SKA project to comply
  with this legislation.
- The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 which covers
  environmental and heritage related issues. Proponents are required to assess proposed developments with
  regard to matters of National Environmental Significance, including threatened species, ecological communities
  and natural and cultural heritage places. A referral will need to be submitted to the Department of Sustainability,
  Environment, Water, Population and Communities to establish the significance of the impact of the SKA.

It is estimated that an environment impact assessment and approval process for the SKA project would take
approximately 18 months to complete (depending on how quickly the SKA can provide the necessary documentation). It
is noted that the approval processes for the ASKAP telescope and optical fibre link from the MRO to Geraldton were
straightforward, with the project not requiring Federal approval. For reference, the ASKAP environmental assessment is
at Attachment 18.

ANZSCC anticipates that the SKA would have a moderate overall environmental impact, though spread across a number
of sites. The impact beyond the actual locations of array stations would be minimal. Overall, the impact is expected to be
significantly less than a large scale mining operation, of which there are many in Western Australia.
Low noise amplifiers used in CSIRO’s Australian SKA Pathfinder. Photography by R Bolton (CSIRO).
Report Summary: Security

Australia and New Zealand offer a highly attractive location for the SKA from the perspective of security. Physical asset and personnel security for the SKA in Australia and New Zealand can be provided at a low cost and organisational overhead:

- The remoteness of the MRO affords it a natural level of security. The surrounding region is sparsely populated and has a low level of crime
- Standard, low-key measures, similar to those in place at other Australian and New Zealand radio astronomy and similar facilities will be sufficient to adequately secure physical assets and on-site personnel
- Off-site personnel would live in safe, well policed communities with no additional requirements for security. Cities and towns in Australia and New Zealand experience levels of crime and violence typical for developed countries
- Aviation and road safety is very good in Australia and New Zealand
- Environmental and other operational risks are moderate and have been well anticipated and planned for
- Insurance requirements and costs will be modest.

A safe, secure environment for the SKA

The requirements for providing an acceptable level of security for SKA project personnel and physical assets would be relatively low key and cost effective in Australia and New Zealand. In general, Australia and New Zealand provide a safe and hospitable living and working environment with moderate levels of crime consistent with the levels experienced in other OECD countries (see Attachment 19 for further details). Overall provision of security for the SKA in Australia and New Zealand would be based on standard, commonsense measures, with no extraordinary provision required. Further information on security measures adopted at Australia’s existing radio astronomy facilities is at Attachment 20.

The Murchison Radio-astronomy Observatory (MRO), proposed site for the core area of the SKA, is located around 100 km from the nearest settlement and 320 km from the nearest major town in a region that experiences low levels of crime. The MRO is located within the boundaries of the 345,900 hectare Boolardy Station (under a pastoral lease currently owned and operated by CSIRO). This remoteness affords the site a natural level of security.

Western Australia has extensive remote area infrastructure. As such, there is extensive experience and a range of service providers available to meet the requirements of the SKA. The level of security proposed for the remote sites is comparable with that provided at remote mining sites in Western Australia but less intense as safety concerns associated with the operation of large machinery in a mine need not be addressed to the same degree.

Construction site

The scope of this project requires a large construction workforce which, for the main remotely located facilities, will require the provision of on-site accommodation for up to 400 people. During construction, the security of the site, its material, workers and visitors will be the responsibility of the selected construction contractor(s).

Construction security requirements will include site access control, security of plant and machinery, security of materiel and control of personnel, contractors and visitors. All personnel working on or visiting construction sites will be required to undergo a site specific induction process covering both safety and security.

Ongoing operations

The Operations and Maintenance Infrastructure Staffing Plan (Attachment 24) has allocated three staff to site security. This ensures that at least one security officer will be present on site at the Operations Centre near the Centre of the Array (OCCA) at all times. The officer’s responsibilities would include preparation and maintenance of the individual site security management plans as well as specific requirements for site security, access control, CCTV, visitor management and control. The officer would be reachable 24 hours a day and have at their disposal a suitable vehicle for access around the OCCA and core sites.
It is suggested that occupational health and safety (OHS) officers should also be appointed to oversee all sites including those in Perth and Geraldton. Health, safety and environmental sustainability are fundamental to the way CSIRO operates the MRO. A manual has been developed to assist CSIRO staff members and affiliates working on the ASKAP project understand the expectations of them in maintaining the highest possible standards of safety, health and environmental sustainability in line with wider CSIRO policy and procedures (see the Working and Support Environment report for details). An OHS manual for SKA operations would be developed in a similar fashion.

Physical assets

The assessed major threats to SKA’s facilities are theft of material or intellectual property, physical damage resulting from vandalism, theft or attempted theft and attacks on personnel. The expected threat level is low in keeping with the relative isolation of sites and the good law and order environment in the areas proposed for SKA infrastructure.

All offices and technical facilities in Perth and Geraldton will be built to good commercial standards. Electronic access control will be required for critical areas and computer server rooms. Commercial security alarm systems and CCTV systems will be fitted where determined appropriate by a threat and risk assessment. Security for the supercomputing facility will be subject to ongoing review due to the critical role it plays in this project. Access to critical areas of this facility will be restricted to those with a need for access through the use of an electronic access control system. Lighting levels in office car parking and building surrounds will be set at a level to deter potential aggressors or trespassers. Security alarm systems will be monitored by a commercial alarm monitoring centre. CCTV images will be recorded and used for post-event analysis.

For the remote facilities, individual antenna structures will be designed with minimum entry locking points and would be unfenced. The installation of a security alarm system is not warranted due to the remoteness of the sites. Local power generation equipment will be fenced. Additional protection could be provided by burying diesel tanks and locating associated pumps in locked housings. Maintenance personnel would be expected to check for signs of attempted unauthorised access to remote facilities during routine visits. CCTV images will be recorded and used for post-event analysis.

The buildings forming the central core will be built to good commercial standard. Important areas of these buildings, including equipment storage areas, control rooms and computer server rooms, will be provided with electronic access control. CCTV will be installed where deemed appropriate to provide further risk mitigation in selected areas. CCTV images will be recorded and used for post-event analysis.

Consideration will be given to installing a stock fence around the remote operations centre to exclude domestic stock. This is considered an appropriate level of protection and is the standard being adopted for ASKAP and other national radio astronomy facilities in Australia.

The airstrip will not be fenced. Pilots using the airstrip would be instructed to undertake a low-level assessment prior to landing to scare any fauna from the immediate vicinity.

Project employees

Security for on-site and near-site resident staff

Security of staff at the on-site and near-site facilities will be greatly assisted by the remoteness of the sites. The likelihood of unauthorised visitors to the site is low although some recreational four-wheel drive vehicles may be expected. The facilities are located within the boundaries of the Boolardy Station, which is currently operated by CSIRO under a pastoral lease.

Appropriate signage indicating access rights and arrangements will be located at major entry points to the site. All on-site buildings will be constructed in accordance with local, state and national building codes and standards including relevant provisions for bushfire and cyclonic protection. All buildings, including residential accommodation, will be lockable. General surveillance CCTV will be provided in the areas surrounding residential accommodation and recreational facilities. CCTV images will be recorded but will not be monitored live.
Electronic access controls will be used for entry to personal accommodation. External lighting in these areas will provide sufficient illumination. Day/night CCTV cameras will be installed around the accommodation and recreational areas to provide general wide-area surveillance. CCTV images will be recorded for post-event analysis of any incidents.

Security for off-site staff

Project personnel located in Perth and Geraldton will be subject to a security environment typical of Australian cities and regional centres. The vast majority of areas in Perth and Geraldton are safe to walk around at any time of the day or night. This type of environment is comfortable and familiar for most people, with no special security provision necessary.

Environmental risks

Due to the remoteness of some of the infrastructure, staff working in these areas will be subject to various, moderate environmental risks. Staff will therefore be required to follow standard procedures such as those introduced by CSIRO for staff already working at the MRO. The health and safety plan to manage environmental risks is covered in the Working and Support Environment report.

Procedures will be adopted to ensure that details of staff and vehicles travelling to remote areas will be sent to the operations centre prior to their departure. Details of staff, vehicles used, route, and times of travel and duration will be recorded.

In addition to the on-site security officer, it is anticipated that the operations centre will have staff trained in OHS procedures who would be available 24 hours a day via a roster on-call system. Staff will be responsible for maintaining contact with vehicles and staff in remote areas, close-of-business security checks, visitor management and access.

Road and aviation safety

Australia has an excellent road and aviation safety record:

- In 2009 there were 1,492 road deaths in Australia (190 in Western Australia, which equates to 0.95 deaths per 10,000 registered vehicles. This rate is below the OECD median and is bettered by only six other OECD countries (Sweden, UK, Japan, Netherlands, Germany and Finland).¹
- In 2009 there were 25 general aviation deaths, which equates to 18.3 deaths per 10,000 registered aircraft. A 2006 study by the Australian Transport Safety Bureau found that the rate of general aviation fatalities in Australia is similar to countries such as the US, Canada and New Zealand.²

Disaster or situation planning

Natural disaster plan

As part of project disaster management and contingency planning, a disaster management plan will be developed and tested. The plan will cover SKA personnel and site visitors and will provide a broad concept for responding to a range of natural disasters. Construction contractors will be expected to develop their own disaster management plans. It is expected that the SKA project and construction contractor plans will be similar in content but would have different management reporting and response arrangements.

Security threats

Any threats relating to national security or terrorism would be communicated to SKA management either by the Western Australia Police or directly from national intelligence agencies. Assistance in dealing with such threats would be made available by appropriate authorities including the Australian Federal Police, Western Australia Police, Emergency Management Australia, the Australian Defence Force and other appropriate government agencies.

Responses to lower level security threats would most likely come from the local police force. Management response will be dictated by the type of threat, likelihood of occurrence and availability of resources, and will be made in cooperation with local security authorities.

**Medical evacuation**

The remoteness of the operations centre and the antenna arrays requires the development of an emergency evacuation procedure for both medical and other reasons. Staff located at, or near, the operations centre would be able to be transported from the nearby airstrip using the Royal Flying Doctor Service or a charter aircraft. Non-emergency evacuation could also be undertaken by a suitable road vehicle. The project disaster management and contingency planning documents will contain a section detailing procedures and contact details to implement such evacuations.

The Royal Flying Doctor Service operates from a base at Meekatharra with two aircraft, four medical officers, eight flight nurses and five pilots (see the Working and Support Environment report for further details).

**Indicative costs of insurance provision for site/facility security and personal security**

Without a more complete understanding of SKA design and operation it is not possible to get a meaningful insurance quote. However, there are useful parallels between the planned SKA project and CSIRO’s infrastructure, activities and staff, and so a comparison with CSIRO’s insurance regime may provide useful information.

CSIRO has 6,000 employees located at 60 sites across Australia. Staff are involved in a mix of office and field work not dissimilar to the activities to be pursued by SKA staff. CSIRO has an annual turnover of €0.8 billion. In many respects it is not dissimilar to SKA operation, albeit approximately 20 times larger in scale.

CSIRO has a four-year lost time average of less than two incidents per million hours worked and a medical treatment rate of eight incidents per million hours worked. This leads to a worker’s compensation premium equivalent to 0.33 percent of payroll with Comcare, the agency responsible for workplace safety, rehabilitation and compensation in the jurisdiction of the Australian Government. The average rate for other Australian Government agencies is 1.6 percent of payroll.

In addition to insurance for worker’s compensation, CSIRO insures its properties and business activities with Comcover. Property insurance is the single largest item at €1.2 million, 0.05 percent of the total sum insured. Insurance for general liability, professional indemnity, directors and staff, business interruption, fraud, motor vehicles, and property in transit amounts, personal accident, travel (inside and outside Australia) and personal effects to €870,000 or approximately 0.1 percent of annual turnover. A risk management discount of 7 percent is applied to both these premiums.
Employment
Report Summary: Employment

Australia and New Zealand offer an excellent environment for the SKA project to attract a range of employees or contractors from the global and domestic labour market.

Australia and New Zealand offer:

- Highly skilled workforce — 49 percent of the Australian workforce is made up of managers, professionals and technical or trade workers and 56 percent of the working age population has tertiary qualifications
- Productivity levels are comparable with EU countries — and growing faster at 1.7 percent per annum
- Low levels of industrial action (less than 0.01 percent)
- Comprehensive legislative and regulatory frameworks for workplace relations, occupational health and safety and antidiscrimination
- Effective and successful skilled migration programs and a range of temporary and permanent visa options
- Excellent access to employment opportunities for spouses/partners with no gender discrimination
- Access to free public health care and education for permanent residents and, in many cases, education for temporary residents.

Recruitment of international and domestic staff

Labour market

The strength of the Australian and New Zealand economies in recent years has resulted in a dynamic labour market with a high participation rate, low unemployment rate and strong growth in demand and supply of skilled workers.

The Australian labour market has demonstrated the ability to sustain a significant growth in employment, including in skilled professions. In the 12 months to November 2010, for example, there was strong growth in employment of professionals (2.5 percent), technical and trade workers (6.4 percent) and machinery operators and drivers (6.7 percent). The expanding mining industry in Western Australia has been a major contributor to economic and employment growth in recent years, accounting for 86,100 (7.1 percent) of a total Western Australian workforce of 1.2 million. Western Australia's top five areas of employment by industry are: construction (11.2 percent), health care and social assistance (9.8 percent), retail trade (9.8 percent), education and training (8.0 percent) and professional, scientific and technical services (7.6 percent).

Australia and New Zealand have a comparatively highly skilled workforce. In Australia the largest occupational groups include: managers (13.2%), professionals (21.5%) and technicians and trade workers (14.8%). Also, 56 percent of Australia's working age population (15–64 years) has a post secondary school qualification.

The aggregate level of productivity of Australian labour is high by international standards. Australia, like the European Union (EU-15) and Canada, is between 85–90 percent of the benchmark US aggregate productivity, as measured by GDP per hours worked. Sectors such as construction, finance and transport and storage exceed this benchmark.

Labour productivity in Australia grew more between 2000–2007 than the EU-15 and Canada: 1.7 percent average per annum compared with 1.2 per cent.

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2 Australian Bureau of Statistics Labour Force, Australia, Detailed Quarterly (6291.0.55..003)
The Australian Government is committed to investing in training and education to further develop a highly skilled and capable workforce. The Government is implementing a range of measures as part of its Skills for Life package to support the sectors, regions and occupations that are expected to experience significant growth in labour demand in the short-to-medium-term. In 2011 there were 50,000 more undergraduate students enrolled at Australian universities compared with 2009. There are also now a record 448,800 apprentices and trainees across the nation.

Further details on the Australian and New Zealand labour market are in Attachment 22.

**Workplace legislation**

Australia and New Zealand have a strong commitment to ensure that workplaces are safe, healthy and fair. A range of legislation is in place to regulate the workplace environment and ensure that high standards are maintained for all workers. By law the same conditions apply to domestic and international workers.

**Workplace relations**

Australia

Most Australian employees are covered by a national workplace relations system, which is established by the Commonwealth *Fair Work Act 2009*. In Western Australia the national system does not apply to private sector employees who are not employed by constitutional corporations; these employees are covered by Western Australian labour laws. It is likely that the SKA would either be a constitutional corporation or another form of entity covered by the national workplace relations system.

In addition to the national scheme, employers and employees remain covered by other Federal and State and Territory laws, including those covering antidiscrimination, occupational health and safety (OHS), workers’ compensation, trading hours, public holidays and long service leave.

The rate of days lost due to industrial action has been relatively low for Australia compared to other OECD countries. From 2005–2008, 5–26 days were lost per 1,000 employees: generally higher than countries such as Germany, New Zealand, the Netherlands and the US, but lower than Canada, France, Spain and the UK.4

New Zealand

New Zealand has national legislation governing OHS, accident compensation and workplace relations. Employees can access collective or individual employment agreements and unions can negotiate collective working conditions on behalf of employees.

Legislation and organisations applicable to workplace relations in Australia and New Zealand are outlined in more detail in Attachment 23.

**Occupational health and safety**

Australia

Employers in Australia have a general duty of care to employees and operate under a comprehensive legislative and regulatory framework that has the principal objective of ensuring the safety and health of workers.

States and Territories have primary responsibility in this area. Employers are obliged to comply with relevant laws governing workplace OHS. These laws impose a range of duties on employers including the duty to provide safe premises, safe systems of work and appropriate training and supervision. There are criminal penalties for dereliction of these duties enforced by various bodies, such as WorkSafe (part of the Western Australia Department of Commerce). There is a national OHS Act which applies to Commonwealth employees.

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Australia is currently working to harmonise workplace safety laws across the States and Territories. The Commonwealth and State and Territory governments have signed the Intergovernmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety to harmonise OHS legislation by 2012. In 2009 an independent statutory body, Safe Work Australia, was established by the Federal, State and Territory Governments to collaborate with businesses, workers, employer and employee associations, and industry groups to achieve the best possible approach to health and safety across Australian workplaces.

All people working legally in Australia are covered by compulsory workers’ compensation schemes legislated at State and Territory level (Federal employees are covered by a national scheme). All schemes operate under a no fault concept in which the employer is held to be liable for workplace injuries. The SKA would be required to maintain the appropriate insurance cover in the relevant jurisdictions. For example, CSIRO pays 0.33 percent of its payroll in insurance cover for its staff.

Australia compares favourably with other OECD countries in rates of fatal and non-fatal injuries incurred by workers. In 2008 there were 2.1 fatal injuries per 100,000 employees. Compare this with: Italy 4, US 4, France 3.4 (2007), Spain 3.3, Canada 2.7, Germany 2.04, UK 0.7.  

New Zealand

The Health and Safety in Employment Act 1992 imposes OHS obligations on employers, employees and others which are comparable with requirements in Australia. Employers must provide a safe workplace (with proper training, supervision and equipment), identify, assess and manage hazards, and investigate health and safety incidents. Employees must take reasonable care to keep themselves safe and to avoid causing harm to others.

Employees who suffer an injury at work in New Zealand are entitled to compensation from an insurance scheme administered by the Accident Compensation Corporation.

Details of relevant occupational health and safety legislation in Australia and New Zealand are in Attachment 23.

Anti-discrimination and other legislation

The legal systems of Australia and New Zealand place great importance on the elimination of discrimination on the grounds of gender, sexual preference, marital status, race, religion, political conviction, impairment, or age. Legislation, and measures to eliminate discrimination, apply to workplaces and most other parts of the community.

A summary of the main Australian Federal, Western Australian and New Zealand legislative requirements, along with details of other legislative requirements with which the SKA may have to comply, is in Attachment 23.

Requirements for, and access to, work permits

The visa and migration systems of Australia and New Zealand would provide the SKA with a range of options to ensure it can readily source and employ professionals from any nationality or cultural background. Furthermore, the Trans-Tasman Travel Arrangement is a reciprocal agreement allowing the free flow of New Zealand and Australian citizens between the two countries. The arrangement allows for unrestricted work rights in both countries.

Overview of Australia’s visa and migration system

Australia has one of the most effective and successful skilled migration programs in the world. It is designed to complement the country’s existing labour force by providing flexible arrangements for skilled migrants and their families to stay in Australia on a permanent or temporary basis. The program is able to accommodate the needs of the SKA which naturally needs to source employees from a global skills pool.

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5 International Labour Organisation LABORSTA database, available at: [http://laborsta.ilo.org](http://laborsta.ilo.org)
Labour agreement

The SKA would have the option of negotiating a Labour Agreement with the Australian Government to streamline recruitment and entry processes, or for such an agreement to be included in a broader project hosting agreement. Many large employers have negotiated such agreements as they are an efficient way to sponsor skilled workers, both temporary and permanent. Labour Agreements are designed to be adaptable to the specific needs of a particular industry or employer.

Visa pathways

Employees of the SKA would have access to a number of visa programs, covering a broad spectrum of potential migrants’ circumstances, as outlined below.

<table>
<thead>
<tr>
<th>Visa option</th>
<th>Key features</th>
<th>Time to acquire</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans-Tasman Arrangement</td>
<td>• New Zealand citizens can travel to Australia without a visa and have full work rights</td>
<td>Issued on arrival</td>
<td>New Zealand passport holder meeting health and character requirements.</td>
</tr>
<tr>
<td>Temporary business (long stay)</td>
<td>• Sponsored from one day to four years</td>
<td>Median of 23 days</td>
<td>Requires employer sponsorship. Applicant must have English language skills and relevant qualifications.</td>
</tr>
<tr>
<td></td>
<td>• Eligible dependents allowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quick processing time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Extensive list of eligible skilled occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Option of Labour Agreements for large scale hiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employer nomination scheme</td>
<td>• Permanent residence &amp; access to government services</td>
<td>3–4 weeks on decision-ready applications</td>
<td>Three years full time work experience. Applicant must be no more that 45 years of age, unless exceptional circumstances exist. The nominated position must provide employment for at least 3 years.</td>
</tr>
<tr>
<td></td>
<td>• Top priority processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Eligible dependents allowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional sponsored migration scheme</td>
<td>• Permanent residence and access to government services</td>
<td>3–4 weeks on decision-ready applications</td>
<td>Once a visa is granted, the applicant must work for the sponsoring employer for 2 years. Relevant diploma or higher qualification required.</td>
</tr>
<tr>
<td></td>
<td>• Top priority processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Eligible dependents allowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Option of labour agreements for large scale hiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Perth and Geraldton are eligible locations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic travel authority</td>
<td>• For business or visitor purposes</td>
<td>Acquired online</td>
<td>Must hold a passport from one of 33 eligible countries.</td>
</tr>
<tr>
<td></td>
<td>• No work rights</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Valid for 12 months for stays of up to 3 months at a time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• On the spot grant to eligible applicants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Access to public services

Medicare

Permanent residents of Australia have access to Medicare, a system which provides free treatment in a public hospital and free, or low cost, treatment by participating general practitioners, medical specialists, optometrists and dentists (specified services only). Most temporary visa holders are not eligible for Medicare (although there are some exceptions) and are advised to have private health insurance.6

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Schooling

Australia has a compulsory schooling system for children less than 15 years of age. There are extensive government and non-government (private, typically full fee paying) school sectors. Most non-government schools have some form of religious affiliation.

As schooling is primarily the responsibility of the States and Territories, arrangements for migrant access to government schools vary: Western Australia makes generous provision for migrant access to government schools. In all States, permanent residents are entitled to attend government schools and are subject to the same fees as local students (a voluntary contribution). In many cases, particularly in Western Australia, temporary visa holders and visitors are also able to attend government schools on the same basis as local students, although that access may depend on the precise visa class and the availability of places. In some cases there may be a requirement to pay full school fees.7

Information about Australia’s schooling system is available from the Department of Education, Employment and Workplace Relations.8

Social welfare

Newly arrived migrants can access a number of social welfare payments including: health care concession cards, Family Tax Benefits and Child Care Benefits. However, access to income support is limited to permanent residents entering through the humanitarian program and is not generally available to other permanent residents in the first two years after their arrival. Furthermore, the level of assistance provided depends on the subclass of visa held.

Overview of New Zealand’s visa and migration system

New Zealand’s visa and migration system offers a range of options for visitor, and temporary and permanent resident work visas. Time to acquire a visa varies according to visa type and workload of the Immigration New Zealand branch processing the application, as outlined below.

<table>
<thead>
<tr>
<th>Visa option</th>
<th>Key features</th>
<th>Time to acquire*</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visa waiver agreements</td>
<td>Citizens of 57 countries automatically receive a free 3-month visitor visa.</td>
<td>Issued on arrival</td>
<td>Citizen or resident of a country with a visa waiver agreement with New Zealand</td>
</tr>
<tr>
<td>Temporary work</td>
<td>3 months to 3 years</td>
<td>25–30 days</td>
<td>Good health, good character, passport valid for 3 months beyond intended visit</td>
</tr>
<tr>
<td>Specific purpose</td>
<td>Available to people who: install or service specialised equipment supplied by an overseas company; take up a position in a multinational company as a chief executive, senior staff member or specialist staff member; or senior or specialist business people who undertake a secondment.</td>
<td>25–30 days</td>
<td>Offer of employment from a New Zealand company or local subsidiary of an overseas company</td>
</tr>
<tr>
<td>Work to resident</td>
<td>Up to 30 months</td>
<td>5 days</td>
<td>Good health, good character, passport valid for 3 months beyond intended visit</td>
</tr>
<tr>
<td>Skilled migrant</td>
<td>For prospective employees for occupations on current skills shortage lists</td>
<td>3 months</td>
<td>Age 55 or less, good health, good character, English language &amp; 100+ points based on age, experience, employability and qualifications. May require occupational registration.</td>
</tr>
</tbody>
</table>

* Average issue times for Immigration New Zealand’s London branch

7 More information available at: http://det.wa.edu.au/policies/
Opportunities for spousal employment

Australia’s migration regulations contain generous provisions for spouses/partners and dependent children accompanying skilled migrants. Spouses and dependents of SKA employees working in Australia on both temporary and permanent visas will be able to work without restriction. There is no discrimination against spouses/partners on the basis of marital status or gender.

The dynamic metropolitan and regional labour markets in Western Australia mean that the spouses of SKA staff should be readily able to find employment. The unemployment rate for both Perth and Geraldton is currently less than 5 percent and there is high demand in a wide range of occupations.

Labour availability and cost

OECD data shows Australia has competitive unit labour costs. In Australia, labour compensation per employee per hour ($US PPP adjusted) is lower than that of Canada, France, Germany, the Netherlands, Sweden, the UK and US. New Zealand’s rate is even lower⁹.

Table 3 provides information on Australian labour cost and availability in terms of annual turnover rate of labour for selected occupations relevant to the skills requirements of the SKA project.

Table 3 – Cost and availability of labour for selected occupations.¹⁰

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Size of cohort (Australia)</th>
<th>Weekly full time earnings before tax (A$ and €)</th>
<th>Employee annual turnover (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional engineer – civil</td>
<td>49,800</td>
<td>1,634 1,089</td>
<td>5.3</td>
</tr>
<tr>
<td>Professional engineer – electrical</td>
<td>18,900</td>
<td>1,450 967</td>
<td>5.3</td>
</tr>
<tr>
<td>Professional engineer – electronic</td>
<td>6,400</td>
<td>1,323 882</td>
<td>5.3</td>
</tr>
<tr>
<td>Professional engineer – telecommunications</td>
<td>10,000</td>
<td>1,500 1,000</td>
<td>9.0</td>
</tr>
<tr>
<td>Professional engineer – industrial, mechanical &amp; production</td>
<td>29,500</td>
<td>1,443 962</td>
<td>5.3</td>
</tr>
<tr>
<td>Professional engineer – other</td>
<td>9,200</td>
<td>1,635 1,090</td>
<td>5.3</td>
</tr>
<tr>
<td>Architect</td>
<td>23,100</td>
<td>1,154 769</td>
<td>6.3</td>
</tr>
<tr>
<td>Technician – architectural, building and surveying</td>
<td>61,200</td>
<td>1,400 933</td>
<td>9.3</td>
</tr>
<tr>
<td>Technician – electrical engineering draftsperson</td>
<td>9,900</td>
<td>1,518 1,012</td>
<td>9.3</td>
</tr>
<tr>
<td>Technician – ICT support</td>
<td>46,800</td>
<td>1,154 769</td>
<td>16.8</td>
</tr>
<tr>
<td>Technician – mechanical engineering</td>
<td>7,700</td>
<td>1,495 997</td>
<td>9.3</td>
</tr>
<tr>
<td>Technician – other building and engineering</td>
<td>23,800</td>
<td>2,142 1,428</td>
<td>9.3</td>
</tr>
<tr>
<td>Technician – civil engineering</td>
<td>13,600</td>
<td>1,350 900</td>
<td>9.3</td>
</tr>
<tr>
<td>Telecommunications technical specialist</td>
<td>4,100</td>
<td>1,250 833</td>
<td>16.8</td>
</tr>
<tr>
<td>Telecommunications trade worker</td>
<td>22,300</td>
<td>1,150 767</td>
<td>10.1</td>
</tr>
<tr>
<td>Trade – structural steel and welding</td>
<td>82,200</td>
<td>1,058 705</td>
<td>9.7</td>
</tr>
<tr>
<td>Trade – carpenter and joiner</td>
<td>122,100</td>
<td>900 600</td>
<td>7.6</td>
</tr>
<tr>
<td>Trade – precision metal worker</td>
<td>9,600</td>
<td>865 577</td>
<td>10.8</td>
</tr>
<tr>
<td>Construction worker / labourer</td>
<td>56,400</td>
<td>1,000 667</td>
<td>17.4</td>
</tr>
<tr>
<td>Earthmoving plant operator</td>
<td>56,200</td>
<td>1,100 733</td>
<td>14.5</td>
</tr>
<tr>
<td>Medical Practitioner – generalist</td>
<td>49,000</td>
<td>1,800 1,200</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Working and Support Environment

The Murchison Widefield Array at the MRO. Photography by Western Australia Department of Commerce.
Report Summary: Working and Support Environment

Australia and New Zealand are desirable places to work, live and raise families and can offer SKA employees many professional and personal advantages:

- The ‘turno’ model enables SKA workers and their families to live predominantly in Geraldton and Perth
- Geraldton is a safe, vibrant community with access to high standard housing and a range of quality education and health care services with a delightful coastal climate and lifestyle and numerous recreational opportunities for visitors and residents
- Perth is a major metropolitan centre, the fourth largest in Australia. It is ranked the 8th most liveable city in the world in The Economist's liveability rankings reflecting its safety, high standard of living and services and superb climate and lifestyle opportunities
- Good access to the SKA core region and national and international destinations is available through Perth and Geraldton airports
- Substantial planning has been done to ensure that workers at the Murchison Radio-astronomy Observatory are safe and well supported.

Secure, accessible and comfortable housing for project employees and their families

Note that this report does not cover proposed staffing arrangements and locations for SKA buildings and facilities, or accommodation for SKA construction or on-shift employees at the SKA core facility. Those issues are covered by the Basic Infrastructure Components report and the Operations and Maintenance Plan (Attachment 24). This report does cover the accommodation requirements for project employees (and their families) not located at the SKA core facility and during off-shift periods.

The SKA project's key facilities would be located in places where employees and their families can live in secure, comfortable homes and communities and enjoy excellent recreation, employment and lifestyle opportunities.

The Operations and Maintenance Plan provides for facilities and a number of staff to be based in Geraldton and Perth. It is assumed that these staff would live locally. In relation to employees undertaking shift work at the SKA core facility, there would be flexibility in the location of housing on a fly/bus-in, fly/bus-out model, though it is assumed that housing located in Geraldton or Perth would be the most congenial and efficient option in most cases.

Housing in Australia generally (including Perth and Geraldton) is available in a range of styles. Detached houses are the most abundant form (around 78 percent of dwellings), though semi-detached houses and apartments are common in larger centres. While all forms of housing would typically have lockable doors and windows, the provision of security fencing or the use of security providers by households is rare given the relatively benign crime environment in most Australian and New Zealand communities.

The fly/bus-in, fly/bus-out model for staffing remote facilities has been developed to a highly efficient and effective state in Australia, and particularly in Western Australia, where some of the world’s largest and most profitable mining operations are located in remote regions. A large number of companies service remote operations in the aviation, logistics, transport and other sectors.

Geraldton and the Mid West

It is proposed that relevant staff, and their families, would be accommodated in the Geraldton area as part of the general community utilising the local housing market which provides a good supply of high standard, secure housing for rental and purchase. The local housing market and industry has the capacity to respond to demand. Housing could either be sourced privately or through an office established by the SKA. Further information on the Geraldton rental and housing market is at Attachment 25.
Geraldton is the major centre of the Mid West region, with a population of around 37,000 people, making it the 38th most populous city in Australia. The city has a relatively young population, with 75 percent of households made up of families with dependent children, and a diverse economic base. The Mid West region covers an area of more than 470,000 km², nearly 20 percent of the State of Western Australia, and consists of productive farmland in the western quarter around the Geraldton area with the balance of the region predominately pastoral. The Geraldton and Mid West region includes a number of accessible smaller coastal and rural communities which may provide an attractive lifestyle option for some people.

Geraldton prides itself on a strong sense of community, excellent education and health services, diverse employment opportunities, cultural experiences and a relaxed, family-friendly lifestyle. The city is set in a pristine coastal environment and enjoys a Mediterranean-style coastal climate with hot, dry summers and mild winters.

Geraldton is recognised as a growing tourism centre with regular visits by major cruise ships and is rated as being in the top five wind surfing and kite surfing hot spots in the world. It is also a host port, and yacht sponsor, in the Clipper Round the World Yacht Race. More details of Geraldton Tourism, run by the local government, can be found on their website at www.geraldtontourist.com.au.

The City of Greater Geraldton\(^1\) has a strong culture of active and positive deliberative engagement. It finished 5\(^{th}\) out of 136 entries from 23 countries in the Bertelsmann Foundation ‘Reinhard Mohn Prize’ for deliberative democracy\(^2\). Geraldton was also recently shortlisted in the United Nations Environmental Program ‘Livcom Awards’\(^3\) an international competition to identify the most liveable communities in the world.

A comprehensive regional framework\(^4\) is in place to guide future public and private investment, and sustainable development, in the Mid West region. The plans are intended to support major project development, ensure compatibility amongst them and, wherever possible, identify synergies in relation to major infrastructure requirements.

**Perth**

Relevant staff and their families could be readily accommodated in Perth utilising the extensive local housing market. Housing could either be sourced privately or through an office established by the SKA. Further information on the Perth rental and housing market is at Attachment 25.

Perth is the capital and largest city of the State of Western Australia and the 4\(^{th}\) most populous city in Australia. The Perth metropolitan area has an estimated population of almost 1,700,000. Perth is a prosperous, fast growing city largely due to the prolonged resource sector boom in Western Australia. Perth ranks highly in quality of life measures, and is rated as the world’s 21\(^{st}\) most liveable city in the Mercer Quality of Living Survey 2010\(^5\) and 8\(^{th}\) most liveable city in the world by The Economist Liveability ranking\(^6\). It offers extensive sporting, cultural, retail and other facilities and services.

Perth is a culturally diverse city. The 2006 census found that around 34 percent of the population was born overseas. Nationalities most represented in Perth’s overseas-born population were from the United Kingdom, southeast Asia (mainly Malaysia), New Zealand, and southern and east Africa (mainly South Africa). Around 6.2 percent are recent arrivals, that is, since the 2001 census.\(^7\)

Perth has a Mediterranean-style climate with hot, dry summers and mild winters. Eighty percent of Perth’s rain falls between May and September, though warm sunny weather is common throughout the year. Perth has more annual hours of sun on average than any other major Australian city.

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High quality health and education

Health

Australia's healthcare system provides universal access to health care, through the public system, while allowing choice for individuals through a substantial private sector system. SKA employees and families who are permanent residents (see the Employment report for details) receive an immediate entitlement to public healthcare, administered through the Medicare system. This is an Australia-wide health insurance scheme, funded through the tax system. Medicare provides free treatment as a public patient in a public hospital; free or subsidised treatment by doctors in a general practice; and subsidies on some medicines and treatment by participating specialists.

Many Australian residents also have private health insurance. There are many healthcare funds in the marketplace and each offers a variety of schemes and different levels of cover. People with private health insurance receive benefits such as choice of doctor, choice of hospital and shorter waiting periods for non-urgent procedures. Private health insurance can also help with the cost of services such as dental, optical, physiotherapy and podiatry services.

Geraldton and the Mid West

Geraldton has both a public and private hospital, and provides access to a broad range of secondary and specialist health services in addition to community health, mental health and public health service facilities and programs. There is another hospital at Meekatharra which also serves as the regional base for the Royal Flying Doctor Service. Health centres are located at Mt Magnet, Cue, Sandstone, Yalgoo, Wiluna, Morawa-Perenjori, Kalbarri, Northampton, Dongara and Three Springs.

Geraldton Regional Hospital provides a comprehensive range of services, including a 66-bed acute facility with a 24-hour accident and emergency department. St John of God operates a private hospital in the vicinity of the Geraldton Regional Hospital. Services include a 60 bed acute facility providing acute medical, surgical, paediatric, maternity and children’s wards. It also includes a centre housing a wide array of specialist medical, radiological and pathology services.

There is a wide provision of general practice providers including Panaceum Medical Group, Batavia Health, Aero-Medical Group, University Medical Practice and the Victoria Medical Practice. The Geraldton Aboriginal Medical Service is a major Indigenous-focused medical group which is also available to the broader public.

The Royal Flying Doctors Service provides a range of aero-medical and primary health care services to remote communities across Australia. The western operations base of the RFDS is based at Meekatharra, approximately 120 km east of the Murchison Radio-astronomy Observatory. The Meekatharra Base operates two aircraft with four medical officers, eight flight nurses and five pilots. Services include emergency transfers to Meekatharra Hospital, inter-hospital transfers to Perth and fortnightly primary health clinics in the Mid West and Gascoyne regions.

Perth

Perth has a range of public and private hospitals and health services providing the full scope of modern health care. Further information on health services available in the metropolitan area can be found at http://www.health.wa.gov.au.

International schools/education

Primary and secondary

As a major regional centre, Geraldton provides a good choice of public and private primary and secondary schools, which are listed at Attachment 26. Perth offers a very wide choice of public and private schools, including a number offering the International Baccalaureate qualification. These are also listed at Attachment 26.
**Tertiary**

**Geraldton**

The Geraldton Universities Centre (GUC) campus is an independent tertiary provider administered by the University of Western Australia, providing a range of accredited tertiary education courses. The Durack Institute of Technology (DIT) is the major provider of vocational education and training in the Mid West and Gascoyne regions and has an extensive range of courses available. DIT and GUC have developed an innovative media and journalism undergraduate course and are in the process of jointly developing an engineering course, designed to offer training relevant to the SKA project. The Combined University Centre for Rural Health (CUCRH) is a nationally recognised research centre with a specific focus on rural, remote and indigenous health. CUCRH has a strong post-graduate and post-doctorate research in multiple areas.

**Perth**

Perth has four high-quality public universities of international standing: the University of Western Australia, Curtin University, Murdoch University, and Edith Cowan University. There is also one private university, the University of Notre Dame. There is an extensive network of trade and vocational training providers in the Perth metropolitan area including Central Institute of Technology (formerly Central TAFE); West Coast Institute of Training (northern suburbs); Polytechnic West (eastern and south-eastern suburbs; formerly Swan TAFE); and Challenger Institute of Technology (Fremantle/Peel).

**Transport**

**Geraldton**

Several airlines operate services to Geraldton Airport including SkyWest, Skippers and Qantas. The combined airlines provide multiple daily services to Perth. Perth to Geraldton return tickets range from approximately €172 to €367. SkyWest also operates a popular Bali, Indonesia service via Port Hedland and will soon commence a Melbourne service via Kalgoorlie. Geraldton Airport is serviced by several air charter operators providing both single and dual prop light aircraft up to 24-seat aircraft. These aircraft regularly service mines and pastoral operations in and around the Mid West, Goldfields and the Pilbara and would provide a capable service should direct flights (on a regular or irregular basis) be required from Geraldton to the SKA site. Geraldton Airport (owned and operated by the City of Greater Geraldton) is a major regional airport facility catering to over 130,000 (RPT and charter) passengers per annum, with the following services and capacity:

- 1,980 m strip capable of Boeing 737-800 or Airbus A320
- 980 m sealed cross strip
- Three terminals including the principal regular passenger transport terminal and two charter services terminals
- The principle RPT terminal has full personal and baggage screening facilities
- Refuelling services
- Fire and rescue facilities.

Current detailed planning and design is taking place to extend the runway to 2,600 m for wide bodied Boeing 787 aircraft. Geraldton Port Authority operates a major port within the Geraldton city centre. It has seven berths and capacity for multiple products serviced up to ‘Panamax’ (70,000 DWT) vessels. Geraldton is Australia’s 2nd largest wheat export port. The Western Australian and Australian Governments have provided funding and approval for the development of a second major port at Oakajee (25 km to the north of Geraldton). This port will have capacity to service ‘Cape’ (210,000 DWT) vessels. Geraldton Port Authority hosts Australian Government agencies responsible for customs, quarantine and maritime safety.
The Public Transport Authority runs bus services from Perth to Geraldton-Kalbarri via three possible routes. Geraldton has a public transport bus service, Trans-Geraldton, which provides a comprehensive and quality service throughout the urban area.

Geraldton is well serviced by taxi and hire car operators, with depots at the Geraldton Airport. The nearest international airport is Perth Airport (see below).

Perth

Perth Airport is the major domestic and international air transport hub for Western Australia, with extensive services to regional Western Australia, other Australian states and New Zealand, and destinations in Asia, Europe, US and Africa. Perth’s westerly location on the Australian continent means that travel times to Asia and Europe are significantly shorter than from other Australian cities.

Perth Airport handled more than 11 million passengers in the 2009–2010 financial year, of which 71 percent were domestic and 29 percent international travellers. Perth Airport also encompasses several smaller terminal operations, which provide charter services and flights to specific regional areas in Western Australia. The flight time from Perth to Boolardy airstrip is approximately 75 minutes in a 10-seater turbo propellor plane.

Fremantle Ports operates on commercial principles as a Western Australian Government Trading Enterprise with responsibility for facilitating trade through the State’s biggest general cargo port. The Inner Harbour at Fremantle handles almost all of the container trade for Western Australia. It also provides facilities for livestock exports, motor vehicle imports, other general cargo trades, cruise ships and visiting naval vessels. Fremantle Ports cooperates with Commonwealth Government agencies responsible for customs, quarantine and maritime safety.

Leisure facilities


Health and safety plan

The SKA would require an occupational health and safety (OHS) plan in order to comply with legislative requirements and the relevant codes of practice (see the Employment report). A comprehensive plan for operating safely at the Murchison Radio-astronomy Observatory and in the Mid West region has already been developed by CSIRO (Attachment 21). The plan has been developed in keeping with CSIRO’s proactive ‘zero harm’ OHS policy and could provide the basis for the SKA OHS plan. The plan covers legal requirements; risk management and planning; specific hazards and environmental risks (wildlife, heat, safe travel requirements); plant and equipment (hazardous materials etc.); training and communications, record keeping and incident reporting; emergency and injury management; construction site rules and safety and hygiene rules.

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Implementation Plans and Costs
Motivated Alternative Justification
Rationale for a motivated alternative configuration

For several years the astronomy community has maintained a vision of the SKA as a highly sensitive instrument covering a wide range of frequencies at cm-wavelengths, enabled by a superb radio-quiet environment across a large range of baselines extending to at least 3,000 km. Such an array provides for transformational capability in global radio astronomy. It is well suited to be a platform for radio astronomy over at least the next 50 years, with every expectation that it will undergo progressive evolution over time.

However, various extensions of scope from the 2005 concept have occurred over the last few years, leading to the Model SKA configuration (hereafter the compliant configuration) presented in the Request for Information. Derived infrastructure costs indicate the cost of the compliant configuration will be high, principally driven by the following:

- Three large 5 km diameter cores with receptors scattered throughout, which significantly increases cabling costs (power and optical fibre)
- The large number of small receptors resulting in extremely large numbers of connection components
- High cost of energy and maintenance for AA-mid, coupled with high infrastructure cost
- Large staff presence at the Operations Centre near the centre of the array.

Therefore, the ANZSCC also present a motivated alternative configuration that offers SKA the capacity to build more financially achievable infrastructure without significantly impacting on the array’s ability to deliver transformational science. The motivated alternative configuration presented is a result of scaling back elements of the design that entailed relatively high incremental costs when compared to the likely incremental benefits and for which the costs are least well understood.

It should be emphasised that the motivated alternative is not a fully optimised design: this process should involve a system integrated approach including much broader considerations than infrastructure alone. In estimating capital and operating costs for both configurations, more focus has been given to minimising capital costs. Uncertainty in the capital component, although large, is still less than the very significant error on a 30-year operational lifetime model. This approach is in keeping with producing as robust a cost estimate as possible, consistent with the SKA Siting Group’s requirements for a credible implementation model.

Ideally, cost optimisation would be done over the whole of life costs and including the entire SKA system. That has not been possible for this response. When such an analysis is done, it may point to a significantly different implementation. However, the nominated alternative demonstrates, within an AACE Class 4 capital cost estimate, that significant cost reductions can be achieved in the infrastructure component and still deliver transformational science.

In Australia and New Zealand, the motivated alternative configuration would:

- Deliver on the vision of the SKA as a highly sensitive instrument enabled by a superb radio-quiet environment across a large range of baselines extending beyond 5,000 km. The presence of extensive optical fibre networks for research and education in Australia and New Zealand, together with a reduction in the number of remote array-stations from the compliant configuration, provides an affordable implementation path for long baselines.
- Entail capital costs much closer to the publicly stated SKA project budget that has formed the basis for building the level of international funding support achieved for SKA to date. Retaining collecting area along three spiral arms and using concentrated cores to minimise cabling costs significantly reduces infrastructure expense.
- Retain options for progressive evolution of architecture, for example, as component costs decrease.
A motivated alternative model configuration for the SKA

The infrastructure cost of the motivated alternative configuration is about half the infrastructure cost of the compliant configuration (€1 b).

We estimate that the motivated alternative configuration would deliver with no or little detrimental impact 13 of the possible 14 science projects in the SKA Design Reference Mission (see Attachment 27 for detailed information on the motivated alternative).

The motivated alternative configuration demonstrates that Australia and New Zealand can offer the SKA a robust, practical, affordable site that ensures integrity of science. Elements central to supporting the motivated alternative include:

- The capability to deliver very long baselines affordably using the extensive existing research optical fibre networks AARNet (in Australia) and KAREN (in New Zealand)
- The legal capability and policy support to protect radio-quietness for both the core and remote array-stations leading to optimal science
- A workforce with the experience, expertise and capacity to deploy high technology infrastructure (noting that the cost of infrastructure is largely driven by international component pricing)
- A secure, long term environment for efficient operation of the geographically distributed SKA for its lifetime of over 50 years.

Features of the motivated alternative configuration in the central area include:

- Clustering antennas into slightly larger array-stations closer to the core to reduce costs of data and power distribution
- Initial deployment of two receptors systems, the model here adopting dishes and AA-low, with capability for future incorporation of an AA-mid array
- A reduction to three spiral arms.

This alternative design illustrates a sound architecture that can support the full range of the SKA’s science objectives and deliver a revolutionary advance in radio astronomy capability. We estimate that the alternative design could be delivered for an infrastructure cost about a factor of two less than that estimated for the compliant configuration.

Figure 1 – Central region of the motivated alternative configuration.

Major changes from the compliant configuration to the motivated alternative include:

- Two receptor technologies, rather than three
- Inner core radius of approximately 0.5 km (rather than 2.5 km) for each receptor technology
- Emanating from each densely filled inner core are three spiral arms of receptor stations out to 2.5 km radius
- From a radius of 2.5 km from the centre of each core there are three intermediate spiral arms, rather than five
- These spiral arms are truncated at a maximum 140 km radius, rather than 180 km
- 12 remote stations (not 25), all sited on the existing research network fibre (see Figure 2)
- Significantly lower operational costs over the lifetime of the SKA due to having access to AARNet fibre network for remote array-stations.
Features of the alternative configuration across Australia and New Zealand include:

- Retention of collection area and configuration along a range of baselines to 5,000 km
- Cost effective placement of remote array-stations along the research fibre optic backbone across Australia and New Zealand, minimising construction and operational expenses
- An array-station at the south of the South Island of New Zealand (not shown).

This alternative design takes maximum advantage of the extensive high bandwidth research network in Australia managed by AARNet, and the equivalent New Zealand network KAREN. Detailed information is provided in the Data Transport report of this submission. The compliant configuration is shown for comparison in Attachment 39.

The densely packed dish core of the motivated alternative is well placed to undertake sensitive pulsar searches, with the central 10 km of the motivated alternative dish array having 94 percent the sensitivity and 88 percent the survey speed of the compliant configuration. The motivated alternative configuration also provides a range of intermediate and long baselines (to 5,000 km) which form an integral part of the SKA science case (SKA Memo 135) adding value across the range of science programs. The long baselines will provide an instrument with angular resolution exceeding that of almost all other astronomical telescopes, opening new opportunities to test Einstein’s theory of general relativity, measure parallaxes and proper motions, and to probe the physics of black holes.

The AA-low component of the motivated alternative constitutes a powerful instrument to probe distant galaxies via HI absorption and to study the origins and evolution of cosmic magnetism. Although reduced in scope, the sparse aperture array can still probe Epoch of Re-ionisation (EoR) physics, and further expenditure on this aspect of the SKA should await the outcomes of the current EoR pathfinder experiments (LOFAR and MWA). This breadth and depth of science performance is remarkable, considering that cost savings of 50 percent have been achieved for the total passive SKA infrastructure.

Table 1 (below) provides a summary of the impact on SKA science resulting from the change from the compliant configuration to the motivated alternative. The AA-mid has been removed, resulting in a very large cost saving. To mitigate the effect of this change on frequency coverage, the design of dish and AA-low receiver systems are assumed to be adjusted to ensure full coverage of the SKA frequency range. Within this scenario, AA-mid remains an option for future implementation. This is, of course, only one example of a number of possible technology changes that could be implemented. Refer to Attachment 27 for further information comparing the motivated alternative to the compliant configuration.

Figure 2 – Motivated alternative configuration in Australia. An array-station is also sited in New Zealand.
Table 1 – Assessment of the impact on the ability to fulfil the SKA Design Reference Mission (DRM), by changing the compliant configuration (CC) to the motivated alternative (MA).

<table>
<thead>
<tr>
<th>Design Reference Mission</th>
<th>Impact</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-biotic Molecules in/around Protoplanetary Disks</td>
<td>None</td>
<td>Max baseline has increased for MA, thus improving maximum resolution. MA sensitivity is better than conforming model. Dirty beam sidelobe rms is reduced compared to CC.</td>
</tr>
<tr>
<td>Probing Gravity, Dark Matter with Radio Pulsars</td>
<td>None</td>
<td>MA dish array meets DRM sensitivity requirements.</td>
</tr>
<tr>
<td>Pulsar Timing with the SKA</td>
<td>None</td>
<td>Sensitivity of MA is only 6% lower than CC. Neither meet the published DRM sensitivity requirement of $10^4$ m$^2$ K$^{-1}$.</td>
</tr>
<tr>
<td>The transient radio sky</td>
<td>None</td>
<td>Higher filling factor in the inner core than CC, which will assist processing of high time-resolution data.</td>
</tr>
<tr>
<td>Pulsar Surveys with the SKA</td>
<td>None</td>
<td>Longer baselines available for astrometry to assist timing. Higher filling factor in the inner core will assist processing of high time-resolution data. 6% reduction in sensitivity.</td>
</tr>
<tr>
<td>Neutral Gas in Galaxies: HI Deep Field</td>
<td>None</td>
<td>Very minor impact on all measures. 2% reduction in sensitivity.</td>
</tr>
<tr>
<td>Resolving AGN/Star Formation in Galaxies</td>
<td>None</td>
<td>Motivated Alternative exceeds required survey speed for this project by a factor of 80,000. No impact on science.</td>
</tr>
<tr>
<td>Cosmic Magnetism Deep Field</td>
<td>Low</td>
<td>Requires dish array &lt; 20 km. Sensitivity and PSF$^\text{rms}$ largely unaffected. Survey speed (SS) reduced by 12%.</td>
</tr>
<tr>
<td>Continuum Deep Field</td>
<td>Low</td>
<td>Requires dish array &lt; 500 km. Sensitivity, survey speed and PSF$^\text{rms}$ largely unaffected. SS reduced by 12%.</td>
</tr>
<tr>
<td>Wide Field Polarimetry</td>
<td>Low</td>
<td>Sensitivity largely unaffected. SS reduced by 12%, but MA dish array still meets SS requirement for this experiment.</td>
</tr>
<tr>
<td>Galaxy Evolution vs. Cosmic Time: HI Absorption</td>
<td>Low</td>
<td>Max baseline has increased, but total sensitivity slightly reduced Low impact to a redshift $z = 2$, but sensitivity reduction could lead to 6 x longer integration times if AA-low used at $z &gt; 2$.</td>
</tr>
<tr>
<td>HI Baryon Acoustic Oscillations</td>
<td>Low</td>
<td>Neither CC nor MA meets survey speed requirement (both fall short by 2 orders of magnitude). SS reduced by 12%.</td>
</tr>
<tr>
<td>Probing AGN environments via HI Absorption</td>
<td>Low</td>
<td>Max baseline has increased, but total sensitivity slightly reduced Low impact to a redshift $z = 2$. Sensitivity reduction could lead to 6 x longer integration times if AA-low used at $z &gt; 2$.</td>
</tr>
<tr>
<td>EoR HI Imaging Tomography</td>
<td>Medium</td>
<td>Sensitivity, image fidelity of MA reduced compared to CC. Survey either takes 6 times longer, or survey strategy requires re-scoping (e.g. image the EoR on larger angular scales).</td>
</tr>
</tbody>
</table>
Basic Infrastructure Components

CSIRO’s Australian SKA Pathfinder at the MRO. Photography by Terrace Photographers.
Report Summary: Basic Infrastructure Components

To determine suitable standards and costing for basic infrastructure, we have drawn on the expertise of Australian companies who have successfully deployed large scale infrastructure in the Western Australian interior, as well as on recent direct experience with deployments at the Murchison Radio-astronomy Observatory (MRO) and Boolardy Station. The Australian radio astronomy community and industry partners have world-class expertise in RF screening and radio-quiet compliance, as proven on existing national facilities managed by CSIRO. This enables us to provide SKA with robust costs for the highly specialised radio-quiet compliant structures required for a radio astronomy observatory.

CSIRO currently manages radio astronomy national facility infrastructure for the science community in Australia and internationally. CSIRO is currently leaseholder and manager of the 125 km² MRO and 3850 km² Boolardy Station. CSIRO owns funded radio astronomy infrastructure on these properties and elsewhere in Western Australia, including the radio-quiet compliant MRO control building, the accommodation and recreation facilities at the Boolardy homestead precinct, the optical fibre link between the MRO and Geraldton and the MRO Support Facility in Geraldton. CSIRO has indicated its willingness to make this infrastructure available, as appropriate, to support the SKA project and to assist the SKA project in any associated lease and access negotiations. Other research partners (iVEC and ICRAR) have also indicated that they could make infrastructure available in Perth, following suitable arrangements being negotiated. This proposal takes advantage of this existing infrastructure. For new building infrastructure required, pre-fabricated modular construction methods are used wherever possible to facilitate deployment. Australian companies have extensive experience with such deployments in remote Western Australia. Staff placements are optimised with management and operations staff in Perth and observatory support staff, including remote station maintenance personnel, based in Geraldton. The operations centre is sited near the Boolardy Station homestead precinct, extending the existing facilities. The security of infrastructure is enhanced by Australia’s low rates of crime and corruption and the natural protection provided by the remoteness of the astronomy infrastructure sites.

<table>
<thead>
<tr>
<th>Proposed solution</th>
<th>Strength</th>
<th>Potential risk</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buildings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separately funded</td>
<td>Fit-for-purpose infrastructure already funded for the site</td>
<td>Higher labour and accommodation costs in remote areas</td>
<td>Optimise staff placements to minimise deployment costs and provide best lifestyle options for staff and their families.</td>
</tr>
<tr>
<td>to SKA standards</td>
<td>utilisates experience in RF compliance and extensive experience in remote deployments in WA</td>
<td></td>
<td>Additional costs associated with remote location counteracted by cost reductions due to low RF mitigation requirements and low security risk.</td>
</tr>
<tr>
<td>Substantialinvestment in existing buildings suitable to support SKA at MRO, Geraldton and Perth</td>
<td>Secure environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunkers built to ensure RF compliance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction camp - Utilise existing CSIRO accommodation and supplement with mining-style camps</td>
<td>Proven solution with many options available for negotiation</td>
<td>Camps expensive and/or in demand</td>
<td>Explore options for sharing with mining infrastructure in WA</td>
</tr>
<tr>
<td>Roads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All weather road to site</td>
<td>Provides all weather access to site up to 110 km/h</td>
<td>High capex cost to seal road</td>
<td>Murchison Shire Council is in the process of sealing a road that leads to the MRO. Funding mechanisms are currently being explored.</td>
</tr>
<tr>
<td>Graded roads around site</td>
<td>Remote location means roads can be optimally placed</td>
<td>Rain can hinder access</td>
<td>Alternative access routes to remote stations</td>
</tr>
<tr>
<td>Foundations and other ground work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete or rock anchor</td>
<td>Firm and accessible granite bedrock underlying the MRO and surrounding area provides cost effective options for foundations.</td>
<td>Higher trenching costs through rock</td>
<td>Current experience with ASKAP indicates a combination of mass concrete foundations and rock anchors are an appropriate and cost effective solution</td>
</tr>
<tr>
<td>Aperture array areas require minimal ground disturbance</td>
<td>Flat firm ground needs little treatment</td>
<td>Careful site choice through surveying</td>
<td>Deploy appropriate machinery based on experience with ASKAP and optical fibre installation from MRO to Geraldton</td>
</tr>
<tr>
<td>Airstrips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Experience with the Murchison Widefield Array (MWA) indicates suitable ground is available</td>
</tr>
</tbody>
</table>
Visual representation of the location

The SKA head office and computing centre will be in Perth, Western Australia, an international city of 1.7 million people with a strong economy and excellent social and physical infrastructure. The support office will be in Geraldton, a coastal city some 70 minutes flying time north of Perth with excellent lifestyle options and amenities. The Mid West covers an area of more than 470,000 square kilometres, nearly a fifth of the State of Western Australia. The population is concentrated along the coast with more than 70 percent living around the city of Geraldton-Greenough. The operations centre is at Boolardy Station homestead precinct, some 300 km northeast of Geraldton. There is all weather road access, airstrips and purpose-built operational, accommodation and recreation facilities. The three cores of the central site are at the MRO, 35 km north of the operations centre and have all weather road access, airstrips, a stand-alone emergency backup power supply, and an 80 + 80 dB radio frequency screened control building. The overall array configuration proposed is shown in Attachment 39.

All the principal SKA operations and maintenance infrastructure is within access to the Western Australian coastline, offering modern infrastructure and services and an enviable lifestyle for SKA staff and their families.

Geraldton is a major regional centre with a population of around 27,000 people, making it the fourth largest city in Western Australia. It is a recent finalist in a United Nations competition to determine the most liveable communities in the world.

Perth ranks highly in quality of life measures and is ranked as the world’s 21st most liveable city in The Economist Liveability index.
Central area containing three cores (SKA Core)

The SKA Core will be located within the Murchison Radio-astronomy Observatory (MRO). The flat, sparsely populated terrain surrounding the site, which also has very low density of pastoral activity, leads to optimal cost effective routing of optical fibre and power, allowing for a close to ideal layout for SKA array-stations.

The stable subsurface environment leads to cost effective foundation designs being suitable. The core site is on the high ground (watershed) between two river systems thus there is minimal water pooling.

The sparse human infrastructure ensures all array-stations can be placed in locations compliant with existing EMI buffer zones.

Legislative and regulatory measures are in place to protect a radio-quiet zone with a radius of 260 kilometres, centred on the MRO and covering a vast area of 212,000 km².

Remote station (>180 km from core)

Each remote station has its own 80 m² maintenance and storage facility which will be constructed with a concrete floor slab, a structural steel frame with metal wall and roof cladding, and able to provide all necessary light and power.

These buildings will also contain water tanks and emergency and first aid supplies, ensuring a self-sufficient base for remote station maintenance staff.
Operations centre near centre of the array (SKA OCCA)

The SKA OCCA will be located in the vicinity of the existing Boolardy Station homestead accommodation precinct with its own airstrip, some 30 km from the SKA Core.

This location presents a number of benefits to SKA including:
- It is closer to Geraldton and will be on the all weather access road
- Removes the centre of human activity from the zone requiring maximum radio-quiet
- Places the majority of offices and work buildings close to the accommodation precinct, minimising travel issues.

The operations centre buildings consisting of a data processor building, a power building and several other buildings containing workshops and offices will be located at the OCCA. Adjacent to the operations centre will be the accommodation village.

CSIRO has indicated its willingness to make CSIRO infrastructure available, as appropriate, to support the SKA project, and to assist the SKA project in any associated lease and access negotiations.

SKA model site-specific plans

Roads

Two types of road are proposed and costing in this response. The main access road from Geraldton to the site will be an all weather road. For costing purposes, where upgrading of existing sealed roads is required, a single lane, chip sealed road has been assumed (4 m wide sealed surface on prepared gravel surface and shoulders). This road is of the standard being adopted in the region for main trunk roads and will be designed and constructed in accordance with Australian standards. Parts of this road are already undergoing upgrade to this level and the costings in this response cover the remaining upgrade required to bring the entire length of road from Geraldton to the MRO up to this standard. The road will be fit-for-purpose for SKA construction and operation.

The minor roads will consist of cleared and graded roads which will utilise local materials (such as gravel and aggregate) to supplement the existing sub-base. These roads will typically be suitable for vehicles travelling at 40 km/h to 80 km/h in dry conditions. This standard of road is the current standard at the MRO and is able to handle the heavy construction traffic currently deployed on site during ASKAP and MRO infrastructure construction. Costs from recent ASKAP experience are assumed in the costings provided. These minor roads can be closed to heavy traffic during heavy rain, but they are still accessible by 4WD vehicle.

Major

The main access route to the central area will be via the Mullewa-Carnarvon Road, then 40 km on the Meeberrie-Wooleen Road, 19 km on the Boolardy-Wooleen Road and 58 km on the Pindar-Beringarra Road. This entire road is a two-way, two-lane road with 3.5 m wide lanes and 3 m shoulders and is already operational. For the SKA project, it is proposed that 207 km of this road be upgraded with a 4 m wide sealed surface, so the entire route from Geraldton to the MRO will be an all weather surface suitable for vehicles travelling up to 110 km/h. It will support all types of vehicle traffic and loads likely to be used at the SKA site during construction and operation and, being sealed, would not generate dust. Water crossings will also be enhanced (via a 4 m wide deck) to provide all weather access. The central operation buildings, the accommodation facilities and the maintenance facilities will also be located on this road providing a safe and easily accessible route for operations and maintenance staff.
**Minor**

We propose that all roads within the central site be constructed to the same standard as currently utilised on the MRO. This is also the standard used by pastoralists in the Mid West. The minor roads will consist of cleared and graded tracks using local materials (such as gravel and aggregate) to supplement the existing sub-base. These roads will typically be suitable for vehicles travelling at 40 km/h to 80 km/h in dry conditions. This type of minor road is favoured by pastoralists as it is cost effective to maintain and reduces land degradation from rain water run-off. In addition, these roads would be treated with stabilising agents during construction and maintenance to minimise dust.

The pastoral land surrounding the core is already traversed by such tracks and in many areas existing minor roads may be able to be used, rather than creating new minor roads. In this response we conservatively estimate that 30 percent of the minor roads required could already exist. In severe rain events, some minor roads may have to be closed to heavy traffic (to minimise damage to the road). In the event of critical access being required, the roads are accessible by 4WD vehicle. In the event of an emergency this area is also accessible by air. In most circumstances flexible scheduling could ensure that maintenance work can continue in other areas if particular sections of the road are closed.

**Safety**

The road standards outlined above are the usual standard and most cost effective in remote areas of Australia. Road design, safety standards and driver behaviour are a proven combination, as demonstrated by an excellent road safety record. In 2009 there were 1,492 road deaths in Australia (190 in Western Australia), which equates to 0.95 deaths per 10,000 registered vehicles. This rate is well below the OECD median and is bettered by only six other OECD countries (Sweden, UK, Japan, Netherlands, Germany and Finland).

**Equipment and office buildings**

**The central area containing three cores (SKA core)**

The SKA core will be located within the MRO, as shown on Figure 2. The RF shielded MRO control building could be used to host some functionality requirements of the SKA including the emergency operations room, some workshop and lunch facilities near the centre of the array, as well as housing the data processing equipment for the AA-low stations within the core. The MRO control building will be in place and commissioned for SKA Phase 1. Delivery areas etc are provided for. CSIRO has indicated its willingness to make this infrastructure available, as appropriate, to support the SKA project, and to assist the SKA project in any associated lease and access negotiations. Approximately 5 km away is a newly constructed emergency access airstrip, constructed by CSIRO. This airstrip is 1200 m long, made of compacted gravel and has a cleared approach and take-off zone at each end of the marked strip. There are white painted markers defining the strip and an airsock. The airstrip is suitable for Royal Flying Doctor Service planes and requires no further upgrade to be fit-for-purpose for SKA. Access roads into the MRO already exist and are proposed to be upgraded to an all weather surface (as outlined above). The MRO will also contain the RF compliant 1.1 MW power station. It is proposed that this hybrid solar-diesel power station be extended to provide stand-alone power for construction and SKA Phase 1, as well as providing backup emergency power if required for the core area during SKA Phase 2 operations.

**SKA Operations Centre working buildings near the Centre of the Array (SKA OCCA)**

The SKA OCCA will be located in the vicinity of the existing Boolardy Station homestead accommodation precinct. Located approximately 30km from the MRO, the homestead precinct already contains accommodation for scientists, a kitchen, recreation facilities, power and water for 37 people, which will require no further upgrade to be fit-for-purpose for the SKA. It has its own airstrip (managed by CSIRO). The airstrip is 1200m long, made of compacted gravel, and with a cleared approach and take-off zone extending at each end of the marked strip. There are white painted markers defining the strip and an airsock. The airstrip is suitable for Royal Flying Doctor Service planes and is fit-for-purpose for the SKA. The operations centre will consist of a data processor building, a power building and several other buildings containing workshops and offices. There will also be an operations control room that will serve as a backup local control desk and telecommunications area to the primary SKA monitoring and control room in Perth. Adjacent to the operations centre will be the accommodation village for the majority of maintenance staff working at both the operations centre and the central area. The SKA OCCA will be based on the size stated in the Request for Information (1500 m² of computer room and communications space). In addition to this requirement we have made the following allowances, see Tables 1 and 2 below.
Table 1 – Description of operations centre buildings requirements.

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer room</td>
<td>1500 m²</td>
<td>As per Request for Information</td>
</tr>
<tr>
<td>Communications space for optical fibres</td>
<td>500 m²</td>
<td>Allowance for an area adjacent the data centre to collect, arrange and manage all fibre cables and for an ‘airlock’ allowing entry into the operations centre without loss of RF integrity</td>
</tr>
<tr>
<td>Operations - control room</td>
<td>100 m²</td>
<td>As per Request for Information</td>
</tr>
<tr>
<td>Power building</td>
<td>250 m²</td>
<td>Allowance made to house power equipment</td>
</tr>
<tr>
<td>Office space</td>
<td>300 m²</td>
<td>Sized to accommodate 20 people at an allowance of 15 m² per person (in line with standard government office requirements)</td>
</tr>
<tr>
<td>Meeting room space</td>
<td>Included above</td>
<td>Included in office area above</td>
</tr>
<tr>
<td>Allowance for circulation space between functions, amenities and sundry plant space</td>
<td>663 m²</td>
<td>Additional allowance of 25 percent for special requirements (in addition to net areas stated above)</td>
</tr>
<tr>
<td>Total building area</td>
<td>3,313 m²</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Description of additional operations centre building space and related facilities.

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>300 m²</td>
<td>Sized to accommodate 20 people at 15 m²/person (including meeting rooms)</td>
</tr>
<tr>
<td>Meeting room space</td>
<td>Included above</td>
<td>Included in office area above</td>
</tr>
<tr>
<td>Canteen and kitchen facility</td>
<td>150 m²</td>
<td>Sized to suit 100 people (see below)</td>
</tr>
<tr>
<td>Space for maintenance activities</td>
<td>750 m²</td>
<td>Allowance for storage, workshops, vehicle parking and maintenance staff</td>
</tr>
<tr>
<td>Circulation space between functions, amenities and sundry plant space</td>
<td>300 m²</td>
<td>Additional allowance of 25% for special requirements in addition to net areas stated above</td>
</tr>
<tr>
<td>Total</td>
<td>1,500 m²</td>
<td></td>
</tr>
</tbody>
</table>

There is no need for the entire buildings to be RF shielded. However RF shielding has been included for the 1500 m² computer room. The RF shielding methodology and costs have been based on those used for the MRO control building. For the maintenance facility 750 m² has been allocated and will combine some ‘clean’ electronic workshops and warehouse and storage facilities. This building will be steel framed, metal clad and insulated. The internal space will be divided into the required zones and rooms by use of divisional walls. Office accommodation for 20 people (including maintenance staff) will be located adjacent to the workshop and will be constructed from prefabricated modules that are assembled on site. Again this provides a number of benefits to the SKA including a scalable and cost effective solution with lower on site construction costs. The office component has been sized at an allowance of 15 m² per person (including meeting rooms), which is in line with standard government office requirements.

The Observatory Support Office (SKA OSO)

The SKA OSO will be located in Geraldton where the CSIRO MRO support facility will be built (construction starts in late 2011 with completion by early 2012). As part of its role to support national facility infrastructure, CSIRO has indicated its willingness to make this infrastructure available, as appropriate, to support the SKA project, and to assist the SKA project with any associated lease and access negotiations. The building will accommodate office space for approximately 30 people, a spares handling store as well as a small laboratory/workshop for line replaceable unit triage. In the vicinity of the building will be parking space for the trucks and other vehicles servicing the MRO and nearby remote stations. It will be constructed to be fit-for-purpose for SKA.

SKA Head Office Building (SKA HOB) in Perth

The SKA HOB is proposed to be located in Perth and will take advantage of already existing and funded facilities. The International Centre for Radio Astronomy Research (ICRAR) is a joint venture of Curtin University and The University of Western Australia (UWA). Curtin University has 37,000 students (29 percent international), UWA has 21,000 (22 percent international) with both universities having strong teaching, research, physical sciences and engineering faculties. ICRAR is a new organisation with 70 staff members and 30 PhD students spread across its two research nodes. ICRAR has indicated it
could make office accommodation available at these campuses for up to 100 SKA staff, following suitable arrangements being negotiated. This accommodation would facilitate a close connection between SKA astronomers and engineers, ICRAR staff and the students, and faculties and laboratories available on both campuses. This space will be provided at no cost to the SKA project, will be fit-for-purpose and will be sought for commencement in 2014.

SKA Super Computing Building (SKA SCB)

The SKA SCB and its associated facilities could be housed within the Pawsey Supercomputing Centre for SKA Science, which is currently under construction on CSIRO’s property in Bentley, Perth.

When complete, the current scope of the Pawsey Centre will provide the computing, networking and storage services for ASKAP and the MWA, as well as support the geosciences and other leading computational science communities.

The Pawsey Centre has been designed to be scalable and will require addition of approximately 1,000 m² of active floor space to meet SKA’s needs.

The Centre has been designed to be a world’s best computing centre. When operational in 2013, the main computing and storage facilities will be petascale, placing it among the top 20 centres worldwide.

The current floor space would be appropriate for the data flow and processing needs of SKA Phase 1. The Pawsey Centre machine room and data centre have been designed in a flexible and scalable manner, consistent with current design trends around the world. Approximately 500 m² of the initial 1,000 m² space will be online in 2013. iVEC, whose Board has responsibility for the Pawsey Centre, has indicated its willingness to make the remaining 500 m² available for the SKA’s preconstruction needs. The main Pawsey Centre computing facility has been designed through a close collaboration of iVEC, CSIRO, ICRAR and other radio astronomy stakeholders to ensure it can accommodate the data flow, storage and processing requirements of SKA precursors with an ability to scale to SKA Phase 1 operations. Particular care has been taken to ensure the challenges facing radio astronomy data throughput, observatory real-time operations and radio astronomy survey scientists have been addressed.

Additional office space for computing staff (located at the SKA HOB) will also be made available in the Pawsey Centre main building.

Accommodation for construction crews and operations and maintenance staff

Construction camp(s)

We have calculated that the total person weeks required to construct the infrastructure in the central area is approximately 105,000. Based on a five year infrastructure construction period, this would require an average on site work force of 397 people. Assuming a 33 percent uplift between average person weeks required and peak work force requirements, we would calculate a peak work force of 530 people. Due to the size and scale of the central area, we envisage that logistically adjacent towns would provide a likely base for a portion of the staff working on infrastructure on the outer sections of the 180 km zone.

The SKA construction phase accommodation will provide each person with a 13 m² single room including an en suite. There will be a common mess area, wet mess facilities and recreation facilities. The camp will also include self-contained power supply, water supply and waste water treatment facilities. A portion of the construction camp will be constructed to a higher standard and become permanent accommodation at completion of the construction phase. The SKA project’s accommodation will comply with the Building Code of Australia’s requirements and the Western Australian Construction Camp Regulations.
The location of the main construction camp will be nearby the central core to allow good access to the main work site and ensure maximum productivity is achieved. Due to the size of the overall central area, some work areas will be able to be catered for (both logistically and economically) from existing towns (such as Meekatharra and Mullewa) and communities (such as Pia Wajarri). CSIRO is willing to offer existing accommodation at the Boolardy Station homestead accommodation precinct for use as the first accommodation site for the team deploying the construction camp and also as supplementary construction accommodation. CSIRO is willing to assist with negotiations required to enable this option.

Permanent accommodation village

We propose that the canteen, kitchen and accommodation and recreation facilities be housed at the existing Boolardy Station homestead precinct, which is 700 m from the working buildings and is easily accessible for staff.

The kitchen facility (including a canteen and dining facilities) is intended as an extension of the existing facilities, which can currently cater for 37 staff. CSIRO has indicated its willingness to make this infrastructure available, as appropriate, to support the SKA project and to assist the SKA project in any associated lease and access negotiations. These supplementary facilities (to accommodate the required work force) will use pre-fabricated modular construction, enabling easy and economical integration with existing facilities. Permanent accommodation will provide each person on site with a 13 m² single room including an en suite. In addition there will be a common mess area, wet mess facilities, common room, laundry, first aid facility and recreation facilities, such as basketball courts, gymnasium and gazebos. The accommodation village will also include a self-contained water supply and waste water treatment facilities, resulting in an environmentally friendly facility. Costs for all these items are included in the accommodation camp overall costs.

In this response, the infrastructure costings assume accommodation for 130 staff (as outlined below) on an ongoing basis. The staff on site will share a room with their ‘turno’ partner. Most of these staff will be located on site, however we have also allowed for other local accommodation options, as indicated in Table 4.

Table 4 – Number and location of accommodation options for operation and maintenance workforce on site.

<table>
<thead>
<tr>
<th>Staff description</th>
<th>Number</th>
<th>Accommodation location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers and office staff</td>
<td>10</td>
<td>Accommodation camp</td>
</tr>
<tr>
<td>Visitors, overflow</td>
<td>12</td>
<td>Accommodation camp</td>
</tr>
<tr>
<td>Maintenance staff</td>
<td>98</td>
<td>88 at accommodation camp *</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 at Meekatharra (existing available accommodation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 at Mullewa (existing available accommodation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 at Mt Augustus (existing available accommodation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 at Pia Wajarri Community (existing available accommodation)</td>
</tr>
<tr>
<td>Support staff (catering, cleaning, etc)</td>
<td>10</td>
<td>Accommodation camp</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>Sum of existing and new accommodation</td>
</tr>
</tbody>
</table>

*An additional option may be accommodation at the Murchison Settlement, roughly 70 km from the MRO. The Settlement has 200 hectares of Crown land under the control of the Murchison Shire Council, which is potentially available for residential and commercial development.
Remote stations

At each remote station an allowance has been made for an 80 m² maintenance and storage facility. The maintenance and storage building will be constructed with a concrete floor slab, a structural steel frame with metal wall and roof cladding and will provide all necessary light and power. These buildings will also contain water tanks and first aid supplies, making these remote sites self-sufficient for remote station maintenance staff.

Airstrips

Airstrips already exist within the vicinity of the SKA site including the:

- Newly constructed airstrip to service the MRO (located 5 km from the central core) that is is fully compliant with the Royal Flying Doctor Service requirements
- Boolardy Station two airstrips (located approximately 30 km from the central core) that are fully compliant with the Royal Flying Doctor Service requirements.

The airstrips are 1200 m long, made of compacted gravel and have a cleared approach and take-off zone extending from each end of the marked strip. There are white painted markers defining the strip and an airsock. CSIRO is willing to offer use of these airstrips to the SKA project and is willing to assist with any negotiations required to enable take-up of these options. All of these airstrips offer SKA viable, existing and fit-for-purpose solutions. Surrounding pastoralists also rely on aircraft for travel and mustering purposes and therefore have their own airstrip.

Safety

Australia’s aviation safety record is very strong. In 2009 there were 25 general aviation deaths, which equates to 18.3 deaths per 10,000 registered aircraft. A 2006 study by the Australian Transport Safety Bureau found that the rate of general aviation fatalities in Australia is similar to countries such as the US, Canada and New Zealand.

Water and sanitation

Provision of suitable and environmentally approved water and sanitation facilities is included within the costings for the accommodation villages. Rain water will be collected from the buildings and high quality bore water is available at Boolardy Station. The remote accommodation camps include environmentally appropriate waste treatment facilities. The MRO control building will provide water and sanitation facilities for SKA staff.

Dish foundations

Dish foundations will be constructed to meet the stability requirements of SKA compliant 15 m dishes. Two alternative foundation types have been developed to deal with the different conditions likely to be encountered on site. In sandy soils a mass concrete foundation (7 m x 7 m x 1 m) is proposed, while the majority of antennas will utilise a foundation comprising four rock anchors in combination with a 5.5 m x 5.5 m x 0.8 m deep reinforced concrete foundation. These designs were optimised following foundation work undertaken in the area for the 36 ASKAP antennas and provide an easily constructed, robust and cost effective means of achieving stable foundations. The flat, cleared nature of the site means there would be very little work (and cost) required to achieve the requisite ground works for the for the AA-low (180 m diameter) and AA-mid (90 m diameter) stations.

Aperture array site preparation and bunkers

AA-mid aperture array bunkers

The four RF-screened bunkers required for each station can be combined into one common bunker, which is a more economical method of achieving the required SKA functionality. These bunkers will be constructed using prefabricated modular techniques similar to those used at the MRO to RF shield the control building and correlator room. At this stage, the cost of bunkers has not been optimised. A generous estimate is included in the budget to account for the specifications (including shielding requirements for the cooling systems) not being well known.
AA-low aperture array bunkers

The AA-low shielded bunkers (outside the central core area) will be constructed using prefabricated modular techniques similar to those used for the MRO’s control building and correlator room as this is considered the most economical method of constructing a suitably shielded bunker. For the 37 AA-low stations contained within the central core, it is proposed the bunker functionality be housed in the existing MRO RF shielded control and operations building. The existing 230 m² correlator room (which is shielded to 80 dB) could potentially be supplemented by a 280 m² modular RF shielded room constructed within the existing shielded building, representing a cost benefit of approximately €4m to the SKA. CSIRO has indicated its willingness to make this infrastructure available, as appropriate, to support the SKA project, and to assist the SKA project in any associated lease and access negotiations.

Construction methods and material sources

The ANZSSC has deliberately chosen a combination of construction methods and materials that are cost effective, environmentally friendly and readily available, so there will be few to no supply chain issues.

Table 5 – Construction methods and material sources.

<table>
<thead>
<tr>
<th>Component</th>
<th>Method and material source</th>
<th>Benefit to the SKA</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads – major</td>
<td>Single lane all weather road, chip seal assumed</td>
<td>• Upgrade of existing capacity so vehicles can travel in all weather and up to 110 km/h</td>
<td>• Cost effective solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fit-for-purpose in remote regions</td>
<td></td>
</tr>
<tr>
<td>Roads – minor</td>
<td>Cleared and graded tracks utilising local materials (such as gravel and aggregate)</td>
<td>• Approximately 30% of minor roads will utilise existing tracks: vehicles can travel 30–80 km/h in dry conditions</td>
<td>• Environmentally sustainable and cost effective solution</td>
</tr>
<tr>
<td>Airstrips</td>
<td>Existing airstrips at Boolardy Station and ASKAP</td>
<td>• Immediately available and both fully compliant with Royal Flying Doctor Service requirements</td>
<td>• Cost effective, fit-for-purpose solution</td>
</tr>
<tr>
<td>Dish foundations</td>
<td>Combination of newly constructed mass concrete foundations or rock anchors plus concrete foundations</td>
<td>• Easily constructible and utilises readily available material</td>
<td>• Cost effective, fit-for-purpose solution</td>
</tr>
<tr>
<td>SKA OCCA</td>
<td>Prefabricated modular buildings utilising structural steel frame, concrete floor slab, metal walls and roof cladding</td>
<td>• Reliable construction method used across remote areas in Australia</td>
<td>• Commonly used for mining and manufacturing enabling infrastructure</td>
</tr>
<tr>
<td>SKA OSO, HOB and SCB will all be existing buildings</td>
<td></td>
<td>• Proven turnaround times for prefabrication and delivery</td>
<td>• Reduced labour impact due to off site factory production and on site assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Numerous local suppliers who can meet SKA’s construction schedule</td>
<td>• No transport issues (such as land lock and trucking)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cost and time effective building solution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Results in fit-for-purpose, economical, robust and long lasting buildings</td>
<td></td>
</tr>
<tr>
<td>Accommodation and construction camps</td>
<td>Prefabricated modular buildings utilising structural steel frame, concrete floor slab, metal walls and roof cladding</td>
<td>• Utilise existing accommodation and facilities at Boolardy Station and various towns and settlements</td>
<td>• Commonly used for mining and manufacturing enabling infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reliable construction method used across remote areas in Australia</td>
<td>• Reduced labour impact due to off-site factory production and on-site assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Proven turnaround times for prefabrication and delivery</td>
<td>• No transport issues (such as land lock and trucking)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Numerous local suppliers who can meet SKA’s construction schedule</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cost and time effective building solution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• RF shielding is not required to the accommodation camp due to the distance to the nearest antenna</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Results in fit-for-purpose, economical, robust and long lasting buildings</td>
<td></td>
</tr>
</tbody>
</table>
Aperture array preparation and bunkers

RF shielded bunkers to be constructed in modular format with a welded steel shell

- Can be readily constructed off site and transported to site for installation
- Capital cost benefits due to existing ASKAP RF shielded control building being utilised to service AA-low stations in the central core
- Reduced labour impact due to off site factory production and on site assembly
- No transport issues (such as land lock and trucking)

Security measures

Australia classified low risk therefore only measures deemed necessary are stock fencing on AA-low and AA-mids

- Commonly utilised in the region and economical material
- Cost effective fit-for-purpose solution used already at the MRO

Security measures for infrastructure components

The infrastructure requirements for providing an acceptable level of security for the SKA project personnel and physical assets will be relatively low key and cost effective in both Australia and New Zealand. The proposed site for the core area of the SKA project is located approximately 100 km from the nearest settlement and 320 km from the nearest major town.

This region experiences very low levels of crime. Its remoteness affords the site a natural level of security, due to low levels of traffic and thus heightened local awareness of any new vehicles in the area. The MRO is located within the boundaries of the 345,900 hectare Boolardy Station (under a pastoral lease currently operated by the CSIRO).

Construction phase

During construction the security of the site, its material, workers and visitors will be the responsibility of the selected construction contractor(s). Construction security requirements will include site access control, security of plant and machinery, security of materiel and control of visitors. All personnel working on or visiting construction sites will be required to undergo a site specific induction process covering safety and security.

Ongoing operations

The assessed threats to the SKA project’s facilities are: theft of material or intellectual property, physical damage resulting from theft or attempted theft and potential attacks on personnel. All offices and technical facilities in Perth and Geraldton will be built to good commercial standards. Electronic access control will be required to critical areas and computer server rooms. Commercial security alarm systems and CCTV systems will be fitted where determined appropriate (by a threat and risk assessment). Lighting levels in office car parking and building surrounds will be set at a level to deter potential criminals. For the remote facilities, individual antenna structures will be designed with minimum entry locking points and will be unfenced.

The installation of a CCTV security system could be implemented for post event analysis, if deemed appropriate. Buildings forming the central core will be built to good commercial standard. Important areas of these buildings, including equipment storage areas, control rooms and computer server rooms, will be provided with electronic access control. For the AA-low and AA-mid stations stock fencing is recommended (to keep local cows, goats and sheep) away from the stations. Airstrips will not be fenced: pilots using the airstrip would be instructed to undertake a low level assessment prior to landing to scare any fauna.

Accommodation

The accommodation and recreational precincts for staff are potential areas of security concern. Risks include theft from accommodation, as well as damage to infrastructure and buildings. Entry to personal accommodation will be governed by electronic access control.

External lighting in these areas will provide sufficient illumination to provide a perception that any untoward behaviour will be detected. Day/night CCTV cameras will be installed around the accommodation and recreational areas to provide general wide area surveillance. The CCTV will be monitored at the main operations centre and footage will be recorded for post event analysis of any incidents.
Relevant national building codes and standards

All construction in Australia is governed by the Building Code of Australia (BCA), which stipulates the minimum standards required for different classes of buildings.

The BCA is widely recognised outside Australia and their standards are used as a guide in other countries, such as Japan and New Zealand, and the BCA has historical links with the standards developed and adopted in the United Kingdom.

The BCA is considered to be world class in setting standards for safety of people in buildings and also for providing a high level of structural integrity and energy efficiency.

Table 6 – National building codes and standards applicable to the SKA project.

<table>
<thead>
<tr>
<th>Infrastructure component</th>
<th>Building codes and standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer room and communications space</td>
<td>BCA Class 5 – general and office area</td>
</tr>
<tr>
<td></td>
<td>BCA Class 8 – computer ‘active floor’</td>
</tr>
<tr>
<td>Office and meeting room space</td>
<td>BCA Class 5</td>
</tr>
<tr>
<td>Canteen and common mess area</td>
<td>BCA Class 6</td>
</tr>
<tr>
<td>Maintenance facilities</td>
<td>BCA Class 7 – maintenance and workshop facilities</td>
</tr>
<tr>
<td></td>
<td>BCA Class 5 – office areas</td>
</tr>
<tr>
<td>Construction phase accommodation</td>
<td>BCA Class 1B – accommodation</td>
</tr>
<tr>
<td></td>
<td>BCA Class 6 – wet mess, canteen etc.</td>
</tr>
<tr>
<td></td>
<td>BCA Class 10 – laundry etc.</td>
</tr>
<tr>
<td>Permanent accommodation camp</td>
<td>BCA Class 1B – accommodation</td>
</tr>
<tr>
<td>SKA SCB in Perth</td>
<td>BCA Class 5, 7 &amp; 8</td>
</tr>
<tr>
<td>SKA HOB in Perth</td>
<td>BCA Class 5</td>
</tr>
<tr>
<td>Power station switch-room building</td>
<td>BCA Class 5</td>
</tr>
</tbody>
</table>

How operations and maintenance staffing model will be accommodated on site

Operations and maintenance staff working near the core area will be accommodated primarily at the OCCA. Accommodation is allocated on a working arrangement of an eight-day on, six-day off shift (similar to the ALMA ‘turno’ system) with an employee’s home station being either Geraldton or Perth.

Accommodation will be of a similar standard to that provided for permanently operating accommodation camps on remote mine sites. Some staff will be located at surrounding towns and communities enabling easy and economical access to the various work zones. See Attachment 24 – Operations and Maintenance Plan.

Maintenance staff for remote stations will be accommodated in Geraldton or Sydney. Access to the remote sites will be via commercial aircraft to a nearby centre and then via vehicle or air. Maintenance will typically be scheduled, rather than reactive, given the SKA has built-in redundancy through the number of remote array-stations.

Transport to and from operations and maintenance infrastructure

SKA Core

The maintenance groups servicing the dishes, AA-systems roads and buildings will be equipped with suitable 4WD vehicles. The vehicles will be based at the SKA OCCA (or surrounding towns and communities where staff are staying) and staff will head out to the areas requiring maintenance at the beginning of each work day.

SKA OCCA

At the SKA OCCA there will be several vehicles and bicycles available for staff to move between the operations buildings and the accommodation village. Each week, on the day of the shift change, charter buses (based in Geraldton) will transport OCCA staff via an all weather road to Geraldton. The airstrip at Boolardy Station can also be utilised.
SKA OSO in Geraldton

It is expected that the majority of the staff complement located at the SKA OSO will work a normal five-day week with their home station in Geraldton. There will be several 4WD vehicles stationed in Geraldton for additional trips to the OCCA (for example managers, site visitors and for deliveries of spares).

SKA HOB and SCB in Perth

It is expected that the majority of the staff complement at the HOB and super computer building (SCB) will have their home station in Perth. Staff would use their own private transport (or public transport) to travel between both buildings, as required.

Movement of staff and spares

Australia and New Zealand are sovereign, but closely allied, states with highly integrated economies and collaboration across a range of policy areas. Within Australia, the federal system of government would enable the SKA to operate across the continent in an effective, integrated legal and regulatory environment. Together, Australia and New Zealand are able to offer the SKA a seamless cross-jurisdictional environment in which to operate.

Within Australia

The Australian federal system is well suited to facilitate the operation of national scale organisations — our Constitution guarantees the free movement of people and goods between states.

Across Australia–New Zealand

With regard to the movement of staff and spares across an Australia–New Zealand SKA, there are a number of measures already in place including:

- The Trans-Tasman Mutual Recognition Arrangement (TTMRA), an agreement between the Australian Government, State and Territory Governments and the Government of New Zealand, which is to implement mutual recognition principles relating to the sale of goods and the registration of occupations.
- The Closer Economic Relationship (CER) Trade Agreement came into effect in 1983 and is widely regarded as one of the most comprehensive frameworks for bilateral economic integration in the world. The CER provides for a free flow of goods, services and people. Key features of the CER Agreement include the total elimination of tariffs and quantitative restrictions in trade between New Zealand and Australia and the harmonisation of customs procedures.

Total cost for each major infrastructure component including a 10 year construction program and a 30 year operation and maintenance

The cost estimates outlined by the ANZSCC below are defined as the total amount minus any discounts ('costs to the project'). The cost estimates for infrastructure components, power provision and data connectivity include plant, workforce and equipment necessary for construction, supply and/or delivery in a fit-for-purpose state. These costs and unit rates (for the constructed elements) do not include indirect costs and contingencies, or local taxes, import duties and other tariffs.

Infrastructure costs have been based on costs and rates applicable in Australia as at September 2011 and specific to the various regions where construction will be carried out. The operations and maintenance costs shown in Table 7 are for the 30 years of operations requested in the RfI (see Attachments 28 and 29 for further details). Where equipment required replacement within the 30-year timeframe, this cost has been included in the 30-year operational costings, even if it occurred at the end of the 30 years. General maintenance of buildings is included to ensure that buildings are always fit-for-purpose throughout the 30-year period.
Table 7 – Total costs for each major infrastructure component for the Model SKA.

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Roads (major and minor)</td>
<td>70,965,000</td>
<td>28,338,210</td>
<td>Allows for operational (staffing), maintenance and life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Includes capex credit of €2,240,000</td>
</tr>
<tr>
<td>Equipment and office buildings</td>
<td>35,825,167</td>
<td>21,766,665</td>
<td>Allows for operational (staffing), maintenance and life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Includes capex credit of €8,733,333</td>
</tr>
<tr>
<td>Construction camps</td>
<td>40,666,667</td>
<td>n/a</td>
<td>Allows for operational (staffing), maintenance and life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Includes capex credit of €4,800,000</td>
</tr>
<tr>
<td>Airstrip</td>
<td>183,600</td>
<td></td>
<td>Allows for operational (staffing), maintenance and life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Includes capex credit of €100,000 per airstrip</td>
</tr>
<tr>
<td>Dish foundations</td>
<td>157,200,000</td>
<td>n/a</td>
<td>No assumed asset replacement or operational cost over the 30 year period</td>
</tr>
<tr>
<td>Aperture array prep and bunkers</td>
<td>214,333,333</td>
<td>9,975,050</td>
<td>Allows for life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Includes capex credit of €4,000,000</td>
</tr>
<tr>
<td>Security</td>
<td>728,333</td>
<td>76,475</td>
<td>Allows for life cycle costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Excludes insurance premiums</td>
</tr>
<tr>
<td>Total</td>
<td>519,718,500</td>
<td>60,340,001</td>
<td></td>
</tr>
</tbody>
</table>

Refer to Attachments 28-30 for further information on our cost estimate as well as our cost methodology and confidence level for both the capital and operational costs.

The Australia and Western Australian governments have developed a draft strategy to acquire the relevant interests in SKA sites, which they propose to discuss with the SKA organisation (and/or SKA project member states and organisations) in detail should the sites be required, including how to resolve the issue of the costs of acquiring land access.

Report Summary: Basic Infrastructure Components — Motivated Alternative

The motivated alternative configuration provides SKA with more financially achievable infrastructure solutions while maintaining a very high level of scientific outcome. A major cost driver associated with basic infrastructure components of the SKA model is the high capex costs associated with roads and the size and scale of buildings, as well as the associated staff required to operate and maintain these facilities. Details of the motivated alternative configuration are provided in Attachment 27.

By reconfiguring the elements of the array, as well as its associated infrastructure, we have been able to achieve a number of capex and opex benefits outlined in Table 8 and 9, below.

Table 8 – Principal differences between compliant configuration and motivated alternative configuration.

<table>
<thead>
<tr>
<th>Model SKA</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads to central area</td>
<td>Revised configuration requires less roads</td>
<td>Increased efficiency in layout results in reduction in length of road required</td>
<td>Capex and opex savings are significant, key science preserved, future options retained</td>
</tr>
<tr>
<td>Size of operations centre</td>
<td>Reduced size of building (2,063 m²)</td>
<td>Due to the revised configuration and data requirements, the physical size of the operations building can be reduced resulting in a reduction in capex</td>
<td>Operations activities are best undertaken in Perth, rather than on site, Remote station maintenance staff not based on site</td>
</tr>
<tr>
<td>Size of sundry buildings</td>
<td>Reduced size of building (1300 m²)</td>
<td>Due to reduced operational requirements, the building size can be decreased</td>
<td>Options retained for future expansion</td>
</tr>
<tr>
<td>Construction accommodation</td>
<td>Reduced project scope results in a reduced peak workforce (160 people)</td>
<td>Reduction in scope results in lower person hours required for construction and consequently a lower peak work force to accommodate</td>
<td></td>
</tr>
<tr>
<td>Permanent accommodation</td>
<td>Reduced permanent accommodation (60 units)</td>
<td>Reduced operational requirements allows for a reduction in the number of permanent accommodation units required</td>
<td>Options retained for future expansion</td>
</tr>
<tr>
<td>Model SKA</td>
<td>Motivated alternative</td>
<td>Strength of motivated alternative</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
<td>----------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>AA-mids – 250</td>
<td>AA-mids – removed</td>
<td>Cost savings in infrastructure, and power consumption and maintenance staff</td>
<td>It is assumed that the dishes and AA-low can extend their operational ranges to cover the science projects currently proposed for AA-mid</td>
</tr>
<tr>
<td>AA-low – 250</td>
<td>AA-low 100</td>
<td>The proposed number of AA-low is still sufficient to achieve the major science objectives of this frequency range</td>
<td>Options for future expandability retained</td>
</tr>
<tr>
<td>Remote station numbers (25 across Australia, 600 antennas)</td>
<td>Remote station numbers reduced, but base line extended through to New Zealand (11 in Australia &amp; 1 in New Zealand: 288 antennas)</td>
<td>Operational costs are reduced by deploying remote stations on the existing AARNET backbone in Australia, providing secure bandwidth back to the central site</td>
<td>Excellent configurability still obtained due to extensive AARNET and KAREN networks</td>
</tr>
<tr>
<td>Antenna numbers to central area (2,400)</td>
<td>Reduced number of antennas (2,100)</td>
<td>All key science projects able to be successfully completed</td>
<td>Future options for expansion retained</td>
</tr>
</tbody>
</table>

Table 9 – Total costs for each major infrastructure component for the motivated alternative configuration.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads (major and minor)</td>
<td>37,046,833</td>
<td>14,688,151</td>
<td>Allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €2,100,000</td>
</tr>
<tr>
<td>Equipment and office buildings</td>
<td>27,219,167</td>
<td>16,672,624</td>
<td>Allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €8733,333</td>
</tr>
<tr>
<td>Construction camps</td>
<td>18,566,667</td>
<td>n/a</td>
<td>Includes capex credit of €4,100,000</td>
</tr>
<tr>
<td>Airstrip</td>
<td>183,601</td>
<td></td>
<td>Allows for operational (staffing), maintenance and life cycle costs. Includes capex credit of €100,000 per airstrip</td>
</tr>
<tr>
<td>Dish foundations</td>
<td>124,000,000</td>
<td>n/a</td>
<td>No assumed asset replacement or operational cost over the 30 year period</td>
</tr>
<tr>
<td>Aperture array prep and bunkers</td>
<td>16,000,000</td>
<td>3,150,016</td>
<td>Operational (staffing), maintenance and life cycle costs are included in Equipment and Office buildings. Allows for life cycle costs. Includes credit of €4,000,000</td>
</tr>
<tr>
<td>Security</td>
<td>100,000</td>
<td>10,500</td>
<td>Allows for life cycle costs. Excludes insurance premiums</td>
</tr>
<tr>
<td>Total</td>
<td>222,932,667</td>
<td>34,704,892</td>
<td></td>
</tr>
</tbody>
</table>
Geraldton offers an excellent lifestyle.

Electrical Power
Report Summary: Electrical Power

It is proposed that the power for SKA Phase 1 be provided by an on site diesel solar photovoltaic (PV) hybrid power station as an extension of the Horizon Power station due for completion at the Murchison Radio-astronomy Observatory (MRO) in 2013. The MRO power station is funded through a combination of CSIRO, Commonwealth Government and Western Australian State Government mechanisms. This extension would facilitate a cost effective and sustainable roll out of power, matching investment to requirements and taking advantage of developing capability in green energy technologies. Options for power supply for SKA Phase 2 include connection to the electricity grid piped gas supply and renewable energy options such as solar PV, solar thermal, geothermal and wind.

Integration of power for major projects in the Mid West region of Western Australia, including the SKA, is being explored by Government. If this integration is possible the SKA may be able to take advantage of cost efficiencies offered by concurrent development of a few major regional projects.

In this response two possible options for provision of power are explored: grid connection and provision of power from gas. The best option is not likely to be known for a few years and will be dependent on a number of factors, including investment decisions by other major industries in the region and Government decisions.

The power distribution network proposed has been designed to minimise radio frequency emissions and to take advantage of the productive workforce available in Australia for efficient operations and maintenance.

Power to the SKA high performance computer in Perth in both Phases will be provided by the grid, with options for geothermal to reduce cooling costs.

The ANZSCC has also developed in this response a motivated alternative model for SKA deployment, which ensures the integrity of the science while achieving a major cost reduction in infrastructure. The cost reductions in power infrastructure are presented in this chapter.

<table>
<thead>
<tr>
<th>Component</th>
<th>Proposed solution</th>
<th>Strength</th>
<th>Risk</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKA Phase 1</td>
<td>Extend the MRO</td>
<td>• Stand-alone power under control of project</td>
<td>• Carbon pricing may increase diesel costs</td>
<td>• Can expand renewable component of the MRO power station to decrease reliance on diesel</td>
</tr>
<tr>
<td></td>
<td>power solar PV</td>
<td>• Leverages existing funded power station at MRO, cost</td>
<td>• Needs arrangements in place to use MRO</td>
<td>• Including options for future use in current negotiations for MRO power</td>
</tr>
<tr>
<td></td>
<td>power station</td>
<td>effective for SKA Phase 1</td>
<td>power station</td>
<td>• MRO power station incorporates RF screening to required standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• MRO power station for early construction power</td>
<td>• RF compliance is challenging and can be</td>
<td>• Provide storage adequate to ensure continuous power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operational costs reduced through renewable component,</td>
<td>expensive</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>with options to increase renewable penetration</td>
<td>• Some reliance on diesel, with associated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>fuel delivery costs</td>
<td></td>
</tr>
<tr>
<td>SKA Phase 2</td>
<td>Power line from</td>
<td>• Option to buy green power</td>
<td>• High upfront capital cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Western Australian</td>
<td>• Low land-use and good geophysical attributes enables</td>
<td>• Lack of redundancy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>grid to MRO</td>
<td>optimal roll-out of power reticulation</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Depending on the investment climate, it</td>
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<td></td>
<td></td>
<td></td>
<td>may be possible to move some capex to</td>
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<td></td>
<td></td>
<td></td>
<td>open through financial arrangements</td>
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<td></td>
<td></td>
<td></td>
<td>• SKA Phase 1 stand-alone power supply</td>
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<td></td>
<td></td>
<td></td>
<td>can become emergency backup</td>
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<td></td>
<td>• Australian power supply is first world</td>
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<td></td>
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<td></td>
<td>standard and reliable</td>
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<td></td>
<td></td>
<td></td>
<td>• Gas supply</td>
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<td></td>
<td>• High upfront cost</td>
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<td></td>
<td>• May be cost-effective in combination with</td>
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<td></td>
<td></td>
<td></td>
<td>other projects</td>
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<td></td>
<td></td>
<td></td>
<td>• Gas off northwest WA</td>
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</tbody>
</table>

| Renewables     | Australia is rapidly building capability and the climate is | • Technology still under development        | • Maintain watching brief on solar prototypes currently under construction in Australia |
Potential sources of power for the SKA outlined in this report offer a number of benefits, including an RFI compliant, reliable and cost effective power supply for SKA Phase 1, and, for Phase 2, options for integration into a cost effective and green roll out of power into the Mid West.

In the sections below, responses to questions in the Request for Information are provided for the compliant configuration in the Model SKA. While a number of options exist for provision of power for both SKA Phase 1 and SKA Phase 2, for the purposes of costing, we assume a stand-alone power station for SKA Phase 1 and a grid connection for SKA Phase 2, with some of the intermediate and more remote array-stations provided with stand-alone power stations.

In the Australian 2005 document Proposal to site the SKA in Australia, a solution for powering the SKA Phase 2 with a gas fired power station was presented. The 2005 analysis is presented as Attachment 32 and includes updated costs. It could be practical to construct a gas fired power station near the Murchison Settlement, 70 km west of the core, and use a transmission line to bring power to the computing facility and antenna distribution system. However, this option does not provide the project with access to a range of diversified renewable energy solutions or cheap base load coal fired power. The majority of the discussion below focuses on the construction of a transmission line from the Western Australian grid to the project so that these benefits can be accessed.

An integrated vision for provision of power for major projects in the Mid West is being explored by Government. If a plan is developed and implemented, SKA may be able to take advantage of the cost efficiencies offered from the concurrent development of several major regional projects.

There may be a number of solutions that present within the next few years, such as the sharing of power generation infrastructure with other projects in the region (whether this be powered by gas, the grid or stand-alone generation). Industry has indicated willingness to work with the SKA on options for a cost effective shared solution. There is long experience of developing power solutions in remote areas of Australia, and the appropriate technical skills are available locally.

The differences between power provision for the compliant configuration and a financially achievable motivated alternative model are also presented. The motivated alternative configuration is outlined in detail in Attachment 27.

The most appropriate solution for power to the SKA depends significantly on the final power demand of the system. Selection of the method of power provision should be undertaken as part of an overall optimisation of the SKA system, including infrastructure, telescope components and operations.

Power transmission line option for central area of array, remote stations and supercomputer building

Central area

The model SKA’s central area has a power requirement of approximately 65 MW; 55 MW for the equipment out to 180 km from the cores, and 10 MW for the data processor and operations centre buildings. This requirement could be met through provision of a transmission line connection to the Western Australian electricity grid, with some of the more
distant array-stations having stand-alone diesel generators with options for increased renewable penetration, outlined below. Further details on opportunities in Australia for renewable power development are outlined in Attachment 33.

Single line diagram of proposed system

In the proposed model, the power to the central area would be delivered by a 132 kV single circuit transmission line from the proposed country north region of Western Power’s transmission network. This would provide the SKA with a highly reliable, well managed source of electrical energy from a AAA-rated, state government owned utility. Power transmission for the central area of the array would connect to the upgraded north region transmission network of Western Power. The preferred option is yet to be finalised and the expansion proposals will be subject to regulatory and financial approvals. The existing network in the country north region is 132 kV which extends 400 km from the northern outskirts of Perth to the north of Geraldton.

Connecting to existing infrastructure

Western Australian electricity market

By connecting to the Western Australian Interconnected System (the SWIS), the SKA would be able to purchase power from an AAA-rated, distributed network of power stations and renewable energy generators. The Western Australian electricity market is predominantly a bilateral trade market which allows customers to contract with power producers and use the electricity transmission network to send power to their facilities. In this market it is feasible to purchase some of the SKA’s energy needs from renewable sources.

At the time of writing, the Western Australian Government is constructing the 10 MW Greenough River solar PV farm through Verve Energy. Two independent power producers (Investec and Infigen) are planning 100+ MW wind farms, and Investec is also proposing a €133m 50 MW solar farm, near Geraldton (see, for example, the Greater Geraldton Carbon Neutral Mid West Plan in Attachment 34). In addition, the Shire of Perenjori is progressing the development of multi-use infrastructure to support the establishment of a 200 MW solar farm. This has attracted the interest of at least four private
companies, with one proposing to develop its own 200 MW solar power station. Australia has rapidly developing capability and opportunities in renewable energy (see Attachment 33).

Gaining access to the market via the grid provides reassurance that technical and commercial performance standards will be met courtesy of the regulation and auditing of market participants and Western Power. This is done through the State Government’s Economic Regulation Authority and the requirements of the Electricity Market Rules, Western Power’s Technical Rules and the mandatory application of international and Australian and New Zealand Standards. Both the Market Rules and Technical Rules contain performance standards that ensure power reliability, stability and quality is maintained at a level expected of a technologically advanced society. Refer to Attachment 35, Figure 1, for a visual overview of one option for the proposed electricity supply and reticulation.

Proposed SKA transmission network

This report proposes power be supplied to the SKA via a new 132 kV transmission line originating from the upgraded Western Power country north network. The connection point will be decided depending on the outcome of Western Power’s network expansion plan from Three Springs to Geraldton. A new transmission line to the MRO from this infrastructure would have a route length of approximately 350 km. The transmission line will terminate at a new 132/33 kV substation. This new substation will be located approximately 50 km from the core to ensure radio-quiet compliance. The line’s route will be chosen to ensure terrain shielding opportunities are maximised while avoiding proximity to antenna clusters.

Insulation levels and conductors for the final 50 km will be designed to minimise RFI from arcing and corona losses. Voltage regulation is proposed to be performed at the SKA 132/33 kV substation and will employ electrically quiet technology to minimise RFI. This will include a reactive power control using switched reactive elements mounted in a shielded building, as well as transformer tap changers that have been modified to ensure the oil tank acts as a shield. This design assumes that the retail power supply metering will be installed at Western Power’s SKA 33 kV main switchboard, with the terminal station equipment, transmission line and SKA site substation plant owned, operated and maintained by Western Power or a private sector utility provider. All Western Power proposals for expansions to the network, including those funded by third party capital contributions, are subject to approval and financing decisions by the Western Australian Government.

At the connection point, the provider will construct a new feeder circuit inside the selected substation supplying the SKA. This will comprise a 132 kV circuit breaker (and associated protection) and a bus zone and feeder protection. The transmission line will be a single circuit circular steel pole supported line with an optical fibre ground wire (OPGW) to provide lightning protection and secure communications for remote operation, control and monitoring of the SKA substation and metering system (refer to Attachment 35, Figure 2, for a visual representation of the minimum requirements of the 330/132 kV main substation).

The new SKA 132/33 kV substation, will consist of a 132 kV circuit breaker and an 85 MVA 132/33 kV transformer in an outdoor switchyard. To improve reliability, the 85 MVA transformer could be replaced by a redundant arrangement of two 50 MVA transformers. In the event of one transformer failing, antenna availability would just be reduced, rather than a total system outage, the equipment selected in the cost estimates is rated for continuous operation at 45 °C. The SKA 33 kV switchgear will be located indoors and comprise a single 33 kV bus with seven outgoing circuits supplying four 33/6.6 kV substations. The substation building will be no closer than 50 km from any SKA antenna and therefore only low level shielding will be required.

Distribution

Power will be reticulated from the SKA 33 kV main switchboard via a distribution system operating at 33 kV, 6.6 kV and 415 V. To reduce RFI a number of mitigation measures will be implemented, including a 33 kV and 6.6 kV underground cable with solid continuously welded aluminium screens, double voltage rated switchgear, cable insulation, plus shielded substations employing 6.6 kV RFI filters on each interface between RFI sources and the distribution network. The anticipated fault levels are 6.5 kA on the 33 kV system and 2.6 kA on the 6.6 kV system. All cables will be direct buried at a depth of one metre, resulting in no change in the cable ratings as a result of seasonal ground temperature variations.

The primary distribution to the core area and inner spiral arms originates from three 33/6.6 kV substations, known as power hubs. These hubs supply a system of 6.6 kV ring main power feeders which in turn supply the localised
6.6 kV – 415/240 V substations. These ring main feeders are normally operated with open points (near the halfway point of the ring) to minimise voltage drop while preserving maintainability. The normally open points may be varied slightly during commissioning or at time of abnormal operation (during maintenance and/or repair) to shift loads between hubs. The inner spiral distribution of 6.6 kV circuits will originate from the power hubs, but are radial spur feeders as the route length is too great to allow duplicate feed sources.

Power supply to the outer spiral antenna arrays is teed off a dedicated 33 kV ring main which has two points of supply (power hub one and power hub three). Each power hub has two incoming 33 kV supplies from the main SKA 33 kV switchboard. The tee off substations contain voltage regulators to control the ring supply voltage to acceptable limits.

Power hubs

Power hubs are the central distribution points from which the various parts of the array will receive power, including the three cores and the 15 inner spiral arms. The typical power hub distribution scheme (refer to Attachment 35 Figure 5) illustrates the connections within 33/6.6 kV hub one and shows two typical ring main circuits being supplied from the hub. These ring main circuits can supply a number of remote substations (depending on their capacities) and normally operate as spur feeders with an open point at or near the centre of the ring. Ring main units (RMUs) are never operated ‘fully closed up’ as this would tie the substation 6.6 kV busses together. A simple key interlocking scheme prevents inadvertent operation of the rings in this state.

Core distribution

Each of the three cores will be supplied from the power hubs at 6.6 kV, which will form the core distribution network. This network will comprise core substations that step down in voltage from 6.6 kV to 415/240 V and will each supply one or more dishes and AA stations. Core substations will be supplied from two different power hubs using 6.6 kV underground rings for redundancy, maintainability and hub load optimisation.

The size and quantity of core substations on each ring shown in this report are for illustrative purposes only and could be constructed using any combination of substation capacities, provided the total load on any one ring is supplied from one end and do not exceed 4 MW.

Ring main circuits are typically operated with an open point close to the midpoint of the ring, but can be closed during maintenance and for moving loads between main transformers and power hubs. All of these large 6.6 kV substations will be modular, fully shielded and RFI filtered. Refer to Attachment 35, Figure 6, for a visual representation of a core distribution scheme.

Dishes

Each dish in the core area has relatively low power consumption (6 kW), but the core itself has a very high density of dishes (approximately 1,500). It is expected multiple 6.6 kV substations will be distributed throughout the core, with multiple dishes supplied from each substation via 415 V reticulation. The final distribution transformer will be protected by fuses to avoid the need for any electronic equipment and thus shielding.

All cable terminations and insulators on the transformer will be enclosed in RF shielded termination housings so any emissions resulting from insulation breakdown in the termination will be fully contained.

AA-low stations

Approximately 160 AA-low stations are located in the core area, each with power consumption of 40 kW, resulting in a power requirement of 6.4 MW. Each core substation will supply one or two AA-low stations at 415 V.

AA-mid stations

Approximately 160 AA-mid stations are located in the core area, each with higher power consumption of 123 kW, resulting in a power requirement of 19.8 MW. Each AA-mid station will require its own core substation, comprising a 6.6 kV / 415 V transformer.
Data processor and operations centre buildings

The data processor and associated operations centre buildings will be located adjacent to one another (approximately 30 km from the centre of the core area). A dedicated 33/6.6 kV operations centre substation will be built nearby. Power will be reticulated to the operations centre and data processor building at 6.6 kV, allowing for use of 6.6 kV RF filters and a 6.6 kV diesel rotary backup power supply.

Inner spiral arm distribution

The inner spiral arms extend from each core out to approximately 13 km and comprise five dish spirals, five AA-low station spirals and five AA-mid station spirals. The power hubs are located midway along the arm to reduce power losses and improve voltage regulation. Each power hub will supply five spirals, with 6.6 kV to 415/240 V spiral substations located along each spiral arm, with power reticulation at 415 V (which will be similar to the core substations).

Dishes

There are approximately 70 dishes per arm and, due to their high density near the core, it is anticipated each spiral arm substation will supply between one and six dishes at 415 V, depending the distance between each dish.

AA-low stations

Each AA-low arm contains seven stations, their low density means each station will have a dedicated spiral substation in close proximity.

AA-mid stations

Each AA-mid arm contains seven stations, their low density means each station will have a dedicated spiral substation in close proximity.

Clump distribution / outer spiral arms

The clump distribution network will supply the first five clumps (starting approximately 13 km from the core out to approximately 50 km), via a radial distribution system with five arms that closely follow each spiral. Each arm will be supplied from a 33 kV underground outer spiral ring.

The ring will increase the reliability of the distribution scheme by allowing power to be maintained to the clumps, even in the event that an element in the ring fails or is taken out of service for maintenance.

The two ring main switching stations are where power is fed onto the ring from the main substation 33 kV feeders to power hubs one and three. Due to the cost of cabling, the last five clumps in each outer spiral arm will be supplied by standalone shielded diesel generators mounted in a transportable module. It will be possible to manufacture the modules at a convenient location and move them to site fully tested and ready for service. If one fails, or needs major maintenance, it will be possible to replace the entire power module in a few hours. There is potential for adding increased renewable penetration to these stations.

Each clump consists of 11 dishes (66 kW), one AA-low station (40 kW) and one AA-mid station (123 kW), totalling 229 kW per clump. For simplicity each dish is assumed to have a load of 6 kW, and there will be 10 clumps per arm, resulting in a total load of 2.29 MW. Each radial feeder will support only the first five clumps in each arm, resulting in a load of 1.15 MW, the remainder will be powered from the stand-alone stations.

To provide 1.15 MW over approximately 50 km on a single feeder without excessive voltage drop, power will need to be distributed at 33 kV. To prevent RFI, the 33 kV line will need to be in an underground cable with continuous welded aluminum screen. When the 33 kV cable passes a clump, a shielded clump node — comprising an RMU, a 33 kV / 415 V transformer with circuit breakers) and fault indicators — will be installed. The node will effectively provide a tee-off from the 33 kV line which will run to a clump substation located near the centre of the clump (at the AA-mid station, which is the largest load). The circuit breakers in the RMU will also be used to energise each arm incrementally and limit transformer inrush currents. All equipment will be capable of being remotely monitored and controlled.
For each of the five outer clumps on each spiral (proposed to be powered by diesel) the generators will be placed several hundred meters from the clump in a shielded enclosure. Power will be reticulated to clump substations at 415 V from the generator switchboard. On site fuel storage will be sufficient for three months of unattended operation and underground tanks are recommended. Provision will be made for the connection of solar PV arrays to reduce the amount of diesel fuel consumed.

Remote stations

The 25 remote stations outside the 180 km radius will each consist of 24 dishes and have a power requirement of 96 kW. Depending on the location, this power may be provided from the grid via aerial bundled cable at a voltage of 6.6 kV, to minimise the possibility of corona generated RFI. The last two kilometres will use shielded 6.6 kV buried cable to eliminate RFI close to the antennas.

ANZSCC’s proposed site selection of the remote stations has deliberately targeted sites that have a low probability of RFI from nearby activity, but are still close enough that it is practical to connect to them the grid.

If a utility supply is uneconomic, locally generated power will be used and follow the design proposed for the outer reaches of the spiral arms, with smaller modular power plants. It is proposed that these plants will consist of a renewable component (solar PV panels, or small wind turbines, connected to batteries) and a diesel generator. Power distribution at the remote stations will be via a single step down transformer with simple fused protection and 415/240 V distribution to each antenna. For the purpose of pricing the proposal, we have assumed shielded diesel or biodiesel modules. In total, over 30 such stand-alone power generation systems are proposed (25 within 180 km). This scale of deployment provides opportunities for innovation and accelerated development of renewable technologies, with associated spin-off benefits. Cost advantages from the scale of deployment are not assumed in capex or opex estimates below.

Supercomputer building in Perth (SKA SCB)

With total power consumption estimated at 40 MW, a computing centre of this size would normally include a diesel rotary uninterruptable power supply system (DRUPS). This avoids the need for a very large battery bank and is standard equipment in a large data centre. Single or dual utility supplies will provide power under normal conditions, however some embedded trigeneration may be incorporated to reduce electrical demand from chillers, as well as providing a number of environmental benefits and reduced operating cost.
Power generation for central area of array, remote stations and supercomputer building

Overview diagram for each location where power is generated

Central area

This diagram outlines the potential power generation source for the central area of the array for SKA Phase 1. The full SKA Phase 2 configuration is shown for reference.

The power supply for SKA Phase 1 will consist of the partial installation of the ring mains system and an extension of the MRO power station.

No diagram or detail is provided for the power generation scheme for SKA Phase 2 as this is assumed to be fed from a transmission line to the grid in this scenario.

Figure 2 – Power generation for SKA Phase 1 – central array.

Remote array-stations

The grid connection will use 6.6 kV overhead line and then underground cable for the last two kilometres to ensure RFI is minimised.

Figure 3 – Typical grid connection for remote station power scheme.
Supercomputer building (SKA SCB)

The proposal is to provide the supercomputer with a highly reliable power supply that is to the same design standard used for a data centre.

![Figure 4 – Typical stand-alone connection for remote station power scheme.](image)

![Figure 5 – Basic single line diagram of supercomputer power supply arrangement.](image)

Estimates of power provision quality

Table 1 – Estimated power provision quality.

<table>
<thead>
<tr>
<th>Component or location</th>
<th>Quality estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central area</td>
<td></td>
</tr>
<tr>
<td>Redundancy within the transmission system</td>
<td>The transmission system to the SKA site is a single dedicated 132 kV feeder with no redundancy. Redundancy in the distribution network is provided by the proposed use of dual 132 kV / 33 kV transformers and 33 kV ring main switchgear that allows faulty sections to be isolated while leaving the remainder in operation. The SKA Phase 1 power station could provide backup emergency power to the MRO. The Boolardy Station homestead precinct power supply could provide back-up power in the vicinity of the OCCA.</td>
</tr>
<tr>
<td>Fault level rating in kA</td>
<td>The SKA switchgear and cables will be industry standard with a capability in excess of the actual fault levels. Rising fault levels possible with network augmentation will be catered for by the network operator’s technical rules and design requirements. The current design assumes fault levels of 3.2 kA, 2.2 kA and 15.4 kA on the 33 kV, 6.6 kV and 415 V systems, respectively</td>
</tr>
<tr>
<td>Historical supply reliability from the Western Power grid</td>
<td>The Geraldton 132 kV terminal station is reported as having had only one short outage in the last five years. The ASAI records for low voltage customers in the Geraldton region is reported by Western Power as 99.974% for 2009/10</td>
</tr>
<tr>
<td>Forecast supply reliability to the operations and computing centres</td>
<td>12 hours per annum of down time</td>
</tr>
<tr>
<td>Forecast supply reliability to the cores</td>
<td>14 hours per annum of down time (conservatively estimated to be higher than Geraldton due to the remote nature of the supply)</td>
</tr>
<tr>
<td>Remote stations</td>
<td></td>
</tr>
<tr>
<td>Historical supply reliability from the grid</td>
<td>Four hours per annum of down time</td>
</tr>
<tr>
<td>Component or location</td>
<td>Quality estimate</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Forecast supply reliability to remote station</td>
<td>12 hours per annum of down time</td>
</tr>
<tr>
<td>Supercomputer building (SKA SCB)</td>
<td>Western Power reports that the system average interruption duration index (SAIDI) was 217 minutes in 2009/10. However, as stated above, the 132 kV transmission network is much more reliable and can be considered close to 100% reliable. The reliability of the SKA power infrastructure will therefore be dependent on the quality and design of the SKA system itself.</td>
</tr>
<tr>
<td>Historical supply reliability from the Western Power grid</td>
<td>The connection point in this design will be at the 33 kV bus. As this is after power factor correction and the 132 kV / 33 kV transformers the voltage will be automatically controlled to within 2% of nominal</td>
</tr>
<tr>
<td>Voltage variation at connection point</td>
<td>The nominal grid frequency is 50 Hz and typically remains within 0.1 Hz. Under fault conditions the frequency typically remains within 0.25 Hz low or 0.1 Hz high. Over a 24 hour period the frequency may be moved very slightly to ensure 50Hz based clocks remain accurate to within one second.</td>
</tr>
<tr>
<td>Frequency variation</td>
<td>The connection point in this design will be at the 33 kV bus. As this is after power factor correction and the 132 kV / 33 kV transformers the voltage will be automatically controlled to within 2% of nominal</td>
</tr>
<tr>
<td>Emissions intensity</td>
<td>The connection point in this design will be at the 33 kV bus. As this is after power factor correction and the 132 kV / 33 kV transformers the voltage will be automatically controlled to within 2% of nominal</td>
</tr>
<tr>
<td>CO₂</td>
<td>0.81 kg/kWh</td>
</tr>
<tr>
<td>NOₓ</td>
<td>0.0021 kg/kWh</td>
</tr>
<tr>
<td>SO₂</td>
<td>0.0039 kg/kWh</td>
</tr>
<tr>
<td>These values apply to the Western Australian electricity network (not all renewable energy sources)</td>
<td></td>
</tr>
<tr>
<td>Mean time to repair (including travel and equipment delivery) in days</td>
<td>Simple faults will be possible to diagnose via remote supervisory and control capability. Physical plant failure may require local maintenance staff, or technical staff from Geraldton. If staff had to travel from Geraldton, it could take about four hours to reach the core and up to two more hours to reach the outer parts of the spiral arms. If a transformer has failed it will be necessary to mobilise lifting equipment to remove and replace it. This will require an outage of the antennas fed by that transformer lasting two or three days. For the remote stations, depending on nearby availability of technicians, repair time may be up to a week. Observing policy will determine whether repairs are scheduled or ad hoc.</td>
</tr>
<tr>
<td>Reliability (ASAI) of the connection using system data from a similar supply point</td>
<td>The Western Power network is very reliable and typically has less than four hours per annum of down time at Geraldton</td>
</tr>
</tbody>
</table>

**Fuel delivery and storage in intermediate (<180 km) zone**

Fuel deliveries will be required at 25 of the most remote antenna clusters on the spiral arms. Using appropriately sized buried fuel tanks (for continuous unattended power generation for no less than two months), deliveries are likely to be required six times per year. Western Australia has a mature fuel distribution system and several fuel terminal and bulk storage facilities are available four to 12 hours drive from the outer spiral arms.

**Overview of operations for each power generation location**

A supervisory control and data acquisition system (SCADA) will be provided to monitor and control the SKA power generation and distribution system. The human machine interface (HMI) for the system will utilise PC based displays and keyboards located at the operations centre, SKA main 33 kV substation and the 33 kV / 6.6 kV power hubs one, two and three. All remote power generating stations and distributed substations will have a laptop plug-in port to facilitate maintenance and testing. It will also be possible to connect, to and monitor the performance of, the power system from any other remote location that has access to the Internet. This will allow SKA staff to conduct this maintenance remotely, and therefore cost effectively. All electrical network protective relays will be networked using IEC 61850 standard communications so they can be remotely interrogated for fault finding.

Power supplies to prime substations, switchboards and SCADA equipment racks will be from the switchgear protection relaying control. Indication of DC supplies and HMI PCs will be provided with small UPS modules. Without the need for human intervention, the SCADA system will initiate and perform all automatic switching functions for re-energisation of the power supply network or diesel generators following a power supply interruption. This will include sequential switching of high voltage (HV) circuit breakers to stagger the transformer magnetising inrush current loading on the system. The SCADA will also provide a high level overview of the electrical network, with structured detailed monitoring, reporting and analysis of fault conditions and abnormal operating modes. Detailed fault reporting will enable
maintenance crews to be directed to the faulty element in the specific substation or cable route. Where substations are connected in open HV ring main configurations, the faulty elements will be able to be isolated and the open points in the rings reconfigured to allow power supply to be restored and maintenance or repair to be rostered.

During switching operations, a burst of RFI is emitted. This is an acceptable emission as it only happens when an electrical fault occurs and again when restoring the power supply. This RFI burst will be one pulse for less than 200 ms and is not expected to occur more frequently than once every few years.

Communications circuits will share the site fibre network and facilities will also be incorporated to monitor the operation of the local area switches and routers with the site local area networks. Analysis of the energy consumption of various portions of the network and specific receptor arrays will be possible.

Fuel consumption and storage for the remote sites (where diesel generators are employed) will be monitored and checked against deliveries to streamline fuel supply and identify underperforming generator sets. Generator maintenance records will also be held in the system.

Safe operation of the HV electrical reticulation network will be controlled through an access permit system. The SCADA system will hold records (such as which plant is isolated, earthed, or out of service) and will include pre-prepared and tested instructions for standard safety isolation and earthing practices applicable to specific network components. Providing a description of the remote operation of the electricity network and remote un-manned power generation systems is standard practice in remote areas.

**Power availability for each generation location**

*Table 2 – Power availability for each generation location.*

<table>
<thead>
<tr>
<th>Component or location</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central area</td>
<td>Power to the central core will be provided by a transmission system designed to the highest engineering standards</td>
</tr>
<tr>
<td>Grid</td>
<td>24 hours per annum of down time for each of the generating stations on a spiral arm or remote cluster</td>
</tr>
<tr>
<td>Remote stations</td>
<td>24 hours per annum of down time for each of the generating stations on a spiral arm or remote cluster</td>
</tr>
<tr>
<td>Stand-alone generating module supply</td>
<td>Using the design methods intended for data centres, it will be possible to achieve better than 99.99% reliability</td>
</tr>
<tr>
<td>Grid</td>
<td>It is anticipated the supercomputer building will host a DRUPS as backup to the grid connected supply</td>
</tr>
<tr>
<td>Supercomputer building</td>
<td></td>
</tr>
</tbody>
</table>

Using the design methods intended for data centres, it will be possible to achieve better than 99.99% reliability.
Schematic diagram showing power distribution network

The proposed distribution network structure seeks to ensure the delivery of reliable and cost-effective power by using standard voltages, transformers, and switchgear. Minor modifications will be made to the standard transformers and cable designs to ensure potential RFI is controlled and that the cable is suitably termite resistant (these modifications are further discussed in the RFI mitigation section, Page 13). A level of redundancy is built into this design where it is easy and cost-effective on the high voltage system. No redundancy has been considered at the 415 V distribution system.

Specify components likely to be used to form the power network

The designed power network will consist of the following components:

- 132 kV transmission line with RF controls to minimise emissions
- 132 kV to 33 kV step down transformers
- 33 kV buried cable with integral RFI shielding
- 33 kV / 6.6 kV shielded step down transformers
- 33 kV / 415 V shielded step down transformers
- 6.6 kV / 415 V shielded step down transformers
- Shielded switchrooms for the electrical protection and control equipment
- Shielded diesel engine modules
- Miscellaneous circuit breakers and fuses for electrical protection and configuration
- A remote control and monitoring system.

All outdoor plant will be specified for continuous operation at 45 °C to ensure availability of power during hot weather.
Power provision for the zones of the telescope and for the data processor

The power supply to the central cores consists of rings of 6.6 kV substations that can be reconfigured to isolate faulty sections. Each substation will consist of a transformer and 415 V power distribution board for the feeds to antennas. The power supply to the spiral arms will consist of a 33 kV shielded underground cable system to compact substations, for the delivery of 415 V supplies to the antennas and antenna clumps. The outermost clumps of each spiral arm will be supplied by modular shielded diesel generators so the cost of supplying power over great distances can be kept as low as possible. If practical, the remote clumps of antennas will be fed by power from the grid. Where it is necessary to construct the antennas more than 20 km from the local grid, a shielded diesel engine modules could be supplied as a cheaper alternative.

Describe any back-up systems and redundancy built into network

The network has been designed so the 33 kV and 6.6 kV systems provide a level of redundancy, allowing the ring arrangement to be modified so that a faulty section can be removed from service without affecting the power supply of other sections. Using this approach it will be possible to have several electrical issues over the entire network and yet only lose a few percent of the antennas. Operators will be capable of remotely reconfiguring the network to isolate a faulty section and restore as many antennas as possible. The SKA Phase 1 power station is proposed as auxiliary backup power at the core during Phase 2. Due to the large number of remote array-stations, each individual one is not critical for science outcomes and so there is considerable in built redundancy.

RFI mitigation, lightning protection and other control and safety systems

The distribution system has to meet the requirements of Western Power’s Technical Rules in order to be given approval to be connected to its grid. This set of rules does not define the electromagnetic compatibility requirements (such as those stipulated in IEC 61000). To meet these requirements we have designed the system to have an inherently low ability to emit RFI and, where possible, equipment will be shielded to protect against any stray emissions.

RFI mitigation will be provided by the application of the following hierarchy of controls during the design phase:

- Avoiding equipment with RFI emissions
- Selecting equipment with low RFI emission levels
- Filtering and shielding emissions that cannot be avoided.

Following these simple rules ensures not only low emission levels, but also a low probability that emission levels will increase over time.

Public network assets

The proposed design requires extension of the 132 kV public network from near Geraldton to the central core. This asset could be constructed by the SKA project. The Request for Information requires a buffer of 50 km from any public transmission assets. For this proposed design, there will be a minimum of 50 km between the 132 kV system and any antenna. To ensure that the project has control over the RFI emissions, the last 20 km section of transmission line would be owned by the project.

The location of the array-stations has been carefully chosen to ensure that no public power asset is closer than 20 km from the antennas.

Cables

All power distribution is via buried cable to ensure the highest level of performance and security. The cable will consist of individual phase conductors wrapped in overlapping copper tape as a power earth. This will provide a level of shielding and will be completed with an overall wrap of overlapping copper tape around the three phases. As a final high quality
RF shield, the cable will be in a continuously welded corrugated aluminium sheath and this will be further protected by water- and vermin-proof moulded nylon or high density polyethylene (HDPE).

All cable types will increase their RFI over time due to microscopic partial breakdown of insulating material. This phenomenon can be minimised by ensuring the cable operates at lower temperatures and lower voltage stress. This is achieved by burying the cable and increasing the insulation rating (11 kV for the 6.6 kV cable), which is further backed up by the aluminium sheath.

Transformers

33 kV cables will enter specially manufactured transformers that consist of fully welded steel containment tanks and termination housings. The aluminium cable sheath will be bonded to the casing of the tank and protected from moisture to ensure dissimilar metal corrosion does not take place. Inside the termination housing, copper tapes will be connected to an earth stud for electrical safety and to drain away any high frequency electric fields induced on the tape. This is repeated on the 6.6 kV side of each transformer. In this way any high frequency signals on the power system will be contained in the cables and transformer enclosures. As the cables are highly lossy at high frequency any source of RFI will dissipate relatively quickly in the event of a weakness in the scheme.

Filters and shielding

An operating voltage of 6.6 kV for the majority of the system was chosen as it is the highest voltage at which a high performance RF filter can operate.

These filters have been designed for other experiments at the MRO and are now a standard item from at least one supplier.

The central computer and operations centre will be shielded to ensure RFI is contained to the defined level. Australia has extensive experience in designing such control and computing buildings. The building will be designed along the same principles as those at the MRO to ensure low maintenance needs. Double RFI locks at the entrance of the building ensure no breach of the shield. The buildings will also be designed to ensure compliance with the highest safety standards.

Lightning protection

Lightning protection will include lightning terminals at all buildings, antennas and outdoor substations, plus a comprehensive earthing system to disperse lightning and draw it away from the electrical system. The soil types at the MRO and surrounding land, are well understood and effective AS/NZS1768 compliant earthing systems have been constructed on the existing radio astronomy equipment. This design standard will be adopted for the SKA. The design aims to achieve an impedance of less than five ohms to the earth and milliohms to the infrastructure. The overhead power line will be protected by an overhead earth wire to minimise the probability of a direct hit on the line itself.

Schedule of power provision roll out

Power network for SKA Phase 1

It is proposed that provision of power for SKA Phase 1 could be through an extension of the power station to be constructed and operated by Horizon Power for the MRO. The MRO power station is being funded through a combination of CSIRO, Commonwealth Government and Western Australia State Government mechanisms.

The proposal consists of:

- Increasing the capacity of the MRO power station (1.1 MW with 50 percent renewable generation currently funded) by adding an additional generator module, fuel storage, solar PV and a 6.6 kV / 33 kV substation
- Constructing a small portion of the SKA Phase 2 6.6 kV power distribution and 33 kV power nodes
- Installing a single temporary 33 kV buried cable from the power station to the power node

This approach is shown in Figure 2.
This proposed solution provides the SKA with a number of cost and delivery benefits including:

- The initial construction power supply requirement could be met with existing MRO infrastructure without delay. CSIRO is negotiating a power purchase agreement with Horizon Power and CSIRO has expressed its willingness to include SKA considerations in its negotiations.
- Virtually no equipment installed for SKA Phase 1 will need to be modified for expansion to Phase 2.
- Utilising existing systems (designed for high reliability and expansion of the renewable energy portion) while still achieving RFI emissions compliance.
- Arrangement capable of operating continuously with low RFI (designed to the standards necessary for plant close to the core area).
- The operator, Horizon Power, being a AAA-rated State Government owned utility.
- The SKA Phase 1 power station could provide emergency backup power at the MRO for Phase 2.

Table 3 – Anticipated construction times.

<table>
<thead>
<tr>
<th>Component</th>
<th>Anticipated timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land acquisition and planning approvals</td>
<td>18 months</td>
</tr>
<tr>
<td>Design and procurement</td>
<td>6 months</td>
</tr>
<tr>
<td>Off site fabrication and acceptance testing</td>
<td>8 months</td>
</tr>
<tr>
<td>Installation and commissioning of shielded</td>
<td>2 months</td>
</tr>
<tr>
<td>Installation of underground cables and switchgear</td>
<td>6 months, in parallel to engine fabrication and testing</td>
</tr>
</tbody>
</table>

Power network for SKA Phase 2

The expansion of SKA Phase 1 infrastructure to accommodate the total power needs for Phase 2 will require the installation of the remainder of the power distribution system. It will also require construction of a transmission line to the main electricity grid or alternative power source, as appropriate. Overall, this arrangement would ensure the timely roll out of power infrastructure without limiting attainment of science objectives.

Table 4 – Anticipated planning and construction times for the transmission line and system connection.

<table>
<thead>
<tr>
<th>Component</th>
<th>Anticipated timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning approvals</td>
<td>24 months</td>
</tr>
<tr>
<td>Line and substation</td>
<td>18 months</td>
</tr>
</tbody>
</table>

As the roll out of antennas is progressive over a number of years, the installation of electrical infrastructure is not considered to be on a critical path, as trenching and prebuilt substation equipment is easily and quickly installed. The longest lead item will be the substation equipment with a planning and procurement time of approximately eight months.
As SKA Phase 2 has a much longer deployment timescale than other large projects in the Mid West, it is assumed in this response that generation capacity will be driven by the other customers and thus suitable power will be readily available by the time it is required for the SKA.

**Power provision during construction phase leading up to completion of SKA Phase 1 and Phase 2**

The MRO power station is designed to deliver up to 1.1M W at 0.8 power factor under all environmental conditions. It consists of four diesel generator sets and a 500 kW AC solar panel array. Further funding is available in 2012 for increasing the renewable penetration of the MRO power station. It is proposed to connect to the power reticulation around the site for use as a construction power supply. The lead time required to achieve this is about two months (for design and procurement of equipment and to set up temporary switchboards).

**Operations plan for power network**

**Waste management**

As the proposed SKA power supply network obtains the vast majority of its energy requirements from the grid, it is anticipated the system in the core will not generate any waste materials. Waste management must be considered for the outer spiral arm stand-alone power stations. It is proposed that these be transportable so maintenance and waste removal, can occur well away from any sensitive natural environment. This could also be the case for more remote array-stations that are not on the grid.

**Consumables and spares provision**

It is proposed spare parts, such as electrical switchgear, cable, RFI filters and portable diesel generating modules, be stored at the operations centre building 30 km from the cores. This will allow maintenance personnel access to parts close to where they are most likely to be needed and equidistant from the remote sites in the spiral arms. For more remote sites, spares will be stored in Sydney or Geraldton, or by local service centres contracted for the purpose.

**Staffing**

The power system network consists entirely of standard equipment that is proven and highly reliable. The majority of the effort required to keep it safe and reliable will consist of routine inspection and testing, much of which can be performed from a remote location.

It is estimated that four crews of two people will be required to physically check the equipment on a regular basis. The diesel generating modules will be best serviced through an exchange program allowing labour intensive maintenance to be done at a central facility. The design developed for the MRO is based around this approach and is standard within the industry. Note: this requirement will only exist after the first three years of operation. It will be achieved by bringing people to site (one day per site per month) to perform the module exchange.

Travel time is an important consideration. There are benefits in training staff to be versatile and capable of maintaining a number of the systems at each array-station. The high productivity standard of the Australian workforce is of benefit in this regard.
Regulations applicable to power network

National standards

Table 5 – National and state standards applicable to the power network.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Implication for the SKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>International and Australian and New Zealand Standards</td>
<td>State utilities already operating in accordance with these Standards</td>
</tr>
<tr>
<td>Code of Conduct for the Supply of Electricity to Small Use Customers</td>
<td>State utilities already operating in accordance with this Code</td>
</tr>
<tr>
<td>The Handling and Storage of Flammable and Combustible Liquids AS1940</td>
<td>State utilities already operating in accordance with these Standards</td>
</tr>
<tr>
<td>Steel Tanks for Flammable and Combustible Liquids AS1692</td>
<td>State utilities already operating in accordance with these Standards</td>
</tr>
<tr>
<td>Flammable and Combustible Liquids Code NFPA30</td>
<td>State utilities already operating in accordance with this Code</td>
</tr>
<tr>
<td>Recommended practice for fire protection for electric generating plants and high voltage direct current converter stations NFPA850</td>
<td>State utilities already operating in accordance with this Code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State/ local</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Corporations Act 2005</td>
<td>State utilities already operating in accordance with this Act</td>
</tr>
<tr>
<td>Wholesale Electricity Market Rules</td>
<td>State utilities already operating in accordance with these Rules</td>
</tr>
<tr>
<td>Electricity Networks Access Code 2004</td>
<td>State utilities already operating in accordance with this Code</td>
</tr>
<tr>
<td>Electricity Industry (Code of Conduct) Regulations 2005</td>
<td>State utilities already operating in accordance with these Regulations</td>
</tr>
<tr>
<td>Technical Rules</td>
<td>State utilities already operating in accordance with these Rules</td>
</tr>
<tr>
<td>State Government’s Economic Regulation Authority</td>
<td>State utilities already operating in accordance with the governance provided by this body</td>
</tr>
</tbody>
</table>

Agreements required to connect to existing power infrastructure

Table 6 – Agreements applicable to the power network.

<table>
<thead>
<tr>
<th>Agreement required</th>
<th>Implication for SKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Regulation Authority, Access Arrangement</td>
<td>The Economic Regulation Authority oversees the Access Code which provides a regulatory, technical and commercial framework for fair and legally binding access to infrastructure such as the SWIS. For the SKA this would guarantee access to the network through predefined rules for gaining access to power generated by any power plant also connected to the network</td>
</tr>
<tr>
<td>State Government Budget Approval Process for Spending by State Utilities</td>
<td>All expenditure by State utilities (such as Western Power) is subject to approval by the Western Australian Government through the annual State Budget Process. The SKA may be required to contract with a private sector infrastructure provider for transmission and connection of infrastructure.</td>
</tr>
</tbody>
</table>
Costs to the project for the provision and operation of the power network

Capital costs and associated uncertainties of the power generation system(s), and transmission and distribution networks for the three main zones of the SKA

The capital costs associated with power generation system(s), and transmission and distribution networks for the three main zones of the SKA are shown below.

Table 7 – Estimated capital costs.

<table>
<thead>
<tr>
<th>Component</th>
<th>Compliant configuration estimated cost</th>
<th>Motivated alternative estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>132 kV to the SKA site</td>
<td>See note 1 &amp; Table 8</td>
<td>See note 1 &amp; Table 8</td>
</tr>
<tr>
<td>SKA 33 kV main switchboard &amp; 33 kV primary cabling, power hub substations and central control centre substation</td>
<td>€94 m</td>
<td>€34 m</td>
</tr>
<tr>
<td>Phase 1 supplement of MRO power station to 5 MW</td>
<td>€11.3 m</td>
<td>Assumed to be provided by the MRO power station</td>
</tr>
<tr>
<td>Remote station and supercomputer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core and inner spiral distribution(&lt;13 km from centre)</td>
<td>€18.7 m</td>
<td>€14 m</td>
</tr>
<tr>
<td>outer spirals distribution (13-180 km from centre)</td>
<td>€156 m</td>
<td>€82.7 m</td>
</tr>
<tr>
<td>Remote array-stations</td>
<td>€48.7 m</td>
<td>€34.7 m</td>
</tr>
<tr>
<td>Supercomputer supply</td>
<td>NIL – included in power tariff</td>
<td>NIL – included in power tariff</td>
</tr>
<tr>
<td>Commissioning</td>
<td>2.7 m</td>
<td>2 m</td>
</tr>
<tr>
<td>Total</td>
<td>€331.4 m</td>
<td>€167.4 m</td>
</tr>
</tbody>
</table>

Note 1: The 132 kV line from near Geraldton to the SKA site will require an upfront capital contribution. It has been assumed that the SKA project will incur the full cost of this line. Given other developments planned for the region, it may be possible to share this cost with other users, but this has not been assumed in this response. It has been assumed that a third party will finance the capital contributions and that the project will fund its contribution (at a 15 percent rate of return) through an ongoing charge. These costs are incorporated into the operating expense estimated for SKA. The project could alternatively decide to make a larger initial capital contribution from project funds, which would reduce operating expenses.

Refer to Attachment 30 for information on capital cost estimation methodology and level of confidence. See below for information on anticipated uncertainties relating to the above estimates. Depending on the level of renewable energy required, and its availability at the time of SKA Phase 2, there may be a capital cost in commissioning a new power source. Land costs are treated in the Basic Infrastructure report.

Indicative costs of 30 years of power provision to the three main zones of the SKA, the supercomputer and associated uncertainties

Table 8 – Indicative operational and maintenance costs.

<table>
<thead>
<tr>
<th>Component</th>
<th>Compliant configuration estimated cost</th>
<th>Motivated alternative estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply to the SKA site</td>
<td>Based on 65 MW and an equivalent tariff to be AUD19.7 c/kWh delivered, the annual operating cost will be €74.9 m. See Note 1.</td>
<td>Based on 29 MW and an equivalent tariff anticipated to be AUD 19.7 c/kWh delivered, the annual operating cost will be €33.4 m. See Note 1.</td>
</tr>
<tr>
<td>Distribution system</td>
<td>Operation and maintenance cost of €2.8 m pa plus €11.7m pa for diesel fuel and maintenance of remote spiral arm sites</td>
<td>Operation and maintenance €2 m plus €4.7 m pa for diesel fuel and maintenance of remote spiral arm sites</td>
</tr>
</tbody>
</table>
Remote array-stations

The grid connected sites are expected to cost €2.4 m pa for energy and the sites operating on diesel generators will cost €2.8 m pa for fuel and routine maintenance.

Supercomputer

Based on 40 MW and a tariff anticipated to be AUD 12.7 c/kWh delivered, the annual operating cost will be €29.7 m.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>€124 m pa</td>
<td>€73 m pa</td>
</tr>
</tbody>
</table>

**Note 1:** The Market Rules and transmission network open access arrangements allow several ownership models for the transmission line. All require an upfront capital contribution for the transmission line. With third party finance it may be possible to invested capex upfront and have the investor recover the return through SKA operating costs. The base electricity cost for non-renewable energy (a market rate in Western Australia for 132 kV customers) is estimated to be AUD 12.7 c/kWh, inclusive of renewable energy credit and transmission charges. The rest of the tariff is return on investment calculated at 15 percent for the new transmission line, and this return on investment is included to create an equivalent tariff charge.

**Note 2:** No reduction in supercomputer size has been assumed for the Motivated alternative Model.

**Associated uncertainties**

These estimates are based on 2011 electricity prices and pricing methodology from Synergy – Western Australia’s government owned retailer. Large uncertainties are unavoidable in any estimation of future energy costs. An additional uncertainty is in the return on capital that would be required for the transmission line and substation assets: 15 percent has been assumed for this.

For the purposes of deriving an operational cost (recognising uncertainties with energy prices and infrastructure costs), it has been assumed that energy prices increase in line with the Australian consumer price index. The 30-year operating cost in current day terms will therefore be €3,700 m for the compliant configuration and €2,200 m for the motivated alternative proposal. Note that no impacts from climate change, including government policy on potential for carbon pricing, has been included.

**Report Summary: Electrical Power — Motivated Alternative Configuration**

The ANZSCC has also developed in this response a motivated alternative model for SKA deployment which ensures integrity of the science while achieving a major cost reduction in infrastructure. Full details of the motivated alternative are presented in Attachment 27.

The electrical power solution for the motivated alternative provides the SKA with a number of benefits, particularly pertaining to value for money. A major cost driver for the power provision for the compliant configuration is the cost of copper cabling throughout the large dense cores of all three receptor types. The motivated alternative assumes smaller, dense cores and clustering of receptors into array-stations closer to the centre than in the prescribed configuration. This makes significant differences to the cost of providing power, as cabling lengths are substantially reduced with little no impact on the quality of the science.

Deploying only two receptor types enables the power provision to be 6.6 kV throughout the intermediate zone, which greatly facilitates essential radio-quiet compliance. Australia’s secure environment and low crime rate makes it feasible to deploy remote power stations within the intermediate zone, further reducing cabling costs.

The motivated alternative proposes siting one array-station in the south of New Zealand. The power for this array-station would come from the grid, which draws approximately 79 percent from renewable sources.

Table 9 indicates the principal differences between the compliant configuration and that of the motivated alternative, as well as the rationale behind the choices made.
Table 9 – Principal differences between the compliant configuration and the motivated alternative.

<table>
<thead>
<tr>
<th>SKA model</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk power delivery 50 km from the core</td>
<td>Bulk power delivery 30 km from the core</td>
<td>Longer 132 kV and shorter 33 kV lines saves cost. The design will use higher rated equipment to ensure low emissions. Shorter 33 kV system makes underground shielded cable feasible and eliminates the need for higher RFI risk overhead cable or conductors.</td>
<td>The 132 kV design will have robust RF screening for the last 20 km. In addition to this, a low corona loss design (with corona rings and other fittings normally seen on higher voltage designs) will be incorporated to ensure the potential for emissions is minimised.</td>
</tr>
<tr>
<td>Spiral arms from separate cores not linking early</td>
<td>Spiral arms linked as soon as possible</td>
<td>This significantly reduces the quantity, cost and complexity of the distribution system and removes the risk associated with overhead conductor or cable.</td>
<td>By slightly re-orienting the arrangement of spiral arms and clumping the antennas the arms can be linked much closer to the core.</td>
</tr>
<tr>
<td>65 MW total load of core, spiral arms and computing centre</td>
<td>28.6 MW total load of core, spiral arms and computing centre, plus 1.9 MW fed by diesel generators at end of spiral arms</td>
<td>Lower load by removing AA-mid and lower cost cabling to inner and mid spiral arms by eliminating loads at the last 2–4 clumps by supplying stand-alone generators. Lower load allows for a voltage distribution system low enough that RFI filtration can be added.</td>
<td>The lower distribution voltage allows for a much lower likelihood of emissions and facilitates the retrofitting of filters and RF damping if emissions become a problem. Cost is higher In the SKA model because of the need to keep HV equipment away from antennas.</td>
</tr>
<tr>
<td>Power drop off point at least 50 km from core</td>
<td>Computing centre 30 km south of the core and adjacent to bulk power delivery</td>
<td>This saves need for long, dedicated distribution power feeders to the computing centre and brings what will be a focal point for maintenance and technical teams away from antennas, making RFI compliance easier to achieve.</td>
<td>Doing this introduces many advantages as the operations and maintenance staff, accommodation and the control centre can be in close proximity. This eliminates much of the travel induced RFI.</td>
</tr>
<tr>
<td>Each spiral arm for the inner and intermediate distance is an individual antenna</td>
<td>All antennas are in the core or in a 25 antenna clumps</td>
<td>Having clumps of antennas reduces the number of transformers needed to feed them. Also reduces the RFI risk due to fewer transformers and less equipment in general.</td>
<td>By taking the string of antennas and condensing it into a series of tightly packed clumps reduces the cost as well as the complexity of the distribution system.</td>
</tr>
<tr>
<td>Loose clusters</td>
<td>Compact clusters</td>
<td>Reduces the cost of power distribution and allows operation at low voltage over the entire cluster.</td>
<td>Packing antennas close together reduces the cost of infrastructure without significant impact on the science.</td>
</tr>
</tbody>
</table>
The skyline of Perth, where the Pawsey High Performance Computing Centre for SKA Science is located.
Report Summary: Data Transport

Australia and New Zealand have a mature and well regulated telecommunications environment, with extensive existing national and international optical fibre connectivity available through high bandwidth research networks and commercial providers. This provides a low technical- and commercial-risk platform for provision of the data transport infrastructure essential for the SKA to reach its scientific potential.

In addition, the very sparse population and flat terrain within 180 km of the core site enables optimum routing of the site’s dedicated optical fibre network. Australia’s technically educated workforce, and availability of state of the art fibre laying services, provides the means for cost effective deployment and commissioning of the network.

The recently installed optical fibre link between the Murchison Radio-astronomy Observatory (MRO) and Perth can be used to provide the connectivity between the core site, the rest of the SKA infrastructure and the global science community. This link has sufficient capacity to support both SKA Phase 1 and SKA Phase 2.

As well as outlining the data transport solution for the compliant configuration of the Model SKA, we propose a motivated alternative configuration that couples major cost reductions with outstanding science performance. The motivated alternative takes advantage of the existing research networks in Australia and New Zealand to deliver affordable long baselines while still maintaining a transformational science capability.

Given the extremely large number of individual receivers and high data rates required we believe the cost of active components, while not requested in this response, will be a major cost driver for the SKA data transport solution. The design proposed, for both the compliant configuration and the motivated alternative configuration, will help minimise this cost.

<table>
<thead>
<tr>
<th>Component</th>
<th>Proposed solution</th>
<th>Strength</th>
<th>Risk</th>
<th>Mitigation/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National infrastructure</td>
<td>• Utilise recently established high bandwidth MRO-Perth fibre</td>
<td>• SKA compliant fibre from data processor to supercomputer site already in place</td>
<td>• Negotiations for access being finalised as at 09/11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Utilise existing national optical fibre backbone infrastructure for remote stations</td>
<td>• Dedicated telecommunications carrier owned by the research community already in existence</td>
<td>• Negotiations underway with other providers. Alternative is to reconfigure remote stations to use existing AARNet optical fibre backbone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dedicated optical fibre for inner 180 km</td>
<td>• Flat terrain enables cost optimised fibre routes and efficient mechanised deployment</td>
<td>• Remote location requires field trips for deployment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Stable regulatory environment</td>
<td>• A single telecommunications legislative framework applies throughout Australia</td>
<td>• Stringent approval process required</td>
<td></td>
</tr>
<tr>
<td>Operations and maintenance</td>
<td>• Contract with existing and/or future research network providers</td>
<td>• Established research network across Australia and New Zealand</td>
<td>• Time to respond in a remote location can be longer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lack of full redundancy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Backup operations from site</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Consider strategic links to connect to existing fibre to provide redundancy</td>
<td></td>
</tr>
</tbody>
</table>
| International infrastructure     | • Utilise current worldwide connectivity from Australia using existing network providers | • Global connectivity at terabits per second exists with multiple diverse 10 Gbps optical fibre links already in service to Europe through Asia and the United States
• Global connectivity supported by research network providers already demonstrated | • Australia and New Zealand are distant from international science centres
• 100 Gbps network infrastructure not yet in place | • Use modern communication technology to allow close communication with overseas partners
• Educated community drives increased bandwidth provision over time
• Adoption of higher speed communication links (40–100 Gbps) have been demonstrated over existing infrastructure within Australia |
An Australia–New Zealand site is well placed to meet SKA’s data transport needs through a mature and integrated telecommunications industry, a demonstrated optical fibre connection from the MRO to Perth, extensive existing research networks, the ability to efficiently deploy new fibre networks and the future data capacity stimulated by the roll out of Australia’s National Broadband Network (NBN).

The data transport network and related capital and operational costs described below have been developed based on knowledge gained from Australia’s 20-year experience in deploying and operating national and international data transport networks to meet the needs of the research community. In particular, we draw on the recent knowledge gained from the roll-out of optical fibre networks designed to support the requirements of radio astronomy infrastructure (including ASKAP) at the MRO, and its national connectivity to the Long Baseline array in eastern Australia and the Warkworth facility in New Zealand.

Describe your site specific plan for the cable network in the central area out to 180 km

SKA network infrastructure – central area architecture

The proposed network infrastructure architecture for the central area and spiral arms supports:

- Unidirectional signal transport from receivers of multiple types to the data processor
- Bidirectional communication requirements of the command and control systems
- Distribution of timing from the data processor to the receivers.

The network architecture assumes a digital signal transport output from the receivers in increments of 10 Gbps as it is mature technology with well understood transmission characteristics and does not require active dispersion compensation across the central 180 km zone (see Attachment 36). This solution allows a broad range of output rates to be accommodated by using multiple 10 Gbps interfaces. It leverages the low cost, and low inherent risk, of volume production pluggable 10 Gbps optics. In addition, costs are sufficiently well understood that we can obtain the AACE Class 4 cost estimate requested, which would be challenging if a 100 Gbps architecture were assumed.

The network architecture will provide a dedicated point to point connection from each 10 Gbps transmitter interface to a corresponding 10 Gbps receiver at the data processor. For command and control and timing, a separate fibre pair for each function is provided from the data processor to every receiver. An additional fibre pair is provided for an industrial supervisory control and data acquisition system (SCADA) from each receiver. This architecture is consistent across the central area inner cores, outer cores, and 180 km spiral arms and is shown in Figure 1 overleaf.
This diagram shows the connectivity framework for the optical fibre links between the receivers, data processor, supercomputer and remote sites. The arrows show the direction of primary data flow between the major components.

Passive wave division multiplexing (WDM) and optical amplification of connections is proposed for unidirectional signal transport. This has substantial cost benefits while ensuring all connections are dedicated 10 Gbps paths. The design is based on wave division multiplexors of 40 channels capacity per fibre.
The rationale for adopting this architecture, and further technical details on the optical fibre infrastructure proposed for each receiver type, is supplied in Attachment 36.

**Capital cost to the project of implementing and commissioning the network**

The estimated capital cost of the passive equipment for the 180 km central area to implement the network, as described in the Request for Information and subsequently provided additional network topology information (email from SKA Program Development Office dated 31 May 2011), is listed below.

Table 1 – Passive network equipment capital costs and commissioning (180 km central area only).

<table>
<thead>
<tr>
<th>Passive equipment and installation</th>
<th>Equipment and commissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre</td>
<td>€4,511,800</td>
</tr>
<tr>
<td>Cabling infrastructure, splicing, termination, testing and documentation</td>
<td>€24,673,141</td>
</tr>
<tr>
<td>Trenching and conduit</td>
<td>€46,053,333</td>
</tr>
<tr>
<td>Total</td>
<td>€75,238,275</td>
</tr>
</tbody>
</table>

Consistent with the *Request for Information* active equipment costs have not been included. The capital cost of the active optical fibre components required to transmit and receive the stated data traffic rates is estimated to be over six times the total for the passive components above and is likely to dominate the total cost of the data transport solution. The active component cost is, in turn, a function of international commercially priced components.

Based on experience constructing ASKAP fibre, the component of direct labour in the above is approximately 22 percent. The remainder is made up of equipment hire, materials and support costs.

**Assumptions**

The following assumptions have been used in determining the estimates above:

- Pricing of the civil works is based on current prices for equivalent infrastructure from the ASKAP project, with appropriate consideration for the scale of the job.
- Pricing of fibre is based on current prices attained by ASKAP for long haul, direct bury and conduit construction methods. Overhead cabling was not considered, as reticulation of fibre has been assumed to follow the below ground deployment of power and data conduits. Underground fibre deployment also increases the operational lifetime of the fibre, reduces ongoing maintenance costs and improves temperature stabilisation of the power and data services.
- Fibre reticulation, trunk fibre and splicing quantities are taken directly from the tables specified in the Request for Information. Estimates on the costs for splicing, trenching, conduit terminations are taken directly from the installed fibre works program on site at ASKAP and the completed long haul fibre between Geraldton and the MRO.
- Testing and commissioning is included as specified in the Request for Information.
- Refer to Attachment 36 for a breakdown of the costs provided and details on the pricing methodology used.

**The operating costs to the project of maintaining the described network**

An estimate of the annual maintenance costs of the network is shown in Table 2.
Table 2 – Costs for maintaining the central area network.

<table>
<thead>
<tr>
<th></th>
<th>Life span (years)</th>
<th>MTBF * per year</th>
<th>SKA capital cost</th>
<th>SKA recurrent cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre system</td>
<td>40–60</td>
<td>0.01</td>
<td>€50,565,135</td>
<td>€505,651</td>
</tr>
<tr>
<td>Patch and passive system</td>
<td>10–20</td>
<td>0.03</td>
<td>€24,673,141</td>
<td>€740,194</td>
</tr>
<tr>
<td>Maintenance staff &amp; provision</td>
<td></td>
<td></td>
<td>€680,141</td>
<td></td>
</tr>
<tr>
<td>for spares, tools, vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; fuel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>–</td>
<td>–</td>
<td>€75,238,275</td>
<td>€1,925,987</td>
</tr>
</tbody>
</table>

*mean time between failure (MTBF)

1 Based on AARNet and CSIRO plant installed across Australia in rural and remote areas.

2 Recurrent cost is the capital cost of equipment multiplied by the MTBF, expressed as cost per year

Assumptions

On behalf of the Australian research and education community AARNet is currently maintaining thousands of kilometres of fibre across Australia and has extensive experience and expertise in the commissioning and maintenance of optical fibre systems in a cost effective manner. The costs outlined above are based on this experience. The following assumptions have been used in determining the estimates above:

- MTBF excludes major natural disasters
- All fibre systems installed to industry best practice and standards
- Patch field costs are mainly labour cleaning and replacing patch leads.

The regulatory environment governing networks of this type and the impact of any regulations (on the described model of operation)

There is a single regulatory framework governing networks of this type throughout Australia. This provides the SKA with confidence and stability in a secure data operating environment.

The relevant regulatory environment is mature with clearly defined rules and approval processes. Based on recent past experience by industry partners installing similar networks, the ANZSCC is confident that Australia’s regulatory environment is a strong asset for the implementation of the data transport network proposed for the SKA.

Full deregulation of the Australian telecommunications market occurred on 1 July 1997. Although deregulated, the main governing instrument is the *Telecommunications Act 1997.*

Under the Act a licensed telecommunications carrier is given wide ranging rights to install and operate telecommunications networks throughout Australia. Local approvals are required prior to construction. In the case of the SKA, the main approvals are heritage and environmental approvals, which require approximately 12 months to obtain.

By way of example, AARNet is a licensed telecommunications carrier owned and controlled by its shareholders (Australian universities and CSIRO) whose role is to provide telecommunications requirements unique to the higher education and research sector. They construct networks on behalf of their shareholders and they can also enter into arrangements with other carriers to gain access to existing fibre and/or services.

Over the past two years AARNet, on behalf of CSIRO, installed 400 km of optical fibre from Geraldton to the ASKAP site at the MRO. The project was successfully delivered in time and on budget. It was constructed to the same standards used by other telecommunication carriers in Australia.

During fibre installation for the MRO two main local approvals were required:

1. Western Australia Department of Environment and Conservation
   A clearing permit was required to install the cable. The permit was obtained by performing a targeted field fauna and flora survey. As most of the flora flowers during August and September, the survey was required to be performed during that period. The clearing permit was issued within three months of completion of the survey.
2. Western Australia Department of Indigenous Affairs (DIA)
   DIA can issue a Section 18 Certificate where indigenous sites of significance are identified near the path of the cable. To establish requirements a Linear Identification and Avoidance archaeological survey and an ethnographic review are required. As the fibre crossed some areas that had previously been registered with the DIA, and were thus recorded as part of the surveys, a Section 18 Certificate was required to be issued prior to work commencing. This process took approximately 12 months.

Any existing data connectivity infrastructure to be incorporated

The table below indicates the existing data connectivity infrastructure to be incorporated in the implementation, both for the intermediate and remote zones. CSIRO owns the MRO to Geraldton optical fibre link and has expressed its willingness to make the fibre available to the SKA as part of its existing arrangements with AARNet.

Table 3 – Existing data infrastructure.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Description</th>
<th>Owner</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRO to Geraldton fibre</td>
<td>400 km of 48 core fibre and associated huts and facilities</td>
<td>CSIRO</td>
<td>Connectivity of data processor to supercomputer</td>
</tr>
<tr>
<td>Geraldton to Perth fibre</td>
<td>450 km of 36 core fibre and access to associated huts and facilities</td>
<td>Australian Government</td>
<td>Connectivity of data processor to supercomputer</td>
</tr>
<tr>
<td>MRO to Pawsey Supercomputing Centre in Perth network</td>
<td>8 Tbps capable, 900 km DWDM transmission system</td>
<td>AARNet and CSIRO</td>
<td>Link already made available for early deployment and connectivity of remote stations to data processor</td>
</tr>
<tr>
<td>National research and education DWDM backbone network</td>
<td>8 Tbps capable network stretching 7000 km from Perth to Adelaide and on to all major east coast cities</td>
<td>AARNet</td>
<td>Connectivity of remote stations to data processor and diverse international paths</td>
</tr>
<tr>
<td>Other national fibres</td>
<td>Extensive fibres throughout Australia (see Figure 3)</td>
<td>Nextgen Networks, Australian Government, Telstra</td>
<td>Potential additional connectivity of remote stations to data processor at lower cost</td>
</tr>
<tr>
<td>International links</td>
<td>Capacity to Asia, the US and Europe</td>
<td>AARNet</td>
<td>Connectivity of the supercomputer to data centres in other parts of the world</td>
</tr>
</tbody>
</table>
This diagram shows Australia’s existing optical fibre networks, together with proposed array-station locations. This network provides a number of immediate benefits to the SKA including:

- Many array-stations already in vicinity of AARNet
- All array-stations in vicinity of existing fibre
- Excellent range of baselines for optimal array performance
- Ability to cost-effectively deploy dedicated fibre in 180 km region.

Examples of existing capability and capacity of local contractors (if available)

AARNet is a licensed telecommunications carrier which, over the past two years, has installed 400 km of optical fibre from Geraldton to the ASKAP site at the MRO on behalf of CSIRO. Local contractors were utilised for the work. In addition, in 2010 Nextgen Networks installed 450 km of high bandwidth optical fibre between Geraldton and Perth.

There are over 15 civil works companies in Australia who are experienced in installing long lengths of optical fibre in remote areas. As part of the regional backbone blackspots program of Australia’s NBN roll out, 20 companies rapidly mobilised six specialist teams to install 10,000 km of long haul optical fibre networks. This was successfully completed in 12 months.

Provide a connectivity plan describing how the SKA signal transport and network requirements will be accommodated and on what timescales for:

Remote sites to data processor

As Figure 3 illustrates, Australia’s substantial existing optical fibre infrastructure is a major strength, providing the option of quickly and economically establishing remote station connectivity even within SKA Phase 1.

The long haul DWDM technologies proposed for remote station connections to the data processor are commercially available today. All remote array-stations are located in the vicinity of existing optical fibre cable owned by AARNet or by other commercial telecommunications carriers.

There are therefore two cost models that can be used to connect the remote stations. In the first, a short tail is constructed from each remote station to the nearest commercial telecommunications carrier’s fibre. From there, fibre or
optical wavelengths would be provided by the carrier back to the data processor. The second model is to build a longer tail either to the core or to the AARNet fibre backbone, from where bandwidth can be provided back to the core. As negotiations are still to be finalised, costs for both models have been provided below. The higher cost is assumed in overall costing estimates. The existing national AARNet DWDM backbone has capacity to trunk the additional services required to interconnect the remote stations. Data services extending from Perth to the MRO across the existing optical fibre backbone will be in production within the next 12 months (as part of existing plans to support ASKAP). The installed active system would be upgraded with more wavelengths to support the remote station interconnects.

**SKA network infrastructure — remote sites**

SKA remote stations would be located throughout continental Australia with network connectivity to the central site data processor via a network provider at research rates.

The interface between the receivers at the remote station and the active DWDM equipment is proposed to be 10 Gbps to be consistent with the architecture proposed for the core. Each station’s traffic will then be aggregated into a long haul system for transmission across the optical fibre backbone to the data processor site.

The following steps are required to connect a remote station to the data processor via the existing AARNet backbone:

- Build fibre from the remote station to the backbone
- Install amplifier huts if the tail distance is greater than 100 km
- Upgrade existing backbone equipment to connect fibre tail from the remote site to the backbone
- Install DWDM equipment at remote station site and huts, if required
- Commission data transponders at remote sites and data processor and other locations.

Transmission of the 25 remote stations data will be aggregated at the data processor with reconfigurable optical add drop multiplexors (ROADMs). In addition, remote stations will be interconnected in a cascade loop fashion, with one wavelength heading ‘east’ to the next station and the other heading ‘west’ to the previous station, with at least 10 Gbps of bandwidth available for monitor and control and site data service redundancy.
Data processor to supercomputer centre

The connection between the data processor and the supercomputer will be provided by long haul DWDM systems. SKA deployment is scheduled to commence in the next six to eight years. Based on discussions with multiple long haul DWDM vendors, transmission systems spanning 900 km and capable of supporting more than 100 Gbps per wavelength (typically 200 Gbps or 400 Gbps) and up to 128 wavelengths per fibre, will be commercially available within this timescale. These DWDM systems will transmit approximately 25 Tbps over each pair of fibre.

Therefore to support the specified data volume of 400 Tbps, 16 fibre pairs will be required. A fibre trunk already exists between the data processor site and the supercomputer site, which has more than sufficient fibre capacity.

Supercomputer centre to data centres in other parts of the world and to the main office building (if not co-located with the supercomputer centre)

Australia has a broad and well established network of international telecommunications services that can accommodate connectivity requirements for overseas data centres at the rates, and within the timeframe, specified in the Request for Information.

We assume that data centres will be sited in North America and/or Canada, Europe and Asia. For the 10 Gbps global connection requirements for SKA Phase 1, the network is already in place and funded by AARNet, its members and the Australian Government and other international national research and education networks (NRENs). Domestic connectivity from the supercomputer site to the Australian east coast cable landing stations is already in place and will be provided via an 8 Tbps national research network.
Post 2020 international capacity

The 2011 Australian research network infrastructure does not have the 100 Gbps capacity required for international connections. Planning and investment is already underway to ensure this capacity will be in place by 2020. There is a high level of confidence that this requirement will be met, on commercially attractive terms, based on the following:

- Existing and proposed cable systems will be upgraded and commissioned with 40 Gbps and 100 Gbps wavelengths over the next few years (see Table 4)
- The Australian government’s investment in the NBN will significantly increase the overall national demand for international connectivity, driving down the unit cost
- The Australian government’s eResearch program places a high priority on the provision of network services
- Bandwidth requirements of the higher education and research sector have historically been ahead of commercially available services and this will drive the need for upgrades to capacity
- Precedents have been established for cable system providers to offer the research community access at significantly reduced rates.

This international link capacity is reticulated to the global research community through the existing interconnection and peering arrangements between NRENs. Each NREN operates their own internal network and obtains international capacity to connect to other neighbouring NRENs, thus building a mesh of connected NRENs around the globe. NRENs provide both a high capacity routed IP network as well as the ability to connect to each other via point to point private networks, as has been demonstrated by the Joint Institute for VLBI in Europe (JIVE) in their eVLBI demonstration in 2010 which linked Australia, the United States, China and Europe. As long as the data centres are connected to an NREN’s high speed network the supercomputer site in Australia can easily provide the data and results to the international science community.

This diagram shows the current AARNet international capacity. This capacity is for both connecting to the global Internet as well as neighbouring NRENs. The largest are 2 x 10 Gbps dedicated research links to the US via Hawaii. AARNet also has more than 10 Gbps general Internet capacity going to the US. Recently AARNet increased its capacity into Asia, as well as upgrading the capacity out of Perth. There is also a 1 Gbps link from New Zealand to Australia connecting KAREN to AARNet. Note: Singapore is a major hub to Europe.

Figure 6 – AARNet current network capacity.
In the next few years AARNet is planning to upgrade its capacity to the international community.

The areas of focus are:
- Perth to Singapore with capacity of 10–100 Gbps
- Sydney to the US via Auckland, upgrade of research links to 40 Gbps or 100 Gbps
- Sydney to Guam then Japan, Singapore the US at 10–100 Gbps.

The table below highlights the richness and capacity of existing, stable, competitive systems that operate currently in Australia.

**Table 4 – International cable systems leaving Australia.**

<table>
<thead>
<tr>
<th>Cable system</th>
<th>Current capacity</th>
<th>Future capacity</th>
<th>Direction</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Cross</td>
<td>2.4 Tbps</td>
<td>9.6 Tbps</td>
<td>East – US</td>
<td>Operational</td>
</tr>
<tr>
<td>Pipe PPC1</td>
<td>2.56 Tbps</td>
<td>2.56 Tbps</td>
<td>East — Guam</td>
<td>Operational</td>
</tr>
<tr>
<td>Telstra Endeavour</td>
<td>1.28 Tbps</td>
<td>1.28 Tbps</td>
<td>East – Hawaii</td>
<td>Operational</td>
</tr>
<tr>
<td>AJC</td>
<td>240 Gbps</td>
<td>1000 Gbps</td>
<td>East – Asia</td>
<td>Operational</td>
</tr>
<tr>
<td>Jasuraus</td>
<td>5 Gbps</td>
<td>20 Gbps</td>
<td>West – Asia</td>
<td>Operational</td>
</tr>
<tr>
<td>SEA-ME-WE-3</td>
<td>480 Gbps</td>
<td>480 Gbps</td>
<td>West – Asia</td>
<td>Operational</td>
</tr>
<tr>
<td>Matrix</td>
<td>2.5 Tbps</td>
<td>10 Tbps</td>
<td>West – Asia</td>
<td>Planning</td>
</tr>
<tr>
<td>Pacific Fibre</td>
<td>2.5 Tbps</td>
<td>10 Tbps</td>
<td>East – USA</td>
<td>Planning</td>
</tr>
</tbody>
</table>
For data connectivity plans described in (2), in each case provide information on:

### Capital cost to the project of implementing and commissioning networks

**Remote sites to data processor**

Table 5 – Estimated capital cost for implementing and commissioning networks.

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimated cost, nearest commercial telecommunications carrier fibre</th>
<th>Estimated cost, AARNet backbone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optic fibre tails to existing fibre backbone</td>
<td>€5,892,500</td>
<td>€30,350,000</td>
</tr>
<tr>
<td>Active network and transponders to provide the required data to each remote station.</td>
<td>€13,060,000</td>
<td>€13,060,000</td>
</tr>
<tr>
<td>Remote station local fibre infrastructure</td>
<td>€1,396,600</td>
<td>€1,396,600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€20,349,100</strong></td>
<td><strong>€44,806,600</strong></td>
</tr>
</tbody>
</table>

**Assumptions**

Refer to Attachment 36 for a breakdown of the costs provided and for details on the assumptions and pricing methodology used.

**Data processor to supercomputer centre**

Under existing CSIRO arrangements, fibre is already available for the passive fibre component of the system. There is no additional capital expenditure required.

**Supercomputer centre to data centres in other parts of the world**

As the required 10 Gbps capacity is already in place via existing research networks, there is no additional capital expenditure required for SKA Phase 1.

For SKA Phase 2, additional capacity upgrades will be required. We have allocated ~€33m in the budget estimates to secure procurement of adequate international capacity. This is based on past experience and discussions with research network providers. This would provide the research network community with 20-year indefeasible rights of use (IRUs) of at least 200 Gbps from Perth to Asia and 400 Gbps from Sydney to the US via Auckland and Hawaii to connect with the other neighbouring NRENs.

### Operational cost of running networks

**Remote sites to data processor**

Table 6 – Estimated operational cost of running the networks.

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimated cost, connection to nearest commercial telecommunications carrier fibre</th>
<th>Estimated cost, connection to AARNet backbone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational cost per year</td>
<td>€1,677,333</td>
<td>€2,753,333</td>
</tr>
</tbody>
</table>

**Assumptions**

The cost included for the nearest telecommunications option is just the tail and transponder maintenance.
This cost for the AARNet connection is based on maintenance requirements for incremental components. It includes tails and huts, active and passive components, incremental power consumption, air conditioning, rack space etc.

**Data processor to supercomputer centre**

The fibre is in place and negotiations on the management agreement to access the fibres are being finalized. Based on the draft agreement it is anticipated that there will be no cost to the SKA project. This includes maintenance of fibres under a joint CSIRO-AARNet arrangement (CSIRO is a shareholder of AARNet with a permanent position on the AARNet Board). Active components are not included.

**Supercomputer centre to data centres in other parts of the world**

If the capital contribution mentioned above is set aside then there would be no operational costs charged to SKA as they would be generally covered by the research community.

**Regulatory environment governing networks of this type and the impact of regulations on the described model of operation**

The regulatory environment has been described above for Western Australia. Other States in Australia have similar arrangements, applying their own legislation for environmental and heritage approvals. The Telecommunications Act is Commonwealth legislation and applies uniformly across Australia.

For international connectivity it is proposed the research network provider buy capacity on an existing cable and not be exposed to the regulatory environment of laying cables.

**Management and operations plans for these networks, including details of suggested service level agreements and typical mean time to repair times for comparable locations**

Generally there are two major areas that can be considered with respect to operations and maintenance:

- Physical cable plant, related pits, joints and enclosures
- Passive and active network equipment.

For physical cable plant, the typical mode of operation for research networks with Australia is that AARNet manages the maintenance services and coordinates any repairs as required. The recurrent maintenance cost is typically for what can be called ‘fibre repair readiness’, whereby trained contract staff at nearby locations have the necessary cable and equipment and can effect a repair on a short timescale. The actual repair cost is not covered by the repair readiness service but is paid on a time and materials basis. Experience with networks across Australia suggests this system works very well and is a very cost effective way of ensuring breaks are repaired in a timely manner by skilled staff.

In addition, all cable plant installed is required to be registered in the national ‘dial before you dig’ database which provides cable location information over the telephone. Anyone planning to excavate in a given area is expected to check with this service before commencing work to minimise disturbance to existing cables. The remoteness of the Australian deployment provides a natural level of protection to cables. The low levels of human activity in the region, along with the clear route identification, means the risk of disturbance to the cable is much less than in more populated areas.

Management of network equipment is typically organised via a network operations centre (either operated by AARNet or by the institution responsible for the network). As discussed, spares for modular components, such as power supplies and transceivers, would be kept at strategic locations with vendor maintenance contracts used for the larger and/or more expensive equipment.
Table 7 – Overview of typical response and rectification times.

<table>
<thead>
<tr>
<th>Urgent defect or fault</th>
<th>Response or rectification time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A fault that prevents, or substantially impedes, the transmission of data and other</td>
<td>Response time: within 12 hours of the initial report</td>
</tr>
<tr>
<td>telecommunications signals, or which results in the fibre performing at a level</td>
<td>Rectification time target: within 48 hours of the initial report</td>
</tr>
<tr>
<td>inferior to, the fibre pair specifications in Schedule 1.</td>
<td>(where practical, depending on severity of damage and working</td>
</tr>
<tr>
<td></td>
<td>conditions)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-urgent defect or fault</td>
<td>Response or rectification time</td>
</tr>
<tr>
<td>A fault or defect that is not urgent</td>
<td>Response time: within two business days of the initial report</td>
</tr>
<tr>
<td></td>
<td>Rectification time: within 14 days of the initial report</td>
</tr>
</tbody>
</table>

Examples of existing capability and capacity of local contractors (if available)

See the section ‘Examples of existing capability and capacity of local contractors (if available)’ above.

AARNet currently manages international research access for the research community, including involvement in radio astronomy eVLBI experiments. There is more than sufficient existing capability currently servicing the market. Nationally there are over 50 companies that could provide maintenance support services for the network with at least 10 companies located in close proximity to the central site area.

Existing infrastructure to be incorporated into the implementation

See Table 3.

Remote stations in other countries

For the compliant configuration of the model SKA it is proposed that all array-stations be sited in Australia. For the motivated alternative configuration, one array-station in the south island of New Zealand is proposed. Details are provided below.
Report Summary: Data Transport — Motivated Alternative Configuration

The data transport solution for the motivated alternative configuration provides SKA with a number of benefits, particularly reduced capital and operational costs. A major cost driver for the data transport provision in the SKA model proposed in the Request for Information is the huge amount of data traffic to be transported and processed. The Australia–New Zealand SKA Coordination Committee (ANZSCC) presents a scientifically motivated alternative with smaller dense cores, fewer AA-low receivers and no AA-mid receivers. This significantly reduces data transport requirements and the number of components and connectors.

The basic optical fibre architectural framework from the receivers to the data processor for the motivated alternative configuration is the same as for the compliant configuration. In the motivated alternative configuration the AA-mid receivers have been removed and the number of dishes and AA-low receivers reduced. The data rates used for the dishes with phased array feeds (PAFs), dishes with single pixel feeds (SPFs) and AA-low receivers are the same as per the Request for Information. The costs for the motivated alternative model in Table 9 and 10 below include the costs of one remote station in New Zealand.

The motivated alternative topology differs primarily by adopting an aggregation methodology made up of building blocks as described in Figure 8, below. This approach has been selected to also enable optimisation of power and data infrastructure costs.

Table 8 – Comparison of data traffic between the two configurations.

<table>
<thead>
<tr>
<th>Data rates produced by SKA receivers</th>
<th>Model SKA bit rate per receiver (Gbps)</th>
<th>Model SKA N° of receivers</th>
<th>Model SKA data traffic (Tbps)</th>
<th>Motivated alternative bit rate per receiver (Gbps)</th>
<th>Motivated alternative N° of receivers</th>
<th>Motivated alternative data traffic (Tbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishes with single pixel receivers</td>
<td>216</td>
<td>130</td>
<td>28</td>
<td>216</td>
<td>50</td>
<td>11</td>
</tr>
<tr>
<td>Beam formed dish stations beyond 180 km</td>
<td>216</td>
<td>25</td>
<td>5</td>
<td>216</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Dishes with phased array feeds (up to 100 km from core)</td>
<td>1,858</td>
<td>2,270</td>
<td>4,218</td>
<td>1,858</td>
<td>2,125</td>
<td>3,948</td>
</tr>
<tr>
<td>AA-low</td>
<td>33,440</td>
<td>250</td>
<td>8,360</td>
<td>33,440</td>
<td>100</td>
<td>3,344</td>
</tr>
<tr>
<td>AA-mid</td>
<td>16,800</td>
<td>250</td>
<td>4,200</td>
<td>16,800</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total data traffic to data processor</td>
<td>16,811</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7,306</td>
</tr>
</tbody>
</table>

Table 9 – Comparison of data transport capital costs between the two configurations.

<table>
<thead>
<tr>
<th>Capital costs</th>
<th>Estimated cost, connection to nearest commercial telecommunications carrier fibre</th>
<th>Estimated cost, connection to AARNet backbone</th>
<th>Motivated alternative configuration</th>
<th>Cost comparison, AARNet backbone vs motivated alternative configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core total fibre install and local reticulation</td>
<td>€75,238,275</td>
<td>€75,238,275</td>
<td>€38,622,507</td>
<td>51%</td>
</tr>
<tr>
<td>Fibre from data processor to supercomputer</td>
<td>€0</td>
<td>€0</td>
<td>€0</td>
<td>-</td>
</tr>
<tr>
<td>Remote array-stations to data processor network</td>
<td>€20,349,100</td>
<td>€44,806,600</td>
<td>€17,454,693</td>
<td>39%</td>
</tr>
<tr>
<td>Allowance for purchase of international network capacity</td>
<td>€33,333,333</td>
<td>€33,333,333</td>
<td>€33,333,333</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>€128,920,708</td>
<td>€153,378,208</td>
<td>€89,410,534</td>
<td>58%</td>
</tr>
</tbody>
</table>
Table 10 – Comparison of data transport operational costs between the two configurations.

<table>
<thead>
<tr>
<th>Operating costs</th>
<th>Estimated cost Nearest commercial telecommunications carrier fibre</th>
<th>Estimated cost AARNET backbone</th>
<th>Motivated alternative configuration</th>
<th>Cost comparison AARNET backbone vs motivated alternative configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central area network</td>
<td>€1,925,987</td>
<td>€1,925,987</td>
<td>€1,092,119</td>
<td>57%</td>
</tr>
<tr>
<td>Fibre data processor to super computer</td>
<td>€0</td>
<td>€0</td>
<td>€0</td>
<td>-</td>
</tr>
<tr>
<td>Remotes to data processor network</td>
<td>€1,677,333</td>
<td>€2,753,333</td>
<td>€1,391,333</td>
<td>51%</td>
</tr>
<tr>
<td>Total</td>
<td>€3,603,231</td>
<td>€4,679,321</td>
<td>€2,483,452</td>
<td>53%</td>
</tr>
</tbody>
</table>

It is also estimated that the capital cost reduction for active equipment would be approximately 57 percent: a substantial saving, given the very high cost of the active equipment required to support the scale of the SKA data transport network.

![Diagram](image)

*Figure 8 – Motivated alternative topology.*
The diagram shows the location of the motivated alternative remote stations throughout Australia. All remote stations are in close proximity to the AARNet backbone.

Figure 9 – Motivated alternative configuration and accessible high bandwidth optical fibre.

Further details on the motivated alternative configuration topology, cost breakdown and assumptions are provided in Attachment 36.
The Moon being used as a detector for ultra-high-energy neutrinos at CSIRO’s Parkes telescope. Photography by Seth Shostak.
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<th>Title</th>
</tr>
</thead>
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</tr>
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<td>Explanatory statement issued by the Australian Communications and Media Authority</td>
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A Memorandum of Understanding on Radio Quiet matters relating to the Murchison Radio-astronomy Observatory and Square Kilometre Array project

Foreword

In 2007 the Commonwealth of Australia and the State of Western Australia signed a Memorandum of Understanding (2007 MoU) in relation to Australia’s bid for the Square Kilometre Array (SKA) project. The 2007 MoU covered a broad range of issues in relation to the project to ensure that the two governments were aligned in their approaches to what is now Australia and New Zealand’s bid for this landmark science facility.

Clause 3.6 of the 2007 MoU envisages subsequent and supplementary agreements between the Commonwealth Government and the Western Australian Government in relation to the SKA project. This new MoU is not intended to replace the 2007 MoU. Rather, this MoU builds on the commitment in the 2007 MoU to preserve and potentially enhance the excellent radio quiet characteristics of the proposed Australian SKA site. To the extent that there is an inconsistency between the terms of this Memorandum of Understanding and the 2007 MoU in respect of radio quiet issues, the terms of this Memorandum of Understanding are to prevail.

The planned SKA radio telescope will be one of the largest scientific projects ever undertaken anywhere in the world. In the period before the final SKA site choice is made, Australia can demonstrate that it is the best location for the SKA, and this MoU is an important step in that process.

The region around the Murchison Radio-astronomy Observatory (MRO) is characterised by low population density, excellent observing conditions, and a very radio quiet environment, which is vital for gathering the faint signals for which the SKA is being designed. The MRO is being managed by CSIRO as a world-class observatory and will play a most important role in both Australian and international radio astronomy regardless of siting outcomes for the SKA. The MRO is the location of the Australian SKA Pathfinder (ASKAP) radio telescope being constructed by CSIRO, the Murchison Widefield Array radio telescope being constructed by an international consortium of institutions in Australia, USA and India, and other international radio astronomy projects.

The Western Australian site was selected because it offers several features particularly desirable for future radio astronomy. In particular, the local geology surrounding the MRO site and its remoteness from centres of population has allowed the establishment of the Mid West Radio Quiet Zone (RQZ) which is very large by world standards. The intention of a RQZ is that it provides for an extremely low noise environment that an instrument like the SKA needs.

Since the signing of the 2007 MoU the Commonwealth and Western Australian Governments have worked successfully together to achieve significant progress toward a very strong joint Australian-New Zealand bid for the SKA project.

- Negotiations with the native title claim group, the Wajarri Yamatji claim group, were successfully concluded and an Indigenous Land Use Agreement was registered with the National Native Title Tribunal in November 2009. This allowed the grant of a lease to CSIRO for the purpose of the MRO.
• Significant progress has now been achieved with the ASKAP project, including successfully combining the ASKAP first antenna with antennas in Parkes, Narrabri, Coonabarabran, Hobart and New Zealand, to create very high-resolution images. As at January 2011 there are six ASKAP antennas on site with completion due in 2013.

• There has been ongoing engagement between the Governments, CSIRO and industry in the region in regard to radio quiet measures.

The Governments recognise the importance of other economic and regional activities located within and adjacent to the RQZ. The identification of the core SKA site was selected collaboratively between the Western Australian Government and CSIRO, to maximise the potential for co-existence with mining infrastructure, particularly outside the 70 kilometre core protection zone. The Governments recognise that these developments, like radio astronomy, will produce significant long term economic benefits for Australia.

The Governments recognise the importance of CSIRO’s role in maintaining technical advisory guidelines; developing technical solutions with stakeholders; and as the MRO entity responsible for the notification of radio interference.

The Governments recognise the important role undertaken by the Australian Communications and Media Authority (ACMA) and its independence of this MoU.

Demonstration of Australia’s commitment and capability to effectively implement a radio quiet zone co-existing with other nationally important industry is a most important aspect of Australia’s bid to host the international SKA project.

This MoU reflects the principles and intent outlined in the joint Commonwealth and State Communiqué (Communiqué), agreed on 3 December 2010, to develop strategies which will allow the co-existence of radio astronomy and other economic development in the Mid West of Western Australia.

The successful collaboration of the Commonwealth and Western Australian Governments has been critical to the progress of the MRO and SKA preparatory projects to date, and will be crucial to the achievement of future milestones if Australia and New Zealand are to win the bid to host the SKA.

As the engineering and science requirements of the SKA become more defined, more will be known about the radio quiet needs of the SKA and related projects. It is therefore important that both governments restate their commitment to the MRO and SKA project now and their common undertaking to cooperate in this venture, particularly in relation to radio quiet matters.

SIGNED FOR AND ON BEHALF OF EACH OF THE PARTIES BY:

[Signature]
Senator the Hon Kim Carr
Minister for Innovation, Industry, Science and Research

[Signature]
Hon John Day MLA
Minister for Science and Innovation
A Memorandum of Understanding on Radio Quiet matters relating to the Murchison Radio-astronomy Observatory and Square Kilometre Array Project between

THE COMMONWEALTH OF AUSTRALIA

and

THE STATE OF WESTERN AUSTRALIA

1. Preamble

1.1 The Square Kilometre Array radio telescope (SKA) is a planned, very large-scale, next-generation radio telescope being developed by scientists from more than 50 institutions across 20 countries. It is currently planned for construction by an international consortium of funding partners over the period 2016-25 and is expected to operate for more than 50 years.

1.2 The Australian and Western Australian Governments (the Governments) remain committed to working together, and, in time, with the New Zealand and other Australian State and Territory Governments, to ensure that Australia and New Zealand provide the best site possible for the SKA, as outlined in the 2007 Memorandum of Understanding.

1.3 Optimum operation of the SKA requires that candidate sites establish a radio quiet zone to regulate emissions that fall within the observing frequency range (70 MHz – 25.5 GHz), to ensure these emissions do not impair the operation of the SKA. The SKA operates over a wide range of frequencies including outside the bands identified by the International Telecommunications Union (ITU) as being used by the radio astronomy service. The establishment of an effective radio quiet zone will be crucial for Australia and New Zealand’s joint bid to host the SKA, and is crucial for the successful operation, now and into the future, of the Murchison Radio-astronomy Observatory for the Australian SKA Pathfinder (ASKAP), the Murchison Widefield Array (MWA) and other radio astronomy projects.

1.4 The Governments have entered into this Memorandum of Understanding to build upon the commitment in the 2007 Memorandum of Understanding to preserve the excellent radio quiet characteristics of the proposed Australian SKA site.

1.5 Where there appears to be an inconsistency between the terms of this Memorandum of Understanding and the 2007 Memorandum of Understanding in respect of radio quiet issues, the terms of this Memorandum of Understanding will prevail.

1.6 As articulated in the 2007 Memorandum of Understanding, the Governments continue to recognise:

a) the value of large international science projects to Australia and Western Australia;

b) the potential benefits of the SKA for Australian astronomy and Australian science and technology more generally;

c) the particular economic and social benefits of the project to Western Australia; and

d) the need, in due course, to seek to extend this agreement to include the Governments of the other Australian States and Territories where SKA array stations may be sited.
2. **Radio Quiet Goals**

2.1 The overall goals of the Governments remain unchanged from the 2007 Memorandum of Understanding. These goals are to establish the world's premier site for radio astronomy by:

a) Creating a unique world-class observatory, the Murchison Radio-astronomy Observatory (MRO), housing the Australian SKA Pathfinder telescope, the Murchison Wide Field Array, potentially the future SKA, and other radio astronomy projects and infrastructure;

b) Securing, on acceptable terms, the siting of the SKA in Australia and New Zealand;

c) Establishing the Mid West Radio Quiet Zone (RQZ) that provides protection from both licensed radiofrequency interference (such as radio, TV, mobile phones and CB radios) and incidental radio emissions from electrical equipment other than deliberate transmissions emitted under licences issued by ACMA;

d) Allowing shared use of spectrum within the RQZ within acceptable limits, and in accordance with the principles outlined in Section 4.5, and as further supported by the technical advisory guidelines being developed by CSIRO, and mutually agreed between the Governments.

e) Facilitating the continued development and viability of other economic activities in the region (including, but not limited to, resource and infrastructure operations) through negotiation of mutually agreeable strategies to control radiofrequency interference; and

f) Implementing measures with the intent to enhance the legal status of the RQZ, and provide for the establishment of supplementary radio quiet zones.

2.2 The Australian New Zealand Square Kilometre Array Coordination Committee (ANZSCC) will monitor progress against these objectives under its terms of reference.

3. **Radio Quiet Arrangements as at June 2011**

3.1 To date, the Governments and the CSIRO have taken a consultative approach to radio quiet issues and it is intended that this approach continues.

3.2 In 2001 the Western Australian Government placed exemptions over areas of land at the core SKA site and surrounding areas under Section 19 of the Mining Act 1978 (Western Australia) (Exemptions). The Exemptions prevent the granting of exploration and mining titles within the S19/157 and S19/158 zones. The areas were identified after detailed investigation by the Geological Survey of Western Australia, in collaboration with CSIRO, and were selected because of the then perceived low mineral and petroleum prospectivity of the areas.

3.3 In April 2005 Embargo 41 was introduced by the ACMA to restrict issue of licences within 150 kilometres of the original Radio Astronomy Park based on the Milleura pastoral lease. The Embargo was revised in 2007 to account for the relocation of the MRO to the Boolardy pastoral lease.

3.4 The Western Australian Government has created a Radio Telescope Mineral Resource Management Area applicable to a 70 kilometre radius centred on the MRO, within which new tenements granted from 22 December 2006 will have conditions requiring all mining and exploration activities to be conducted according to a Radio Emissions Management Plan (REMP).
3.4.1 The REMP requires that, prior to commencement of any exploration or mining activity, an assessment of its potential radiofrequency interference at the centre of the MRO is to be completed. The REMP provides that if any interference is potentially above predetermined levels to protect the radio quietness, the activities and/or equipment will need to be modified to reduce interference to acceptable levels. The REMP further provides that the Operator will be required to commit to compliance with the REMP and any breaches of such compliance could result in penalties being imposed including forfeiture of the tenement.

3.5 The Radiocommunications Assignment and Licensing Instruction (RALI) MS 32, was introduced by the ACMA in September 2007 and covers an area of up to 260 kilometre radius surrounding the MRO. RALI MS 32 provides a means to issue apparatus licenses through co-ordination, to reduce radio-frequency interference to radio astronomy at the MRO.

3.6 Licence conditions in licenses issued in the 2.3 GHz band issued by the ACMA include recognition of the RQZ.

4. Principles

Cooperation

4.1 The Governments, and their respective departments and agencies, will continue to cooperate closely to achieve the objectives of this Memorandum of Understanding. They will work together to maintain a unified Australian position on radio quiet matters affecting the MRO and the SKA.

4.2 The Governments, and their respective departments and agencies, intend to use reasonable endeavours to adhere to the co-existence principles outlined in the agreed Communiqué established on 2 December 2010, this Memorandum of Understanding and the Mid West Radio Quiet Zone Management Framework and to establish a coexistence regime based on those principles. A copy of the Communiqué is provided at Appendix B.

Radio Quiet Standards

4.3 The Governments recognise that it will not be possible or necessary to eliminate radiofrequency interference (RFI) entirely, but will never the less encourage and facilitate the close cooperation of relevant Commonwealth and State Government bodies and industry, as outlined in the Management Framework, to resolve issues relating to radio quiet. A copy of the Management Framework is provided at Appendix C.

4.4 Each Government acknowledges the need to support the radio quiet requirements of the radio astronomy projects, through implementation of measures to ensure that best efforts are made to minimise RFI in the region of the RQZ.

4.5 The Governments will work together to protect the radio quiet nature of the MRO in accordance with the following:

a) The centre point of the RQZ is latitude 26° 42' 15" South, longitude 116° 39' 32" East (GDA94 datum). The zones are measured from this point;

b) 0 - 70 km – Radio astronomy is the primary use of spectrum in this region. Any proposed use of radiofrequency spectrum other than radio astronomy is considered to be secondary to the radio quiet requirements of radio astronomy in this area;
c) 70 - 150 km – Within the framework of any legislation or regulation applicable to this zone, a co-existence principle applies. Industry in this region is required to consult with the MRO entity (currently CSIRO) with a goal of developing and implementing technical solutions that minimise the radiofrequency impact of their operation on the radio astronomy operations. In return, the MRO entity will be required to facilitate practical and cost-effective solutions in a timely manner that maximise opportunity for shared use of spectrum within acceptable limits, as outlined in the Management Framework; and

d) 150 - 260 km – Managed in accordance with ACMA’s Radiocommunications Assignment Licensing Instruction MS32 incorporating, in the future, any amendments required to maintain consistency with further ACMA measures as agreed between the two Governments.

Mutual Co-existence

4.6 Subject to subsequent regulatory measures which establish radio astronomy primacy in the 0-70 kilometre range, the Governments are committed to a principle of co-existence of radio astronomy and industry in the Mid West region of Western Australia.

4.7 The Governments recognise and support that the radio quiet requirements of the radio astronomy services in the MRO may lead to restrictions or prohibitions on, or joint solutions with respect to, mining activity (including exploration) in accordance with Clause 4.5 above.

4.8 The Governments will use best endeavours to seek to develop, in conjunction with relevant stakeholders, strategies to assist with the viability, efficient and cost-effective operation of radio astronomy, economic developments and social activities can be maintained and successfully co-exist in the Mid West of Western Australia.

4.9 The Governments recognise the need for industry outside the 70 kilometre zone to have sufficient certainty regarding long-term spectrum use to enable investment decisions to be made. This extends to ongoing support for agreed technical solutions as set out in the Management Framework.

4.10 The preliminary assessment of technical solutions will be based on RALI MS32 scientific thresholds. Further assessment will be undertaken to allow for solutions to be developed outside those thresholds, in accordance with the Principles in the Management Framework.

5. Tasks

5.1 To achieve the goals identified in Section 2 of this Memorandum of Understanding, the Governments will work cooperatively together on the following tasks, and any additional tasks as included in the Management Framework:

a) maintaining the commitment to existing arrangements designed to protect the radio quiet characteristics of the proposed SKA site by managing both licensed and incidental transmissions;

b) designing and implementing further measures consistent with the Principles outlined in Section 4 of this Memorandum of Understanding;
c) maintaining a close and frequent liaison between key Government agencies and authorities to undertake co-operative negotiations in good faith, as needed to support the development of the MRO and instruments constructed therein, and community and commercial developments in the region that will potentially affect the MRO;

d) encouraging and facilitating ongoing cooperation and discussion in good faith between relevant parties including, but not limited to, the MRO entity, pastoralists, indigenous groups, and resource and infrastructure proponents, to resolve radio quiet issues associated with the MRO;

e) ensuring the MRO entity will develop and promulgate appropriate technical advisory guidelines to inform and assist other spectrum users to comply with any radio quiet requirements;

f) ensuring the MRO entity will facilitate practical solutions that maximise opportunities for shared use of spectrum within acceptable limits;

g) reviewing on a case by case basis the proposed remote array sites earmarked through the Governments’ land acquisition processes in order to identify sites and buffer areas that can be excluded from mineral and petroleum exploration and development, and other activities which would interfere with the SKA for the life of the SKA project; and

h) any other tasks needed to achieve the above goals.

6. Roles and responsibilities

6.1 The primary coordination, ministerial advisory and decision-making body under this Memorandum of Understanding is the ANZSCC, established to coordinate matters relating to Australia’s involvement in the SKA project.

6.2 The ANZSCC will establish, as necessary, advisory groups to assist in managing matters relating to radio quiet.

6.3 The ANZSCC will continue to report to the Ministers for Science for the Commonwealth and Western Australian Governments. In addition, the responsible Ministers in the two Governments may meet from time to time to advance the radio quiet needs of the SKA project with due consideration to other current and future economic activity of the Mid West of Western Australia, as required and as circumstances permit.

6.4 CSIRO as the current MRO managing entity, will have different roles under separate capacities as outlined in this MoU and the Management Framework. CSIRO has provided the Australian Minister for Innovation, Industry, Science and Research with a letter of intent acknowledging the regime represented by the MoU and Management Framework confirming it will operate consistently with this regime.

6.5 The Government parties acknowledge ACMA is an independent Authority responsible for managing spectrum, developing the regulatory framework to protect the Mid West Radio Quiet Zone, and for issuing apparatus licences within that regulatory framework. ACMA is not an Australian Government party to this MoU.

6.6 Future roles and responsibilities for the various aspects of the SKA project, which have not already been decided will be open to negotiation in good faith between the Governments from time to time in accordance with the Principles outlined in section 4 above.
7. **Contributions by the Governments**

7.1 The Governments have made substantial funding contributions to the MRO, the Australian SKA Pathfinder Project and Square Kilometre Array Project.

7.2 Future funding contributions for any matters which may arise relating to the establishment and use of the core SKA site for radio astronomy, and which have not already been funded, will be open to negotiation in good faith between the Governments from time to time.

8. **Communication**

8.1 The Governments, with the oversight of the ANZSCC, will consult with interested stakeholders to inform them of developments and seek feedback and comment on MRO developments, particularly in relation to the radio quiet matters within the RQZ region.

9. **Duration of Memorandum of Understanding**

9.1 This Memorandum of Understanding commences from the date of signature by both Ministers until it is replaced by a new memorandum of understanding or agreement, the development of which will be informed by the outcome of international SKA siting decisions, unless terminated earlier by mutual consent.

9.2 Following the SKA siting decision, should CSIRO be replaced by a new MRO entity, this Memorandum of Understanding will be modified to apply to the new entity, although the principles of this Memorandum of Understanding will be transferred to any future Memorandum of Understanding.

10. **Variation of Memorandum of Understanding**

10.1 This Memorandum of Understanding may be varied by the written agreement of the Parties in accordance with clause 9 and the Principles set out in clause 4 of this Memorandum of Understanding.

11. **Status of Memorandum of Understanding**

11.1 This Memorandum of Understanding does not create any contractual relationship nor is it legally binding on the parties.

11.2 Subject to clause 11.1, the parties to this Memorandum of Understanding shall apply their best endeavours to comply with its principles and intent.

11.3 The Management Framework is to be regarded as an attachment to this Memorandum of Understanding.

**SIGNED FOR AND ON BEHALF OF EACH OF THE PARTIES BY:**

\[Signature\]

Senator the Hon Kim Carr
Minister for Innovation, Industry, Science and Research

\[Signature\]

The Hon John Day MLA
Minister for Science and Innovation

2011  27 June 2011
Explanatory Notes

ANZSCC
The ANZSCC oversees the joint Australian and New Zealand bid to host the international Square Kilometre Array (SKA) project and provides advice to its responsible ministers.

Industry
Industry is defined as any commercial operator or entity within 260km of the core of the Mid West Radio Quiet Zone.

Operator
An operator is any commercial entity undertaking mining related activities.

MRO entity
CSIRO is the current manager of the MRO but could be replaced by another entity in the future, should Australia/New Zealand win the host SKA bid. Should a new MRO entity be established with the responsibility for the SKA project in Australia and New Zealand, it will manage the MRO within the boundaries of Australian legislation and this MOU as varied pursuant to clause 9.2.

Murchison Radio-astronomy Observatory (MRO)
The area of General Purpose Lease L139 058 of area of 12,793 ha within which a significant portion of the SKA receiving facility will be constructed, and which is being used for other radio-astronomy projects.

Mid West Radio Quiet Zone (RQZ)
The area of 260 kilometre radius surrounding the centre of the MRO within which radio-frequency interference (RFI) from 70 MHz to 25.5 GHz will be restricted or co-ordinated if required, to reduce the levels received at the centre of the MRO. Current regulatory measures that aim to reduce RFI on the RQZ are the ACMA’s RALI 32 and Embargo 41. The Western Australian Government’s Radio Telescope Mineral Resource Management Area 7618, and Section 19 (157 and 158) mining exemption zones under the Western Australian Mining Act (1978) aim to reduce radio frequency interference from adjacent mining operations to acceptable levels.

It is noted that the ACMA is considering replacing Embargo 41 with a Radiocommunications Frequency Band Plan. The Band Plan will incorporate various agreements reached between the State and Commonwealth Governments as outlined in the attached Communiqué (Appendix B). The ACMA is currently (as of the date of signing this MoU) considering further measures relating to protection for the RQZ.
Communiciqué

Commonwealth and Western Australian Government officials met on 2 December 2010 to discuss spectrum management in the Mid West Radio Quiet Zone. Currently the Australian Communications and Media Authority (ACMA) is consulting on a Band Plan which aims to increase radio-quiet protection for the Murchison Radio-astronomy Observatory (MRO). In re-affirming their strong support for the Square Kilometre Array (SKA) bid and the enhancement of radio-quiet protection for the MRO, the Commonwealth and State recognise there is a unique opportunity to promote co-existence of the MRO with other industry uses. Consequently the Governments remain committed to having an effective management regime based on a collaborative approach within a set of agreed guidelines. The management regime will include but not be limited to:

- dispute resolution procedures in a formal agreement
- technical advisory guidelines regarding the compliant operation of equipment in the Mid West Radio Quiet Zone.

Both Governments acknowledge the need to support the radio-quiet requirements of radio astronomy projects through the implementation of measures to minimise radio-frequency interference in the region of the Mid West Radio Quiet Zone and have agreed to work towards a regime which incorporates the following elements.

While industry may be able to operate within the 70km radius Radio Telescope Mineral Resource Management Area, such operation would be secondary to radio astronomy and consequently subject to the stringent controls of the proposed ACMA Band Plan and the Western Australian Mining Act (1978).

For industry, activity between a radius of 70km and 150km a co-existence principle will apply. Industry in this region would be required to consult with the MRO entity to develop technical solutions that minimise the radio-frequency impact of their operation on the radio astronomy operations. In return the MRO entity will be required to facilitate practical solutions that maximise opportunity for shared use of spectrum within acceptable limits. It is intended to incorporate the co-existence principle and Management Framework for the Mid West Radio Quiet Zone in a formal agreement between the Commonwealth and State Government of Western Australia.

In developing this approach the Governments recognise the need for industry to have sufficient certainty regarding long-term spectrum use to enable investment decisions to be made. This extends to ongoing support for agreed technical solutions.

The Mid West region of Western Australia continues to present the world’s best site for radio astronomy and all parties are committed to realising the vision this opportunity presents.
MID WEST RADIO QUIET ZONE
Management Framework
1. Introduction

This Management Framework has been produced by the Australian and Western Australian Governments with input from key stakeholders including industry. The Management Framework provides a mechanism for co-operation and collaboration between radio astronomy and other users to streamline processes that manage spectrum use in the Mid West Radio Quiet Zone. This Framework is recognised by the Australian and Western Australian Governments as the agreed process by which proponents consult with the Murchison Radio-astronomy Observatory (MRO) entity as required under current (and future) radio quiet regulations.

The Management Framework has been developed in accordance with the Governments’ objective to protect the radio quiet nature of the MRO and facilitate co-existence between radio astronomy and industry, and demonstrates the Governments’ commitment to foster cooperation to achieve mutually agreeable solutions.

The MRO, located 315 km north east of Geraldton in Western Australia (General Purpose Lease L139 058), is currently being used for a variety of radio-astronomy projects and is the area within which the Australia-New Zealand bid proposes to locate a significant portion of the Square Kilometre Array (SKA).

2. Principles

The ‘Memorandum of Understanding (MoU) on Radio Quiet matters relating to the Murchison Radio-astronomy Observatory and Square Kilometre Array project’ between the Australian and Western Australian Governments states the principles underpinning the Governments’ goals related to establishing and maintaining the Mid West Radio Quiet Zone, as described below:

Co-operation

1. The Governments, and their respective departments and agencies, will continue to co-operate closely to achieve the objectives of the Memorandum of Understanding. They will work together to maintain a unified Australian position on radio quiet matters affecting the MRO and the SKA.

2. The Governments, and their respective departments and agencies, intend to use reasonable endeavours to adhere to the co-existence principles outlined in the agreed Communiqué established on 2 December 2010, the MoU and this Management Framework and to establish a coexistence regime based on those principles.

Radio Quiet Standards

3. The Governments recognise that it will not be possible or necessary to eliminate radiofrequency interference (RFI) entirely, but agree to encourage and facilitate the close co-operation of relevant Australian and State Government bodies and industry to resolve issues relating to radio quiet.

4. Each Government acknowledges the need to support the radio quiet requirements of the radio astronomy projects, through implementation of measures to ensure that best efforts are made to minimise RFI in the region of the RQZ.

5. The Governments will work together to protect the radio quiet nature of the MRO in accordance with the following:

   a) The centre point of the RQZ is latitude 26° 42’ 15” South, longitude 116° 39’ 32” East (GDA94 datum). The zones are measured from this point;

   b) 0 - 70 km – Radio astronomy is the primary use of spectrum in this region. Any proposed use of radiofrequency spectrum other than radio astronomy is considered to be secondary to the radio quiet requirements of radio astronomy in this area;
c) 70 -150 km – Within the framework of any legislation or regulation applicable to this zone, a co-existence principle applies. Industry in this region is required to consult with the MRO entity (currently CSIRO) with a goal of developing and implementing technical solutions that minimise the radiofrequency impact of their operation on the radio astronomy operations. In return, the MRO entity will be required to facilitate practical and cost-effective solutions in a timely manner that maximise opportunity for shared use of spectrum within acceptable limits; and

d) 150 - 260 km – Managed in accordance with ACMA’s Radiocommunications Assignment Licensing Instruction (RALI) MS 32 incorporating, in the future, any amendments required to maintain consistency with further ACMA measures as agreed between the two Governments.

Mutual Co-existence

6 Subject to subsequent regulatory measures which establish radio astronomy primacy in the 0-70km range, the Governments are committed to a principle of co-existence of radio astronomy and industry in the Mid West region of Western Australia.

7 The Governments recognise and support that the radio quiet requirements of the radioastronomy services in the MRO may lead to restrictions or prohibitions on, or joint solutions with respect to, mining activity (including exploration) in accordance with Principle 5 above.

8 The Governments will use best endeavours to develop strategies to ensure that the viability, efficient and cost-effective operation of radio astronomy, economic developments and social activities can be maintained and successfully co-exist in the Mid West of Western Australia.

9 The Governments recognise the need for industry outside the 70 km zone to have sufficient certainty regarding long-term spectrum use to enable investment decisions to be made. This extends to ongoing support for agreed technical solutions in accordance with this Framework.

10. The preliminary assessment of technical solutions will be based on RALI MS32 scientific thresholds. Further assessment will be undertaken to allow for solutions to be developed outside those thresholds, in accordance with the Principles in this Management Framework.

3. Mid West Radio Quiet Zone instruments and policy documents

The management of spectrum within the Mid West Radio Quiet Zone is currently governed and managed through a number of Australian and Western Australian Government instruments.

3.1 Radio Telescope Mineral Resource Management Area

The Western Australian Government has created a Radio Telescope Mineral Resource Management Area applicable to a 70 km radius centered on the MRO, within which tenements granted from 22 December 2006 will have conditions requiring all mining and exploration activities to be conducted according to a Radio Emissions Management Plan (REMP).

The REMP requires that, prior to commencement of any exploration or mining activity, an assessment of its potential radiofrequency interference at the centre of the MRO is to be completed. If any interference is potentially above predetermined levels to protect the radio quietness, the activities and/or equipment will need to be modified to reduce interference to acceptable levels. The Operator will be required to commit to compliance with the REMP and any breaches of such compliance could result in penalties being imposed including forfeiture of the tenement.
3.2 **Section 19 of the Western Australian Mining Act 1978**

The Western Australian Government has placed exemptions over land at the core S KA site and surrounding areas under Section 19 of the Mining Act 1978 (Western Australia). The exemptions prevent the granting of exploration and mining titles within the S19/157 and S19/158 zones.

The areas were identified after detailed investigation by the Geological Survey of Western Australia, in collaboration with CSIRO, and have been selected because of the then perceived low mineral and petroleum prospectivity of the areas.

3.3 **Embargo 41**

*Embargo 41*, established by Australian Communications and Media Authority (ACMA), restricts the allocation of new licenses to use spectrum within specified radii from the centre of the Mid West Radio Quiet Zone, depending on frequency. The embargo applies to all apparatus licensed, coordinated terrestrial stations and earth stations that are located within the specified zone.

Under the embargo, existing licensed services can continue to operate. However, assignment proposals that seek to expand or modify existing apparatus licensed services are subject to the embargo.

3.4 **Radiocommunications Assignment and Licensing Instruction (RALI) MS 32**

The ACMA has established the RALI MS 32 which sets out processes to co-ordinate apparatus licensed services within the Mid West Radio Quiet Zone and provides criteria for assessment of proposed assignments located within a co-ordination zone. The co-ordination zone has a radius of up to 260 kilometres from the centre of the Mid West Radio Quiet Zone, depending on frequency.

The criteria for assessment consist of a threshold power density at the centre of the Mid West Radio Quiet Zone and a method of estimating the power density at the centre. The definitions of the various zones and the threshold power densities are shown in RALI MS 32.

3.5 **Possible future instruments**

Additional measures may be considered in future to consolidate the existing policy framework, extend the lower frequency range for protection, and clarify the protection from class licensed devices and spectrum licensed devices, as well as regulating incidental radio-wave interference. The Governments’ support for current and future regulatory instruments is contingent upon their consistency with the principles in Section 2 above. The ACMA’s independent role is acknowledged in this process.

3.6 **Further policy documents**

In addition to the regulations detailed in Sections 3.1 through to 3.4, the policy and procedural framework that underpins this document is also governed by:

- The Memorandum of Understanding between the Australian and Western Australian Governments on Radio Quiet matters relating to the Murchison Radio-astronomy Observatory and Square Kilometre Array project.
- The *Joint Communiqué*, dated 3 December 2010, from the Australian and Western Australian Governments on radio frequency spectrum management in the Mid West Radio Quiet Zone.
3.7 Future amendments

The Governments acknowledge that this Framework may require amendment from time to time but intend that no amendments will be made that materially prejudice the rights of key stakeholders including the MRO entity or industry proponents.

4. Responsibilities

This section sets out the roles and responsibilities of government, industry and radio astronomy stakeholders regarding the realisation of mutually acceptable co-existence in the Mid West Radio Quiet Zone. The steps in the consultative process to facilitate co-existence between radio astronomy and industry are detailed under Section 5.

4.1 Roles and responsibilities

Australia - New Zealand SKA Coordination Committee (ANZSCC)

The ANZSCC oversees the joint Australian and New Zealand bid to host the international SKA project and provides advice to the responsible ministers.

The ANZSCC has, (and may delegate to officers in the relevant organisations), the following responsibilities:

- Provide advice to the MRO entity and industry regarding the implementation of policy objectives related to the Mid West Radio Quiet Zone.
- Provide advice to the Western Australian Department of Mines and Petroleum in relation to the Radio Telescope Mineral Resources Management Area, Radio Emissions Management Plans and Mid West Radio Quiet Zone.
- Monitor the development of, and ongoing management of Technical Advisory Guidelines.
- Support negotiations between the proponents and the MRO entity on the development and implementation of technical solutions for minimising harmful radiofrequency interference in the Mid West Radio Quiet Zone to maximise opportunity for shared use of spectrum prior to licence applications being submitted to ACMA.

MRO entity

CSIRO is the current MRO entity. Following the SKA siting decision, should CSIRO be replaced by a new organisation, this Management Framework will be modified to apply to the new entity. The principles of this Management Framework will be transferred to any future Framework. Any technical solutions previously reached (by agreement or pursuant to the dispute resolution process) and any agreements reached between the MRO entity and industry will apply to the new entity. It is agreed by both Governments that the MRO entity’s responsibilities under this Management Framework will be transferred to any future MRO or SKA entity including:

- Management responsibility for the MRO according to a management plan and under the terms of a lease with the Western Australian Government.
- Maintain the Technical Advisory Guidelines for the Mid West Radio Quiet Zone.
- Assess proposals as required, to determine if the proposed activities would cause harmful radio-frequency interference to the MRO.
- Advise whether harmful radio-frequency interference is acceptable or not to radio astronomy on a case-by-case basis taking into account the Principles in section 2 above.
• Work co-operatively with industry in a timely manner to develop the most effective technical solutions that are consistent with the requirement to minimise harmful radio-frequency interference to radio astronomy services (NB: Timeframes can vary depending on the scale of a licence application).

• Work with proponents to facilitate the development of practical and cost-effective solutions that maximise opportunities for shared use of spectrum within acceptable limits.

• Act in accordance with consultation and dispute resolution processes detailed under Sections 5 and 6 in respect of apparatus and class licenses.

• Provide technical advice on licence applications as requested by ACMA, in accordance with Section 5.2.

Some obligations, such as those relating to other users of the MRO and under the MRO ILUA registered with the National Native Title Tribunal on 13 November 2009 may not be transferred.

Industry proponent (proposed licence applicant)

Industry is defined as any commercial operator or entity within the 260km of core of the Mid West Radio Quiet Zone. An operator is any commercial entity undertaking mining related activities.

• Advise and consult with the MRO entity on any proposed licence applications and equipment requirements. Where applicable, the proponents will work with the MRO entity to develop a technical solution.

• Identify radio spectrum requirements and self-assess whether, due to apparatus equipment specifications (eg frequency and proximity to the MRO), their requirements fall under existing instruments, including through consideration of the Technical Advisory Guidelines.

• Where applicable, act in accordance with consultation and dispute resolution processes detailed under Sections 5 and 6.

• Where applicable, subsequent to finalising processes with the MRO entity outlined in Section 5, engage with ACMA for licence applications.

Australian and Western Australian Governments

While self-regulating and self-monitoring principles apply, in dispute resolution cases the Australian and Western Australian Governments are to act in accordance with Section 5.3.

Both Governments agree to use best endeavours to work with proponents to seek to ensure that agreed technical solutions developed in the initial negotiation will have longevity in licence renewals under the standard ACMA renewal process.

Australian Communications and Media Authority

The ACMA is an Australian government agency responsible for the regulation of broadcasting, the internet, radiocommunications and telecommunications under various acts. In terms of managing spectrum and how that applies to the RQ Z, its role is predominantly set out in the Radiocommunications Act 1992.

Regardless of the conclusions reached through the Management Framework process, the overarching legislation applies. The ACMA will consider licence applications in accordance with its independent regulatory role.

ACMA will make the final decision regarding interference disputes in accordance with its regulatory role and cannot be bound by the advice of the proponents or the MRO entity.
5. **Apparatus Licenses – consultation process**

An apparatus licence is issued by ACMA, and authorises the operation of a radio communications transmitter. Industry proponents that require an apparatus licence within a 260 km radius of the centre point of the MRO (see Section 2.5(a)) should refer to RALI MS 32 to determine if, due to their spectrum requirements and location, they fall within the current ACMA regulations. If the industry proponent’s spectrum requirements fall within governing radio quiet regulations, they are to engage in the following management consultation process before submitting an application to the ACMA.

This process is not intended to operate in place of the requirements of the *Radiocommunications Act 1992*, but is the preliminary process by which a proposed applicant within 70 - 260 km of the MRO consults with the MRO entity prior to making its apparatus licence application.

A flowchart outlining the consultative process to reach agreement between key stakeholders on the acceptability of proposed apparatus equipment (and licenses) is provided at Appendix 1. The dispute resolution processes (Appendices 2 and 3) will commence should negotiations not result in an agreed outcome in the allocated timeframe.

### 5.1 Self assessment

The first stage of the apparatus licence consultation process is self assessment – *this stage is noted in blue at Appendix 1*.

Industry proponents seeking access to radio spectrum that falls within governing regulations are firstly to consult the Technical Advisory Guidelines. The Technical Advisory Guidelines indicate whether the apparatus equipment under consideration by the industry proponent may or may not impact on the radio astronomy operations and whether alternative technical solutions may therefore need to be developed with the MRO entity.

The industry proponent will notify the MRO entity of the outcome of its self assessment. The MRO entity will then make its own assessment, on a case by case basis (within ten working days), of compliance with the Technical Advisory Guidelines and consistency with Section 2 and accordingly either:

i. endorse the industry proponent’s assessment in writing as being an acceptable solution for radio astronomy, with the proponent then submitting its licence application to ACMA (see Section 5.4); or

ii. notify the industry proponent that following the MRO entity’s technical assessment, the consultation process detailed in Section 5.2 will need to be initiated.

### 5.2 Negotiated Technical Solutions

Following self assessment of proposed apparatus equipment, the MRO entity will notify the industry proponent whether an alternative technical solution will need to be developed (applicable under Section 5.1 (a) (ii)) – *this stage is noted in purple at Appendix 1*.

Both parties will follow the guiding principles of this Management Framework. A standard Non-Disclosure Agreement may be negotiated if required.

If the MRO entity notifies the proponent that modifications to the proposal are required, then the MRO entity and the proponent must collaborate in good faith to reach a practical and cost-effective technical solution to minimise the radio frequency interference to radio astronomy. The MRO entity will advise whether the resulting solution is acceptable or not to radio astronomy, and the proponent confirms the practicality and cost-effectiveness of the solution is acceptable for its project.
A timeline must be mutually established for the development of practical technical solutions. A timeframe of 85 business days is an indicative estimate of a reasonable initial timeframe if significant technical work is required. Timeframes can vary depending on the scale of a licence application and may be shorter for more basic applications.

The collaborative work may involve technical meetings between the proponent and the MRO entity. Where these are held, both parties (the proponent and MRO entity) may use teams of experts to seek a technical solution. The exchange of relevant information is required to make detailed assessments of radio frequency interference and joint consideration of possible solutions.

Both parties will cover their own expenses in attending meetings and conducting the required investigations. The MRO entity and the proponent will work together to develop solutions, considered reasonable and practical, within the framework described above for achieving minimisation of harmful radio frequency interference. The proponent is expected to agree to bear additional costs (reasonable and practical) to minimise the harmful radio frequency interference.

If, after 85 business days, or an agreed extension of time, the parties cannot reach agreement on the terms of an acceptable technical solution, either party may commence the dispute resolution procedure in Section 5.3.

In the case where a technical solution has been reached (by agreement or pursuant to the dispute resolution process):

a) the technical solution should be signed off by the authorised representatives from the MRO entity and the proponent in a form that can be provided to ACMA (which shall include a statement that the technical solution has been reached in accordance with this Framework);

b) the technical solution should include, as far as is practicable, in the terms of the proposed ACMA licence and conditions;

c) the licence approval processes outlined under Section 5.4 shall be initiated; and

d) the parties will not make any statement inconsistent with the application and, if requested by ACMA, will either:

i. communicate to ACMA that the impact of the proposed technical solution is acceptable; or

ii. not provide advice in addition to 5.2 a) to ACMA in relation to a technical solution where either party has lodged a notice under paragraph 5.3 c) v. i. but not received a notice under 5.3 c) v) ii).

5.3 Dispute resolution

The dispute resolution process described here provides for resolution procedures between the MRO entity and other spectrum users prior to any application being made to ACMA – this stage is noted in red at Appendix 1. It is acknowledged that ACMA is the decision-making body for the granting of licenses.

a) In the event that the MRO entity and industry are not able to come to an agreed technical solution for minimising radiofrequency interference, the MRO entity and the proponent should consult with the senior management in their respective organisations, who may work to facilitate an agreed technical solution.

b) If senior management has not reached an agreement after ten business days they are to notify the appropriate State and/or Australian Government departments, and either party may request that the matter be determined by a panel of three experts (this process is shown in Appendix 2) or the parties may jointly request the appointment of a third party mediator (this process is shown in Appendix 3).
c) The process for deciding upon and engaging an expert panel, and conducting the determination, is as follows:

i. the MRO entity will appoint one expert, industry will appoint one expert and one expert will be jointly appointed by the Parties;
   a. If the parties cannot agree on a third panel member, the third member will be selected by one of the bodies listed in Section 5.3 d) ii) below.

ii. the expert panel will comply with the following provisions:
   a. the panel will have the technical expertise necessary to resolve the dispute and will consider any technical advice obtained by the parties in the context of the co-existence regime provided by the Framework;
   b. each expert must have an understanding, or have the capacity to come to such an understanding quickly, of the relevant aspects of the Mid West Radio Quiet Zone (including in a technical capacity for both industry and radioastronomy); and
   c. each expert must not have a vested interest, or perceived conflict of interest, in either party and be capable of providing an impartial determination;

iii. the experts must consider the proposed solutions advanced by the MRO entity and the proponent, or consider an alternative solution, and determine a preferred technical solution consistent with the principles of this Management Framework and in accordance with recognised expert determination rules;

iv. the experts must prepare a report containing their determination and submit it to both parties and appropriate State and/or Australian Government departments;

v. if after receiving the report:
   i. either party notifies the other party and appropriate State and/or Australian Government departments within 10 business days that they consider that the experts’ determination is inconsistent with this Management Framework; and
   ii. those departments, having received such notification, notify the parties within a further 10 business days that the departments have reached an agreed position that the experts’ determination is inconsistent with this Management Framework, then the dispute will be resolved pursuant to Section 5.3(e) below;

vi. otherwise the parties will be deemed to have accepted the experts’ determination and the technical solution shall be signed off and the licence application made in accordance with Sections 5.2 and 5.4.


d) The process for deciding upon and engaging a mediator, and conducting the mediation, is as follows:

i. Parties can mutually nominate a mediator subject to the approval of the appropriate State and/or Australian Government departments:

ii. If a mediator cannot be agreed upon within five business days parties agree to mutually nominate an association from the list below, or another mutually acceptable association, that will nominate a third party mediator to assist the parties:
   a. Australian Commercial Disputes Centre;
   b. The Institute of Arbitrators & Mediators Australia; or
   c. Mediation Australia.
   If either party wishes, the appropriate government authority can be approached in lieu of an association to nominate a mediator.

iii. In any event the mediator will comply with the following provisions:
a. must have an understanding, or have the capacity to come to such an understanding quickly, of the relevant aspects of the Mid West Radio Quiet Zone (including in a technical capacity for both industry and radio astronomy);

b. must not have a vested interest, or perceived conflict of interest, in either party and be capable of providing an impartial direction through the mediation process; and

c. will consider the technical advice provided by experts in the context of the co-existence regime provided by the Framework.

iv. If the mediation process results in a technical solution being reached then the technical solution shall be signed off and the licence application with in accordance with Sections 5.2 and 5.4.

v. If the mediation process has not achieved an agreement after twenty business days, the mediator must prepare a report regarding the negotiation process and provide it to the parties and to appropriate State and/or Australian Government departments, and the dispute will be resolved pursuant to Section 5.3(e) below.

e) In the cases where a technical solution is not reached, then:

i. relevant departments will then work with the MRO entity and industry proponent to determine policy based recommendations for consideration by ACMA; and

ii. If a solution is not reached at this stage the application may be submitted to ACMA and considered in the light of the principles of spectrum management and governing regulations. ACMA will make the final decision regarding licensing disputes in accordance with its regulatory role and cannot be bound by the advice of the proponents or the MRO entity. The applicant may choose to accompany their application with the mediator’s report, the experts’ report or other supporting material. The Governments’ may provide separate policy advice, as appropriate.

f) Each party will bear their own costs incurred as part of the dispute resolution procedure, including the costs of any representatives they engage. The costs of any appointed experts or independent mediator will be borne by the proponent (50%), the Australian Government (20%), the Western Australian Government (20%) and the MRO entity (10%).

5.4 Licence approval

The expectations and responsibilities of parties for submitting licence approvals are outlined in Section 4 – this stage is noted in green at Appendix 1.

Once a licence has been issued by the ACMA in relation to a technical solution it shall be deemed to be an agreed technical solution for the purposes of this Framework and the MRO entity will, upon request, advise the ACMA in writing accordingly.

Once a licence has been issued by the ACMA based on the technical solution, the MRO entity will not make a formal interference complaint to the ACMA if the equipment is being operated in a manner consistent with the conditions of the licence. Should interference be detected from faulty equipment or equipment not being operated at the relevant specification, this is to be discussed in the first instance between the project proponents, with the aim of promptly resolving the source of interference in a collaborative manner, as outlined in Section 7.

In all circumstances, approval of licenses is subject to ACMA’s discretion. ACMA has a legislatively-determined process for assessing licence applications, which includes a process for the settlement of interference disputes as outlined in Part 4.3 of the Radiocommunications Act 1992.
The ACMA processes will continue to be available to parties and indeed it is important to note that regardless of the conclusions reached through the Management Framework process, the Radiocommunications Act 1992 applies.

ACMA will make the final decision regarding interference disputes in accordance with its regulatory role and cannot be bound by the advice of the proponents or the MRO entity.

For further information in regard to apparatus licensing please refer to ACMA’s website, www.acma.gov.au.

5.5 Licence renewal

Under Section 103 of the Radiocommunications Act 1992, an apparatus licence can be issued for a maximum of five years.

It is anticipated that, in some cases, industry proponents will require the use of apparatus equipment for a period longer than five years. Accordingly, industry proponents will be required to seek licence renewal for their apparatus equipment.

In the case of licence renewals where there is no change to the technical specifications of the technical solution, then the MRO entity will continue to accept the technical solution previously licensed and advise ACMA in writing accordingly.

In the case where the MRO entity requests a change in the technical specifications, then:

- The MRO entity and industry proponent will work collaboratively to seek to develop a new mutually satisfactory technical solution which does not impose unreasonable additional costs on the industry proponent, or unreasonable negative impact on radio astronomy.
- The new technical solution is to be agreed to prior to the end of the final licence period and both parties are required to allow sufficient time to undertake such a process. Guidelines for collaboration are covered under Section 5.2 above.
- If a new technical solution is not agreed, the MRO entity will continue to accept the technical solution previously licensed, and will advise ACMA in writing accordingly.

In the case where the industry proponent requires a new technical solution, the processes in Section 5.2 are to be followed.

The Governments recognise the need for industry to have sufficient certainty regarding long-term spectrum use to enable investment decisions to be made. This extends to ongoing support for agreed technical solutions. However, in all circumstances, approval of licence renewals is subject to ACMA’s discretion.

6. Class licenses – notification process

The ACMA manages spectrum used by services which employ a limited set of common frequencies using equipment under a common set of conditions through class licensing. A class licence sets out the conditions under which any person is permitted to operate. It is not issued to an individual user, and does not involve licence fees.

The ACMA is considering introducing a clause into relevant class licenses that a transmitter’s operation must comply with Mid West Radio Quiet Zone instruments.

The Australian and Western Australian Governments recognise the need to work together to minimise impact of the class license devices on radio astronomy in the 70 to 150km zone. The Australian and Western Australian Governments also recognise the need for proponents to have access to class licensed equipment and are supportive that conditions on the use of such devices...
are consistent with the principles underpinning the Mid West Radio Quiet Zone as set out under Section 2. In keeping with these principles, the appropriate use of class licensed equipment is dependent on its proximity to the MRO.

Intermittent use of class licensed equipment consistent with the International Telecommunication Union’s protection criteria used for radio astronomical measurements, Recommendation ITU-R RA.1513 on interference is considered tolerable for the MRO and users may self-assess against this tolerance.

The Australian and State Governments retain the right to jointly review potential class licence interference issues during the life of the MRO. Equipment for essential services may be used, consistent with the Radiocommunications Act 1992.

6.1 Core protection zone: 0 - 70 km radius

In accordance with Section 2 paragraph 5(b) radio astronomy is the primary use of spectrum within 70km of the MRO. As such, use of class licensed equipment for purposes other than radio astronomy is considered to be secondary and should not cause harmful interference to radio astronomy.

It is recommended that industry proponents engage with the MRO entity for advice on the use of current or proposed class licensed equipment that may cause harmful interference to radio astronomy. If it can be determined that the proposed equipment, operated at a particular location in a particular manner, will not cause interference to radio astronomy, the proponent may request ACMA to provide written advice authorising the use of the device, as described in Sections 140 to 142 of the Radiocommunications Act 1992. Accordingly, the MRO entity may provide appropriate advice to ACMA.

If interference from class licensed equipment within this zone is observed by radio astronomy instruments, in the first instance the source will be investigated by the MRO entity. The Governments recognise the potential for unintended breaches of licence conditions by intermittent use and agree to work with ACMA to resolve these issues where appropriate.

The MRO entity and the user will then work together to seek to develop class licensed equipment solutions, considered reasonable and practical, to prevent harmful radio frequency interference. If a technical solution is not reached between the parties, the MRO entity and the proponent should consult with the senior management in their respective organisations, who may work to facilitate an agreement.

In cases where the use of class licensed equipment cannot be agreed between senior management, either party can access the below dispute resolution process:

a) Refer the matter to ACMA, which will then determine whether it will appoint a conciliator as described in Part 4.3 of the Radiocommunications Act 1992.

   i. If direct negotiation (with or without a conciliator) leads to a solution which allows continuing use of the class licensed equipment, the MRO entity would request written advice from the ACMA under Sections 140 to 142 of the Radiocommunications Act 1992.

   ii. If direct negotiation (with or without a conciliator) does not lead to a solution allowing use of the class licensed equipment, the MRO entity may provide written advice to the ACMA advising that use of the equipment is causing harmful interference to radio astronomy, and if possible, provide an alternative practical and cost-effective technical solution to allow communications to proceed without undue harmful interference on the MRO.

b) Where parties cannot reach agreement, radio astronomy is considered primary to other uses of spectrum.

6.2 Co-existence zone: 70 - 150 km radius
In accordance with Section 2 paragraph 5(c) a co-existence principle applies within 70 – 150 km of the MRO. In cases where interference from class licensed equipment within this zone is observed by radio astronomy instruments, the source of interference will be investigated by the MRO entity. The MRO entity and the proponent will then work together to seek to develop class licensed equipment solutions, considered reasonable and practical, to prevent harmful radio frequency interference.

If a technical solution is not reached between the parties, the MRO entity and the proponent should consult with the senior management in their respective organisations, who may work to facilitate an agreement.

In cases where the use of class licensed equipment cannot be agreed between senior management, either party can access the below dispute resolution process:

a) Refer the matter to ACMA, which will then determine whether it will appoint a conciliator as described in Part 4.3 of the Radiocommunications Act 1992.

   i. If direct negotiation (with or without a conciliator) leads to a solution which allows continuing use of the class licensed equipment, the MRO entity would request written advice from the ACMA under Sections 140 to 142 of the Radiocommunications Act 1992.

   ii. If direct negotiation (with or without a conciliator) does not lead to a solution allowing use of the class licensed equipment, the MRO entity would need to provide written advice to the ACMA of its issues which do not allow co-existence and provide an alternative practical and cost-effective technical solution to allow communications to proceed.

7 Industry Consultation

The Government Parties support ongoing consultation between the MRO entity and adjacent industry. Interaction will include, but not be limited to:

a) Sharing information and facilitating co-operation in relation to their proposed spectrum use;

b) Discussing and co-ordinating activities so as to minimise any impact on the parties and their projects (eg by co-ordinating construction and expansion activities);

c) Promptly discussing ad hoc technical issues such as those caused by faulty equipment, or equipment not being operated as per the agreed technical solution; and

d) Examining opportunities for infrastructure sharing and other joint positive initiatives.

The form of this interaction is to be developed between the appropriate parties.
Appendix 1
Apparatus licence consultation process flow-chart

Proponent identifies need for apparatus licenced equipment within 70 to 260km of the MRO.

Proponent consults the Technical Advisory Guidelines to assess whether a technical solution needs to be developed. Proponent notifies the MRO entity of the outcome of its self-assessment.

MRO entity endorses proponent’s assessment that proposed equipment is acceptable to radio astronomy.

MRO entity notifies the industry proponent that following its own technical assessment, the process to develop technical solution needs to be initiated.

MRO entity and proponent exchange relevant information and work cooperatively to develop a mutually acceptable technical solution.

Technical solution not agreed

Agreed technical solution

Dispute resolution process

Following mediation/expert panel, solution not agreed.

Proponent submits licence application to ACMA — application to reflect specifications of the reached technical solution.

Proponent submits licence application to ACMA.

Licence application considered by ACMA, MRO entity to provide technical advice on application as requested. Approval of licence subject to ACMAs discretion.
Appendix 2
Apparatus licence dispute resolution process flow-chart (expert determination)
Appendix 3

Apparatus licence dispute resolution process flow-chart (mediation)

MRO entity and proponent exchange relevant information and work cooperatively to develop a mutually acceptable technical solution.

Technical solution not agreed

Matter referred to senior management of both organisations to negotiate a solution

After 10 business days if a solution is not agreed appropriate departments are notified. Parties may mutually agree to appoint a third party mediator. Alternatively, either party may request that the matter be determined by an expert panel (Appendix 2).

Parties jointly engage a mediator (5 business days timeframe)

i. Parties mutually nominate a mediator, or
ii. Mediator nominated by an agreed association, or
iii. An appropriate government authority can nominate a mediator in lieu of an association.
Nomination of mediator subject to the Governments’ approval

After 20 business days if no solution agreed

Mediator to prepare report regarding the negotiation process and its outcomes and submit it to both parties and appropriate Government departments.

Departments to work with the parties to reach agreement on a technical solution. Departments to determine policy based recommendations for consideration by ACMA.

Proponent submits licence application to ACMA – if applicable, application to be accompanied by mediator’s report and policy recommendation

Licence application considered by ACMA. MRO entity to provide technical advice on the application as requested. Approval of licence subject to ACMA’s discretion.
Radiocommunications Act 1992

Act No. 174 of 1992 as amended

This compilation was prepared on 31 May 2011 taking into account amendments up to Act No. 36 of 2011

The text of any of those amendments not in force on that date is appended in the Notes section

The operation of amendments that have been incorporated may be affected by application provisions that are set out in the Notes section

Prepared by the Office of Legislative Drafting and Publishing, Attorney-General’s Department, Canberra
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An Act about management of the radiofrequency spectrum, and other matters

Chapter 1—Preliminary

Part 1.1—Formal matters

1 Short title [see Note 1]

This Act may be cited as the Radiocommunications Act 1992.

2 Commencement

This Act commences on 1 July 1993.
Part 1.2—Object of this Act

3 The object of this Act

The object of this Act is to provide for management of the radiofrequency spectrum in order to:

(a) maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum;

(b) make adequate provision of the spectrum:
   (i) for use by agencies involved in the defence or national security of Australia, law enforcement or the provision of emergency services; and
   (ii) for use by other public or community services;

(c) provide a responsive and flexible approach to meeting the needs of users of the spectrum;

(d) encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided;

(e) provide an efficient, equitable and transparent system of charging for the use of spectrum, taking account of the value of both commercial and non-commercial use of spectrum;

(f) support the communications policy objectives of the Commonwealth Government;

(g) provide a regulatory environment that maximises opportunities for the Australian communications industry in domestic and international markets;

(h) promote Australia’s interests concerning international agreements, treaties and conventions relating to radiocommunications or the radiofrequency spectrum.

4 Outline of this Act

In order to achieve this object:

(a) Chapter 2 provides for radio frequency planning that involves preparation of:
   (i) a spectrum plan and frequency band plans (see Part 2.1); and
(ii) marketing plans and conversion plans (see Part 2.2); and

(b) Chapter 3 provides for licensing radiocommunications under:
   (i) spectrum licences (see Part 3.2); and
   (ii) apparatus licences (see Part 3.3); and
   (iii) class licences (see Part 3.4);

(c) Chapter 3 also provides for registration of licences (see Part 3.5); and

(ca) Chapter 3 also provides for the re-allocation of parts of the spectrum (see Part 3.6); and

(d) Chapter 4 provides for general regulatory requirements aimed at:
   (i) providing for standards and other technical regulation (see Part 4.1); and
   (ii) regulating various acts relating to radio emissions, particularly those involving interference with radiocommunications (see Part 4.2); and
   (iii) settling interference disputes (see Part 4.3); and
   (iv) providing for restricted use zones (see Part 4.4); and

(e) Chapter 5 provides for various other matters dealing with the administration and enforcement of this Act.
Part 1.3—Interpretative provisions

5 Definitions

In this Act, unless the contrary intention appears:

AAT means the Administrative Appeals Tribunal.

ACCC means the Australian Competition and Consumer Commission.

ACMA means the Australian Communications and Media Authority.

advisory guideline means an advisory guideline made under section 262.

aircraft includes a balloon.

apparatus licence means an apparatus licence issued under Part 3.3.


apply, in relation to a label, has a meaning affected by section 9A.

Australia, when used in a geographical sense, includes the external Territories.

Australian aircraft means an aircraft that is in Australian control or is registered in accordance with the Civil Aviation Regulations as an Australian aircraft.

Australian space object means a space object that the ACMA determines in writing to be an Australian space object for the purposes of this Act. A determination is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
**Australian vessel** means a vessel that is in Australian control or:
(a) not being an air-cushion vehicle—is an Australian boat within the meaning of the *Fisheries Management Act 1991*; or
(b) being an air-cushion vehicle—would be an Australian boat within the meaning of that Act if it were a boat within the meaning of that Act.

**authority**, in relation to the Commonwealth, a State or a Territory, means:
(a) a Department; or
(b) a body (whether incorporated or unincorporated) established for a public purpose by or under the law of the Commonwealth, the State or the Territory, as the case may be; or
(c) any other body corporate in which:
   (i) the Commonwealth, the State or the Territory, as the case may be; or
   (ii) a body corporate referred to in paragraph (b); has a controlling interest.

**broadcasting services bands licence** has the same meaning as in the *Broadcasting Services Act 1992*.

**broadcasting station** means a transmitter that is operating for the purposes of:
(a) a broadcasting services bands licence; or
(b) the provision of a national broadcasting service within the meaning of the *Broadcasting Services Act 1992*.

**BSA control rules** means:
(a) sections 54A and 56A of the *Broadcasting Services Act 1992*; and
(b) clause 41 of Schedule 6 to the *Broadcasting Services Act 1992*.

**BSA coverage area** means coverage area within the meaning of Schedule 4 to the *Broadcasting Services Act 1992*.

**BSA datacasting licence** means a datacasting licence under Schedule 6 to the *Broadcasting Services Act 1992*. 
BSA exempt re-transmission service means a service that, under subsection 212(1) of the Broadcasting Services Act 1992, is exempt from the regulatory regime established by that Act.

BSA licence area means licence area within the meaning of the Broadcasting Services Act 1992.

BSA television licence area plan means a television licence area plan within the meaning of the Broadcasting Services Act 1992.

category 1 digital radio multiplex transmitter licence means a transmitter licence for one or more multiplex transmitters that are for use for transmitting any or all of the following services in a designated BSA radio area:

(a) one or more digital commercial radio broadcasting services;
(b) one or more digital community radio broadcasting services;
(c) one or more restricted datacasting services.

category 2 digital radio multiplex transmitter licence means a transmitter licence for one or more multiplex transmitters that are for use for transmitting any or all of the following services in a designated BSA radio area:

(a) one or more digital commercial radio broadcasting services;
(b) one or more digital community radio broadcasting services;
(c) one or more digital national radio broadcasting services;
(d) one or more restricted datacasting services.

category 3 digital radio multiplex transmitter licence means a transmitter licence for one or more multiplex transmitters that are for use for transmitting either or both of the following services in a designated BSA radio area:

(a) one or more digital national radio broadcasting services;
(b) one or more restricted datacasting services, where each relevant restricted datacasting licence is held by a national broadcaster.

certificate means:

(i) a certificate of proficiency; or
(ii) a compliance certificate; or
(iii) a frequency assignment certificate referred to in subsection 100(4A); or
(iv) any other kind of certificate that may be issued under this Act.

certificate of proficiency means a certificate of proficiency issued under section 121.

change, in relation to information in the Register, means any one or more of the following:
(a) the addition of matter to the information;
(b) the alteration of matter included in the information;
(c) the deletion of matter from the information.

channel A datacasting transmitter licence has the meaning given by section 98A.

cchannel B datacasting transmitter licence has the meaning given by section 98B.

class licence means a class licence issued under Part 3.4.

commercial broadcasting service has the same meaning as in the Broadcasting Services Act 1992.

commercial radio broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

commercial television broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

community television broadcasting service has the same meaning as in the Broadcasting Services Act 1992.

Commonwealth officer means.
(a) a Minister; or
(b) a person who, whether on a full-time or a part-time basis, and whether in a permanent capacity or otherwise:
(i) is in the service or employment of the Commonwealth, the Administration of a Territory or an authority of the Commonwealth; or
(ii) holds or performs the duties of any office or position established by or under a law of the Commonwealth or a Territory; or
(c) a member of the Defence Force; or
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(d) the Commissioner of the Australian Federal Police, a Deputy Commissioner of the Australian Federal Police, an AFP employee or a special member of the Australian Federal Police (all within the meaning of the Australian Federal Police Act 1979); or

(e) a member of the police force of a Territory.

*community broadcasting service* has the same meaning as in the Broadcasting Services Act 1992.

*conciliator* means a person appointed under section 202.

*conciliator’s report* means a report by a conciliator under section 208.

*conversion plan* means a plan prepared under section 38.

*core condition* means a condition included in a spectrum licence under section 66.

*datacasting service* has the same meaning as in the Broadcasting Services Act 1992.

*datacasting transmitter licence* means a transmitter licence for a transmitter that is for use for transmitting a datacasting service, but does not include:

(a) a transmitter licence issued under section 101B, 101C, 102 or 102A; or

(aa) a digital radio multiplex transmitter licence; or

(b) an NBS transmitter licence; or

(c) a prescribed transmitter licence.

*datacasting transmitter licence fee* means a fee imposed under the Datacasting Transmitter Licence Fees Act 2006.

*Defence Department* means the Department of State that deals with defence and that is administered by the Minister administering section 1 of the Defence Act 1903.

*Department* means:

(a) in relation to the Commonwealth—an Agency within the meaning of the Public Service Act 1999; or

(b) in relation to a State or Territory—a body that, in relation to that State or Territory, is a body of such a kind.
designated BSA radio area means:
(a) the BSA licence area of a commercial radio broadcasting licence; or
(b) the BSA licence area of a community radio broadcasting licence, where that BSA licence area is the same as the BSA licence area of a commercial radio broadcasting licence.

Note: See also section 8AD of the Broadcasting Services Act 1992, which deals with deemed radio broadcasting licence areas.

designated community radio broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

designated teletext service has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

device has the meaning given in subsection 9(1).

digital commercial radio broadcasting licence means a commercial radio broadcasting licence that authorises the provision of one or more digital commercial radio broadcasting services.

digital commercial radio broadcasting service has the same meaning as in the Broadcasting Services Act 1992.

digital community radio broadcasting licence means a designated community radio broadcasting licence that authorises the provision of one or more digital community radio broadcasting services.

digital community radio broadcasting representative company, in relation to a designated BSA radio area, has the meaning given by section 9C.

digital community radio broadcasting service has the same meaning as in the Broadcasting Services Act 1992.

digital national radio broadcasting service has the same meaning as in the Broadcasting Services Act 1992.

digital radio channel plan means a plan under section 44A.

digital radio moratorium period has the same meaning as in the Broadcasting Services Act 1992.

digital radio multiplex transmitter licence means:
(a) a category 1 digital radio multiplex transmitter licence; or
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(b) a category 2 digital radio multiplex transmitter licence; or
(c) a category 3 digital radio multiplex transmitter licence.

digital radio start-up day has the same meaning as in the

disputed conduct means conduct (including any act and any refusal
or omission to act) of a kind referred to in paragraph 205(1)(a).

domestic digital television receiver means domestic reception
equipment that:
(a) is not a hand-held device; and
(b) is capable of receiving television programs transmitted in:
   (i) SDTV digital mode; or
   (ii) HDTV digital mode; and
(c) has such other characteristics (if any) as are specified in a
   legislative instrument made by the ACMA under this paragraph.
For the purposes of paragraph (b), disregard clause 6 of Schedule 6

EMC standard means a standard made solely for the purposes of
either or both of the following:
(a) paragraph 162(3)(b);
(b) paragraph 162(3)(e).

environment means the physical environment.

Federal Court means the Federal Court of Australia.

foreign aircraft means an aircraft that is not an Australian aircraft.

foreign space object means a space object that is not an Australian
space object.

foreign vessel means a vessel that is not an Australian vessel.

foundation category 1 digital radio multiplex transmitter licence
has the meaning given by section 98C.

foundation category 2 digital radio multiplex transmitter licence
has the meaning given by section 98D.

foundation digital radio multiplex transmitter licence means:

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(a) a foundation category 1 digital radio multiplex transmitter licence; or
(b) a foundation category 2 digital radio multiplex transmitter licence.

**frequency band** means any contiguous range of radio frequencies.

**frequency band plan** means a plan prepared under section 32.

**HDTV digital mode** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**import** means import into Australia.

**in Australian control** means in the control or possession of one or more of any of the following:
(a) the Commonwealth (including an arm of the Defence Force) or a State or Territory;
(b) an authority of the Commonwealth;
(c) an authority of a State;
(d) an authority of a Territory.

**incumbent digital commercial radio broadcasting licensee** has the meaning given by subsection 9D(1).

**incumbent digital community radio broadcasting licensee** has the meaning given by subsection 9D(2).

**inspector** has the meaning given in section 267.

**interference** means:
(a) in relation to radiocommunications—interference to, or with, radiocommunications that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device; or
(b) in relation to the uses or functions of devices—interference to, or with, those uses or functions that is attributable, whether wholly or partly and whether directly or indirectly, to an emission of electromagnetic energy by a device.

**international broadcasting licence** means an international broadcasting licence under the *Broadcasting Services Act 1992*. 

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**international broadcasting service** has the same meaning as in the *Broadcasting Services Act 1992*.

**label** has a meaning affected by section 9A.

**licence** means a spectrum licence, an apparatus licence or a class licence.

**licensee** means:

(a) in relation to a spectrum licence—the person specified in the licence as the licensee, whether the licence was originally issued to that person or subsequently assigned to him or her; or

(b) in relation to an apparatus licence—the person who holds the licence;

and, in Part 2 of the Schedule, includes the person from whom the spectrum licence in question, or the part of the spectrum licence in question, was resumed.

**marketing plan** means a plan prepared under section 39 or 39A.

**member**, in relation to the Australian Federal Police, includes a special member of the Australian Federal Police.

**member of the crew**, in relation to a vessel, aircraft or space object, includes the person in charge of the vessel, aircraft or space object.

**national broadcaster** has the same meaning as in the *Broadcasting Services Act 1992*.

**national broadcasting service** has the same meaning as in the *Broadcasting Services Act 1992*.

**NBS transmitter licence** means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service, but does not include a digital radio multiplex transmitter licence.

**newspaper** means a newspaper that is in the English language and is published on at least 4 days in each week, but does not include a publication if less than 50% of its circulation is by way of sale.
**non-foundation digital radio multiplex transmitter licence** means a digital radio multiplex transmitter licence that is not a foundation digital radio multiplex transmitter licence.

**non-standard device** has the meaning given in subsection 9(2).

**non-standard transmitter** has the meaning given in subsection 9(3).

**open narrowcasting television service** has the same meaning as in the *Broadcasting Services Act 1992*.

**part**, in relation to a spectrum licence, means:

(a) a specified portion of the frequencies at which operation of radiocommunications devices is authorised under the licence; or

(b) a specified portion of the area within which operation of radiocommunications devices is so authorised; or

(c) a specified portion of the frequencies at which operation of radiocommunications devices is so authorised in a specified portion of the area within which operation of radiocommunications devices is so authorised.

**period of emergency** means a period declared to be a period of emergency under subsection 219(1).

**permit** means a permit issued under section 167.

**pre-acquisition declaration** means a declaration published in the *Gazette* under clause 1 of Part 1 of the Schedule.

**provisional international broadcasting certificate** means a provisional international broadcasting certificate issued under section 131AF.

**public or community service** has the meaning given in section 10.

**qualified company** means a company that:

(a) is formed in Australia; and

(b) has a share capital.

**qualified operator** means a person who holds a certificate of proficiency.

**radiocommunication** has the meaning given in section 6.
**radiocommunications device** has the meaning given in subsection 7(1).

**radiocommunications receiver** has the meaning given in subsection 7(3).

**radiocommunications transmitter** has the meaning given in subsection 7(2).

**radio emission** has the meaning given in subsection 8(1).

**re-allocation deadline**, in relation to a spectrum re-allocation declaration, has the meaning given by section 153B.

**re-allocation period**, in relation to a spectrum re-allocation declaration, has the meaning given by section 153B.

**receiver licence** means an apparatus licence of the kind referred to in subsection 97(3).

**reception**, in relation to radio emission, includes interception.

**Register**, except in section 183, means the Register of Radiocommunications Licences established under section 143.

**restricted datacasting licence** has the same meaning as in the Broadcasting Services Act 1992.

**restricted datacasting service** has the same meaning as in the Broadcasting Services Act 1992.

**restrictive order** means an order made under subsection 222(1).

**resumption notice** means a notice published in the Gazette under clause 3 of Part 1 of the Schedule.

**SDTV digital mode** has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

**space object** means an object (whether artificial or natural) that is beyond, has been beyond or is intended to go beyond the major portion of the Earth’s atmosphere, or any part of such an object, even if the part is intended to go only some of the way towards leaving the major portion of the Earth’s atmosphere.

Note: Under section 10A, the ACMA may determine that a particular object is not a space object for the purposes of this Act.
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**spectrum** means the range of frequencies within which radiocommunications are capable of being made.

**spectrum access charge** means a spectrum access charge fixed under section 294.

**spectrum licence** means a spectrum licence issued under Part 3.2.

**spectrum licence tax** means a tax imposed under the Radiocommunications (Spectrum Licence Tax) Act 1997.

**spectrum plan** means:
(a) in relation to a time before the first plan prepared under section 30 comes into effect—the last plan prepared under section 18 of the Radiocommunications Act 1983; and
(b) in relation to a time after the first plan prepared under section 30 comes into effect—a plan prepared under section 30.

**spectrum re-allocation declaration** means a declaration under section 153B.

**standard** means a standard made under section 162.

**State officer** means a person who, whether on a full-time basis or a part-time basis, and whether in a permanent capacity or otherwise:
(a) is in the service or employment of a State or an authority of a State; or
(b) holds or performs the duties of any office or position established by or under a law of a State;
and includes a member of the police force of a State.

**subscription television broadcasting service** has the same meaning as in the Broadcasting Services Act 1992.

**supply** includes supply (including re-supply) by way of sale, exchange, lease, hire or hire-purchase.

**television program** includes so much of a television program as consists only of sounds or images.

**temporary community broadcasting licence** has the same meaning as in the Broadcasting Services Act 1992.

**this Act** includes the regulations.
transmitter has the meaning given in subsection 8(2).

transmitter licence means an apparatus licence of the kind referred to in subsection 97(2).

vessel means a vessel or boat of any description, and includes:
(a) an air-cushion vehicle; and
(b) any floating structure.

6 Definition of radiocommunication

(1) For the purposes of this Act, radiocommunication is:
(a) radio emission; or
(b) reception of radio emission;
for the purpose of communicating information between persons and persons, persons and things or things and things.

(2) The reference in subsection (1) to communicating information includes communicating information between a part of a thing and:
(a) another part of the same thing; or
(b) the same part of that thing;
(as, for example, in the operation of a radar device).

Note: Division 3 of Part 1.4 has the effect of extending the concept of radiocommunication in certain circumstances.

7 Definitions of radiocommunications device, radiocommunications transmitter and radiocommunications receiver

(1) For the purposes of this Act, a radiocommunications device is:
(a) a radiocommunications transmitter other than a radiocommunications transmitter of a kind specified in a written determination made by the ACMA for the purposes of this paragraph; or
(b) a radiocommunications receiver of a kind specified in a written determination made by the ACMA for the purposes of this paragraph.

(2) For the purposes of this Act, a radiocommunications transmitter is:
(a) a transmitter designed or intended for use for the purpose of radiocommunication; or

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(b) anything (other than a line within the meaning of the *Telecommunications Act 1997*) designed or intended to be ancillary to, or associated with, such a transmitter for the purposes of that use; or
(c) anything (whether artificial or natural) that is designed or intended for use for the purpose of radiocommunication by means of the reflection of radio emissions and that the ACMA determines in writing to be a *radiocommunications transmitter* for the purposes of this Act.

(3) For the purposes of this Act, a *radiocommunications receiver* is:
(a) anything designed or intended for use for the purposes of radiocommunication by means of the reception of radio emission; or
(b) anything (other than a line within the meaning of the *Telecommunications Act 1997*) designed or intended to be ancillary to, or associated with, such a thing for the purposes of that use; or
(c) anything (whether artificial or natural) that is designed or intended for use for the purpose of radiocommunication by means of the reflection of radio emissions and that the ACMA determines in writing to be a *radiocommunications receiver* for the purposes of this Act.

(4) This Act does not preclude the same thing from being both a radiocommunications receiver and a radiocommunications transmitter, or any other kind of transmitter, for the purposes of this Act.

(5) A determination by the ACMA under this section is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

**8 Definitions of radio emission and transmitter**

(1) For the purposes of this Act, a *radio emission* is any emission of electromagnetic energy of frequencies less than 420 terahertz without continuous artificial guide, whether or not any person intended the emission to occur.

(2) For the purposes of this Act, a *transmitter* is:
(a) anything designed or intended for radio emission; or
(b) any other thing, irrespective of its use or function or the purpose of its design, that is capable of radio emission.

9 Definitions of device, non-standard device and non-standard transmitter

(1) For the purposes of this Act, a device is:
   (a) a radiocommunications transmitter; or
   (b) any other transmitter; or
   (c) a radiocommunications receiver; or
   (d) any other thing any use or function of which is capable of being interfered with by radio emission.

(2) For the purposes of this Act, a non-standard device is a device that:
   (a) if the device has not been altered or modified in a material respect after its manufacture or, if it has been imported, after its importation—does not comply with a standard that was applicable to it when it was manufactured or imported, as the case may be; or
   (b) if the device was so altered or modified—does not comply with a standard that was applicable to it when it was so altered or modified.

(3) For the purposes of this Act, a non-standard transmitter is a transmitter that is a non-standard device.

9A Application of labels

(1) A reference in this Act to a label includes a reference to a statement.

(2) For the purposes of this Act, a label is taken to be applied to a thing if:
   (a) the label is affixed to the thing; or
   (b) the label is woven in, impressed on, worked into or annexed to the thing; or
   (c) the label is affixed to a container, covering, package, case, box or other thing in or with which the first-mentioned thing is supplied; or
(d) the label is affixed to, or incorporated in, an instruction or other document that accompanies the first-mentioned thing.

9B Digital mode

For the purposes of this Act, a service is transmitted in digital mode if the service is transmitted using a digital modulation technique.

9C Digital community radio broadcasting representative company

(1) For the purposes of this Act, a company is the digital community radio broadcasting representative company for a particular designated BSA radio area if:

(a) the company is a qualified company; and
(b) the incumbent digital community radio broadcasting licensees for the designated BSA radio area have given the ACMA a joint written notice electing that this paragraph apply to the company; and
(c) before the company was formed, the promoters of the company invited each incumbent digital community radio broadcasting licensee for the area to subscribe for shares in the company on the basis that:

(i) the incumbent digital community radio broadcasting licensees who accepted the invitation would be issued with an equal number of shares; and
(ii) no other persons would be entitled to subscribe for shares in the company; and
(d) the invitations referred to in paragraph (c) were:

(i) published on the ACMA’s website; and
(ii) open for a period of at least 90 days beginning on or after the commencement of this section; and
(e) there was no discrimination between subscribers for shares in the company in relation to the consideration payable for the issue of the shares concerned; and
(f) the total amount of money payable as consideration for the issue of the shares in the company is not substantially in excess of the total amount that, as at the time the invitations referred to in paragraph (c) are published, would be required for the viable operation of the company; and
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(g) none of the recipients of an invitation referred to in paragraph (c) were subject to duress as to whether the invitation should be accepted; and

(h) the company has a constitution; and

(i) the company’s constitution provides that a person is not eligible to hold a share in the company unless the person is a digital community radio broadcasting licensee whose BSA licence area is the same as the designated BSA radio area; and

(j) the company’s constitution provides that, if:

   (i) a digital community radio broadcasting licence is allocated to a person under the Broadcasting Services Act 1992 after the commencement of this section; and

   (ii) the BSA licence area of the digital community radio broadcasting licence is the same as the designated BSA radio area;

the company must:

   (iii) within 30 days after the allocation of the digital community radio broadcasting licence, offer to issue shares in the company to the holder of the digital community radio broadcasting licence, where the number of shares offered equals the number of shares already held by a particular digital community radio broadcasting licensee; and

   (iv) keep the offer open for at least 90 days; and

   (v) ensure that, if the offer is accepted, the amount of money payable as consideration for the issue of the shares is not substantially in excess of the amount that was payable by an incumbent digital community radio broadcasting licensee who subscribed for shares in the company in response to an invitation referred to in paragraph (c); and

(k) the company’s constitution provides that the purposes of the company are:

   (i) holding shares in one or more companies that hold, have applied for, or propose to apply for, category 1 digital radio multiplex transmitter licences, or category 2 digital radio multiplex transmitter licences, for the designated BSA radio area; and
(ii) exercising the powers conferred by this Act on a digital community radio broadcasting representative company; and

(iii) carrying out activities incidental to the purposes mentioned in subparagraphs (i) and (ii); and

(l) the company complies with such other conditions (if any) as are specified in the regulations.

Note: See also section 8AD of the Broadcasting Services Act 1992, which deals with deemed radio broadcasting licence areas.

(2) For the purposes of the application of paragraph (1)(i) and subparagraph (1)(j)(iii) before the digital radio start-up day for the designated BSA radio area, digital community radio broadcasting licensee includes an incumbent digital community radio broadcasting licensee.

(3) An election under paragraph (1)(b) given in relation to a particular designated BSA radio area has no effect if an election under that paragraph has been previously given in relation to that area.

(4) An election under paragraph (1)(b) is irrevocable.

(5) The promoters of a company may request the ACMA to publish on its website the invitations referred to in paragraph (1)(c).

(6) The ACMA must comply with a request under subsection (5) if the ACMA is satisfied that the request was made in good faith.

9D Incumbent digital radio broadcasting licensees

Incumbent digital commercial radio broadcasting licensee

(1) For the purposes of this Act, if:

(a) the licensee of a commercial radio broadcasting licence held the licence at the commencement of this section; and

(b) the licence was not allocated under subsection 40(1) of the Broadcasting Services Act 1992;

the licensee is an incumbent digital commercial radio broadcasting licensee.
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*Incumbent digital community radio broadcasting licensee*

(2) For the purposes of this Act, if the licensee of a designated community radio broadcasting licence held the licence at the commencement of this section, the licensee is an *incumbent digital community radio broadcasting licensee*.

10 Public or community services

(1) For the purposes of this Act, a *public or community service* is a service provided by a body or organisation of a kind specified by the Minister, by written instrument, to be bodies or organisations for the purposes of this section.

(2) Each such body or organisation must either be:

(a) an authority of the Commonwealth, a State or a Territory; or

(b) a body or organisation that:

(i) is not carried on for the purpose of profit or gain to its members; and

(ii) applies its profits (if any) or other income in achieving its objects; and

(iii) does not provide for making any distribution, whether in money, property or otherwise, to its members.

(3) The instrument is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

10A ACMA determinations about space objects

(1) Despite the definition of *space object* in section 5, the ACMA may make a written determination that a particular object is not a *space object* for the purposes of this Act.

Note: Under subsection 33(3A) of the *Acts Interpretation Act 1901*, objects may be specified by reference to a particular class or classes of objects.

(2) A determination under this section is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

11 References to offences against this Act etc.

(1) A reference in this Act to an offence against this Act or to an offence against a provision of this Act includes a reference to an

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offence against section 6 of the *Crimes Act 1914*, or an ancillary offence (within the meaning of the *Criminal Code*), that relates to this Act or that provision, as the case requires.

(1A) A reference in this Act to an *offence against this Act* includes a reference to an offence against section 136.1 or 137.1 of the *Criminal Code* that relates to this Act.

(2) A reference in this Act to a conviction of an offence includes a reference to:

(a) making an order under section 19B of the *Crimes Act 1914* in relation to the offence; or

(b) payment, under regulations made under paragraph 314(2)(d), of a penalty in relation to the offence.
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Part 1.4 Application of this Act

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Part 1.4—Application of this Act

12 Outline of this Part

(1) This Part is about the scope of this Act’s operation, and the situations in which that operation is extended or restricted.

(2) Division 1 applies this Act to the Crown.

(3) Division 2 describes how questions of location affect the application of this Act.

(4) Division 3 brings certain activities within the concept of radiocommunication for the purposes of this Act.

(5) Division 4 is about the situations and activities that are exempt from the operation of this Act.
Division 1—General

13 Crown to be bound

(1) Subject to subsection (2), this Act binds the Crown in all its capacities.

(2) Nothing in this Act renders the Crown liable to be prosecuted for an offence.
Division 2—Provisions relating to location and similar matters

14 Operation of this Division

This Division has effect subject to Division 4.

15 Application to external Territories

This Act extends to all the external Territories.

16 Application outside Australia

(1) Except so far as the contrary intention appears, this Act applies outside Australia (whether or not in a foreign country), but only in relation to:

(a) Australian citizens ordinarily resident in Australia, in respect of radio emissions intended to be received in Australia, other than:

(i) radio emissions made by a genuine member of the crew of a foreign vessel, foreign aircraft or foreign space object in the course of his or her duties as such a member; or

(ii) radio emissions made from a foreign country by a person in the performance of a duty imposed by the law of that country; and

(b) members of the crew of Australian aircraft, Australian vessels and Australian space objects; and

(c) Australian aircraft, Australian space objects and Australian vessels; and

(ca) foreign space objects, in the circumstances specified in a written determination by the ACMA; and

(d) anything to which this Act extends because of section 17 or 17A.

(2) For the purposes of paragraph (1)(a), a radio emission that is intended to be retransmitted to Australia is taken to be intended to be received in Australia.
(3) Section 195 applies without limitation outside Australia (whether or not in a foreign country).

(4) A determination under paragraph 16(1)(ca) is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

17 Offshore areas

(1) Subject to subsection (2), this Act applies in relation to the offshore areas in respect of the States and Territories as if references in this Act to Australia, when used in a geographical sense, included references to the offshore areas in respect of the States and Territories.

(2) The extended application given to this Act by subsection (1) extends only in relation to:
   (a) acts, matters and things directly or indirectly connected with exploration of, or exploitation of the resources of, the continental shelf of Australia or of an external Territory; and
   (b) acts done by or in relation to, and matters, circumstances and things affecting, or any person who is in offshore area for a reason directly or indirectly connected with such exploration or exploitation.

(3) In this section:

   offshore area, in relation to a State or Territory, has the same meaning as in the Offshore Petroleum and Greenhouse Gas Storage Act 2006.

17A Western Greater Sunrise area

(1) Subject to subsection (2), this Act applies in relation to the Western Greater Sunrise area as if references in this Act to Australia, when used in a geographical sense, included references to the Western Greater Sunrise area.

(2) The extended application given to this Act by subsection (1) extends only in relation to:
   (a) acts, matters and things directly or indirectly connected with exploration of, or exploitation of the resources of, either or both of the Greater Sunrise unit reservoirs; and
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(b) acts done by or in relation to, and matters, circumstances and things affecting, any person who is in the Western Greater Sunrise area for a reason directly or indirectly connected with such exploration or exploitation.

(3) In this section:

**Greater Sunrise unit reservoirs** has the same meaning as in the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

**Western Greater Sunrise area** has the same meaning as in the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

18 Application to the atmosphere etc.

Except so far as the contrary intention appears, references in this Act to Australia, a foreign country, a place or any waters include references to the space (including the atmosphere and outer space) above.
Division 3—Provisions extending the concept of radiocommunication

19 Operation of this Division

(1) This Division:
   (a) only applies in relation to anything to which this Act extends under Division 2; and
   (b) has effect subject to Division 4.

(2) Subsections 20(1) and (2) and sections 21 and 22 each have effect without prejudice to the effect that this Act has apart from that subsection or section.

20 Radio transmissions for the purpose of measurement

(1) This Act applies in relation to:
   (a) a measurement transmission made in the course of, or in relation to:
       (i) trade and commerce between Australia and places outside Australia; or
       (ii) trade and commerce among the States; or
       (iii) trade and commerce within a Territory, between a State and a Territory or between 2 Territories; or
       (iv) any trading activity of a trading corporation, or any other activity of the corporation carried on for the purpose of its trading activities; or
       (v) any other activity carried on by a trading corporation; or
       (vi) any financial activity of a financial corporation, or any other activity of the corporation carried on for the purpose of its financial activities; or
       (vii) any other activity carried on by a financial corporation; or
       (viii) the operation of lighthouses, lightships, beacons or buoys; or
       (ix) the making of astronomical or meteorological observations; or
(b) a measurement transmission made by or on behalf of the Commonwealth, an authority or instrumentality of the Commonwealth, a foreign corporation or a body corporate incorporated in a Territory; or
(c) a measurement transmission made in a Territory or a place outside Australia; or
(d) any other measurement transmission;

in the same way as it applies in relation to radiocommunication.

Note: Section 6 sets out the general meaning of radiocommunication.

(2) This Act applies in relation to:

(a) a measurement transmitter used in the course of, or in relation to:
   (i) trade and commerce between Australia and places outside Australia; or
   (ii) trade and commerce among the States; or
   (iii) trade and commerce within a Territory, between a State and a Territory or between 2 Territories; or
   (iv) any trading activity of a trading corporation, or any other activity of the corporation carried on for the purpose of its trading activities; or
   (v) any other activity carried on by a trading corporation; or
   (vi) any financial activity of a financial corporation, or any other activity of the corporation carried on for the purpose of its financial activities; or
   (vii) any other activity carried on by a financial corporation; or
   (viii) the operation of lighthouses, lightships, beacons or buoys; or
   (ix) the making of astronomical or meteorological observations; or

(b) a measurement transmitter used by or on behalf of the Commonwealth, an authority or instrumentality of the Commonwealth, a foreign corporation or a body corporate incorporated in a Territory; or

(c) a measurement transmitter in a Territory or a place outside Australia; or

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(d) any other measurement transmitter;
in the same way as it applies in relation to a radiocommunications transmitter.

Note: Subsection 7(2) sets out the general meaning of radiocommunications transmitter.

(3) This section does not apply with respect to:
(a) State banking that does not extend beyond the limits of the State concerned; or
(b) State insurance that does not so extend.

(4) In this section:

financial corporation means a financial corporation to which paragraph 51(xx) of the Constitution applies, and includes a body corporate formed within the limits of Australia that carries on as its sole or principal business the business of:
(a) banking within the meaning of paragraph 51(xiii) of the Constitution; or
(b) insurance within the meaning of paragraph 51(xiv) of the Constitution.

foreign corporation means a foreign corporation to which paragraph 51(xx) of the Constitution applies.

measurement transmission means radio emission for purposes connected with making a measurement by means of the propagation or other qualities of radio emission.

measurement transmitter means a transmitter designed or intended for measurement transmission.

trading corporation means a trading corporation to which paragraph 51(xx) of the Constitution applies.

21 Astronomical and meteorological observations

This Act applies to a radio emission in connection with making astronomical or meteorological observations in the same way as it applies to a radiocommunication.
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22 Lighthouses etc.

This Act applies to a radio emission in connection with the operation of lighthouses, lightships, beacons and buoys in the same way as it applies to a radiocommunication.
Division 4—Matters to which this Act does not apply

23 Foreign space objects, vessels and aircraft

(1) This Act does not apply to foreign space objects, except in accordance with a determination by the ACMA under paragraph 16(1)(ca).

(2) This Act does not apply to transmitters or radiocommunications receivers on board a foreign vessel that is travelling, or is in transit, (whether in or outside Australia) on a voyage:
   (a) from a point outside Australia to a port in Australia; or
   (b) from a port in Australia to a point outside Australia; or
   (c) from a point outside Australia to another point outside Australia.

(3) This Act does not apply to transmitters or radiocommunications receivers on board a foreign aircraft that is travelling, or is in transit, (whether in or outside Australia) on a voyage:
   (a) from a point outside Australia to an airport in Australia; or
   (b) from an airport in Australia to a point outside Australia; or
   (c) from a point outside Australia to another point outside Australia.

(4) Subsections (2) and (3) apply subject to the provisions of any agreement, treaty or convention between Australia and any other countries that makes provision in relation to radio emission.

(5) However, nothing in this section limits section 195 or Part 5.5.

24 Defence research and intelligence

(1) This Act does not apply to anything done or omitted to be done by a member of the Defence Force, or by an officer of the Defence Department, in the performance of his or her functions or duties as such a member or officer in relation to the operation of an organisation:
   (a) that is part of the Defence Force or part of the Defence Department; and
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(b) the purpose of which relates to:
   (i) research for purposes connected with defence; or
   (ii) intelligence.

(2) This Act does not apply in relation to anything done or omitted to be done by or on behalf of:
   (a) the Australian Secret Intelligence Service; or
   (b) the Australian Security Intelligence Organisation.

25 Special defence undertakings

This Act does not apply to anything done or omitted to be done by a person performing a function or duty in relation to the operation of a facility that is:
   (a) jointly operated by the Commonwealth and a foreign country; and
   (b) a special defence undertaking for the purposes of the Defence (Special Undertakings) Act 1952.

26 Additional exemption for defence matters

(1) Subject to subsection (2), Parts 3.1, 4.1 and 4.2 do not apply to anything done or omitted to be done by a member of the Defence Force, or by an officer of the Defence Department, if:
   (a) the act or omission takes place in the performance of one of his or her functions or duties as such a member or officer; and
   (b) the function or duty concerned is, under the regulations, taken for the purposes of this subsection to be a function or duty that relates to:
      (i) military command and control; or
      (ii) intelligence; or
      (iii) weapons systems.

(2) The regulations may provide for the application, in specified circumstances, of all or any of Parts 3.1, 4.1 or 4.2, or any of the provisions of those Parts, to a member of the Defence Force, or to an officer of the Defence Department, in the performance of one of his or her functions or duties as mentioned in subsection (1).
27 Exemption for defence, law enforcement and emergency personnel

(1) This section applies to a person performing a function or duty in relation to:

(a) the defence, security or international relations of:
   (i) Australia; or
   (ii) a foreign country whose naval, military or air force is acting in co-operation with the Defence Force of Australia; or

(b) the Australian Federal Police or the police force of a State or Territory; or

(baa) the performance of the functions of the Integrity Commissioner (within the meaning of the Law Enforcement Integrity Commissioner Act 2006); or

(ba) one of the following bodies:
   (i) the Independent Commission Against Corruption established by the Independent Commission Against Corruption Act 1988 of New South Wales;
   (ii) the Western Australian Anti-Corruption Commission established by the Anti-Corruption Commission Act 1988 of Western Australia; or

(bb) one of the following bodies:
   (i) the New South Wales Crime Commission established by the New South Wales Crime Commission Act 1985 of New South Wales;
   (ii) the Crime and Misconduct Commission established by the Crime and Misconduct Act 2001 of Queensland; or

(bc) the Australian Crime Commission established by section 7 of the Australian Crime Commission Act 2002; or

(bd) the New South Wales Police Integrity Commission established by the Police Integrity Commission Act 1996 of New South Wales; or

(be) a body that:
   (i) performs functions related to the investigation, prevention or prosecution of serious crime, or of corruption (whether or not the body also performs other functions); and
   (ii) is covered by a written determination made by the ACMA for the purposes of this paragraph; or
(c) a fire-fighting, civil defence or rescue organisation; or
(d) an ambulance service; or
(e) the Royal Flying Doctor Service; or
(f) any other organisation whose sole or principal purpose
involves securing the safety of persons during an emergency.

(2) The ACMA may determine in writing that acts or omissions by
members of a class of persons to whom this section applies are
exempt from either or both of the following:
   (a) all or any of Parts 3.1, 4.1 and 4.2;
   (b) specified provisions of those Parts.
The exemption may be expressed to apply generally or in specified
circumstances.

(3) A determination under paragraph (1)(be) or subsection (2) is a
disallowable instrument for the purposes of section 46A of the Acts
Interpretation Act 1901.

(4) For the purposes of subparagraph (1)(be)(i), serious crime
is conduct that, if engaged in within, or in connection with, Australia,
would constitute an offence against the law of the Commonwealth,
a State or a Territory punishable by imprisonment for a period
exceeding 12 months.

28 Use of devices by the ACMA

Parts 3.1, 4.1 and 4.2 do not apply to anything done by the ACMA
in connection with the use of a device in performing its functions
or exercising its powers under this Act.
Chapter 2—Radio frequency planning

29 Outline of this Chapter

(1) This Chapter provides for the preparation of plans that will govern the allocation of the spectrum under the licensing systems provided for in Chapter 3.

(2) Part 2.1 is about preparing:
   (a) a spectrum plan that covers so much of the spectrum as is relevant to regulation of radiocommunications under this Act; and
   (b) frequency band plans that cover particular parts of the spectrum in more detail.

(3) Part 2.2 is about the additional plans necessary to enable selected parts of the spectrum to be allocated under the spectrum licensing system, namely:
   (a) conversion plans that govern conversion into spectrum licences of apparatus licences that apply in the parts of the spectrum in question; and
   (b) marketing plans that govern allocation under spectrum licences of so much of the parts of the spectrum in question as have not been allocated under apparatus licences; and
   (c) marketing plans that govern allocation under spectrum licences of parts of the spectrum that are subject to re-allocation.

(4) Part 2.3 is about preparing digital radio channel plans relating to digital radio multiplex transmitter licences.
Part 2.1—Spectrum plans and frequency band plans

30 Spectrum plans

(1) The ACMA may, by written instrument, prepare a spectrum plan.

(2) A spectrum plan must:
   (a) divide into such number of frequency bands as the ACMA thinks appropriate so much of the spectrum as the ACMA thinks necessary for the purpose of regulating radiocommunications under this Act; and
   (b) designate one or more bands to be used primarily for the general purposes of defence; and
   (c) specify the general purpose or purposes for which each other band may be used.

(3) In this section:
   used includes:
   (a) reserved for future use; and
   (b) reserved for the prevention or control of interference to radiocommunications.

31 Planning of broadcasting services bands

(1) The Minister may, after consulting the ACMA, and in accordance with the spectrum plan, by written instrument:
   (a) designate a part of the spectrum as being primarily for broadcasting purposes or restricted datacasting services, or both; and
   (b) refer it to the ACMA for planning under Part 3 of the Broadcasting Services Act 1992.

(1AA) The Minister may, by written instrument, vary a subsection (1) designation so as to enlarge or reduce the part of the spectrum covered by the designation.
(1A) The Minister may, after consulting the ACMA, and in accordance with the spectrum plan, by written instrument:
   (a) designate a part of the spectrum as being partly for the purpose of:
       (i) digital radio broadcasting services; and
       (ii) restricted datacasting services; and
   (b) refer that part of the spectrum to the ACMA for planning under Part 3 of the Broadcasting Services Act 1992.

(1B) Subsection (1A) does not limit subsection (1).

(1BA) The Minister may, by written instrument, vary a subsection (1A) designation so as to enlarge or reduce the part of the spectrum covered by the designation.

(1C) The Minister may, by written instrument, determine that a designation under subsection (1A) ceases to be in force at a specified time.

(1D) The Minister may, by written instrument, determine that a designation under subsection (1A) has effect only in relation to one or more specified areas of Australia.

(2) If a subsection (1) or (1A) designation is in force in relation to a particular part of the spectrum, the ACMA may make a written determination that licences, or specified kinds of licences, can be issued in specified circumstances in relation to that part of the spectrum, or in relation to a specified part or parts of that part of the spectrum.

(3) In making or varying a subsection (2) determination, the ACMA must:
   (a) promote the objects, and have regard to the matters, described in section 23 of the Broadcasting Services Act 1992; and
   (b) promote the object of this Act, to the extent this is not inconsistent with paragraph (a).

This subsection has effect subject to subsection (4).

(4) A subsection (2) determination (including as varied) must not be inconsistent with the spectrum plan.
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(5) Subject to subsections (3) and (4), the ACMA may, by written instrument, vary a subsection (2) determination.

(6) The ACMA may, by written instrument, revoke a subsection (2) determination.

(7) An instrument under subsection (1), (1AA), (1A), (1BA), (1C), (1D), (5) or (6) is not a legislative instrument.

(8) A determination under subsection (2) is not a legislative instrument.

32 Frequency band plans

(1) The ACMA may, by written instrument, prepare frequency band plans, each relating to one or more frequency bands.

(2) However, if a frequency band plan relates to a frequency band that is:
   (a) within a part of the spectrum referred to the ACMA under subsection 31(1) or (1A); and
   (b) wholly or partly covered by a frequency allotment plan prepared under section 25 of the Broadcasting Services Act 1992;

   the frequency band plan must be consistent with the frequency allotment plan.

(2A) The rule in subsection (2) does not apply if:
   (a) a direction is in force under section 14 of the Australian Communications and Media Authority Act 2005; and
   (b) the direction requires the ACMA, when performing its spectrum management functions, to act in accordance with particular policy objectives that are expressed to be digital dividend policy objectives; and
   (c) the ACMA is satisfied that the inconsistency would be likely to facilitate any or all of those objectives.

(3) A frequency band plan must not be inconsistent with the spectrum plan.

(4) A frequency band plan:
   (a) must make provision in relation to the purpose or purposes for which the band or bands may be used; and
(b) without limiting paragraph (a), may provide for:
   (i) the one or more purposes for which any part of a band
       (including any particular frequency or frequency
       channel) may be used; and
   (ii) parts of the spectrum to be reserved for provision of
        public or community services.

(5) A frequency band plan:
   (a) may be of general application or may be limited as provided
       in the plan; and
   (b) without limiting paragraph (a), may apply:
       (i) with respect to a specified area; and
       (ii) with respect to a specified period.

(6) In this section:

   used includes:
   (a) reserved for future use; and
   (b) reserved for the prevention or control of interference to
       radiocommunications.

33 Publication etc. of plans

(1) Before preparing a spectrum plan or a frequency band plan, the
    ACMA must, by notice published in the Gazette:
    (a) state that a draft of the plan is available for public comment;
        and
    (b) state how copies of the draft may be obtained; and
    (c) invite interested parties to make representations about the
        draft plan on or before the day specified in the notice; and
    (d) specify an address or addresses to which representations
        about the draft plan may be sent.

(2) The day specified under paragraph (1)(c) must be at least one
    month later than the day on which the notice is published.

(3) A person may, not later than the day specified under
    paragraph (1)(c), make representations to the ACMA about the
    draft plan.

(4) The ACMA:
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(a) must give due consideration to any representations so made; and

(b) may, having considered the representations, alter the draft plan.

(5) The requirements of this section do not apply to the draft plan as altered under paragraph (4)(b).

(6) This section does not apply to the preparation of a plan if the ACMA is satisfied that the preparation of the plan is a matter of urgency.

34 Revocation and variation of plans

(1) The ACMA may, at any time, revoke or vary a spectrum plan or frequency band plan.

(2) Section 33 applies to such a revocation or variation as if references in that section to the draft of a plan were references to the proposal for such a revocation or variation.

(3) In the case of a variation, the plan as varied must comply with any requirements under section 30 or 32, as the case requires.

35 Disallowance of plans

A spectrum plan prepared under section 30 and frequency band plans, and revocations and variations under section 34, are disallowable instruments for the purposes of section 46A of the Acts Interpretation Act 1901.
Part 2.2—Conversion plans and marketing plans

36 Designation of parts of the spectrum for spectrum licences

(1) The Minister may, after consultation with the ACMA, give to the ACMA a written notice designating a specified part of the spectrum to be allocated by issuing spectrum licences.

(2) The notice is to be expressed to apply with respect to one or more specified areas.

(3) The ACMA may, at the Minister’s request or on its own initiative, make recommendations to the Minister about notices that should be given.

(4) Before making a recommendation, the ACMA must give members of the public reasonable opportunity to make representations to the ACMA about the recommendation it should make.

(5) The Minister must not give a notice that relates wholly or partly to a part of the spectrum referred to the ACMA under subsection 31(1) or (1A), unless the part of the spectrum that the notice relates to is covered by a determination under subsection 31(2).

(6) If there is in force a spectrum re-allocation declaration stating that a particular part of the spectrum is subject to re-allocation with respect to a particular area, then, during the re-allocation period for the declaration, the Minister must not give a notice under this section that relates wholly or partly to that part of the spectrum with respect to the whole or a part of that area.

(7) If, at the beginning of the re-allocation period for a spectrum re-allocation declaration:
   (a) the declaration states that a particular part of the spectrum is subject to re-allocation with respect to a particular area; and
   (b) a notice is in force under this section designating a particular part of the spectrum to be allocated by issuing spectrum licences with respect to a particular area; and
   (c) the part and area covered by the declaration overlap, to any extent, with the part and area covered by the notice;
then:
(d) the notice; and
(e) any conversion plan prepared by the ACMA on receiving the notice; and
(f) any marketing plan prepared by the ACMA on receiving the notice;
cease to have effect at the beginning of that period, to the extent of the overlap.

(8) If:
(a) because of subsection (7), Subdivision A of Division 1 of Part 3.2 ceases to apply to a particular apparatus licence at a particular time; and
(b) before that time, the ACMA gave the licensee an offer under section 56 to issue a spectrum licence to replace the apparatus licence;
subsection (7) does not prevent:
(c) the licensee accepting the offer; or
(d) the ACMA issuing the spectrum licence.

37 Preparation or variation of frequency band plans

The ACMA may, before preparing a conversion plan or a marketing plan under this Part, prepare a frequency band plan under section 32, or vary a frequency band plan under section 34, in order to assist it in preparing the conversion plan or marketing plan.

38 Conversion plans

(1) On receiving a notice designating a specified part of the spectrum to be allocated by issuing spectrum licences, the ACMA must, by written instrument, prepare a conversion plan that sets out the procedures and timetable for issuing spectrum licences to replace existing apparatus licences that authorise operation of radiocommunications devices:
(a) at frequencies within that part of the spectrum; and
(b) within the area or areas specified in the notice.
(2) The conversion plan need not require spectrum licences issued in accordance with it to apply to the whole of the area or areas to which the plan applies.

(3) The conversion plan may contain such other additional matters as the ACMA thinks fit.

(4) The conversion plan must not be inconsistent with:
   (a) the spectrum plan; or
   (b) a frequency band plan that relates, wholly or partly, to the part of the spectrum to which the conversion plan relates.

(5) This section does not apply if there are no apparatus licences to which such a conversion plan would apply.

39 Marketing plans—unencumbered spectrum

(1) On receiving a notice designating a part of the spectrum to be allocated by issuing spectrum licences, the ACMA must also, by written instrument, prepare a marketing plan for issuing spectrum licences that authorise the operation of radiocommunications devices:
   (a) at frequencies, within that part of the spectrum, that will not be used under spectrum licences issued in accordance with the conversion plan; and
   (b) within the area or areas specified in the notice.

(2) The marketing plan is to apply to:
   (a) spectrum licences that might be issued that do not replace apparatus licences; and
   (b) spectrum licences that are issued under section 58.

(3) The marketing plan need not require spectrum licences issued in accordance with it to apply to the whole of the area or areas to which the plan applies.

(4) Without limiting the matters that the marketing plan may contain, it may indicate:
   (a) the procedures to be followed for issuing spectrum licences in accordance with the plan; and
   (b) the timetable for issuing spectrum licences in accordance with the plan; and
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(c) how the spectrum dealt with under the plan is to be apportioned amongst the spectrum licences to be issued; and
(d) how much of the spectrum dealt with under the plan is to be reserved for public or community services; and
(e) the conditions, or types of conditions, that may be included in spectrum licences to be issued.

(5) In indicating the procedures to be followed for issuing spectrum licences, the plan may, for example, indicate whether the licences are to be allocated by auction, by tender, for a pre-determined price or for a negotiated price.

(6) The marketing plan must not be inconsistent with:
   (a) the spectrum plan; or
   (b) a frequency band plan that relates, wholly or partly, to the part of the spectrum to which the marketing plan relates.

39A Marketing plans—re-allocation of spectrum

(1) This section applies if a spectrum re-allocation declaration states that a part or parts of the spectrum should be re-allocated by issuing spectrum licences.

(2) The ACMA must, by written instrument, prepare a marketing plan for issuing spectrum licences that authorise the operation of radiocommunications devices:
   (a) at frequencies within that part, or those parts, of the spectrum; and
   (b) within the area or areas specified in the declaration with respect to that part or those parts.

(3) The marketing plan is to apply to spectrum licences with respect to that part or those parts that might be issued as mentioned in section 153L.

(4) The marketing plan need not require spectrum licences issued in accordance with it to apply to the whole of the area or areas to which the declaration applies.

(5) The marketing plan may indicate:
   (a) the procedures to be followed for issuing spectrum licences in accordance with the plan; and
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(b) the timetable for issuing spectrum licences in accordance with the plan; and
(c) how the spectrum dealt with under the plan is to be apportioned among the spectrum licences to be issued; and
(d) how much of the spectrum dealt with under the plan is to be reserved for public or community services; and
(e) the conditions, or types of conditions, that may be included in spectrum licences to be issued.

(6) Subsection (5) does not, by implication, limit the matters that the marketing plan may indicate.

(7) In indicating the procedures to be followed for issuing spectrum licences, the plan may, for example, indicate whether the licences are to be allocated by auction, by tender, for a pre-determined price or for a negotiated price.

(8) The marketing plan must not be inconsistent with:
(a) the spectrum plan; or
(b) a frequency band plan that relates, wholly or partly, to the part or parts of the spectrum to which the marketing plan relates.

40 Consultation on draft plans

(1) The ACMA may, before preparing a conversion plan or a marketing plan:
(a) make available to the public, in any way it thinks appropriate, copies of a draft of the plan; and
(b) invite interested parties to make representations to the ACMA about the draft plan.

(2) This section does not limit any other action the ACMA may take in consulting with persons about a conversion plan or a marketing plan.

41 Delays in preparing plans

(1) If the ACMA thinks that preparation of a conversion plan or a marketing plan may be unduly delayed because of difficulties in preparing the plan so far as it relates to some of the frequencies
within the part of the spectrum in respect of which the plan is to be prepared, the ACMA may:

(a) decide that, in order not to delay the preparation of a plan in relation to frequencies for which the difficulties do not apply, the task of preparing the plan should be divided into one of preparing more than one plan; and
(b) prepare those plans at different times.

(2) Each of the plans so prepared is taken to have been prepared under section 38, 39 or 39A, as the case requires, and this Part applies to the preparation of each plan accordingly.

42 Variation of plans

(1) The ACMA may, at any time, vary a conversion plan or a marketing plan.

(2) This Part applies in relation to a variation of a conversion plan or a marketing plan in the same way that it applies in relation to the preparation of the plan.

43 Publication of plans

(1) As soon as practicable after preparing or varying a conversion plan or a marketing plan, the ACMA must cause to be published in the Gazette a notice setting out details of where copies of the plan, or an up-to-date version of the plan, can be purchased at a reasonable cost.

(2) The ACMA must take all reasonable steps to ensure that members of the public can obtain copies as set out in the notice.

44 Expressions of interest in spectrum licences

This Part does not prevent the ACMA, prior to preparing a conversion plan or a marketing plan, from seeking from members of the public, in any way the ACMA thinks appropriate, expressions of interest in being issued with spectrum licences in accordance with such a plan.
Part 2.3—Digital radio channel plans

44A Preparation of digital radio channel plans

(1) Before issuing the first digital radio multiplex transmitter licence for a designated BSA radio area, the ACMA must, by legislative instrument, prepare a plan that:

(a) allots a frequency channel or channels in relation to the designated BSA radio area for use by digital radio multiplex transmitter licensees, where each allotted frequency channel has a bandwidth of at least 1.536 MHz; and

(b) reserves a frequency channel of at least 1.536 MHz bandwidth for a category 3 digital radio multiplex transmitter licence for the designated BSA radio area to be issued in accordance with subsection 102E(2); and

(c) determines which of the following types of licences, or which combination of the following types of licences, are to be issued for the designated BSA radio area:

(i) category 1 digital radio multiplex transmitter licence;

(ii) category 2 digital radio multiplex transmitter licence; and

(d) if a particular type of licence mentioned in paragraph (c) is to be issued for the designated BSA radio area—determines whether:

(i) a single licence of that type is to be issued for the designated BSA radio area; or

(ii) 2 or more licences of that type are to be issued for the designated BSA radio area; and

(e) determines technical specifications of multiplex transmitters operated under digital radio multiplex transmitter licences for the designated BSA radio area.

(2) The plan must be consistent with:

(a) the spectrum plan; and

(b) any relevant frequency band plans; and

(c) any relevant frequency allotment plans prepared under section 25 of the Broadcasting Services Act 1992; and
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(d) any relevant licence area plans prepared under section 26 of the *Broadcasting Services Act 1992*; and

(e) any relevant digital channel plans (within the meaning of clause 7A of Schedule 4 to the *Broadcasting Services Act 1992*) made under the commercial television conversion scheme; and

(f) any relevant digital channel plans (within the meaning of clause 22A of Schedule 4 to the *Broadcasting Services Act 1992*) made under the national television conversion scheme.

(3) A plan under subsection (1) is to be known as the digital radio channel plan for the designated BSA radio area.

(4) A copy of a digital radio channel plan is to be made available on the ACMA’s website.

Consultation

(5) Before preparing a plan under subsection (1), the ACMA must:

(a) publish a draft of the plan on the ACMA’s website; and

(b) invite members of the public to make submissions to the ACMA about the draft plan within a specified period of at least 30 days; and

(c) consider any submissions the ACMA receives from members of the public within that period.

Variation of digital radio plans

(6) The ACMA may, by legislative instrument, vary a digital radio channel plan.

(7) Before varying a digital radio channel plan under subsection (6), the ACMA must:

(a) publish a draft of the variation on the ACMA’s website; and

(b) invite members of the public to make submissions to the ACMA about the variation within a specified period of at least 30 days; and

(c) consider any submissions the ACMA receives from members of the public within that period.
ACMA must have regard to authorised digital radio broadcasting services

(8) In preparing a plan under subsection (1) or varying a plan under subsection (6), the ACMA must have regard to:

(a) the digital commercial radio broadcasting services that are, or will be, authorised by commercial radio broadcasting licences for the designated BSA radio area; and

(b) the digital community radio broadcasting services that are, or will be, authorised by community radio broadcasting licences for the designated BSA radio area; and

(c) the digital national radio broadcasting services that are, or will be, provided by national broadcasters in the designated BSA radio area.

(9) Subsection (8) does not limit the matters to which the ACMA may have regard.

Frequency channels to be in the same frequency band

(10) The ACMA must, as far as practicable, ensure that all the frequency channels allotted or reserved by a digital radio channel plan for a particular designated BSA radio area are in the same frequency band.

Technical specifications not to discriminate between digital radio multiplex transmitter licensees

(11) The ACMA must, as far as practicable, ensure that a digital radio channel plan for a particular designated BSA radio area does not discriminate between digital radio multiplex transmitter licensees in relation to the technical specifications of multiplex transmitters.

Definitions

(12) In this section:

commercial television conversion scheme has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

national television conversion scheme has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.
Chapter 3—Licensing of radiocommunications

45 Outline of this Chapter

(1) This Chapter provides for the 3 systems of licences that apply to radiocommunications and for registration of licences.

(2) Part 3.1 prohibits unlicensed radiocommunications, except in emergency situations, and allows for civil proceedings to be taken in some circumstances.

(3) Part 3.2 provides for spectrum licences, under which licensees may use parts of the spectrum.

(4) Part 3.3 provides for apparatus licences, under which licensees may operate the radiocommunications devices to which the licences relate.

(5) Part 3.4 provides for class licences, under which any person may operate radiocommunications devices that come within the terms of the licences.

(6) Part 3.5 provides for registration of these licences in a Register of Radiocommunications Licences.

(6A) Part 3.6 provides for parts of the spectrum to be declared to be subject to re-allocation.

(7) The following diagram shows how this Chapter applies to a particular operation of a radiocommunications device.
Is the situation one of emergency? (See section 49)

Is the operation of the radiocommunications device authorised by a spectrum licence? (See Part 3.2)

Is it authorised by an apparatus licence? (See Part 3.3)

Is it authorised by a class licence? (See Part 3.4)

SECTION 46 MAY PROHIBIT OPERATION OF THE RADIOCOMMUNICATIONS DEVICE.
SECTION 47 MAY PROHIBIT POSSESSION OF THE DEVICE FOR THE PURPOSES OF OPERATION.
SECTION 50 MAY ALLOW CIVIL PROCEEDINGS TO BE TAKEN.
Chapter 3  Licensing of radiocommunications
Part 3.1  Unlicensed radiocommunications
Division 1  Offences

Section 46

Part 3.1—Unlicensed radiocommunications

Division 1—Offences

46 Unlicensed operation of radiocommunications devices

(1) Subject to section 49, a person must not operate a radiocommunications device otherwise than as authorised by:

(a) a spectrum licence; or
(b) an apparatus licence; or
(c) a class licence.

Penalty:

(a) if the radiocommunications device is a radiocommunications transmitter:
   (i) if the offender is an individual—imprisonment for 2 years; or
   (ii) otherwise—1,500 penalty units; or
(b) if the radiocommunications device is not a radiocommunications transmitter—20 penalty units.

(2) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

47 Unlawful possession of radiocommunications devices

(1) Subject to section 49, a person must not have a radiocommunications device in his or her possession for the purpose of operating the device otherwise than as authorised by:

(a) a spectrum licence; or
(b) an apparatus licence; or
(c) a class licence.

Penalty:

(a) if the radiocommunications device is a radiocommunications transmitter:
(i) if the offender is an individual—imprisonment for 2 years; or
(ii) otherwise—1,500 penalty units; or
(b) if the radiocommunications device is not a radiocommunications transmitter—20 penalty units.

(2) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

48 Additional provisions about possession of radiocommunications devices

(1) Without limiting section 47, a person is taken, for the purposes of that section, to have a radiocommunications device in his or her possession for the purpose of operation if it is in his or her possession, otherwise than for the purpose of supply to another person, and can be operated merely by doing one or more of the following:

(a) connecting the device to an electric power supply by means of an electric plug or other electrical connection;
(b) connecting a microphone to the device by inserting a microphone plug into the device;
(c) switching on the device;
(d) switching on any other equipment relevant to the device’s operation;
(e) adjusting settings by manipulating the device’s external switches, dials or other controls;
(f) connecting the device to an antenna.

(2) Subsection (1) only applies in the absence of any evidence to the contrary.

(3) A reference in this Division to a person having a radiocommunications device in his or her possession includes a reference to the person having it under control in any place whatever, whether for the use or benefit of that person or another person, and although another person has the actual possession or custody of it.
Section 49

49 Emergency operation etc. of radiocommunications devices

(1) A person does not contravene section 46 or 47 by operating a radiocommunications device, or having a radiocommunications device in his or her possession, in the reasonable belief that the operation or possession was necessary for the purpose of:
   (a) securing the safety of a vessel, aircraft or space object that was in danger; or
   (b) dealing with an emergency involving a serious threat to the environment; or
   (c) dealing with an emergency involving risk of death of, or injury to, persons; or
   (d) dealing with an emergency involving risk of substantial loss of, or substantial damage to, property.

(2) In proceedings for an offence against section 46 or 47, the burden of proving any of the matters referred to in subsection (1) lies on the defendant.

(3) Nothing in this section limits the scope of the expression “reasonable excuse” in section 46 or 47.
Division 2—Civil proceedings

50 Civil proceedings

(1) If a person (the defendant):

(a) operates a radiocommunications device in a way that is not in accordance with any licence; and

(b) that operation causes interference to radiocommunications carried on by another person (the plaintiff) under a spectrum licence;

the plaintiff may apply to the Federal Court for relief.

(2) The court may grant all or any of the following forms of relief:

(a) an injunction restraining the defendant from causing such interference, from causing interference of a similar kind or from causing or permitting others to cause interference of the same or a similar kind;

(b) an order directing the defendant to do a specified act for the purpose of:

(i) placing the plaintiff as nearly as practicable in the position in which he or she would have been but for the interference; or

(ii) otherwise mitigating detriment to the plaintiff arising out of the interference;

(c) damages against the defendant in respect of loss suffered by the plaintiff as a result of the interference, including loss of any benefit that the plaintiff might reasonably have been expected to obtain but for the interference;

(d) such other relief as the court thinks just.
Part 3.2—Spectrum licences

51 Outline of this Part

(1) This Part is about spectrum licences, under which licensees are authorised to use parts of the spectrum.

(2) Division 1 is about issuing spectrum licences, in particular:
   (a) converting apparatus licences into spectrum licences under conversion plans and (in some cases) marketing plans (Subdivision A); and
   (b) issuing spectrum licences under marketing plans (Subdivision B); and
   (c) what spectrum licences will contain (Subdivision C); and
   (d) how section 50 and related provisions of the Competition and Consumer Act 2010 apply to the issue of spectrum licences (Subdivision D).

(3) Division 2 is about varying spectrum licences.

(4) Division 3 is about suspending and cancelling spectrum licences.

(5) Division 4 is about re-issuing spectrum licences.

(6) Division 5 is about trading spectrum licences.

(7) Division 6 enables the ACMA to resume spectrum licences:
   (a) by agreement with the licensee (Subdivision A); or
   (b) by the compulsory process set out in the Schedule (Subdivision B).
Division 1—Issuing spectrum licences

Subdivision A—Converting apparatus licences into spectrum licences

52 Application of this Subdivision

(1) This Subdivision applies to an apparatus licence if the apparatus licence authorises the operation of a radiocommunications device:
   (a) at frequencies within a part of the spectrum to which a conversion plan applies; and
   (b) within an area to which the conversion plan applies.

(2) The holder of such an apparatus licence is referred to in this Subdivision as the licensee.

53 Preparation of draft spectrum licences

(1) As soon as practicable after preparing a conversion plan, the ACMA must, in respect of each apparatus licence to which this Subdivision applies as a result of the conversion plan, prepare a draft of a spectrum licence to replace the apparatus licence.

(2) The draft spectrum licence must, so far as is practicable, authorise the operation of radiocommunications devices to the same extent as, or to a greater extent than, they are authorised under the apparatus licence to be replaced.

54 Notification of draft spectrum licences

(1) The ACMA must give to the licensee:
   (a) a copy of the draft spectrum licence; and
   (b) a notice inviting the licensee to make representations about the draft spectrum licence on or before the day specified in the notice.

(2) The day specified in the notice must be at least one month later than the day on which the notice is given to the licensee.
Chapter 3  Licensing of radiocommunications
Part 3.2  Spectrum licences
Division 1  Issuing spectrum licences

Section 55

55  Representations about draft spectrum licences

(1) The licensee may, on or before the day specified in the notice, make representations to the ACMA about the proposed spectrum licence.

(2) The ACMA:
   (a) must give due consideration to any representations so made; and
   (b) may, having considered the representations, alter the draft spectrum licence.

56  Offer of spectrum licences

(1) The ACMA must, as soon as practicable after the day specified in the notice, give to the licensee a written offer to issue to the licensee a spectrum licence to replace the licensee’s apparatus licence.

(2) The offer must:
   (a) identify the spectrum licence that the ACMA proposes to issue; and
   (b) specify the amount of spectrum access charge that the licensee must pay to the Commonwealth for the spectrum licence; and
   (c) specify the day on which the offer will close.

Note: Spectrum access charges are determined under Part 5.7.

(3) The day specified in the offer must be at least one month later than the day on which the offer is given to the licensee.

57  Issuing of spectrum licences on acceptance of offers

(1) The ACMA must issue the spectrum licence to the licensee if, on or before the day specified in the offer, the licensee gives the ACMA a written notice:
   (a) accepting the offer; and
   (b) agreeing to pay the amount of spectrum access charge specified in the offer.

Note: Spectrum access charges are determined under Part 5.7.
(2) The spectrum licence comes into force on the day specified in the licence.

(3) Immediately before it comes into force, the apparatus licence that it is to replace ceases to be in force.

58 Failures to accept offers

(1) If the licensee:
   (a) notifies the ACMA, on or before the day specified in the offer, that the licensee does not accept the offer; or
   (b) fails to give the ACMA notice under section 57 before that day;
   the ACMA may allocate the spectrum licence in the manner provided for in sections 60 to 63, and issue the spectrum licence accordingly.

(1A) Subsection (1) has effect subject to section 577J of the Telecommunications Act 1997.

(2) The spectrum licence comes into force on the day specified in the licence.

(3) Immediately before it comes into force, the apparatus licence that it is to replace ceases to be in force.

(4) If the licensee had paid an apparatus licence tax for the apparatus licence, the ACMA must refund to the licensee such portion of the tax as corresponds to the part of the period of the apparatus licence that had, immediately before the licence ceased to be in force, not elapsed.

59 Compliance with plans

(1) The ACMA must ensure that, in issuing a spectrum licence under this Subdivision, the ACMA had complied with any requirements relating to:
   (a) issuing the licence; or
   (b) the procedures to be followed prior to its issue;
that are imposed by the relevant conversion plan.
Section 60

(2) In addition to subsection (1), if the spectrum licence is issued under section 58, the ACMA must also ensure that it has complied with any requirements relating to:
   (a) issuing the licence; or
   (b) the procedures to be followed prior to its issue;
   that are imposed by the relevant marketing plan.

(3) Failure to comply with this section does not affect the validity of a spectrum licence.

Subdivision B—Issuing spectrum licences

60 Procedures for allocating spectrum licences

(1) The ACMA must determine, in writing, the procedures to be applied in allocating spectrum licences under this Subdivision:
   (a) by auction; or
   (b) by tender; or
   (c) by allocation for a pre-determined price or a negotiated price.

(2) The procedures for allocation by auction may, for example, deal with any of the following matters:
   (a) the types of auction;
   (b) advertising of auctions;
   (c) entry fees for prospective bidders;
   (d) reserve prices (if any);
   (e) deposits (if any) payable by successful bidders;
   (f) methods of payment for licences.

(3) The procedures for allocation by tender may, for example, deal with any of the following matters:
   (a) the types of tender;
   (b) advertising of tenders;
   (c) entry fees for prospective tenderers;
   (d) reserve prices (if any);
   (e) the method for resolving which of 2 or more equal tenders is to be successful;
   (f) deposits (if any) payable by successful tenderers;
   (g) methods of payment for licences.
Section 60

(4) The procedures for allocation for a pre-determined or negotiated price may, for example, deal with any of the following matters:
   (a) the way in which prices are to be determined or negotiated;
   (b) advertising of proposed allocations;
   (c) methods of payment for licences.

(5) Procedures determined under subsection (1) may:
   (a) impose limits on the aggregate of the parts of the spectrum that, as a result of the allocation of spectrum licences under this Subdivision, may be used by:
      (i) any one person; or
      (ii) a specified person; or
   (b) impose limits on the aggregate of the parts of the spectrum that, as a result of the allocation of spectrum licences under this Subdivision, may, in total, be used by the members of a specified group of persons.

Note: Persons or groups may be specified by name, by inclusion in a specified class or in any other way.

(6) A limit imposed as mentioned in subsection (5) may be expressed to apply in relation to any or all of the following:
   (a) a specified part of the spectrum;
   (b) a specified area;
   (c) a specified population reach.

For example, procedures might specify an aggregate limit of 15 MHz per person in the band between 1200 MHz and 1300 MHz (inclusive) for a particular area. This subsection does not, by implication, limit subsection (5).

(6A) Procedures that impose limits as mentioned in subsection (5) may impose limits of nil in relation to specified persons or to the members of specified groups of persons.

(7) Procedures determined under subsection (1) may require the ACMA to give specified information to the ACCC.

(8) Subsections (5), (6), (6A) and (7) do not, by implication, limit subsection (1).

(9) The ACMA must not determine procedures imposing a limit as mentioned in subsection (5) unless the ACMA is directed to do so by the Minister under subsection (10).
Section 61

(10) The Minister may give written directions to the ACMA in relation to the exercise of the power to determine procedures imposing a limit as mentioned in subsection (5).

(11) A direction under subsection (10) must be published in the Gazette.

(12) The ACMA must exercise its powers under subsection (1) in a manner consistent with any directions given by the Minister under subsection (10).

(13) Subsection (10) does not, by implication, limit the Minister’s power to give directions otherwise than under that subsection.

(14) Before determining procedures under subsection (1), the ACMA must consult the ACCC about whether the procedures should include a requirement mentioned in subsection (7) and, if so, the nature of the requirement.

(15) This section has effect subject to section 577J of the Telecommunications Act 1997.

61 Preparation of draft spectrum licences

(1) After a marketing plan has been prepared, the ACMA may prepare drafts of spectrum licences that are to be allocated in accordance with the marketing plan.

(2) Drafts of spectrum licences so prepared need not be complete, but each must contain a draft of its core conditions.

62 Issue of spectrum licences

(1) The ACMA may allocate such a spectrum licence in accordance with the procedures determined under section 60 but not otherwise.

(2) The ACMA must issue the spectrum licence to the person to whom it is allocated if the person:
   (a) pays to the ACMA the spectrum access charge for issuing the licence; or
   (b) reaches an agreement with the ACMA for the payment of that spectrum access charge.

Note: Spectrum access charges are determined under Part 5.7.
63 Compliance with marketing plans

(1) The ACMA must ensure that, in issuing a spectrum licence under this Subdivision, the ACMA has complied with any requirements relating to:
   (a) issuing the licence; or
   (b) the procedures to be followed prior to its issue;
that are imposed by the relevant marketing plan.

(2) Failure to comply with this section does not affect the validity of a spectrum licence.

Subdivision C—Contents of spectrum licences

64 Authorisation to use part of the spectrum

(1) A spectrum licence authorises:
   (a) the person specified in the licence as the licensee; and
   (b) subject to section 68, any person authorised by that person;
       to operate a radiocommunications device in accordance with the licence.

(2) Operation of a radiocommunications device is not authorised by the spectrum licence if it is not in accordance with the conditions of the licence.

65 Duration of spectrum licences

(1) A spectrum licence comes into force on the day on which it is issued or on such later day as is specified in the licence for the purpose.
(2) Subject to Division 3, a spectrum licence remains in force for the period specified in the licence.

(3) The licence may specify any period up to 15 years.

66 Core conditions of spectrum licences

(1) A spectrum licence must include the following core conditions:
   (a) a condition specifying the part or parts of the spectrum in which operation of radiocommunications devices is authorised under the licence;
   (b) a condition specifying the maximum permitted level of radio emission, in parts of the spectrum outside such a part, that may be caused by operation of radiocommunications devices under the licence;
   (c) a condition specifying the area within which operation of radiocommunications devices is authorised under the licence;
   (d) a condition specifying the maximum permitted level of radio emission, outside that area, that may be caused by operation of radiocommunications devices under the licence.

(2) The area specified in the condition referred to in paragraph (1)(c) may be the whole of Australia.

(3) A spectrum licence may also include a core condition specifying the periods during which operation of radiocommunications devices is authorised under the licence.

(4) Without limiting subsection (3), the periods specified may include times during each day or times during particular days of each week.

(5) If the issue of the licence is covered by section 153L (which deals with re-allocation of spectrum), a condition mentioned in paragraph (1)(a) of this section may provide for the progressive authorisation of the operation of radiocommunications devices under the licence. The progressivity is to be based on the times when a particular part or parts of the spectrum become available as a result of the expiry, surrender or cancellation of one or more apparatus licences that, under section 153D, are affected by the spectrum re-allocation declaration concerned.

(6) Subsection (5) does not, by implication, limit subsection (1).
67 Conditions about payment of charges

A spectrum licence must include a condition that the licensee meet all obligations (if any) of the licensee to pay:

(a) charges fixed by determinations made under section 60 of the Australian Communications and Media Authority Act 2005; and

(b) spectrum access charges fixed by determinations made under section 294; and

(c) amounts of spectrum licence tax.

68 Conditions about third party use

(1) Except as provided by this section, the licensee of a spectrum licence may authorise other persons to operate radiocommunications devices under the licence.

(2) A spectrum licence:

(a) must include a condition that any operation of a radiocommunications device under the licence by a person other than the licensee must comply with any rules made under subsection (3); and

(b) must include a condition that the licensee must notify any persons whom he or she authorises to operate radiocommunications devices under the licence of their obligations under this Act, in particular:

(i) if applicable, the registration requirements under Part 3.5 for operation of radiocommunications devices under the licence; and

(ii) any rules made under subsection (3).

(3) The ACMA may, by written instrument, make rules about the operation of radiocommunications devices under spectrum licences by persons other than licensees, including rules about the way in which licensees may authorise those persons to operate radiocommunications devices under spectrum licences.

(4) Rules are disallowable instruments for the purposes of section 46A of the Acts Interpretation Act 1901.

(5) This section has effect subject to section 577K of the Telecommunications Act 1997.
Chapter 3  Licensing of radiocommunications
Part 3.2  Spectrum licences
Division 1  Issuing spectrum licences

Section 68A

68A  Authorisation under spectrum licence is to be treated as acquisition of asset

For the purposes of section 50 and subsections 81(1) and (1A) and 88(9), 89(5A) and 90(9) of the *Competition and Consumer Act 2010*, the authorisation, in accordance with subsection 68(1) of this Act, of a person to operate radiocommunications devices under a spectrum licence is taken to be an acquisition by the person of an asset of another person.

69  Conditions about registration of radiocommunications transmitters

(1) A spectrum licence must include a condition that radiocommunications transmitters not be operated under the licence unless the requirements of the ACMA under Part 3.5 for registration of the transmitter under that Part have been met.

(2) The condition may exempt radiocommunications transmitters of particular kinds from meeting those requirements.

69A  Conditions about residency etc.

(1) A spectrum licence must include a condition that, at all times when the licensee derives income, profits or gains from operating radiocommunications devices under the licence or from authorising others to do so, either:
   (a) the licensee is to be an Australian resident (see subsection (3)); or
   (b) the income, profits or gains are to be attributable to a permanent establishment (see subsection (3)) in Australia through which the licensee carries on business.

(2) A spectrum licence must include a condition that, at all times when an authorised person (see subsection (3)) derives income, profits or gains from allowing third parties to operate radiocommunications devices under the licence, either:
   (a) the authorised person is to be an Australian resident; or
   (b) the income, profits or gains are to be attributable to a permanent establishment in Australia through which the authorised person carries on business.

68  Radiocommunications Act 1992
(3) In this section:

**Australian resident** has the same meaning as in the *Income Tax Assessment Act 1997*.

**authorised person** means a person authorised under section 68 by the licensee of a spectrum licence to operate radiocommunications devices under the licence.

**permanent establishment** has the same meaning as in:

(a) if the licensee or authorised person (as appropriate) is a resident of a country or other jurisdiction with which Australia has an agreement, within the meaning of the *International Tax Agreements Act 1953*—that agreement; or

(b) in any other case—the *Income Tax Assessment Act 1997*.

### 71 Other conditions of spectrum licences

(1) The ACMA may include such other conditions in a spectrum licence as it thinks fit.

(2) The ACMA’s power under this section is not limited by sections 67 to 69A.

### Subdivision D—Rules about section 50 and related provisions of the Competition and Consumer Act

#### 71A Issue of spectrum licence is to be treated as acquisition of asset

(1) For the purposes of section 50 and subsections 81(1), 88(9), 89(5A) and 90(9) of the *Competition and Consumer Act 2010*, the issue of a spectrum licence to a person is taken to be an acquisition by the person of an asset of another person.

(2) Subsection (1) does not apply to the re-issue of a spectrum licence under section 82.
Division 2—Varying spectrum licences

72 Variation with agreement

(1) Subject to subsection (2), the ACMA may, with the written agreement of the licensee of a spectrum licence, vary the licence by:

(a) including one or more further conditions; or
(b) revoking or varying any conditions of the licence.

(2) The conditions as varied must still comply with the requirements of Subdivision C of Division 1.

73 Variation without agreement

(1) Subject to subsection (2), the ACMA may, by written notice given to the licensee of a spectrum licence, vary the licence by:

(a) including one or more further conditions; or
(b) revoking or varying any conditions of the licence, other than core conditions.

(2) The conditions as varied must still comply with the requirements of Subdivision C of Division 1.

Note: Variations of spectrum licences under this section are reviewable under Part 5.6.
Division 3—Suspending and cancelling spectrum licences

74 Application of this Division
This Division applies to a spectrum licence if the ACMA is satisfied that the licensee, or a person authorised by the licensee to operate a radiocommunications device under the licence, has:
(a) contravened a condition of the licence, or in any other way contravened this Act; or
(b) operated a radiocommunications device under the licence, or purportedly under the licence:
   (i) in contravention of any other law (whether written or unwritten) of the Commonwealth, a State or a Territory; or
   (ii) in the course of contravening such a law.

75 Suspending spectrum licences
(1) The ACMA may, by written notice given to the licensee, suspend the spectrum licence.

Note: Suspensions of spectrum licences are reviewable under Part 5.6.

(2) The notice must give the reasons for suspending the licence.

(3) The ACMA may, at any time, by written notice given to the licensee, revoke the suspension of the licence.

76 Period of suspension
(1) Subject to subsection (2), the suspension of the spectrum licence, unless it is sooner revoked, ceases:
   (a) if, within 28 days after the suspension, proceedings for an offence against this Act are instituted against the licensee, or against a person authorised by the licensee to operate a radiocommunications device under the licence, and he or she is convicted of the offence—on the expiration of 14 days after the date of the conviction; or
   (b) if such proceedings are instituted within 28 days after the suspension and he or she is not convicted of the offence—on the completion of the proceedings; or
Section 77

(c) in any other case—on the expiration of 28 days after the suspension.

(2) If:
   (a) the notice of suspension specifies a day as the day on which the suspension of the spectrum licence ceases; and
   (b) that day occurs before the day fixed under subsection (1);
   the suspension of the licence, unless it is sooner revoked, ceases on the day so specified.

(3) In subsection (1):

proceedings does not include proceedings by way of appeal or review.

77 Cancelling spectrum licences

(1) The ACMA may, by written notice given to the licensee, cancel the spectrum licence.

   Note: Cancellations of spectrum licences are reviewable under Part 5.6.

(2) The notice must give the reasons for cancelling the licence.
Division 4—Re-issuing spectrum licences

78 Notice of spectrum licences that are about to be re-issued

The ACMA must, from time to time, cause to be published in the Gazette a notice that:
(a) states where information may be obtained about:
   (i) the spectrum licences that will expire during a period specified in the notice; and
   (ii) the parts of the spectrum to which they relate; and
(b) invites expressions of interest from persons who wish to have issued to them spectrum licences relating to those parts of the spectrum.

79 Preparation of draft spectrum licences for re-issue

(1) The ACMA may, at any time prior to a spectrum licence expiring, prepare:
   (a) a draft of a new spectrum licence that would wholly or partly replace that licence; or
   (b) drafts of 2 or more new spectrum licences that, taken together, would wholly or partly replace that licence.

(2) The conditions included in a draft licence need not be the same conditions as those included in the licence that is to be replaced.

80 Procedures for re-allocating spectrum licences

The procedures determined under section 60 apply, so far as they are capable of applying, to re-allocating spectrum licences under this Division in the same way that they apply to allocating spectrum licences under Subdivision B of Division 1.

81 Re-issue of spectrum licences

(1) The ACMA may re-allocate a spectrum licence in accordance with the procedures determined under section 60 (as they apply because of section 80), but not otherwise.
Section 82

(2) The ACMA must issue the spectrum licence to the person to whom it is re-allocated if the person:

(a) pays to the ACMA the spectrum access charge for issuing the licence; or

(b) reaches an agreement with the ACMA for payment of that spectrum access charge.

82 Re-issue of spectrum licences to the same licensees in the public interest

(1) The ACMA may, without following the procedures determined under section 60 (as they apply because of section 80), re-issue a spectrum licence to the person to whom it was previously issued if:

(a) the licence was used in the provision of a service included in a class of services specified in a determination under subsection (3); or

(b) the ACMA is satisfied that special circumstances exist as a result of which it is in the public interest for that person to continue to hold the licence.

(2) Subsection (1) does not imply that the ACMA must issue such a spectrum licence without the person:

(a) paying to the ACMA the spectrum access charge for issuing the licence; or

(b) reaching an agreement with the ACMA for payment of that spectrum access charge.

(3) The Minister may determine, by written instrument, a specified class of services for which re-issuing spectrum licences to the same licensees would be in the public interest.

(4) A determination is a legislative instrument, but section 42 (disallowance) of the *Legislative Instruments Act 2003* does not apply to the determination.

(5) The ACMA must notify the licensee in writing if the core conditions of the re-issued licence differ from the core conditions of the licence it replaces.

Note: Changes in the core conditions of such re-issued licences are reviewable decisions under Part 5.6.

74 *Radiocommunications Act 1992*
(6) This section does not prevent a spectrum licence being issued under section 81 to a person to whom it was previously issued.

83 General rules about newly-issued spectrum licences apply to re-issued spectrum licences

Subdivisions C and D of Division 1 apply to spectrum licences re-issued under this Division in the same way that those Subdivisions apply to spectrum licences issued under Division 1.

84 Commencement of re-issued spectrum licences

A spectrum licence re-issued under this Division comes into force on the day specified in the licence, not being a day occurring earlier than the expiry of the spectrum licence it replaces.
Chapter 3 Licensing of radiocommunications
Part 3.2 Spectrum licences
Division 5 Trading spectrum licences

Section 85

Division 5—Trading spectrum licences

85 Trading spectrum licences

(1) Subject to subsection (2) and section 86 of this Act and section 577L of the Telecommunications Act 1997, the licensee of a spectrum licence may assign, or otherwise deal with, the whole or any part of the licence.

(2) An assignment must comply with any rules made under section 88.

86 Registration of assignments etc.

(1) The parties to an assignment under section 85 of the whole, or any part of, a licence that involves:
   (a) a change in the licensee; or
   (b) the issue of a spectrum licence; or
   (c) the variation of the conditions of a spectrum licence; or
   (d) the cancellation of one or more existing spectrum licences;
must give to the ACMA such information about the assignment as the ACMA requires (if any) for the purpose of amending the Register to take account of the assignment.

(2) The assignment covered by subsection (1) cannot take effect before the Register is amended under Part 3.5 to take it into account.

87 Variation etc. of spectrum licences to take assignments into account

(1) The ACMA may do one or more of the following if it is satisfied it is necessary or convenient to do so in order to give effect to an assignment under section 85:
   (a) vary a spectrum licence by specifying in it as the licensee a different person from the person currently specified;
   (b) vary the conditions of a spectrum licence by:
      (i) including one or more further conditions; or
      (ii) revoking or varying any conditions;
   (c) issue one or more new spectrum licences;
   (d) cancel one or more existing spectrum licences.
(2) A licence as varied, or a new licence issued, under subsection (1) must comply with the requirements of Subdivision C of Division 1.

(3) Subdivision D of Division 1 applies to the issue of a new licence under subsection (1) of this section.

Note: Variations and cancellations under this section are reviewable under Part 5.6.

88 Rules about assignments etc.

(1) The ACMA may determine, by written instrument, rules:
   (a) for assignments of spectrum licences; and
   (b) setting out the circumstances in which spectrum licences are to be varied, issued or cancelled under section 87.

(2) The rules may, for example, restrict assignments of spectrum licences that were issued for the provision of public or community services.

(3) A determination is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

Radiocommunications Act 1992
Division 6—Resuming spectrum licences

Subdivision A—Resuming spectrum licences by agreement

89 ACMA may resume spectrum licences by agreement

(1) The ACMA may resume a spectrum licence, or a part of a spectrum licence, under an agreement entered into with the licensee.

(2) Without limiting the matters that may be included in the agreement, if a part of the licence is to be resumed, the agreement must specify variations to the conditions included in the remaining part of the licence that will be made to give effect to the agreement.

90 Effect of resumption

(1) If the whole of the licence is resumed, it ceases to have effect:
   (a) at the end of the day specified for that purpose in the agreement; or
   (b) if such a day is not specified—at the end of the day on which the agreement is entered into.

(2) If a part of the licence is resumed:
   (a) that part of the licence ceases to have effect at the end of the day on which the ACMA makes the necessary changes to the information in the Register under section 146 to take the resumption into account; and
   (b) the ACMA must vary, in a way that gives effect to the variations specified in the agreement, the conditions included in the remaining part of the licence.

Subdivision B—Resuming spectrum licences by compulsory process

91 ACMA may resume spectrum licences compulsorily

(1) Subject to subsection (2), the ACMA may resume a spectrum licence, or a part of a spectrum licence.
Section 92

(2) The ACMA must not resume the licence unless:
   (a) the Minister has given his or her written approval for the resumption; and
   (b) the ACMA has followed the resumption procedures set out in Part 1 of the Schedule.

92 Effect of resumption

(1) If the whole of the licence is resumed, it ceases to have effect:
   (a) on the day specified for that purpose in the notice of resumption; or
   (b) if such a day is not specified—at the end of the day on which the notice is given.

(2) If a part of the licence is resumed:
   (a) that part of the licence ceases to have effect at the end of the day on which the ACMA makes the necessary changes to the information in the Register under section 146 to take the resumption into account; and
   (b) the ACMA must vary, in the way that in its opinion best gives effect to the resumption, the conditions included in the remaining part of the licence.

Note: Variations under this section are reviewable under Part 5.6.

93 Payment of compensation

(1) Part 2 of the Schedule sets out the procedures to be followed for determining the compensation payable for:
   (a) resuming the licence or the part of the licence; or
   (b) publishing a pre-acquisition declaration that is revoked before resumption of the licence, or the part of the licence, takes place.

(2) If an amount of compensation is determined under those procedures to be payable to a person, the Commonwealth must pay that amount to that person, together with the amount of interest payable under section 94.
94 Interest payable on resumption etc.

(1) Interest is payable on the amount of compensation in respect of the period:
   (a) starting:
      (i) if the licence or the part of the licence is resumed—on the day the resumption took place; or
      (ii) if the pre-acquisition declaration was revoked before the resumption took place—on the day the pre-acquisition declaration was served on the licensee; and
   (b) finishing at the end of the day on which the compensation is paid.

(2) Interest is payable at the rate specified in, or ascertained in accordance with, the regulations.

95 Reaching agreements during the compulsory process

(1) This Subdivision does not prevent the ACMA entering into an agreement under section 89 under which a spectrum licence or a part of a spectrum licence is resumed even though the ACMA was, until the agreement was entered into, in the process of resuming the licence, or the part of the licence, under section 91.

(2) On entering into the agreement, the ACMA must stop the process of resuming the licence, or the part of the licence, under this Subdivision.
Part 3.3—Apparatus licences

96 Outline of this Part

(1) This Part is about apparatus licences, under which licensees are authorised to operate the radiocommunications devices to which the licences relate.

(2) Division 1 is about the types of apparatus licences that may be issued.

(3) Division 2 is about issuing apparatus licences.

(4) Division 3 is about the conditions to which apparatus licences are subject.

(5) Division 4 is about licensees authorising third parties to operate radiocommunications devices under apparatus licences.

(6) Division 5 is about requirements to have qualified operators to operate radiocommunications devices under some apparatus licences.

(7) Divisions 6 and 6A are about suspending and cancelling apparatus licences.

(8) Division 7 is about renewing apparatus licences.
Division 1—Types of apparatus licences

97 Transmitter licences and receiver licences

(1) The ACMA may issue:
   (a) transmitter licences; and
   (b) receiver licences.

(2) A transmitter licence authorises:
   (a) the person specified in the licence as the licensee; and
   (b) subject to Division 4, any person authorised by that person under section 114;
   to operate specified radiocommunications transmitters, or radiocommunications transmitters of a specified kind.

(3) A receiver licence authorises:
   (a) the person specified in the licence as the licensee; and
   (b) subject to Division 4, any person authorised by that person under section 114;
   to operate specified radiocommunications receivers, or radiocommunications receivers of a specified kind.

(4) Operation of a radiocommunications device is not authorised by the relevant apparatus licence if it is not in accordance with the conditions of the licence.

98 Types of transmitter licences and receiver licences

(1) The ACMA may determine, by written instrument, the types of transmitter licences and the types of receiver licences that it may issue.

(2) The ACMA must not issue an apparatus licence that is not a transmitter licence or receiver licence of a type so determined.

(2A) For the purposes of this Act, the type of an apparatus licence is to be ascertained solely by reference to a determination.

(3) A determination is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
98A Channel A datacasting transmitter licence

(1) The ACMA may, by writing, declare that a specified datacasting transmitter licence proposed to be issued is a *channel A datacasting transmitter licence* for the purposes of this Act.

(2) If such a datacasting transmitter licence is issued, the licence is a *channel A datacasting transmitter licence* for the purposes of this Act.

(3) A declaration under subsection (1) is not a legislative instrument.

(4) A copy of a declaration under subsection (1) is to be made available on the ACMA’s website.

98B Channel B datacasting transmitter licence

(1) The ACMA may, by writing, declare that a specified datacasting transmitter licence proposed to be issued is a *channel B datacasting transmitter licence* for the purposes of this Act.

(2) If such a datacasting transmitter licence is issued, the licence is a *channel B datacasting transmitter licence* for the purposes of this Act.

(3) A declaration under subsection (1) is not a legislative instrument.

(4) A copy of a declaration under subsection (1) is to be made available on the ACMA’s website.

98C Foundation category 1 digital radio multiplex transmitter licence

(1) Subject to this section, the ACMA may, by writing, declare that a specified category 1 digital radio multiplex transmitter licence proposed to be issued is a *foundation category 1 digital radio multiplex transmitter licence* for the purposes of this Act.

(2) If such a category 1 digital radio multiplex transmitter licence is issued, the licence is a *foundation category 1 digital radio multiplex transmitter licence* for the purposes of this Act.

(3) A declaration under subsection (1) is not a legislative instrument.
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(4) A copy of a declaration under subsection (1) is to be made available on the ACMA’s website.

98D  Foundation category 2 digital radio multiplex transmitter licence

(1) Subject to this section, the ACMA may, by writing, declare that a specified category 2 digital radio multiplex transmitter licence proposed to be issued is a foundation category 2 digital radio multiplex transmitter licence for the purposes of this Act.

(2) If such a category 2 digital radio multiplex transmitter licence is issued, the licence is a foundation category 2 digital radio multiplex transmitter licence for the purposes of this Act.

(3) A declaration under subsection (1) is not a legislative instrument.

(4) A copy of a declaration under subsection (1) is to be made available on the ACMA’s website.

98E  Limit on declaration of foundation digital radio multiplex transmitter licences

(1) In exercising its powers under subsection 98C(1) or 98D(1) in relation to a particular designated BSA radio area, the ACMA must ensure that the total multiplex capacities under foundation digital radio multiplex transmitter licences for the designated BSA radio area is not more than sufficient to fulfil the number of standard access entitlements that have come into existence, or are likely to come into existence, under subsection 118NQ(2) in its application to the designated BSA radio area.

(2) For the purposes of subsection (1), if the number of standard access entitlements that have come into existence, or are likely to come into existence, under subsection 118NQ(2) in its application to the designated BSA radio area is not a multiple of 7, round up that number to the next higher number that is a multiple of 7.

(3) Subsection (1) does not prevent the ACMA from making a declaration under subsection 98C(1) in relation to a category 1 digital radio multiplex transmitter licence for a particular designated BSA radio area if the ACMA proposes to cancel a
foundation category 1 digital radio multiplex transmitter licence that has been previously issued for that area.

(4) Subsection (1) does not prevent the ACMA from making a declaration under subsection 98D(1) in relation to a category 2 digital radio multiplex transmitter licence for a particular designated BSA radio area if the ACMA proposes to cancel a foundation category 2 digital radio multiplex transmitter licence that has been previously issued for that area.

(5) In this section:

*multiplex capacity* has the same meaning as in Division 4B.
Division 2—Issuing apparatus licences

99 Applications for apparatus licences

(1) A person may apply in writing to the ACMA for an apparatus licence of the type specified in the application.

(2) The application must be in a form approved by the ACMA.

(3) The ACMA may approve different forms for the different types of apparatus licence.

100 Issuing apparatus licences

(1) Subject to sections 100B, 101B, 101C, 102, 102A, 102B, 102C, 102D, 102E and 102F, upon such application being made, the ACMA may issue to the applicant an apparatus licence of the type applied for.

(1A) The ACMA must not issue a temporary community transmitter licence except under section 101A. For the purposes of this subsection, a temporary community transmitter licence is an apparatus licence that authorises operation of one or more radiocommunications transmitters for transmitting a community broadcasting service in accordance with a temporary community broadcasting licence.

(2) The ACMA must not issue an apparatus licence authorising operation of a radiocommunications transmitter within a part of the spectrum designated under subsection 31(1) or (1A) unless:

(a) the issue of the licence is in accordance with a decision of the ACMA under subsection 34(1) or (3) of the Broadcasting Services Act 1992; or

(b) the issue of the licence is in accordance with a determination under subsection 31(2) of this Act; or

(c) the licence is a digital radio multiplex transmitter licence.

(3) Subsection (2) does not prevent the ACMA from issuing an apparatus licence authorising operation of a radiocommunications transmitter for transmitting a broadcasting service if:
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(a) the licence authorises operation of the transmitter only within a part of the spectrum that constitutes capacity reserved under paragraph 31(1)(a) of the Broadcasting Services Act 1992; and

(b) the broadcasting service in question is a broadcasting service of a kind for which the capacity has been so reserved.

(3A) An NBS transmitter licence cannot be issued to any person other than:

(a) the Australian Broadcasting Corporation; or

(b) the Special Broadcasting Service Corporation; or

(c) the Commonwealth.

(3AA) Subsection (2) does not prevent the ACMA from issuing an NBS transmitter licence that authorises the operation of one or more transmitters for transmitting one or more national broadcasting services that are covered by a licence area plan in force under section 26 of the Broadcasting Services Act 1992.

(3B) The ACMA must not issue a transmitter licence authorising operation of a radiocommunications transmitter for transmitting an international broadcasting service unless there is in force an international broadcasting licence that authorises the provision of that service.

(3C) If:

(a) a provisional international broadcasting certificate is in force in relation to an application for a transmitter licence; and

(b) the application for the licence is made by the holder of the certificate; and

(c) the conditions set out in the certificate are satisfied;

the ACMA must not refuse to issue the transmitter licence unless the ACMA is satisfied that there are exceptional circumstances that warrant the refusal.

(4) In deciding whether to issue an apparatus licence, the ACMA must have regard to:

(a) all matters that it considers relevant; and

(b) without limiting paragraph (a), the effect on radiocommunications of the proposed operation of the radiocommunications devices that would be authorised under the licence.
(4A) The ACMA, in deciding whether to issue an apparatus licence, may have regard to a frequency assignment certificate issued by a person accredited under section 263 to issue such certificates for the purposes of this section, stating that the operation of a device under the licence:

(a) on a specified frequency or frequencies, or on a specified frequency channel; and
(b) at a specified constancy; and
(c) at a specified location; and
(d) subject to specified technical conditions;

will satisfy any conditions that are required to be satisfied, in relation to the issue of such a certificate, under a determination made under section 266A.

(5) In deciding whether to issue an apparatus licence, the ACMA may also have regard to whether, in the 2 years before the application, the applicant has been the holder of an apparatus licence that has been cancelled otherwise than under section 100B, 102A, 102AH or 153H.

(6) Without limiting subsection (4), in deciding whether to issue a transmitter licence, the ACMA must have regard to the following additional matters:

(a) if a licence that the ACMA may issue as a result of the application would be a licence in respect of which persons operating the transmitters are required under section 119 to be qualified operators in relation to the licence—whether:

(i) the applicant; or

(ii) each person specified by the applicant as a person whom the applicant proposes to authorise under the licence to operate the transmitters;

is a qualified operator in relation to such a licence;

(b) whether the ACMA is satisfied that the proposed operation of the transmitters is not reasonably likely to cause:

(i) death of, or injury to, persons; or

(ii) loss of, or damage to, property.

(7) If the ACMA refuses to issue the licence, it must give the applicant a written notice of the refusal, together with a statement of its reasons.

Note: Refusals to issue apparatus licences are reviewable under Part 5.6.
(8) Nothing in this Act prevents 2 or more apparatus licences (whether transmitter licences or receiver licences or both) from being contained in the same instrument.

100AA  NBS transmitter licences—authorised channels

(1) If:
   (a) an NBS transmitter licence was issued under section 100; and
   (b) the licence is in force immediately before the end of the simulcast period, or the simulcast-equivalent period, for a BSA coverage area; and
   (c) the licence authorises the operation of one or more radiocommunications transmitters for transmitting one or more national television broadcasting services in that coverage area;
then, after the end of that period, the licence authorises the operation of the transmitter or transmitters concerned for transmitting those services in digital mode in that BSA coverage area using the channel or channels allotted to the national broadcaster concerned under:
   (d) if a BSA television licence area plan is in force for the BSA television licence area that corresponds to that BSA coverage area—the BSA television licence area plan; or
   (e) otherwise—the national television conversion scheme or a digital channel plan.

(2) If:
   (a) an NBS transmitter licence is issued under section 100 when a BSA television licence area plan for the BSA television licence area that corresponds to a coverage area is in force; and
   (b) the licence authorises the operation of one or more radiocommunications transmitters for transmitting one or more national television broadcasting services in digital mode in that coverage area;
the licence authorises the operation of the transmitter or transmitters concerned for transmitting those services in digital mode in that area using the channel or channels allotted to the national broadcaster concerned under the BSA television licence area plan for that BSA television licence area.
(3) If:

(a) an NBS transmitter licence is issued under section 100 when no BSA television licence area plan for the BSA television licence area that corresponds to a coverage area is in force; and

(b) subsection (1) does not apply; and

(c) the licence authorises the operation of one or more radiocommunications transmitters for transmitting one or more national television broadcasting services in digital mode in that coverage area;

the licence authorises the operation of the transmitter or transmitters concerned for transmitting those services in digital mode in that area using the channel or channels allotted to the national broadcaster concerned under the national television conversion scheme or a digital channel plan.

(4) In this section:

**BSA television licence area** means a BSA licence area for a commercial television broadcasting licence.

**digital channel plan** means a digital channel plan covered by clause 22A of Schedule 4 to the *Broadcasting Services Act 1992*.

**national television broadcasting service** means a national broadcasting service that provides television programs.

**national television conversion scheme** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**NBS transmitter licence** means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service.

**simulcast-equivalent period** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**simulcast period** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

### 100A  NBS transmitter licences—authorisation of datacasting services

(1) If:
(a) an NBS transmitter licence is or was issued under section 100; and
(b) the licence authorises the operation of one or more specified radiocommunications transmitters for transmitting a national television broadcasting service in digital mode using one or more channels;
the licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting datacasting services in digital mode using those channels.

(1B) The authorisation of the operation of the transmitter or transmitters concerned for transmitting a datacasting service in digital mode using those channels has no effect unless the licensee holds a BSA datacasting licence authorising the provision of that service.

(2) In this section:

national broadcasting service has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

NBS transmitter licence means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service.

100B NBS transmitter licences required to be issued under digital conversion schemes

(1) If the ACMA is required, under a scheme in force under clause 19 of Schedule 4 to the Broadcasting Services Act 1992, to issue an NBS transmitter licence to a national broadcaster, the ACMA must issue to the broadcaster an NBS transmitter licence that authorises the operation of one or more specified radiocommunications transmitters for transmitting the national broadcasting service or services concerned in digital mode.

(2) If an NBS transmitter licence is issued under this section, the licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting datacasting services in digital mode using the channel or channels concerned.

(2B) The authorisation of the operation of the transmitter or transmitters concerned for transmitting a datacasting service in digital mode using the channel or channels concerned has no effect unless the
licencee holds a BSA datacasting licence authorising the provision of that service.

(2C) If:
  (a) an NBS transmitter licence issued under this section is in force immediately before the end of the simulcast period, or the simulcast-equivalent period, for a BSA coverage area; and
  (b) the licence authorised the operation of one or more radiocommunications transmitters for transmitting one or more national television broadcasting services in digital mode in that area;
the licence is cancelled at the end of that period.

(3) In this section:

national broadcaster has the same meaning as in the Broadcasting Services Act 1992.

national broadcasting service has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

NBS transmitter licence means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service.

simulcast-equivalent period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

simulcast period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

100C NBS transmitter licences—authorisation of radio broadcasting services

(1) If:
  (a) an NBS transmitter licence is or was issued to a particular national broadcaster; and
  (b) the licence authorises the operation of one or more specified radiocommunications transmitters for transmitting a national television broadcasting service in digital mode using one or more channels;
the licence is also taken to authorise the operation of the
transmitter or transmitters concerned for transmitting national radio
broadcasting services in digital mode using those channels.

(2) In this section:

national broadcaster has the same meaning as in the Broadcasting

national broadcasting service has the same meaning as in

national radio broadcasting service means a national broadcasting
service that provides radio programs.

national television broadcasting service means a national
broadcasting service that provides television programs.

NBS transmitter licence means a transmitter licence for a
transmitter that is for use for transmitting, to the public, a national
broadcasting service.

100D  NBS transmitter licences—authorisation of SDTV
multi-channelled national television broadcasting services

(1) If:

(a) an NBS transmitter licence is or was issued to a particular
national broadcaster; and

(b) the licence authorises the operation of one or more specified
radiocommunications transmitters for transmitting a national
television broadcasting service in digital mode using one or
more channels; and

(c) the national broadcaster provides, or proposes to provide, one
or more SDTV multi-channelled national television
broadcasting services;

the licence is also taken to authorise the operation of the
transmitter or transmitters concerned for transmitting the SDTV
multi-channelled national television broadcasting services in digital
mode using those channels.

(2) In this section:

national broadcaster has the same meaning as in the Broadcasting
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*national broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

*national television broadcasting service* means a national broadcasting service that provides television programs.

*NBS transmitter licence* means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service.

*SDTV multi-channelled national television broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**100E NBS transmitter licences—authorisation of HDTV multi-channelled national television broadcasting services**

(1) If:

(a) an NBS transmitter licence is or was issued to a national broadcaster; and

(b) the NBS transmitter licence authorises the operation of one or more specified radiocommunications transmitters for transmitting one or more national television broadcasting services in digital mode using one or more channels; and

(c) the national broadcaster provides, or proposes to provide, one or more HDTV multi-channelled national television broadcasting services;

the licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting HDTV multi-channelled national television broadcasting services using those channels.

(2) In this section:

*HDTV multi-channelled national television broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

*national broadcaster* has the same meaning as in the *Broadcasting Services Act 1992*.

*national broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

94  *Radiocommunications Act 1992*
national television broadcasting service means a national broadcasting service that provides television programs.

NBS transmitter licence means a transmitter licence for a transmitter that is for use for transmitting, to the public, a national broadcasting service.

101 Testing of radiocommunications devices

(1) If the ACMA thinks it necessary for the purposes of paragraph 100(4)(b), the ACMA may, by written notice given to the applicant for a transmitter licence or a receiver licence, request the applicant to:

(a) submit to the ACMA the radiocommunications device specified in the notice, at a time and place specified in the notice, for testing; or

(b) permit the ACMA, or a recognised testing authority, to test the radiocommunications device so specified.

(2) A radiocommunications device submitted under paragraph (1)(a) for testing must be returned to the applicant within a reasonable time.

101A Transmitter licences for temporary community broadcasting

(1) If the ACMA allocates a temporary community broadcasting licence (the related licence) to a person, then the ACMA may issue to the person, upon application by the person under section 99, a transmitter licence that authorises operation of one or more specified radiocommunications transmitters for transmitting the community broadcasting service in accordance with the related licence.

(2) Subsections 100(4) to (8) apply for the purposes of this section.

101B Transmitter licence—application if multi-channelling election is in force in relation to remote licence area

(1) If:

(a) a commercial television broadcasting licence (the related licence) allocated under section 38B of the Broadcasting Services Act 1992 is in force on or after 1 January 2009; and
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(1) If:

(a) a commercial television broadcasting licence (the related licence) allocated under section 38A or 38B of the Broadcasting Services Act 1992 is in force on or after 1 January 2009; and

(b) an election under subclause 6(7B) of Schedule 4 to that Act is in force for a commercial television broadcasting service provided under the related licence;

the licensee of the related licence may apply in writing to the ACMA for the issue of a transmitter licence under this section.

(2) An application under subsection (1) must be in a form approved by the ACMA.

Issue of transmitter licence

(3) If:

(a) an application is made under subsection (1); and

(b) the ACMA is satisfied that there is sufficient radiofrequency spectrum available;

the ACMA must:

(c) vary the relevant digital channel plan under the commercial television conversion scheme to allot a channel to the licensee of the related licence; and

(d) issue to the licensee of the related licence a transmitter licence authorising the operation of one or more specified radiocommunications transmitters for transmitting commercial television broadcasting services in digital mode in accordance with the related licence.

(4) For the purposes of paragraph (3)(b), any part of the spectrum covered by a determination under subsection 34(3) of the Broadcasting Services Act 1992 is taken not to be available.

(5) If the related licence is transferred, the transmitter licence is taken to be issued to the person to whom the related licence is transferred.

101C  Transmitter licence—application before the end of the simulcast period etc. if multi-channelling election is in force

(1) If:

(a) a commercial television broadcasting licence (the related licence) allocated under section 38A or 38B of the Broadcasting Services Act 1992 is in force on or after 1 January 2009; and

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(b) an election under subclause 6(5A), (5AA) or (7B) of Schedule 4 to that Act is in force for a commercial television broadcasting service provided under the related licence; and
(c) no transmitter licence has been issued to the licensee of the related licence under section 101B;
the licensee of the related licence may apply in writing to the ACMA for the issue of a transmitter licence under this section.

(2) An application under subsection (1) must be in a form approved by the ACMA.

*Issue of transmitter licence*

(3) If:
(a) an application is made under subsection (1); and
(b) the ACMA is satisfied that there is sufficient radiofrequency spectrum available;
the ACMA must issue to the licensee of the related licence a transmitter licence authorising the operation of one or more specified radiocommunications transmitters for transmitting commercial television broadcasting services in digital mode in accordance with the related licence.

(4) For the purposes of paragraph (3)(b), any part of the spectrum covered by a determination under subsection 34(3) of the *Broadcasting Services Act 1992* is taken not to be available.

(6) If the related licence is transferred, the transmitter licence is taken to be issued to the person to whom the related licence is transferred.

*Consequences of revocation of election*

(7) If:
(a) an application is made under subsection (1); and
(b) the election referred to in paragraph (1)(b) is revoked before the ACMA makes a decision on the application;
the application is taken never to have been made.

(8) If:
(a) a transmitter licence is issued under subsection (3); and
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(b) the election referred to in paragraph (1)(b) is subsequently revoked;
the transmitter licence is cancelled.

102 Transmitter licences for certain broadcasting services

(1) Subject to subsections (2AA) and (2AB), if a broadcasting services bands licence (the related licence) is allocated to a person under Part 4 or 6 of the Broadcasting Services Act 1992, the ACMA must issue to the person a transmitter licence that authorises operation of one or more specified radiocommunications transmitters for transmitting the broadcasting service or services concerned in accordance with the related licence.

(2) If the related licence is transferred, that transmitter licence is taken to be issued to the person to whom the related licence is transferred.

(2AA) Subsection (1) does not apply if:

(a) the related licence is a commercial radio broadcasting licence allocated on or after the digital radio start-up day for the BSA licence area; and

(b) the related licence is subject to a condition that the related licensee may only provide digital commercial radio broadcasting services under the related licence.

(2AB) Subsection (1) does not apply if:

(a) the related licence is a designated community radio broadcasting licence allocated on or after the digital radio start-up day for the BSA licence area; and

(b) the related licence is subject to a condition that the related licensee may only provide digital community radio broadcasting services under the related licence.

(2AC) If:

(a) the related licence is a commercial radio broadcasting licence allocated before the digital radio start-up day for the BSA licence area; and

(b) under the Broadcasting Services Act 1992, the related licence authorises the related licensee to provide digital commercial radio broadcasting services;
then, after the digital radio start-up day for the BSA licence area, the transmitter licence does not authorise the operation of a radiocommunications transmitter for transmitting those services.

(2AD) If:

(a) the related licence is a designated community radio broadcasting licence allocated before the digital radio start-up day for the BSA licence area; and

(b) under the Broadcasting Services Act 1992, the related licence authorises the related licensee to provide digital community radio broadcasting services;

then, after the digital radio start-up day for the BSA licence area, the transmitter licence does not authorise the operation of a radiocommunications transmitter for transmitting those services.

(2A) If:

(a) a transmitter licence (the first transmitter licence) was issued under this section; and

(b) the first transmitter licence authorises the operation of one or more specified radiocommunications transmitters for transmitting a particular commercial television broadcasting service (the first service) in accordance with a commercial television broadcasting licence held by a person (the first BSA licence); and

(c) another commercial television broadcasting licence (the additional BSA licence) is allocated to the person under section 38A or 38B of the Broadcasting Services Act 1992; and

(d) the first BSA licence and the additional BSA licence relate to the same licence area (within the meaning of whichever of those sections is applicable); and

(e) the additional BSA licence authorises the provision of one or more other commercial television broadcasting services (the additional services); and

(f) the first service and at least one of the additional services are the subject of an election under subclause 6(5A) of Schedule 4 to the Broadcasting Services Act 1992;

then:

(g) despite subsection (1), the ACMA is not required to issue to the person a new transmitter licence in relation to any of the additional services; and
(h) the first transmitter licence is taken to authorise the operation of the transmitter or transmitters concerned for transmitting the additional services in accordance with the additional BSA licence.

(2B) Despite subsection (1), the ACMA is not required to issue a new transmitter licence for a commercial television broadcasting service if:

(a) the service is provided under a licence that was allocated under subsection 38B(6), (7), (8) or (9) of the Broadcasting Services Act 1992; and

(b) a multi-channelling election is in force for the relevant remote area service.

(2C) The operation of a transmitter or transmitters for transmitting the commercial television broadcasting service or services under that commercial television broadcasting licence is, if a multi-channelling election is in force for the relevant remote area service, taken to be authorised by the transmitter licence held by the company that made the election for the relevant licence area.

(2D) If the ACMA approves the revocation of the multi-channelling election, the ACMA must issue a new transmitter licence to the licensee that revoked the election authorising the operation of a transmitter or transmitters for transmitting, in digital mode, the commercial television broadcasting service or services provided under the licence (the related licence) for which that election was made.

(2E) The new licence comes into force on the day from which the revocation takes effect.

(2EA) If the related licence is transferred, the new transmitter licence is taken to be issued to the person to whom the related licence is transferred.

(2F) A transmitter licence issued under subsection (1) to a joint-venture company that is allocated a commercial television broadcasting licence under subsection 38B(5) of the Broadcasting Services Act 1992 is, if a multi-channelling election is in force for the relevant remote area service, taken to authorise the operation of the transmitter or transmitters concerned for transmitting:
(a) the commercial television broadcasting service or services provided under that commercial television broadcasting licence; and
(b) the commercial television broadcasting services provided by either or both of the 2 existing licensees referred to in subsection 38B(1) of that Act for the relevant licence area.

(2G) If:
(a) under subclause 6(5BA) of Schedule 4 to the Broadcasting Services Act 1992, the licensee of a commercial television broadcasting licence (the related licence) gives the ACMA a notice of revocation of an election; and
(b) the ACMA approves the revocation under clause 7B of Schedule 4 to that Act;

the ACMA must issue to the licensee of the related licence a new transmitter licence that authorises the operation of one or more specified radiocommunications transmitters for transmitting commercial television broadcasting services in digital mode in accordance with the related licence.

(2H) The new transmitter licence comes into force on the day on which the revocation takes effect.

(2J) If the related licence is transferred, the new transmitter licence is taken to be issued to the person to whom the related licence is transferred.

(3) If:
(a) a transmitter licence is or was issued under this section; and
(b) the licence authorises the operation of one or more specified radiocommunications transmitters for transmitting the broadcasting service or services concerned in digital mode using one or more channels;

the licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting datacasting services in digital mode using those channels.

(5) The authorisation of the operation of the transmitter or transmitters concerned for transmitting a datacasting service in digital mode using those channels has no effect unless:
(a) the licensee holds a BSA datacasting licence authorising the provision of that service; or
(b) the service is a designated teletext service.

(6) In this section and section 102A:

*exempt remote area service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

*multi-channelling election* means an election under subclause 6(7B) of Schedule 4 to the *Broadcasting Services Act 1992*.

### 102A Transmitter licences required to be issued under digital conversion schemes

(1) If the ACMA is required, under a scheme in force under clause 6 of Schedule 4 to the *Broadcasting Services Act 1992*, to issue a transmitter licence to a person who holds a commercial television broadcasting licence (the *related licence*), the ACMA must issue to the person a transmitter licence that authorises the operation of one or more specified radiocommunications transmitters for transmitting the broadcasting service or services concerned in digital mode in accordance with the related licence.

(2) If the related licence is transferred, the transmitter licence is taken to be issued to the person to whom the related licence is transferred.

(2A) If:

(a) a transmitter licence (the *first transmitter licence*) is or was issued under this section; and

(b) the first transmitter licence authorises the operation of one or more specified radiocommunications transmitters for transmitting a particular commercial television broadcasting service (the *first service*) in accordance with a commercial television broadcasting licence held by a person (the *first BSA licence*); and

(c) either before or after the issue of the first transmitter licence, another commercial television broadcasting licence (the *additional BSA licence*) is or was allocated to the person under section 38A or 38B of the *Broadcasting Services Act 1992*; and

(d) the first BSA licence and the additional BSA licence relate to the same licence area (within the meaning of whichever of those sections is applicable); and

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(e) the additional BSA licence authorises the provision of one or more other commercial television broadcasting services (the \textit{additional services}); and

(f) the first service and at least one of the additional services are the subject of an election under subclause 6(5A) or (5AA) of Schedule 4 to the \textit{Broadcasting Services Act 1992};

the first transmitter licence is taken to authorise the operation of the transmitter or transmitters concerned for transmitting any of the additional services in accordance with the additional BSA licence.

(2B) The operation of a transmitter or transmitters for transmitting a commercial television broadcasting service in digital mode under a licence allocated under subsection 38B(6), (7), (8) or (9) of the \textit{Broadcasting Services Act 1992} to an existing licensee is, if a multi-channelling election is in force for the relevant exempt remote area service, taken to be authorised by the transmitter licence held by the licensee for the relevant licence area.

(2C) The holder of a transmitter licence issued under this section must surrender the licence if:

(a) a commercial television broadcasting licence is allocated under subsection 38B(5) of the \textit{Broadcasting Services Act 1992}; and

(b) the holder is one of the 2 existing licensees referred to in subsection 38B(1) of that Act; and

(c) a multi-channelling election is made for the relevant exempt remote area service.

(2D) If the ACMA approves the revocation of a multi-channelling election for a licensee of a commercial television broadcasting licence (the \textit{related licence}), the ACMA must issue a new transmitter licence to the licensee that revoked the election authorising the operation of a transmitter or transmitters for transmitting the commercial television broadcasting service or services provided by the licensee in digital mode.

(2E) The new licence comes into force on the day from which the revocation takes effect.

(3) If a transmitter licence is issued under this section, the licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting datacasting services in digital mode using the channel or channels concerned.
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(5) The authorisation of the operation of the transmitter or transmitters concerned for transmitting a datacasting service in digital mode using the channel or channels concerned has no effect unless:
   (a) the licensee holds a BSA datacasting licence authorising the provision of that service; or
   (b) the service is a designated teletext service.

(6) If:
   (a) a transmitter licence issued under this section is in force immediately before the end of the simulcast period, or the simulcast-equivalent period, for a BSA licence area; and
   (b) the licence authorised the operation of one or more radiocommunications transmitters for transmitting one or more commercial television broadcasting services in digital mode in that area;
the licence is cancelled at the end of that period.

(7) In this section:

commercial television broadcasting service means a commercial broadcasting service that provides television programs.

simulcast-equivalent period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

simulcast period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

102AA Transmitter licences—authorisation of HDTV multi-channelled commercial television broadcasting services during the simulcast period etc.

(1) If:
   (a) immediately before 1 January 2007, there was in force a transmitter licence issued under section 102 or 102A; and
   (b) the transmitter licence is held by the licensee of a commercial television broadcasting licence (the related licence); and
   (c) the transmitter licence authorises the operation of one or more specified radiocommunications transmitters for transmitting a commercial television broadcasting service in digital mode using one or more channels; and

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(d) the licensee of the related licence provides, or proposes to
provide, a HDTV multi-channelled commercial television
broadcasting service in accordance with the related licence;
the transmitter licence is also taken to authorise the operation of
the transmitter or transmitters concerned for transmitting the
HDTV multi-channelled commercial television broadcasting
service, using those channels, during whichever of the following
periods is applicable:
(e) the simulcast period for the licence area of the related
licence;
(f) the simulcast-equivalent period for the licence area of the
related licence.

(2) In this section:

commercial television broadcasting licence has the same meaning
commercial television broadcasting service means a commercial
broadcasting service that provides television programs.

HDTV multi-channelled commercial television broadcasting
service has the same meaning as in Schedule 4 to the Broadcasting
simulcast-equivalent period has the same meaning as in
simulcast period has the same meaning as in Schedule 4 to the

102AB Transmitter licence—authorisation of SDTV
multi-channelled commercial television broadcasting
services during so much of the simulcast period etc. as
occurs on or after 1 January 2009

(1) If:
(a) immediately before 1 January 2009, there was in force a
transmitter licence issued under section 102 or 102A; and
(b) the transmitter licence is held by the licensee of a commercial
television broadcasting licence (the related licence); and
(c) the transmitter licence authorises the operation of one or more specified radiocommunications transmitters for transmitting:
   (i) the core commercial television broadcasting service in digital mode; and
   (ii) a HDTV multi-channelled commercial television broadcasting service;
   in accordance with the related licence, using one or more channels; and
(d) the licensee of the related licence provides, or proposes to provide, a SDTV multi-channelled commercial television broadcasting service in accordance with the related licence; the transmitter licence is also taken to authorise the operation of the transmitter or transmitters concerned for transmitting the SDTV multi-channelled commercial television broadcasting service, using those channels, during whichever of the following periods is applicable:
   (e) the simulcast period for the licence area of the related licence;
   (f) the simulcast-equivalent period for the licence area of the related licence.

(2) In this section:

*commercial television broadcasting licence* has the same meaning as in the *Broadcasting Services Act 1992*.

*commercial television broadcasting service* means a commercial broadcasting service that provides television programs.

*core commercial television broadcasting service* has the same meaning as in the *Broadcasting Services Act 1992*.

*HDTV multi-channelled commercial television broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

*SDTV multi-channelled commercial television broadcasting service* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

*simulcast-equivalent period* has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*. 

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simulcast period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

102AC Transmitter licences issued before the end of the simulcast period etc.—authorisation of commercial television broadcasting services after the end of the simulcast period etc.

(1) If:

(a) a transmitter licence issued under section 102 was in force immediately before the end of whichever of the following periods is applicable to the licence area of a commercial television broadcasting licence (the related licence):
   (i) the simulcast period for the licence area;
   (ii) the simulcast-equivalent period for the licence area; and
(b) the transmitter licence is held by the licensee of the related licence; and
(c) immediately before the end of the applicable period, the transmitter licence authorised the operation of one or more radiocommunications transmitters for transmitting one or more commercial television broadcasting services in accordance with the related licence;

then, after the end of the applicable period, the transmitter licence authorises the operation of the transmitter or transmitters concerned for transmitting:

(d) one or more HDTV multi-channelled commercial television broadcasting services; and
(e) one or more SDTV multi-channelled commercial television broadcasting services;

in accordance with the related licence, using:

(f) if a BSA television licence area plan is in force for the licence area—the channel or channels allotted to the licensee of the related licence under the BSA television licence area plan; or
(g) otherwise—the channel or channels allotted to the licensee of the related licence under the commercial television conversion scheme or a digital channel plan.

(2) In this section:
commercial television broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

commercial television broadcasting service means a commercial broadcasting service that provides television programs.

commercial television conversion scheme has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.


HDTV multi-channelled commercial television broadcasting service has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

SDTV multi-channelled commercial television broadcasting service has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

simulcast-equivalent period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

simulcast period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

102AD Transmitter licences issued after the end of the simulcast period etc.—authorised channels

(1) If:

(a) a transmitter licence is issued under section 102 after the end of whichever of the following periods is applicable to the licence area of a commercial television broadcasting licence (the related licence):
   (i) the simulcast period for the licence area;
   (ii) the simulcast-equivalent period for the licence area; and

(b) the transmitter licence is held by the licensee of the related licence; and

(c) the transmitter licence authorises the operation of one or more radiocommunications transmitters for transmitting one or more commercial television broadcasting services in accordance with the related licence;

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the transmitter licence authorises the operation of the transmitter or transmitters concerned for transmitting those services in digital mode in accordance with the related licence, using:

(d) if a BSA television licence area plan is in force for the licence area—the channel or channels allotted to the licensee of the related licence under the BSA television licence area plan; or

(e) otherwise—the channel or channels allotted to the licensee of the related licence under the commercial television conversion scheme or a digital channel plan.

(2) In this section:

commercial television broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

commercial television broadcasting service means a commercial broadcasting service that provides television programs.

commercial television conversion scheme has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.


102AG Transmitter licences—re-transmission of commercial television broadcasting services to be in digital mode

(1) The ACMA must not issue a transmitter licence to a self-help provider that authorises the operation of one or more specified radiocommunications transmitters for re-transmitting in analog mode the programs transmitted by a commercial television broadcasting licensee in the licence area of the commercial television broadcasting licence.

(2) Subsection (1) does not apply to the issue of a transmitter licence if the ACMA issues the transmitter licence:

(a) by way of renewal; and

(b) during the simulcast period, or simulcast-equivalent period, for the licence area mentioned in subsection (1).

(3) In this section:
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**analog mode** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**commercial television broadcasting licence** has the same meaning as in the *Broadcasting Services Act 1992*.

**self-help provider** has the meaning given by section 212A of the *Broadcasting Services Act 1992*.

**simulcast-equivalent period** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

**simulcast period** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*.

102AH  Cancellation of transmitter licences—re-transmission of commercial television broadcasting services

**Scope**

(1) This section applies if:
   (a) a transmitter licence (the **analog transmitter licence**) is in force; and
   (b) the analog transmitter licence is held by a self-help provider; and
   (c) the analog transmitter licence authorises the operation of one or more specified radiocommunications transmitters for re-transmitting in analog mode the programs transmitted by a commercial television broadcasting licensee in the licence area of the commercial television broadcasting licence.

**Cancellation of transmitter licence**

(2) The analog transmitter licence is cancelled at the end of the simulcast period, or the simulcast-equivalent period, for the licence area of the commercial television broadcasting licence.

**Definitions**

(3) In this section:

   **analog mode** has the same meaning as in Schedule 4 to the *Broadcasting Services Act 1992*. 

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commercial television broadcasting licence has the same meaning as in the Broadcasting Services Act 1992.

self-help provider has the meaning given by section 212A of the Broadcasting Services Act 1992.

simulcast-equivalent period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

simulcast period has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

102B Datacasting transmitter licences

The ACMA must not issue a datacasting transmitter licence to a person unless:
(a) the person is a qualified company; and
(b) if the issue of the licence is not under a price-based allocation system determined under section 106—the ACMA is satisfied that the issue of the licence would not result in a breach of any of the BSA control rules.

102C Category 1 digital radio multiplex transmitter licences

(1) The ACMA must not issue a category 1 digital radio multiplex transmitter licence to a person unless the person is a qualified company.

(2) The ACMA must not issue a foundation category 1 digital radio multiplex transmitter licence for a particular designated BSA radio area otherwise than in accordance with a price-based allocation system determined under section 106 unless:
(a) the licensee is an eligible joint venture company; and
(b) the application for the licence is accompanied by the fee determined by the ACMA by legislative instrument.

(3) The ACMA must not issue a foundation category 1 digital radio multiplex transmitter licence for a particular designated BSA radio area in accordance with a price-based allocation system determined under section 106 unless:
(a) the ACMA has, by notice published on its website at least 150 days before the issue of the licence, invited applications from eligible joint venture companies for the issue of the
licences otherwise than in accordance with a price-based allocation system determined under section 106; and

(b) either:

(i) no applications were received from eligible joint venture companies after the publication of the notice; or

(ii) one or more applications were received from eligible joint venture companies after the publication of the notice, but the ACMA refused, under section 100, to issue the licence to any of the applicants.

(4) The ACMA must not issue a category 1 digital radio multiplex transmitter licence (other than a foundation category 1 digital radio multiplex transmitter licence) for a particular designated BSA radio area otherwise than in accordance with a price-based allocation system determined under section 106.

Eligible joint venture company

(5) For the purposes of the application of this section to a particular designated BSA radio area, a company is an eligible joint venture company if:

(a) before the company was formed, the promoters of the company initially invited:

(i) each incumbent digital commercial radio broadcasting licensee for the designated BSA radio area; and

(ii) if there is a digital community radio broadcasting representative company for the designated BSA radio area—the digital community radio broadcasting representative company;

(b) to subscribe for shares in the first-mentioned company on the basis that:

(iii) the incumbent digital commercial radio broadcasting licensees who accepted the invitation would be issued with an equal number of shares; and

(iv) the only persons entitled to subscribe for shares in the first-mentioned company are the incumbent digital commercial radio broadcasting licensees and the digital community radio broadcasting representative company; and

(v) assuming that the invitation were to be accepted by each invitee—the incumbent digital commercial radio
broadcasting licensees would, in aggregate, hold
seven-ninths of the shares in the first-mentioned
comppany; and
(vi) assuming that the invitation were to be accepted by each
invitee—the digital community radio broadcasting
representative company would hold two-ninths of the
shares in the first-mentioned company; and
(b) in a case where not all of the invitations referred to in
paragraph (a) were accepted—before the company was
formed, the promoters of the first-mentioned company
invited each person who had accepted an invitation referred
to in paragraph (a) to subscribe for the remaining shares in
the first-mentioned company; and
(c) the invitations referred to in paragraph (a) were:
(i) published on the ACMA’s website; and
(ii) open for a period of at least 120 days beginning on or
after the commencement of this section; and
(d) there was no discrimination between subscribers for shares in
the first-mentioned company in relation to the consideration
payable for the issue of the shares concerned; and
(e) the total amount of money payable as consideration for the
issue of the shares in the first-mentioned company is not
substantially in excess of the total amount that, as at the time
the invitations referred to in paragraph (a) are published,
would be required for the commercially viable operation of
the first-mentioned company if it were assumed that a
foundation category 1 digital radio multiplex transmitter
licence had been issued to the first-mentioned company at
that time; and
(f) none of the recipients of an invitation referred to in
paragraph (a) or (b) were subject to duress as to whether the
invitation should be accepted.

(6) The promoters of a company may request the ACMA to publish on
its website the invitations referred to in paragraph (5)(a).

(7) The ACMA must comply with a request under subsection (6) if the
ACMA is satisfied that the request was made in good faith.
Fee

(8) A fee determined under paragraph (2)(b) must not be such as to amount to taxation.

102D Category 2 digital radio multiplex transmitter licences

(1) The ACMA must not issue a category 2 digital radio multiplex transmitter licence to a person unless the person is a qualified company.

(2) The ACMA must not issue a foundation category 2 digital radio multiplex transmitter licence for a particular designated BSA radio area otherwise than in accordance with a price-based allocation system determined under section 106 unless:
   (a) the licensee is an eligible joint venture company; and
   (b) the application for the licence is accompanied by the fee determined by the ACMA by legislative instrument.

(3) The ACMA must not issue a foundation category 2 digital radio multiplex transmitter licence for a particular designated BSA radio area in accordance with a price-based allocation system determined under section 106 unless:
   (a) the ACMA has, by notice published on its website at least 150 days before the issue of the licence, invited applications from eligible joint venture companies for the issue of the licence otherwise than in accordance with a price-based allocation system determined under section 106; and
   (b) either:
      (i) no applications were received from eligible joint venture companies after the publication of the notice; or
      (ii) one or more applications were received from eligible joint venture companies after the publication of the notice, but the ACMA refused, under section 100, to issue the licence to any of the applicants.

(4) The ACMA must not issue a category 2 digital radio multiplex transmitter licence (other than a foundation category 2 digital radio multiplex transmitter licence) for a particular designated BSA radio area otherwise than in accordance with a price-based allocation system determined under section 106.
Eligible joint venture company

(5) For the purposes of the application of this section to a particular designated BSA radio area, a company is an *eligible joint venture company* if:

(a) before the company was formed, the promoters of the company initially invited:
   (i) each incumbent digital commercial radio broadcasting licensee for the designated BSA radio area; and
   (ii) if there is a digital community radio broadcasting representative company for the designated BSA radio area—the digital community radio broadcasting representative company; and
   (iii) each national broadcaster;

to subscribe for shares in the first-mentioned company on the basis that:

(iv) the incumbent digital commercial radio broadcasting licensees who accepted the invitation would be issued with an equal number of shares; and

(v) the only persons entitled to subscribe for shares in the first-mentioned company are the incumbent digital commercial radio broadcasting licensees, the digital community radio broadcasting representative company and the national broadcasters; and

(vi) assuming that the invitation were to be accepted by each invitee—the incumbent digital commercial radio broadcasting licensees would, in aggregate, hold five-ninths of the shares in the first-mentioned company; and

(vii) assuming that the invitation were to be accepted by each invitee—the digital community radio broadcasting representative company would hold two-ninths of the shares in the first-mentioned company; and

(viii) assuming that the invitation were to be accepted by each invitee—each national broadcaster would hold one-ninth of the shares in the first-mentioned company; and

(b) in a case where not all of the invitations referred to in paragraph (a) were accepted—before the company was formed, the promoters of the first-mentioned company invited each person who had accepted an invitation referred
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to in paragraph (a) to subscribe for the remaining shares in
the first-mentioned company; and
(c) the invitations referred to in paragraph (a) were:
   (i) published on the ACMA’s website; and
   (ii) open for a period of at least 120 days beginning on or
        after the commencement of this section; and
(d) there was no discrimination between subscribers for shares in
the first-mentioned company in relation to the consideration
payable for the issue of the shares concerned; and
(e) the total amount of money payable as consideration for the
issue of the shares in the first-mentioned company is not
substantially in excess of the total amount that, as at the time
the invitations referred to in paragraph (a) are published,
would be required for the commercially viable operation of
the first-mentioned company if it were assumed that a
foundation category 2 digital radio multiplex transmitter
licence had been issued to the first-mentioned company at
that time; and
(f) none of the recipients of an invitation referred to in
paragraph (a) or (b) were subject to duress as to whether the
invitation should be accepted.

(6) The promoters of a company may request the ACMA to publish on
its website the invitations referred to in paragraph (5)(a).

(7) The ACMA must comply with a request under subsection (6) if the
ACMA is satisfied that the request was made in good faith.

National broadcasters

(8) A national broadcaster may hold shares in a company that:
   (a) is the holder of a category 2 digital radio multiplex
       transmitter licence; or
   (b) is an applicant for the issue of a category 2 digital radio
       multiplex transmitter licence; or
   (c) proposes to apply for the issue of a category 2 digital radio
       multiplex transmitter licence.

Fee

(9) A fee determined under paragraph (2)(b) must not be such as to
amount to taxation.
102E Category 3 digital radio multiplex transmitter licences

Holder of a category 3 digital radio multiplex licence

(1) The ACMA must not issue a category 3 digital radio multiplex transmitter licence to a person unless the person is a qualified company, and:
   (a) both:
       (i) each national broadcaster beneficially owns shares in the company; and
       (ii) there are no other beneficial owners of shares in the company; or
   (b) both:
       (i) a single national broadcaster beneficially owns all the shares in the company; and
       (ii) the other national broadcaster has consented to that beneficial ownership.

Obligation to issue a category 3 digital radio multiplex licence

(2) If:
   (a) a digital radio channel plan is in force for a designated BSA radio area; and
   (b) a qualified company applies under section 99 for a category 3 digital radio multiplex transmitter licence for the designated BSA radio area; and
   (c) the requirements of paragraph (1)(a) or (b) of this section are satisfied in relation to the qualified company;
   the ACMA must, under section 100, issue the category 3 digital radio multiplex transmitter licence to the company unless there is already a category 3 digital radio multiplex transmitter licence for the designated BSA radio area.

National broadcaster may hold shares in the holder of a category 3 digital radio multiplex licence etc.

(3) A national broadcaster may hold shares in a company that:
   (a) is the holder of a category 3 digital radio multiplex transmitter licence; or
   (b) is an applicant for the issue of a category 3 digital radio multiplex transmitter licence; or
(c) proposes to apply for the issue of a category 3 digital radio multiplex transmitter licence.

102F Limit on issue of non-foundation digital radio multiplex transmitter licences

(1) Before issuing a non-foundation digital radio multiplex transmitter licence for a particular designated BSA radio area, the ACMA must ensure that:
   (a) one or more foundation digital radio multiplex transmitter licences are in force for the designated BSA radio area; and
   (b) the total multiplex capacities under those foundation digital radio multiplex transmitter licences is sufficient to fulfil the number of standard access entitlements that have come into existence, or are likely to come into existence, under subsection 118NQ(2) in its application to the designated BSA radio area.

(2) For the purposes of subsection (1), if the number of standard access entitlements that have come into existence, or are likely to come into existence, under subsection 118NQ(2) in its application to the designated BSA radio area is not a multiple of 7, round up that number to the next higher number that is a multiple of 7.

103 Duration of apparatus licences

(1) An apparatus licence (other than an apparatus licence issued under subsection 101C(3), 102(2D), 102(2G) or 102A(2D)) comes into force on the day on which it is issued or on such later day as is specified in the licence for the purpose.

(2) Subject to Division 6, an apparatus licence (other than an apparatus licence issued under section 101A, 101B, 101C, 102 or 102A, a datacasting transmitter licence or a digital radio multiplex transmitter licence) remains in force for the period specified in the licence.

(3) The licence may specify any period not exceeding 5 years.

(4) A transmitter licence issued under section 101A:
   (a) subject to paragraph (b), continues in force while the related licence referred to in that section remains in force; and
(b) does not have effect while the related licence referred to in that section is suspended.

(4AA) A transmitter licence issued under section 101B:
(a) subject to paragraph (b), continues in force while the related licence referred to in that section remains in force; and
(b) does not have effect while the related licence referred to in that section is suspended.

(4AB) A transmitter licence issued under section 101C:
(a) subject to paragraph (b), continues in force while the related licence referred to in that section remains in force; and
(b) does not have effect while the related licence referred to in that section is suspended.

(4A) A transmitter licence issued under subsection 102(1):
(a) subject to paragraphs (b) and (c), continues in force while the related licence referred to in that subsection remains in force; and
(b) does not have effect while the related licence referred to in that subsection is suspended; and
(c) does not have effect after the later of the following dates, if the related licence is a CTV licence within the meaning of the Broadcasting Services Act 1992:
(i) 31 December 2006; or
(ii) the date specified in a written determination by the Minister.

(4B) A determination under subparagraph (4A)(c)(ii) is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

(4C) A transmitter licence issued under subsection 102(2D):
(a) subject to paragraph (b), continues in force while the related licence referred to in that subsection remains in force; and
(b) does not have effect while the related licence referred to in that subsection is suspended.

(4D) A transmitter licence issued under subsection 102(2G):
(a) subject to paragraph (b), continues in force while the related licence referred to in that subsection remains in force; and
(b) does not have effect while the related licence referred to in that subsection is suspended.

(4E) A transmitter licence issued under subsection 102A(1):
(a) subject to paragraph (b), continues in force while the related licence referred to in that subsection remains in force; and
(b) does not have effect while the related licence referred to in that subsection is suspended.

(4F) A transmitter licence issued under subsection 102A(2D):
(a) subject to paragraph (b), continues in force while the related licence referred to in that subsection remains in force; and
(b) does not have effect while the related licence referred to in that subsection is suspended.

(5) Subject to Divisions 6 and 6A, a datacasting transmitter licence remains in force for 10 years.

(6) Subject to Division 6, a digital radio multiplex transmitter licence remains in force for 15 years.

104 Compliance with plans

(1) Subject to subsections (2) and (3), the ACMA may issue an apparatus licence that is inconsistent with the spectrum plan or any relevant frequency band plan only if:
(a) the apparatus licence is granted for purposes which relate to an event of international, national or regional significance; or
(b) the issue of the apparatus licence is otherwise in the public interest; or
(c) the apparatus licence authorises a body covered by any of paragraphs 27(1)(b) to (be) to operate specified radiocommunications devices, or radiocommunications devices of a specified kind, for the purpose of investigations or operations conducted by the body.

(2) An apparatus licence of a kind mentioned in paragraph (1)(a) or (b) must not be issued for more than 30 days.

(3) An apparatus licence of a kind mentioned in paragraph (1)(a) or (b) must not be renewed under section 130 more than once.
105 Parts of the spectrum allocated for spectrum licences

(1) Subject to subsection (2), the ACMA must not issue an apparatus licence that authorises the operation of radiocommunications devices at frequencies that are within a part of the spectrum that is designated under section 36 to be allocated by issuing spectrum licences.

(2) The ACMA may issue such an apparatus licence:
   (a) to a body covered by any of paragraphs 27(1)(b) to (be) for the purpose of investigations or operations conducted by the body; or
   (b) if it is satisfied that the special circumstances of the particular case justify the issuing of the licence.

106 Price-based allocation system for certain transmitter licences

(1) The ACMA may determine in writing a price-based allocation system for allocating and/or issuing specified transmitter licences (other than licences issued under section 101A or NBS transmitter licences).

(2) A system so determined:
   (a) may apply generally or in respect of a particular area; and
   (b) may apply only in relation to a specified range of frequencies; and
   (c) may require payment of an application fee, but not a fee that would be such as to amount to taxation.

(3) A system so determined may:
   (a) impose limits on the number of transmitter licences that the ACMA may issue to:
      (i) any one person; or
      (ii) a specified person; or
   (b) impose limits on the number of transmitter licences that the ACMA may, in total, issue to the members of a specified group of persons.

Note: Persons or groups may be specified by name, by inclusion in a specified class or in any other way.
(4) A limit imposed as mentioned in subsection (3) may be expressed
to apply in relation to any or all of the following:
   (a) a specified part of the spectrum;
   (b) a specified area;
   (c) a specified population reach.
   For example, a system might impose a limit of one transmitter
   licence per person in the band between 1800 MHz and 1900 MHz
   (inclusive) for a particular area. This subsection does not, by
   implication, limit subsection (3).

(5) A system so determined may provide that, if the issue of a licence
is covered by section 153M (which deals with re-allocation of
spectrum), the ACMA may defer the issue of the licence until the
relevant frequencies become available as a result of the expiry,
surrender or cancellation of one or more other apparatus licences
that, under section 153D, are affected by the spectrum re-allocation
declaration concerned.

(5A) A system so determined must provide that a person is not eligible
to apply for a channel A datacasting transmitter licence unless the
person meets specified requirements.

(6) A system so determined may require the ACMA to give specified
information to the ACCC.

(6A) The ACMA must not issue a datacasting transmitter licence under
a system so determined if the ACMA is satisfied that the issue of
the licence would result in a breach of one or more of the BSA
control rules.

(7) Subsections (2), (3), (4), (5), (5A), (6) and (6A) do not, by
implication, limit subsection (1).

(8) The ACMA must not determine a system imposing a limit as
mentioned in subsection (3) unless the ACMA is directed to do so
by the Minister under subsection (9).

(9) The Minister may give written directions to the ACMA in relation
to the exercise of the power to determine procedures imposing a
limit as mentioned in subsection (3).

(9A) The Minister may give written directions to the ACMA in relation
to the exercise of the power conferred by subsection (5A).
(10) A direction under subsection (9) or (9A) must be published in the *Gazette*.

(11) The ACMA must exercise its powers under subsection (1) in a manner consistent with directions given by the Minister under subsection (9) or (9A).

(12) Before determining a price-based allocation system under subsection (1), the ACMA must consult the ACCC about whether the procedures should include a requirement mentioned in subsection (6) and, if so, the nature of the requirement.

(13) If a transmitter licence is issued under a system so determined, the ACMA must publish in the *Gazette*:
   (a) the successful applicant’s name; and
   (b) the amount that the applicant agreed to pay to the Commonwealth for issue of the licence.

(14) If:
   (a) a transmitter licence of a kind specified for the purposes of subsection (1) would authorise a person to operate a radiocommunications transmitter; and
   (b) this Act or any other law requires that a person operating a transmitter:
       (i) of that kind; or
       (ii) for a purpose for which the transmitter is to be used;
       be within a specified class of persons;
the Minister may give the ACMA a written direction requiring the ACMA, in determining a price-based allocation system, to limit the persons eligible to apply for such a transmitter licence to:
   (c) persons within that specified class; or
   (d) persons not within, but eligible to be within, that class; or
   (e) persons within that class and persons not within, but eligible to be within, that class.

(15) The ACMA must comply with a direction under subsection (14).

(16) A direction under subsection (14) is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*. 

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(17) Subsections (9) and (14) do not, by implication, limit the Minister’s power to give directions otherwise than under those subsections.

106A  Issue of apparatus licence is to be treated as acquisition of asset of a person for the purposes of section 50 of the Competition and Consumer Act

(1) For the purposes of section 50 and subsections 81(1), 88(9), 89(5A) and 90(9) of the *Competition and Consumer Act 2010*, the issue of an apparatus licence to a person is taken to be an acquisition by the person of an asset of another person.

(2) Subsection (1) does not apply to a transmitter licence issued under section 101B, 101C, 102 or 102A or to an NBS transmitter licence.

(3) Subsection (1) does not apply to the issue of an apparatus licence if the licence is issued by way of renewal of an existing apparatus licence (see Division 7).
Division 3—Conditions of apparatus licences

107 General conditions

(1) An apparatus licence is subject to the following conditions:

(a) a condition that the licensee, and any person authorised by
    the licensee to operate a radiocommunications device under
    the licence, must comply with this Act;

(b) a condition that the licensee inform each person so authorised
    of the person’s obligations to comply with this Act and the
    conditions of the licence;

(c) a condition that the licensee meet all obligations (if any) of
    the licensee to pay:

    (i) charges fixed by determinations under section 60 of the
        Australian Communications and Media Authority Act
        2005; and

    (ii) amounts of apparatus licence tax;

(d) a condition that any radiocommunications device operated
    under the licence must comply with all the standards
    applicable to it;

(f) such conditions (if any) as the ACMA may determine, by
    written instrument, in relation to that particular type of
    apparatus licence;

(g) such other conditions as are specified in the licence.

(2) Paragraphs (1)(a), (b), (c) and (d) do not limit the kinds of
    conditions that may be specified under paragraph (1)(f) or (g) or
    imposed under paragraph 111(1)(a).

Note: Inclusion of conditions under paragraph (1)(g) is a reviewable
decision under Part 5.6.

(3) This section does not apply to:

(a) transmitter licences issued under section 101A, 101B, 101C,
    102 or 102A; or

(b) datacasting transmitter licences; or

(c) digital radio multiplex transmitter licences.

(4) A determination is a disallowable instrument for the purposes of
    section 46A of the Acts Interpretation Act 1901.
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(5) If the issue of an apparatus licence is covered by section 153M (which deals with re-allocation of spectrum), a condition of the licence may provide for the progressive authorisation of the operation of the radiocommunications device under the licence. The progressivity is to be based on the times when a particular part or parts of the spectrum become available as a result of the expiry, surrender or cancellation of one or more other apparatus licences that, under section 153D, are affected by the spectrum re-allocation declaration concerned.

(6) Subsection (5) does not, by implication, limit anything in subsection (1).

108 Additional conditions for transmitter licences

(1) A transmitter licence is subject to the additional conditions set out in subsection (2) relating to the operation of any radiocommunications transmitter under the licence by the licensee, or by any person authorised by the licensee to operate a radiocommunications transmitter under the licence.

(2) The licensee, and any person so authorised:

(a) must not operate, or permit operation of, the transmitter for a purpose that is inconsistent with a purpose of a kind specified in the appropriate frequency band plan (if any) under subsection 32(4); and

(b) must not operate, or permit operation of, the transmitter except in accordance with any conditions specified in the licence that relate to:

(i) containment of interference, or of the likelihood of interference, to radiocommunications; or

(ii) transmission of an identification signal; and

(c) must not operate, or permit operation of, the transmitter except on a frequency or frequencies, or on a frequency channel, and at a constancy, specified in the licence; and

(d) must not operate, or permit operation of, the transmitter:

(i) in a way that would be likely to cause reasonable persons, justifiably in all the circumstances, to be seriously alarmed or seriously affronted; or

(ii) for the purpose of harassing a person; and
(da) must not operate, or permit operation of, the transmitter for transmitting an international broadcasting service unless there is in force an international broadcasting licence authorising the provision of that service; and

(e) if the licence is a licence in respect of which persons operating the transmitter are required under section 119 to be qualified operators in relation to the licence—must not operate the transmitter unless he or she is such a qualified operator; and

(f) must comply with subsection 269A(2) of the *Navigation Act 1912*; and

(g) must comply with any direction:
   (i) that relates to operation of the transmitter; and
   (ii) to which subsection (3) applies.

(3) This subsection applies to a direction that:

(a) is given, in a way not inconsistent with any relevant guidelines under section 112, either orally or in writing; and

(b) is given by:
   (i) a member of the Australian Federal Police; or
   (ii) a member of the police force of a State or Territory; or
   (iii) an officer of the Defence Force; or
   (iv) an officer of the Australian Coastal Surveillance Centre; or
   (v) an officer who is included in a class of officers specified in the regulations, and who is an officer of an organisation specified in the regulations the sole or principal purpose of which is to deal with natural disasters; and

(c) is reasonably necessary for the purposes of:
   (i) securing the safety of a vessel, aircraft or space object that is in danger; or
   (ii) dealing with an emergency involving a serious threat to the environment; or
   (iii) dealing with an emergency involving risk of death of, or injury to, persons; or
   (iv) dealing with an emergency involving risk of substantial loss of, or substantial damage to, property.
Chapter 3  Licensing of radiocommunications
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Division 3  Conditions of apparatus licences

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(4) This section does not limit the kinds of conditions that may be specified under paragraph 107(1)(f) or (g) or imposed under paragraph 111(1)(a).

(5) This section does not apply to:
(a) transmitter licences issued under section 101A, 101B, 101C, 102 or 102A; or
(b) datacasting transmitter licences; or
(c) digital radio multiplex transmitter licences.

108A  Conditions of transmitter licences for temporary community broadcasters

(1) A transmitter licence issued under section 101A is subject to the following conditions:
(a) a condition that the licensee must comply with this Act;
(b) a condition that the licensee meet all obligations (if any) of the licensee to pay:
   (i) charges fixed by determinations under section 293; and
   (ii) amounts of apparatus licence tax;
(c) a condition that the licensee inform each person authorised by the licensee to operate a radiocommunications transmitter under the licence of the person’s obligations to comply with this Act and the conditions of the licence;
(d) a condition that the licensee, and any person so authorised, must comply with guidelines developed by the ACMA under section 33 of the Broadcasting Services Act 1992;
(e) such conditions (if any) as the ACMA determines, by written instrument, in relation to licences issued under section 101A;
(f) such other conditions as are specified in the licence.

Note: Inclusion of conditions under paragraph (1)(f) is a reviewable decision under Part 5.6.

(2) The conditions of the licence, including any further conditions imposed under paragraph 111(1)(a), must not be inconsistent with the related licence as referred to in section 101A.

(3) A determination under paragraph (1)(e) is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

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109 Conditions of transmitter licences for certain broadcasting services

(1) A transmitter licence issued under section 101B, 101C, 102 or 102A is subject to the following conditions:

(a) a condition that the licensee must comply with this Act;

(b) a condition that the licensee meet all obligations (if any) of the licensee to pay:

(i) charges fixed by determinations under section 60 of the Australian Communications and Media Authority Act 2005; and

(ii) amounts of apparatus licence tax;

(c) a condition that the licensee inform each person authorised by the licensee to operate a radiocommunications transmitter under the licence of the person’s obligations to comply with this Act and the conditions of the licence;

(d) if subsection 26(1) of the Broadcasting Services Act 1992 applies—a condition that the licensee, and any person so authorised, must not operate, or permit operation of, such a transmitter otherwise than in accordance with any relevant technical specifications determined by the ACMA under that subsection;

(da) if a BSA television licence area plan is applicable to the transmission of one or more television broadcasting services under the authority of the licence—a condition that the licensee, and any person so authorised, must not operate, or permit operation of, such a transmitter otherwise than in accordance with any relevant technical specifications determined under the plan;

(e) a condition that the licensee, and any person so authorised, must comply with guidelines developed by the ACMA under section 33 of the Broadcasting Services Act 1992;

(f) such other conditions as are specified in the licence.

(1A) The conditions of a licence issued under section 101B, including any further conditions imposed under paragraph 111(1)(a), must not be inconsistent with the commercial television broadcasting licence referred to in section 101B.

(1B) The conditions of a licence issued under section 101C, including any further conditions imposed under paragraph 111(1)(a), must
not be inconsistent with the commercial television broadcasting licence referred to in section 101C.

(2) The conditions of a licence issued under section 102 or 102A, including any further conditions imposed under paragraph 111(1)(a), must not be inconsistent with the related licence as referred to in section 102 or 102A.

Note: Inclusion of conditions under paragraph (1)(f) is a reviewable decision under Part 5.6.

(3) In this section:

*television broadcasting service* has the same meaning as in section 26 of the *Broadcasting Services Act 1992*.

109A Conditions of datacasting transmitter licences

(1) A datacasting transmitter licence is subject to the following conditions:

(a) a condition that the licensee must comply with this Act;

(b) a condition that the licensee meet all obligations (if any) of the licensee to pay:

(i) charges fixed by determinations under section 60 of the *Australian Communications and Media Authority Act 2005*; and

(ii) amounts of apparatus licence tax;

(ba) if the licence is a channel A datacasting transmitter licence—a condition that the licensee will meet all obligations of the licensee to pay amounts of datacasting transmitter licence fee;

(bb) if the licence is a channel A datacasting transmitter licence—a condition that the licensee will comply with the requirements of section 205BA of the *Broadcasting Services Act 1992*;

(c) a condition that the licensee inform each person authorised by the licensee to operate a radiocommunications transmitter under the licence of the person’s obligations to comply with this Act and the conditions of the licence;

(d) a condition that the licensee, and any person so authorised, must not operate, or permit operation of, the transmitter except on a frequency or frequencies, or on a frequency channel, and at a constancy, specified in the licence;
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(e) a condition that the licensee, and any person so authorised, must not operate, or permit operation of, such a transmitter except within:

(i) a part of the spectrum covered by a determination under subsection 34(3) of the *Broadcasting Services Act 1992*; or

(ii) a part of the spectrum covered by a determination under subsection 34(1) of the *Broadcasting Services Act 1992* because of paragraph 34(1)(fa) of that Act;

(f) a condition that the licensee, and any person so authorised, must comply with guidelines developed by the ACMA under section 33 of the *Broadcasting Services Act 1992*;

(g) if the licence is neither a channel A datacasting transmitter licence nor a channel B datacasting transmitter licence—a condition that the licensee, or a person so authorised, will commence to transmit a datacasting service within 1 year after the allocation of the licence or within such longer period as is notified in writing by the ACMA;

(ga) if the licence is a channel B datacasting transmitter licence—a condition that the licensee, or a person so authorised, will commence to transmit a datacasting service within 18 months after the allocation of the licence or within such longer period as is notified in writing by the ACMA;

(gb) a condition that the licensee, or a person so authorised, will comply with any standards under section 130A of the *Broadcasting Services Act 1992* (which deals with technical standards for digital transmission);

(gc) a condition that the licensee, or a person so authorised, will comply with subsection 130V(1) of the *Broadcasting Services Act 1992* (which deals with industry standards);

(i) a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, such a transmitter on or after 1 January 2007 for transmitting a datacasting service unless:

(i) there is in force a BSA datacasting licence, or another licence allocated by the ACMA under the *Broadcasting Services Act 1992*, authorising the provision of that service; or

(ii) that service is provided in accordance with a class licence under the *Broadcasting Services Act 1992*; or
(iii) that service is a BSA exempt re-transmission service;

(ia) if the licence is a channel A datacasting transmitter licence—
a condition that the licensee, and any person so authorised,
must not operate, or permit the operation of, such a
transmitter for transmitting a datacasting service unless:
   (i) the service is provided under, and in accordance with
       the conditions of, a BSA datacasting licence, and the
       service is capable of being received by a domestic
digital television receiver; or
   (ii) the service is an open narrowcasting television service
       that is capable of being received by a domestic digital
       television receiver; or
   (iii) the service is a community television broadcasting
       service that is capable of being received by a domestic
digital television receiver;

(ib) if the licence is a channel B datacasting transmitter licence—
a condition that the licensee, and any person so authorised,
must not operate, or permit the operation of, such a
transmitter for transmitting a datacasting service if the
datacasting service is:
   (i) a commercial broadcasting service; or
   (ii) a subscription television broadcasting service that is
       capable of being received by a domestic digital
television receiver;

(ic) if the licence is a channel B datacasting transmitter licence—
a condition that the licensee, and any person so authorised,
must not operate, or permit the operation of, such a
transmitter for transmitting a datacasting service if the
licensee or the person so authorised is:
   (i) a company that holds a commercial television
       broadcasting licence; or
   (ii) a person who is in a position to exercise control of a
       commercial television broadcasting licence; or
   (iii) a company, where a person is in a position to exercise
       control of the company and a commercial television
       broadcasting licence; or
   (iv) a national broadcaster; or
   (v) a company, where a national broadcaster is in a position
to exercise control of the company;
and the datacasting service is capable of being received by a domestic digital television receiver;

(id) if the licence is a channel B datacasting transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, such a transmitter for transmitting a datacasting service provided under a BSA datacasting licence if the holder of the BSA datacasting licence is:

(i) a company that holds a commercial television broadcasting licence; or

(ii) a person who is in a position to exercise control of a commercial television broadcasting licence; or

(iii) a company, where a person is in a position to exercise control of the company and a commercial television broadcasting licence; or

(iv) a national broadcaster; or

(v) a company, where a national broadcaster is in a position to exercise control of the company;

and the datacasting service is capable of being received by a domestic digital television receiver;

(ie) if the licence is a channel B datacasting transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, such a transmitter for transmitting a datacasting service if:

(i) the service is a BSA exempt re-transmission service; and

(ii) the service is capable of being received by a domestic digital television receiver;

(if) if the licence is a channel A datacasting transmitter licence or a channel B datacasting transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, such a transmitter for transmitting a datacasting service unless that service is transmitted in digital mode (within the meaning of Schedule 4 to the Broadcasting Services Act 1992);

(jj) if the licence is a channel B datacasting transmitter licence—a condition that the licensee, and any person so authorised, will comply with an access undertaking in force under Division 4A in relation to the licence;
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(j) a condition that the licensee, and any person so authorised, will at all times have a constitution;
(k) such other conditions as are specified in the licence.

(1A) The ACMA must not notify a longer period for the purposes of paragraph (1)(g) or (ga) unless the ACMA is satisfied that there are exceptional circumstances that warrant the longer period.

(1B) For the purposes of subparagraph (1)(ib)(ii), it is immaterial whether a domestic digital television receiver is capable of receiving subscription television broadcasting services when used:
(a) in isolation; or
(b) in conjunction with any other equipment.

(1C) A condition specified in a licence under paragraph (1)(k) may deal with the commencement or continuity of transmission of datacasting services.

(1D) Subsection (1C) does not limit paragraph (1)(k).

(1E) Paragraphs (1)(g) and (ga) do not limit subsection (1C).

Constitution of licensee to contain certain provisions

(2) A datacasting transmitter licence is subject to the condition that the licensee’s constitution will at all times contain provisions under which:
(a) a person is not eligible to continue to be the holder of shares in the licensee if, because of holding those shares and of any other relevant circumstances, that or some other person would contravene Part 5 of the Broadcasting Services Act 1992; and
(b) the licensee may secure the disposal of shares held by a person to the extent necessary to prevent a contravention of Part 5 of the Broadcasting Services Act 1992 continuing; and
(c) a person who becomes the holder of shares in the licensee is required to provide to the licensee a statutory declaration:
   (i) stating whether the shares are held by the person beneficially and, if not, who has beneficial interests in the shares; and
   (ii) stating whether the person, or any person who has a beneficial interest in the shares, is in a position to
exercise control of a commercial television broadcasting licence, and giving particulars of any such position; and

(d) a person holding shares in the licensee may be required by the licensee, from time to time, to provide to the licensee statutory declarations concerning matters relevant to the person’s eligibility to continue to be the holder of those shares having regard to the provisions of Part 5 of the Broadcasting Services Act 1992; and

(e) the licensee may secure the disposal of shares held by a person who refuses or fails to provide a statutory declaration under the provisions referred to in paragraph (c) or (d).

Constitution of authorised company to contain certain provisions

(3) A datacasting transmitter licence is subject to the condition that the constitution of a company authorised by the licensee to operate a radiocommunications transmitter under the licence will at all times contain provisions under which:

(a) a person is not eligible to continue to be the holder of shares in the company if, because of holding those shares and of any other relevant circumstances, that or some other person would contravene Part 5 of the Broadcasting Services Act 1992; and

(b) the company may secure the disposal of shares held by a person to the extent necessary to prevent a contravention of Part 5 of the Broadcasting Services Act 1992 continuing; and

(c) a person who becomes the holder of shares in the company is required to provide to the company a statutory declaration:

(i) stating whether the shares are held by the person beneficially and, if not, who has beneficial interests in the shares; and

(ii) stating whether the person, or any person who has a beneficial interest in the shares, is in a position to exercise control of a commercial television broadcasting licence, and giving particulars of any such position; and

(d) a person holding shares in the company may be required by the company, from time to time, to provide to the company statutory declarations concerning matters relevant to the person’s eligibility to continue to be the holder of those shares having regard to the provisions of Part 5 of the Broadcasting Services Act 1992; and
(e) the company may secure the disposal of shares held by a person who refuses or fails to provide a statutory declaration under the provisions referred to in paragraph (c) or (d).

Application of control rules

(4) Schedule 1 to the Broadcasting Services Act 1992 applies for the purposes of subparagraphs (1)(ic)(ii), (iii) and (v), (1)(id)(ii), (iii) and (v), (2)(c)(ii) and (3)(c)(ii) of this section in a corresponding way to the way in which it applies for the purposes of Part 5 of that Act.

(5) Subsections (2) and (3) do not apply to a channel B datacasting transmitter licence unless the relevant transmitter, or any of the relevant transmitters, is operated for transmitting a datacasting service that is capable of being received by a domestic digital television receiver.

Ministerial directions

(6) The Minister may give the ACMA a written direction about the exercise of the power conferred by paragraph (1)(k) to specify conditions in a channel A datacasting transmitter licence.

109B Conditions of digital radio multiplex transmitter licences—general

(1) A digital radio multiplex transmitter licence is subject to the following conditions:
   (a) a condition that the licensee must comply with this Act;
   (b) a condition that the licensee meet all obligations (if any) of the licensee to pay:
      (i) charges fixed by determinations under section 60 of the Australian Communications and Media Authority Act 2005; and
      (ii) amounts of apparatus licence tax;
   (c) a condition that the licensee inform each person authorised by the licensee to operate a multiplex transmitter under the licence of the person’s obligations to comply with this Act and the conditions of the licence;
   (d) if the licence is for 2 or more multiplex transmitters—a condition that one of those multiplex transmitters is to be
used as the main multiplex transmitter and the others as repeater multiplex transmitters;

(e) a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, a multiplex transmitter under the licence except on a frequency channel or channels, and at a constancy, specified in the licence in accordance with the relevant digital radio channel plan;

(f) if the licence is a category 1 digital radio multiplex transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, a multiplex transmitter under the licence for transmitting a service unless:

   (i) the service is a digital commercial radio broadcasting service, and there is in force a commercial radio broadcasting licence authorising the provision of the service in the designated BSA radio area concerned; or

   (ii) the service is a digital community radio broadcasting service, and there is in force a designated community radio broadcasting licence authorising the provision of the service in the designated BSA radio area concerned; or

   (iii) the service is a restricted datacasting service, and there is in force a restricted datacasting licence authorising the provision of the service;

(g) if the licence is a category 2 digital radio multiplex transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, a multiplex transmitter under the licence for transmitting a service unless:

   (i) the service is a digital commercial radio broadcasting service, and there is in force a commercial radio broadcasting licence authorising the provision of the service in the designated BSA radio area concerned; or

   (ii) the service is a digital community radio broadcasting service, and there is in force a designated community radio broadcasting licence authorising the provision of the service in the designated BSA radio area concerned; or

   (iii) the service is a digital national radio broadcasting service; or
(iv) the service is a restricted datacasting service, and there is in force a restricted datacasting licence authorising the provision of the service;

(h) if the licence is a category 3 digital radio multiplex transmitter licence—a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, a multiplex transmitter under the licence for transmitting a service unless:
   (i) the service is a digital national radio broadcasting service; or
   (ii) the service is a restricted datacasting service, and there is in force a restricted datacasting licence authorising the provision of the service;

(i) if the licence is a foundation category 1 digital radio multiplex transmitter licence—a condition that the licensee, or a person so authorised, will:
   (i) commence to transmit a service covered by subparagraph (f)(i) or (ii) on the digital radio start-up day for the designated BSA radio area concerned; and
   (ii) transmit a service covered by subparagraph (f)(i) or (ii) at all times after the commencement referred to in subparagraph (i) of this paragraph;

(j) if the licence is a foundation category 2 digital radio multiplex transmitter licence—a condition that the licensee, or a person so authorised, will:
   (i) commence to transmit a service covered by subparagraph (g)(i), (ii) or (iii) on the digital radio start-up day for the designated BSA radio area concerned; and
   (ii) transmit a service covered by subparagraph (g)(i), (ii) or (iii) at all times after the commencement referred to in subparagraph (i) of this paragraph;

(k) a condition that the licensee, and any person so authorised, must not operate, or permit the operation of, a multiplex transmitter under the licence for transmitting a service unless that service is transmitted using a digital modulation technique;

(l) a condition that the licensee must not carry on any activities other than activities that consist of:
   (i) operating a multiplex transmitter under the licence; and
(ii) activities that are related to the operation of the multiplex transmitter;

(m) a condition that the licensee, and any person so authorised, must not operate, or permit operation of, a multiplex transmitter under the licence otherwise than in accordance with any relevant technical specifications determined by the relevant digital radio channel plan;

(n) a condition that the licensee, and any person so authorised, must comply with guidelines developed by the ACMA under section 33 of the *Broadcasting Services Act 1992*;

(o) a condition that the licensee, and any person so authorised, will comply with any standards under section 130AB of the *Broadcasting Services Act 1992* (which deals with technical standards relating to the operation of multiplex transmitters);

(p) a condition that the licensee, or a person so authorised, will comply with subsection 130V(1) of the *Broadcasting Services Act 1992* (which deals with industry standards);

(q) a condition that the licensee will, if requested to do so by the ACMA, submit to the ACMA, within a specified period of at least 30 days, an implementation plan that complies with any relevant determinations under subsection (2);

(r) a condition that the licensee, and any person so authorised, must comply with an implementation plan submitted to the ACMA by the licensee;

(s) if the licence is a category 3 digital radio multiplex transmitter licence—such other conditions as are specified in the regulations;

(t) such other conditions as are specified in the licence.

*Implementation plans*

(2) The ACMA may, by legislative instrument, determine requirements to be complied with by implementation plans.

(3) The Minister may, by legislative instrument, give the ACMA a direction about the exercise of the power conferred by subsection (2).

(4) The ACMA must comply with a direction under subsection (3).
Licences allocated under subsection 40(1) of the Broadcasting Services Act 1992

(5) Subparagraphs (1)(f)(i) and (g)(i) do not apply in relation to a commercial radio broadcasting licence allocated under subsection 40(1) of the Broadcasting Services Act 1992.

Continuity of transmission

(6) The ACMA may, by legislative instrument, specify circumstances in which a digital radio multiplex transmitter licensee, or a person authorised by such a licensee, is taken, for the purposes of subparagraph (1)(i)(ii), to be transmitting a service covered by subparagraph (1)(f)(i) or (ii).

(7) The ACMA may, by legislative instrument, specify circumstances in which a digital radio multiplex transmitter licensee, or a person authorised by such a licensee, is taken, for the purposes of subparagraph (1)(j)(ii), to be transmitting a service covered by subparagraph (1)(g)(i), (ii) or (iii).

(8) A copy of a declaration under subsection (6) or (7) must be made available on the ACMA’s website.

Ministerial directions

(9) The Minister may, by legislative instrument, give the ACMA a direction about the exercise of the power conferred by paragraph (1)(t) to specify conditions in a digital radio multiplex transmitter licence.

(10) The ACMA must comply with a direction under subsection (9).

109C Conditions of category 1 and category 2 digital radio multiplex transmitter licences—access etc.

Compliance with access regime etc.

(1) A category 1 digital radio multiplex transmitter licence and a category 2 digital radio multiplex transmitter licence are subject to the following conditions:

(a) a condition that the licensee, and each person authorised by the licensee to operate a multiplex transmitter under the
licence, will comply with any applicable obligations under Division 4B;

(b) a condition that the licensee, and any person so authorised, will comply with an access undertaking in force under Division 4B in relation to the licence;

(c) a condition that the licensee, and any person so authorised, will not give access to multiplex capacity under the licence otherwise than in compliance with:
   (i) the standard access obligations (if any) that are applicable to the licence; or
   (ii) the excess-capacity access obligations (if any) that are applicable to the licence; or
   (iii) the distributed-capacity access obligations (if any) that are applicable to the licence.

Proceeds of auctions

(2) If:

(a) a foundation digital radio multiplex transmitter licence was issued otherwise than in accordance with a price-based allocation system determined under section 106; and

(b) the licensee receives the net proceeds of an auction mentioned in subsection 118NT(6);

the licence is subject to the following conditions:

(c) the licensee will set aside the net proceeds of the auction in a separate account with an ADI (within the meaning of the \textit{Banking Act 1959});

(d) the licensee will not apply those net proceeds except for the purpose of:
   (i) promoting the digital radio broadcasting platform in Australia; or
   (ii) discharging a liability of the licensee to pay a fee or charge in relation to the maintenance or operation of the account; or
   (iii) discharging a liability incurred by the licensee in connection with the auction (other than a liability to comply with an obligation under Division 4B).

Definition

(3) In this section:
multiplex capacity has the same meaning as in Division 4B.

109D Conditions of foundation digital radio multiplex transmitter licences

Scope

(1) This section applies to a foundation digital radio multiplex transmitter licence for a designated BSA radio area if:
   (a) the licence was issued otherwise than in accordance with a price-based allocation system determined under section 106; and
   (b) the digital radio moratorium period for the designated BSA radio area has not ended.

Ownership of shares in licensee

(2) The licence is subject to the condition that the licensee must take all reasonable steps to ensure that a person does not hold shares in the licensee unless the person is:
   (a) in any case—an incumbent digital commercial radio broadcasting licensee for the designated BSA radio area; or
   (b) in any case—the digital community radio broadcasting representative company for the designated BSA radio area; or
   (c) in any case—the holder of a digital commercial radio broadcasting licence allocated in accordance with subsection 35D(3) of the Broadcasting Services Act 1992; or
   (d) in the case of a foundation category 2 digital radio multiplex transmitter licence—a national broadcaster.

Issue of shares to digital community radio broadcasting representative company

(3) The licence is subject to the condition that, if:
   (a) there is a digital community radio broadcasting representative company (the representative company) for the designated BSA radio area; and
   (b) the representative company gives the licensee a written request under this paragraph to be issued with shares in the licensee; and
   (c) the request is made:
(i) before the digital radio start-up day for the designated BSA radio area; or
(ii) within 12 months after the digital radio start-up day for the designated BSA radio area; and
(d) if an invitation was made to the representative company under whichever of paragraph 102C(5)(a) or 102D(5)(a) applied in relation to the formation of the licensee—no shares were issued to the representative company in connection with the invitation;
the licensee must:
(e) by written notice given to the representative company, offer to issue to the representative company a number of shares in the licensee such that, if the offer were accepted, the representative company would hold two-ninths of the shares in the licensee; and
(f) ensure that the offer is made within 30 days after the licensee receives the request; and
(g) keep the offer open for at least 120 days after the offer is made; and
(h) ensure that the rights and restrictions (if any) attached to the shares the subject of the offer are the same as the rights and restrictions (if any) attached to the shares held by existing shareholders in the licensee; and
(i) ensure that the offer price per share does not exceed the amount worked out using the formula:
\[
\frac{\text{total price of pre-offer shares}}{\text{number of pre-offer shares}}
\]
where:
- \textit{number of pre-offer shares} is the number of shares in the licensee (the \textit{pre-offer shares}) that were issued before the offer was made.
- \textit{total price of pre-offer shares} is the total amount paid or payable to the licensee as consideration for the issue of the pre-offer shares.

(4) The digital community radio broadcasting representative company for the designated BSA radio area is not entitled to make more than one request under subsection (3).
(5) For the purposes of subsection (4), disregard a request if the request does not result in compliance by the licensee with the requirements of subsection (3).

110 Conditions relating to interference

The conditions that may be specified in an apparatus licence under paragraph 107(1)(g), 108A(1)(f), 109(1)(f), 109A(1)(k) or 109B(1)(t) include, for example:

(a) a condition requiring the licensee to place advertisements, in a specified way, asking members of the public to contact the licensee if they believe that operation of a transmitter to which the licence relates is causing interference to other radiocommunications; and

(b) a condition that, if operation of the transmitter is causing interference to other radiocommunications, the licensee must (at the licensee’s own expense) adjust, or fit devices to, receivers in order to eliminate or minimise the interference.

111 Changes to licence conditions

(1) The ACMA may, by notice in writing given to the licensee of an apparatus licence:

(a) impose one or more further conditions to which the licence is subject; or

(b) revoke or vary any condition imposed under paragraph (a); or

(c) revoke or vary any condition specified under paragraph 107(1)(g), 108A(1)(f), 109(1)(f), 109A(1)(k) or 109B(1)(t); or

(d) if the licence is a transmitter licence, other than a licence issued under section 101A, 101B, 101C, 102 or 102A—vary a condition of the kind referred to in paragraph 108(2)(a), (b) or (c) or 109A(1)(d).

Note: Decisions under this section are reviewable under Part 5.6.

(2) The notice given under subsection (1) must specify that:

(a) the licensee may request a statement of reasons for the change; and

(b) a request must be made within 28 days of receipt of the notice.
Section 112

(3) A person receiving a notice under subsection (1) may request a statement of reasons for the decision within 28 days of receiving the notice.

(4) If the ACMA receives a request in accordance with subsection (3), the ACMA must give the person a statement of reasons within 28 days of receipt of that request.

(5) If the ACMA is required, under a scheme in force under clause 6 or 19 of Schedule 4 to the Broadcasting Services Act 1992, to vary the conditions of a transmitter licence, the ACMA must, by written notice given to the licensee, vary those conditions accordingly.

Ministerial directions

(6) The Minister may, by legislative instrument, give the ACMA a direction about the exercise of a power conferred by paragraph (1)(a), (b) or (c) to impose, vary or revoke conditions of a digital radio multiplex transmitter licence.

(7) The ACMA must comply with a direction under subsection (6).

112 Guidelines relating to conditions etc.

(1) The ACMA may, by written instrument, make guidelines:
   (a) that it is to apply in exercising its powers under sections 107, 108 and 111; or
   (b) for the purposes of paragraph 108(3)(a).

(2) In exercising its powers under sections 107, 108 and 111, the ACMA must comply with any relevant guidelines that are in force.

(3) Subject to subsection (4), a guideline is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

(4) Despite paragraph 46A(1)(c) of that Act, a guideline is taken to be a statutory rule within the meaning of the Statutory Rules Publication Act 1903.

113 Contravention of conditions

(1) A person is guilty of an offence if:
   (a) an apparatus licence relates to the person; and
   (b) the person engages in conduct; and
(c) the person’s conduct contravenes a condition of the licence.

Penalty: 100 penalty units.

(2) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

(3) In this section:

**engage in conduct** means:

(a) do an act; or

(b) omit to perform an act.

### 113A Constitutional safety net—issue of shares to digital community radio broadcasting representative company

(1) If the operation of subsection 109D(3) would result in an acquisition of property from a person otherwise than on just terms, the Commonwealth is liable to pay a reasonable amount of compensation to the person.

(2) If the Commonwealth and the person do not agree on the amount of the compensation, the person may institute proceedings in a court of competent jurisdiction for the recovery from the Commonwealth of such reasonable amount of compensation as the court determines.

(3) In this section:

**acquisition of property** has the same meaning as in paragraph 51(xxxi) of the Constitution.

**just terms** has the same meaning as in paragraph 51(xxxi) of the Constitution.
Division 4—Third party users

114 Licensees may authorise third party users

(1) Subject to subsections (2), (3), (3AA), (3A), (3B), (3D) and (3F), a licensee of an apparatus licence may, by written instrument, authorise other persons to operate radiocommunications devices under the licence.

(2) The licensee must not authorise a person if to do so would be inconsistent with determinations of the ACMA under section 115.

(3) The licensee must not authorise a person if:

(a) the person has been issued an apparatus licence that:

(i) was or is of the same type as the licensee’s licence; and

(ii) authorised operation of radiocommunications devices of the same kind as those to which the licensee’s licence relates; and

(b) the person’s licence:

(i) is suspended; or

(ii) has been cancelled within the last 2 years.

(3AA) The licensee must not authorise a person if:

(a) the licence is a digital radio multiplex transmitter licence; and

(b) the person is not a qualified company.

(3A) The licensee must not authorise a person if:

(a) the licence is a datacasting transmitter licence; and

(b) the person is not a qualified company.

(3B) The licensee must not authorise a person if:

(a) the licence is a datacasting transmitter licence; and

(b) the licensee did not, at least 30 days before the authorisation took place, give to the ACMA a written notice stating the licensee’s intention to authorise the person.

(3C) If:

(a) the ACMA receives a notice of intention under subsection (3B); and
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Section 114A

(b) the ACMA is satisfied that the authorisation would result in a breach of the BSA control rules;
the ACMA may, by written notice given to the licensee within 30 days after the notice of intention was sent to the ACMA, direct the licensee not to authorise the person.

(3D) The licensee must not authorise a person in breach of a direction under subsection (3C).

(3E) If:
   (a) the ACMA receives a notice of intention under subsection (3B); and
   (b) the ACMA is satisfied that the authorisation would not result in a breach of the BSA control rules;
the ACMA must, by written notice given to the licensee, inform the licensee accordingly.

(3F) If the licensee gives a notice of intention to the ACMA under subsection (3B), the licensee must not authorise the person concerned until whichever of the following first happens:
   (a) the licensee receives a notice from the ACMA in relation to the authorisation under subsection (3C) or (3E);
   (b) the end of 30 days after the notice of intention was sent to the ACMA.

(4) Authorising other persons does not prevent the licensee doing anything in accordance with the licence.

114A Authorisation under apparatus licence is to be treated as acquisition of asset of a person for the purposes of section 50 of the Competition and Consumer Act

For the purposes of section 50 and subsections 81(1) and (1A) and 88(9), 89(5A) and 90(9) of the Competition and Consumer Act 2010, the authorisation, in accordance with subsection 114(1) of this Act, of a person to operate radiocommunications devices under an apparatus licence is taken to be an acquisition by the person of an asset of another person.

148  Radiocommunications Act 1992
115 Determinations limiting authorisation of third party users

(1) The ACMA may, by written instrument, determine:
   (a) categories of apparatus licences in respect of which licensees must not authorise other persons to operate radiocommunications devices; or
   (b) classes of persons who must not be so authorised; or
   (c) circumstances in which persons must not be so authorised.

(2) A determination is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

116 Revocation of authorisations

(1) If the ACMA is satisfied that a person authorised under section 114 has contravened a condition of the licence to which the authorisation relates, the ACMA may give the licensee a written notice directing the licensee to revoke the authorisation.

   Note: Directions to revoke an authorisation are reviewable under Part 5.6.

(2) The notice must give the reasons for the direction.

(3) As soon as practicable and, in any event, within 7 days after service of the notice, the licensee must revoke the authorisation.

(4) The licensee must not further authorise the person under section 114 until the direction is:
   (a) revoked under subsection 289(1) of this Act or as provided for by subsection 33(3) of the Acts Interpretation Act 1901; or
   (b) set aside by a court or the AAT.

(5) If:
   (a) a person has been authorised under section 114 in relation to a particular licence; and
   (b) at the time of the authorisation, the person was the licensee of another apparatus licence of the same type that authorised operation of radiocommunications devices of the same kind as those to which the first-mentioned licence relates; and
   (c) the other licence is suspended or cancelled;
   the authorisation is taken to have been revoked on the day on which the other licence is suspended or cancelled.
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117  Licensees must keep records of authorisations

(1) A licensee of an apparatus licence who authorises a person under section 114 must:
   (a) cause a copy of the authorisation to be kept in Australia; and
   (b) retain the copy for at least one year after the authorisation ceases to be in force.

Penalty: 20 penalty units.

(2) Subsection (1) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.

118  Licensees must notify authorised persons of certain matters

(1) As soon as practicable and, in any event, within 7 days after the licensee of an apparatus licence is given:
   (a) a notice under section 111 relating to changes in licence conditions; or
   (b) a notice under subsection 116(1) requiring an authorisation under section 114 to be revoked; or
   (c) a notice under subsection 126(1) or 128C(1) suspending the licence; or
   (d) a notice under subsection 128(1) or 128B(1), or section 128D, cancelling the licence;
the licensee must notify the effect of the notice to each person who is currently authorised under section 114 in relation to the licence.

Penalty: 20 penalty units.

(1A) Subsection (1) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.

(2) Giving such a notice to the licensee does not render unlawful anything done by a person authorised by the licensee under section 114 before the person is notified under subsection (1) of this section.
Division 4A—Access to channel B datacasting transmitter licences

118A Access to channel B datacasting transmitter licences

A reference in this Division to access to a channel B datacasting transmitter licence is a reference to access to services that enable or facilitate the transmission of one or more content services under the licence, where the access is provided for the purpose of enabling one or more content service providers to provide one or more content services.

Note: Content service provider and content service are defined in section 118M.

118B Applicant for channel B datacasting transmitter licences must give the ACCC an access undertaking

(1) A person is not eligible to apply for a channel B datacasting transmitter licence unless:

(a) the person has given the ACCC a written undertaking that, in the event that the licence is issued to the person, each of the following persons:

(i) the first holder of the licence;

(ii) any person authorised by the first holder of the licence to operate radiocommunications transmitters under the licence;

(iii) any future holder of the licence;

(iv) any person authorised by a future holder of the licence to operate radiocommunications transmitters under the licence;

will:

(v) comply with such obligations in relation to access to the licence as are ascertained in accordance with the undertaking; and

(vi) do so on such terms and conditions as are agreed with the holder of the licence (or the person so authorised) or, failing agreement, on such terms and conditions as are ascertained in accordance with the undertaking; and

(b) the ACCC has accepted the undertaking.
Section 118C

(2) The undertaking must be in a form approved in writing by the ACCC.

(3) The undertaking must be accompanied by the fee (if any) specified in the Procedural Rules. The amount of the fee must not be such as to amount to taxation.

(4) The undertaking may be without limitations or may be subject to such limitations as are specified in the undertaking.

(5) The Procedural Rules may make provision for or in relation to a time limit for giving the undertaking.

118C Further information about access undertaking

(1) This section applies if a person gives an access undertaking to the ACCC.

(2) The ACCC may request the person to give the ACCC further information about the access undertaking.

(3) If:
(a) the Procedural Rules make provision for or in relation to a time limit for giving the information; and
(b) the person does not give the ACCC the information within the time limit allowed by the Procedural Rules;
the ACCC may, by written notice given to the person, reject the access undertaking.

(4) If the Procedural Rules do not make provision for or in relation to a time limit for giving the information, the ACCC may refuse to consider the access undertaking until the person gives the ACCC the information.

(5) The ACCC may withdraw its request for further information, in whole or in part.

118D ACCC to accept or reject access undertaking

(1) This section applies if a person gives an access undertaking to the ACCC.
Decision to accept or reject access undertaking

(2) After considering the access undertaking, the ACCC must:
(a) accept the access undertaking; or
(b) reject the access undertaking.

(3) If the ACCC rejects the access undertaking, the ACCC may give the person a written notice advising the person that, if the person:
(a) makes such alterations to the access undertaking as are specified in the notice; and
(b) gives the altered access undertaking to the ACCC within the time limit allowed by the Procedural Rules;
the ACCC will accept the altered access undertaking.

Notice of decision

(4) If the ACCC accepts the access undertaking, the ACCC must give the person a written notice stating that the access undertaking has been accepted.

(5) If the ACCC rejects the access undertaking, the ACCC must give the person a written notice:
(a) stating that the access undertaking has been rejected; and
(b) setting out the reasons for the rejection.

118E Duration of access undertaking etc.

(1) If:
(a) a person gives an access undertaking to the ACCC in relation to a channel B datacasting transmitter licence; and
(b) the ACCC accepts the access undertaking; and
(c) the licence is issued to the person;
the access undertaking:
(d) comes into force when the licence is issued; and
(e) remains in force while the licence is in force; and
(f) is suspended while the licence is suspended.

(2) To avoid doubt, if:
(a) an access undertaking is in force in relation to a channel B datacasting transmitter licence; and
(b) the licence is transferred;
then:

(c) the transfer does not result in the lapse of the access undertaking; and

(d) the transferee, and any person authorised by the transferee to operate radiocommunications transmitters under the licence, is bound by the access undertaking.

(3) If:

(a) a channel B datacasting transmitter licence is renewed; and

(b) immediately before the expiry of the original licence, an access undertaking was in force in relation to the original licence;

the access undertaking:

(c) remains in force while the new licence is in force, as if:

(i) it were an access undertaking in relation to the new licence;

(ii) each reference in the access undertaking to a holder of the original licence were a reference to a holder of the new licence; and

(d) is suspended while the new licence is suspended.

118F Variation of access undertakings

(1) This section applies if an access undertaking is in force in relation to a channel B datacasting transmitter licence.

(2) The licensee may give the ACCC a variation of the access undertaking.

Decision to accept or reject variation

(3) After considering the variation, the ACCC must decide to:

(a) accept the variation; or

(b) reject the variation.

(4) If the ACCC rejects the variation, the ACCC may give the person a written notice advising the person that, if the person:

(a) makes such alterations to the variation as are specified in the notice; and

(b) gives the altered variation to the ACCC within the time limit allowed by the Procedural Rules;
the ACCC will accept the altered variation.

Notice of decision

(5) If the ACCC accepts the variation, the ACCC must give the licensee a written notice:
   (a) stating that the variation has been accepted; and
   (b) setting out the terms of the variation.

(6) If the ACCC rejects the variation, the ACCC must give the licensee a written notice:
   (a) stating that the variation has been rejected; and
   (b) setting out the reasons for the rejection.

118G Further information about variation of access undertaking

(1) This section applies if the licensee of a channel B datacasting transmitter licence gives the ACCC a variation of an access undertaking.

(2) The ACCC may request the licensee to give the ACCC further information about the variation.

(3) If:
   (a) the Procedural Rules make provision for or in relation to a time limit for giving the information; and
   (b) the licensee does not give the ACCC the information within the time limit allowed by the Procedural Rules;
the ACCC may, by written notice given to the licensee, reject the variation.

(4) If the Procedural Rules do not make provision for or in relation to a time limit for giving the information, the ACCC may refuse to consider the variation until the licensee gives the ACCC the information.

(5) The ACCC may withdraw its request for further information, in whole or in part.
118H Decision-making criteria

Acceptance of access undertaking

(1) The ACCC may, by legislative instrument, determine criteria to be applied by the ACCC in deciding whether to accept access undertakings.

(2) In deciding whether to accept access undertakings, the ACCC must apply criteria determined under subsection (1).

Acceptance of variation of access undertaking

(3) The ACCC may, by legislative instrument, determine criteria to be applied by the ACCC in deciding whether to accept variations of access undertakings.

(4) In deciding whether to accept variations of access undertakings, the ACCC must apply criteria determined under subsection (3).

118J Register of access undertakings

(1) The ACCC is to maintain a Register in which the ACCC includes all access undertakings that are in force.

(2) The Register may be maintained by electronic means.

(3) The Register is to be made available for inspection on the internet.

118K Enforcement of access undertakings

(1) This section applies if an access undertaking is in force in relation to a channel B datacasting transmitter licence.

(2) If:
   (a) the ACCC; or
   (b) any person (the affected person) whose interests are affected by the access undertaking;

   thinks that a person (the third person) has breached the access undertaking, the ACCC or affected person may apply to the Federal Court for an order under subsection (3).
(3) If the Federal Court is satisfied that the third person has breached the access undertaking, the Court may make all or any of the following orders:

(a) an order directing the third person to comply with the access undertaking;

(b) an order directing the third person to compensate any other person who has suffered loss or damage as a result of the breach;

(c) any other order that the Court thinks appropriate.

(4) The Federal Court may discharge or vary an order granted under this section.

118L Procedural Rules

(1) The ACCC may, by legislative instrument, make rules:

(a) making provision for or in relation to the practice and procedure to be followed by the ACCC in performing functions, or exercising powers, under this Division; or

(b) making provision for or in relation to all matters and things incidental to any such practice or procedure, or necessary or convenient to be prescribed for the conduct of any business of the ACCC under this Division; or

(c) prescribing matters required or permitted by any other provision of this Division to be prescribed by the Procedural Rules.

(2) Rules under subsection (1) are to be known as Procedural Rules.

(3) The Procedural Rules may make provision for or in relation to any or all of the following:

(a) the confidentiality of information or documents given to the ACCC by a person who gave the ACCC an access undertaking or a variation of an access undertaking;

(b) the form and content of undertakings, variations or other documents given to the ACCC under this Division;

(c) requiring the ACCC to give information to the ACMA about the operation of this Division;

(d) requiring the ACMA to give information to the ACCC that is relevant to the operation of this Division.
Section 118M

(4) The Procedural Rules may make provision for or in relation to a matter by empowering the ACCC to make decisions of an administrative character.

(5) The Procedural Rules may provide that the ACCC may refuse to consider an access undertaking if:
   (a) the ACCC is satisfied that the access undertaking:
       (i) is frivolous; or
       (ii) is vexatious; or
       (iii) was not given in good faith; or
   (b) the ACCC has reason to believe that the access undertaking was given for the purpose, or for purposes that include the purpose, of frustrating or undermining the effective administration of this Division.

(6) The Procedural Rules may provide that the ACCC may refuse to consider an access undertaking given by a person in relation to a channel B datacasting transmitter licence if (apart from section 118B) the person is not eligible to apply for the licence.

(7) Subsections (3), (4), (5) and (6) do not limit subsection (1).

118M Definitions

In this Division:

access has the meaning given by section 118A.

access undertaking means an undertaking under section 118B.

content service means a service covered by subparagraph 109A(1)(i)(i) or (ii), but does not include a service covered by subparagraph 109A(1)(ib)(i) or (ii).

content service provider means a company who provides, or proposes to provide, a content service.

Procedural Rules means Procedural Rules made under section 118L.
Division 4B—Access to digital radio multiplex transmitter licences

Subdivision A—Introduction

118N Simplified outline

The following is a simplified outline of this Division:

- This Division sets out an access regime for digital radio multiplex transmitter licences.
- A digital radio multiplex transmitter licensee is required to comply with access obligations in relation to multiplex capacity under the licence.
- The access obligations facilitate the provision of access to multiplex capacity by content service providers in order that the content service providers can provide content services.
- The terms and conditions on which a digital radio multiplex transmitter licensee is required to comply with the access obligations are as set out in an access undertaking in force in relation to the licence.

118NA Scope

This Division applies in relation to a digital radio multiplex transmitter licence if the licence is:

(a) a category 1 digital radio multiplex transmitter licence; or
(b) a category 2 digital radio multiplex transmitter licence.

118NB Definitions

In this Division:

access undertaking means an undertaking under section 118ND.
content service means:
(a) for the purposes of the application of this Division to a category 1 digital radio multiplex transmitter licence—a service covered by subparagraph 109B(1)(f)(i), (ii) or (iii); or
(b) for the purposes of the application of this Division to a category 2 digital radio multiplex transmitter licence—a service covered by subparagraph 109B(1)(g)(i), (ii), (iii) or (iv).

content service provider means a company who provides, or proposes to provide, a content service.

distributed-capacity access entitlement has the meaning given by section 118NU.

distributed-capacity access obligations has the meaning given by section 118NN.

excess-capacity access entitlement has the meaning given by section 118NT.

excess-capacity access obligations has the meaning given by section 118NM.

external auditor means a person authorised under section 118PD to be an external auditor for the purposes of this Division.

multiplex capacity, in relation to a digital radio multiplex transmitter licence, means:
(a) if the licence is for a single multiplex transmitter—so much of the gross transmission capacity of the multiplex transmitter as is available for the transmission of content services; or
(b) if the licence is for a main multiplex transmitter and one or more repeater multiplex transmitters—both:
   (i) so much of the gross transmission capacity of the main multiplex transmitter as is available for the transmission of content services; and
   (ii) so much of the gross transmission capacity of each of the repeater multiplex transmitters as is available for the transmission of content services.

For the purposes of this definition, in working out so much of the gross transmission capacity of a multiplex transmitter as is
available for the transmission of content services, include transmission capacity used to provide error protection for those content services.

_Procedural Rules_ means Procedural Rules made under section 118PO.

*standard access entitlement* has the meaning given by whichever of section 118NQ, 118NR or 118NS is applicable.

*standard access obligations* has the meaning given by section 118NL.

118NC  National broadcasters

For the purpose of this Division, a national broadcaster is taken to be entitled to provide digital national radio broadcasting services in each designated BSA radio area.

Subdivision B—Access undertakings

118ND  Digital radio multiplex transmitter licensees must give the ACCC access undertakings

(1) A digital radio multiplex transmitter licensee must, within 3 months after the issue of the licence, give the ACCC a written undertaking that each of the following persons:

(a) the first holder of the licence;
(b) any person authorised by the first holder of the licence to operate a multiplex transmitter under the licence;
(c) any future holder of the licence;
(d) any person authorised by a future holder of the licence to operate a multiplex transmitter under the licence;

will comply with such terms and conditions as are ascertained in accordance with the undertaking in relation to:

(e) the standard access obligations (if any) that are, or may become, applicable to the licence; and
(f) the excess-capacity access obligations (if any) that are, or may become, applicable to the licence; and
(g) the distributed-capacity access obligations (if any) that are, or may become, applicable to the licence.
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(2) The undertaking must be in a form approved in writing by the ACCC.

(3) The undertaking must be accompanied by the fee (if any) specified in the Procedural Rules. The amount of the fee must not be such as to amount to taxation.

(4) The undertaking may be without limitations or may be subject to such limitations as are specified in the undertaking.

118NE Further information about access undertakings

(1) This section applies if a digital radio multiplex transmitter licensee gives an access undertaking to the ACCC.

(2) The ACCC may request the licensee to give the ACCC further information about the access undertaking.

(3) If:
   (a) the Procedural Rules make provision for, or in relation to, a time limit for giving the information; and
   (b) the licensee does not give the ACCC the information within the time limit allowed by the Procedural Rules;
the ACCC may, by written notice given to the licensee, reject the access undertaking.

(4) If the Procedural Rules do not make provision for, or in relation to, a time limit for giving the information, the ACCC may refuse to consider the access undertaking until the licensee gives the ACCC the information.

(5) The ACCC may withdraw its request for further information, in whole or in part.

118NF ACCC to accept or reject access undertakings

(1) This section applies if a digital radio multiplex transmitter licensee gives an access undertaking to the ACCC.

Decision to accept or reject access undertaking

(2) After considering the access undertaking, the ACCC must:
   (a) accept the access undertaking; or
(b) reject the access undertaking.

(3) Before accepting the access undertaking, the ACCC must:
   (a) publish a copy of the access undertaking on the ACCC’s website; and
   (b) invite members of the public to make submissions to the ACCC about the access undertaking within a specified period; and
   (c) consider any submissions the ACCC receives from members of the public within that period.

(4) If the ACCC rejects the access undertaking, the ACCC may give the licensee a written notice advising the licensee that, if the licensee:
   (a) makes such alterations to the access undertaking as are specified in the notice; and
   (b) gives the altered access undertaking to the ACCC within the time limit allowed by the Procedural Rules;
   the ACCC will accept the altered access undertaking.

(5) If the ACCC rejects the access undertaking, the ACCC may, by written notice given to the licensee, determine that an undertaking in the terms specified in the determination is the access undertaking in relation to the licence.

(6) Before giving a notice under subsection (5), the ACCC must:
   (a) publish a copy of the notice on the ACCC’s website; and
   (b) invite members of the public to make submissions to the ACCC about the notice within a specified period; and
   (c) consider any submissions the ACCC receives from members of the public within that period.

Notice of decision

(7) If the ACCC accepts the access undertaking, the ACCC must give the licensee a written notice stating that the access undertaking has been accepted.

(8) If the ACCC rejects the access undertaking, the ACCC must give the licensee a written notice:
   (a) stating that the access undertaking has been rejected; and
   (b) setting out the reasons for the rejection; and

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(c) if the ACCC gives a notice under subsection (5)—stating that the notice has been given.

118NG Duration of access undertakings etc.

Duration of access undertaking accepted by ACCC

(1) If:

(a) a digital radio multiplex transmitter licensee gives an access undertaking to the ACCC; and
(b) the ACCC accepts the access undertaking;

the access undertaking:

(c) comes into force at the time of acceptance; and
(d) remains in force while the licence is in force; and
(e) is suspended while the licence is suspended.

Duration of access undertaking determined by ACCC

(2) If, under subsection 118NF(5), the ACCC determines that an undertaking is the access undertaking in relation to a digital radio multiplex transmitter licence, the access undertaking:

(a) comes into force when the determination is made; and
(b) remains in force while the licence is in force; and
(c) is suspended while the licence is suspended.

Transfer of digital radio multiplex transmitter licence

(3) To avoid doubt, if:

(a) an access undertaking is in force in relation to a digital radio multiplex transmitter licence; and
(b) the licence is transferred;

then:

(c) the transfer does not result in the lapse of the access undertaking; and
(d) the transferee, and any person authorised by the transferee to operate a multiplex transmitter under the licence, is bound by the access undertaking.

(4) Subsection (3) does not prevent the variation of an access undertaking.
Renewal of digital radio multiplex transmitter licence

(5) If:
   (a) a digital radio multiplex transmitter licence is renewed; and
   (b) immediately before the expiry of the original licence, an
       access undertaking was in force in relation to the original
       licence;
   the access undertaking:
   (c) remains in force while the new licence is in force, as if:
       (i) it were an access undertaking in relation to the new
           licence; and
       (ii) each reference in the access undertaking to a holder of
           the original licence were a reference to a holder of the
           new licence; and
   (d) is suspended while the new licence is suspended.

(6) Subsection (5) does not prevent the variation of an access
undertaking.

118NH Variation of access undertakings

(1) This section applies if an access undertaking is in force in relation
   to a digital radio multiplex transmitter licence.

(2) The licensee:
   (a) may give the ACCC a variation of the access undertaking;
   and
   (b) must give the ACCC a variation of the access undertaking if
       required to do so by the ACCC.

Decision to accept or reject variation

(3) After considering the variation, the ACCC must:
   (a) accept the variation; or
   (b) reject the variation.

(4) Before accepting the variation, the ACCC must:
   (a) publish a copy of the variation on the ACCC’s website; and
   (b) invite members of the public to make submissions to the
       ACCC about the variation within a specified period; and
(c) consider any submissions the ACCC receives from members of the public within that period.

(5) If the ACCC rejects the variation, the ACCC may give the licensee a written notice advising the licensee that, if the licensee:
   (a) makes such alterations to the variation as are specified in the notice; and
   (b) gives the altered variation to the ACCC within the time limit allowed by the Procedural Rules;
   the ACCC will accept the altered variation.

(6) If the ACCC rejects the variation, the ACCC may, by written notice given to the licensee, vary the access undertaking.

(7) Before giving a notice under subsection (6), the ACCC must:
   (a) publish a copy of the notice on the ACCC’s website; and
   (b) invite members of the public to make submissions to the ACCC about the notice within a specified period; and
   (c) consider any submissions the ACCC receives from members of the public within that period.

Notice of decision

(8) If the ACCC accepts the variation, the ACCC must give the licensee a written notice:
   (a) stating that the variation has been accepted; and
   (b) setting out the terms of the variation.

(9) If the ACCC rejects the variation, the ACCC must give the licensee a written notice:
   (a) stating that the variation has been rejected; and
   (b) setting out the reasons for the rejection; and
   (c) if ACCC gives a notice under subsection (6)—stating that the notice has been given.

Requirement to give variation

(10) The ACCC must not, under paragraph (2)(b), impose a requirement (the current requirement) on the licensee to give the ACCC a variation of the access undertaking unless:
   (a) the current requirement is imposed by a written notice given to the licensee on or after 1 January 2015; and
(b) the ACCC is satisfied that the access undertaking would be rejected if it were given to the ACCC when the current requirement is imposed; and
(c) no previous requirement was imposed on the licensee under paragraph (2)(b) during the 5-year period ending immediately before the current requirement was imposed.

(11) If the licensee does not give the ACCC a variation of the access undertaking when required to do so by the ACCC under paragraph (2)(b), the ACCC may, by written notice given to the licensee, vary the access undertaking.

(12) Before giving a notice under subsection (11), the ACCC must:
(a) publish a copy of the notice on the ACCC’s website; and
(b) invite members of the public to make submissions to the ACCC about the notice within a specified period; and
(c) consider any submissions the ACCC receives from members of the public within that period.

118NI Further information about variation of access undertakings

(1) This section applies if:
(a) an access undertaking is in force in relation to a digital radio multiplex transmitter licence; and
(b) the licensee gives the ACCC a variation of the access undertaking.

(2) The ACCC may request the licensee to give the ACCC further information about the variation.

(3) If:
(a) the Procedural Rules make provision for, or in relation to, a time limit for giving the information; and
(b) the licensee does not give the ACCC the information within the time limit allowed by the Procedural Rules;
the ACCC may, by written notice given to the licensee, reject the variation.

(4) If the Procedural Rules do not make provision for, or in relation to, a time limit for giving the information, the ACCC may refuse to consider the variation until the licensee gives the ACCC the information.
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(5) The ACCC may withdraw its request for further information, in whole or in part.

118NJ Decision-making criteria

Acceptance of access undertaking

(1) The ACCC may, by legislative instrument, determine criteria to be applied by the ACCC in deciding whether to accept access undertakings.

(2) In deciding whether to accept access undertakings, the ACCC must:
   (a) apply criteria determined under subsection (1); and
   (b) have regard to such other matters (if any) as the ACCC considers relevant.

Acceptance of variation of access undertaking

(3) The ACCC may, by legislative instrument, determine criteria to be applied by the ACCC in deciding whether to accept variations of access undertakings.

(4) In deciding whether to accept variations of access undertakings, the ACCC must:
   (a) apply criteria determined under subsection (3); and
   (b) have regard to such other matters (if any) as the ACCC considers relevant.

118NK Register of access undertakings

(1) The ACCC is to maintain a Register in which the ACCC includes all access undertakings that are in force.

(2) The Register may be maintained by electronic means.

(3) The Register is to be made available for inspection on the internet.

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Subdivision C—Standard access obligations, excess-capacity access obligations and distributed-capacity access obligations

118NL Standard access obligations

(1) This section sets out the standard access obligations.

(2) If:

   (a) a content service provider has a standard access entitlement in relation to a fraction of multiplex capacity under a digital radio multiplex transmitter licence; and
   (b) the content service provider may use that entitlement for a particular purpose;

the licensee, and any person authorised by the licensee to operate a multiplex transmitter under the licence, must give the content service provider:

   (c) access to that fraction of multiplex capacity for that purpose; and
   (d) access to services that facilitate the use of that fraction of multiplex capacity for that purpose.

(3) The licensee, or the person so authorised, is not required to comply with those obligations unless an access undertaking is in force in relation to the licence.

118NM Excess-capacity access obligations

(1) This section sets out the excess-capacity access obligations.

(2) If:

   (a) a content service provider has an excess-capacity access entitlement in relation to a fraction of multiplex capacity under a digital radio multiplex transmitter licence; and
   (b) the content service provider may use that entitlement for a particular purpose;

the licensee, and any person authorised by the licensee to operate a multiplex transmitter under the licence, must give the content service provider:

   (c) access to that fraction of multiplex capacity for that purpose; and
(d) access to services that facilitate the use of that fraction of multiplex capacity for that purpose.

(3) The licensee, or the person so authorised, is not required to comply with those obligations unless an access undertaking is in force in relation to the licence.

118NN Distributed-capacity access obligations

(1) This section sets out the distributed-capacity access obligations.

(2) If:

(a) a content service provider has a distributed-capacity access entitlement in relation to a fraction of multiplex capacity under a digital radio multiplex transmitter licence; and

(b) the content service provider may use that entitlement for a particular purpose;

the licensee, and any person authorised by the licensee to operate a multiplex transmitter under the licence, must give the content service provider:

(c) access to that fraction of multiplex capacity for that purpose;

and

(d) access to services that facilitate the use of that fraction of multiplex capacity for that purpose.

(3) The licensee, or the person so authorised, is not required to comply with those obligations unless an access undertaking is in force in relation to the licence.

118NO Compliance with access obligations

(1) This section applies if a digital radio multiplex transmitter licensee, or a person authorised by the licensee to operate a multiplex transmitter under the licence, is required to comply with:

(a) the standard access obligations (if any) that are applicable to the licence; or

(b) the excess-capacity access obligations (if any) that are applicable to the licence; or

(c) the distributed-capacity access obligations (if any) that are applicable to the licence.
(2) The digital radio multiplex transmitter licensee, or the person so authorised, must comply with the obligations on such terms and conditions as are ascertained in accordance with an access undertaking in force in relation to the licence.

118NP Other obligations

The licensee of a digital radio multiplex transmitter licence, and each person authorised by the licensee to operate a multiplex transmitter under the licence, must not discriminate, as between content service providers who have access to multiplex capacity under the licence, in relation to:
   (a) the technical and operational quality of the services supplied to the content service providers; and
   (b) the technical and operational quality and timing of the fault detection, handling and rectification supplied to the content service providers;
for the purposes of facilitating the use of that multiplex capacity.

118NQ Standard access entitlements of commercial broadcasters

Scope

(1) This section applies to a foundation digital radio multiplex transmitter licence for a designated BSA radio area.

Standard access entitlements

(2) If:
   (a) an incumbent digital commercial radio broadcasting licensee for the designated BSA radio area, by written notice given to the digital radio multiplex transmitter licensee, claims access to one-ninth of multiplex capacity under the digital radio multiplex transmitter licence; and
   (b) the notice is given within 30 days after the issue of the digital radio multiplex transmitter licence;
the incumbent digital commercial radio broadcasting licensee:
   (c) is entitled to access to one-ninth of multiplex capacity under the digital radio multiplex transmitter licence (which entitlement is called a standard access entitlement); and
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(d) may only use that standard access entitlement for the purpose of providing, under the digital commercial radio broadcasting licence, one or more digital commercial radio broadcasting services in the designated BSA radio area; and

(e) is not entitled to transfer the digital commercial radio broadcasting licensee’s standard access entitlement.

(3) Subsection (2) has effect subject to subsections (5), (6) and (7).

(4) If the digital radio multiplex transmitter licensee receives a subsection (2) notice, the licensee must, within 7 days after receiving the notice, give a copy of the notice to the ACCC.

(5) An incumbent digital commercial radio broadcasting licensee for the designated BSA radio area must not give a subsection (2) notice to the digital radio multiplex transmitter licensee if:

(a) the incumbent digital radio broadcasting licensee has given another subsection (2) notice to the digital radio multiplex transmitter licensee; or

(b) the incumbent digital commercial radio broadcasting licensee has given a subsection (2) notice to the licensee of another digital radio multiplex transmitter licence for the designated BSA radio area.

(6) If subsection (2) notices would result in demand from incumbent digital commercial radio broadcasting licensees for access to multiplex capacity under the first-mentioned digital radio multiplex transmitter licence being greater than so much of the multiplex capacity under the first-mentioned digital radio multiplex transmitter licence as is neither:

(a) reserved under subsection 118NR(2) (which deals with community broadcasters); nor

(b) covered by a standard access entitlement arising under subsection 118NS(2) (which deals with national broadcasters);

the ACCC may, by written notice given to a particular incumbent digital commercial radio broadcasting licensee before the digital radio start-up day for the designated BSA radio area:

(c) cancel the licensee’s subsection (2) notice; and

(d) determine that this section has effect as if the licensee’s subsection (2) notice had never been given; and

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(e) determine that this section has effect as if the licensee had given a notice under subsection (2) in relation to another foundation digital radio multiplex transmitter licence for the designated BSA radio area.

Transfer of standard access entitlements—notice under subsection 35D(2) of the Broadcasting Services Act 1992

(7) If:

(a) a digital commercial radio broadcasting licensee for the designated BSA radio area holds a standard access entitlement; and

(b) the digital commercial radio broadcasting licensee is given a notice under subsection 35D(2) of the Broadcasting Services Act 1992;

then:

(c) the standard access entitlement is transferred to the ACMA when the notice is given; and

(d) if, as a result of the giving of the notice, the ACMA allocates a digital commercial radio broadcasting licence (the new licence) in accordance with subsection 35D(3) of the Broadcasting Services Act 1992:

(i) the standard access entitlement is transferred to the licensee of the new licence; and

(ii) the licensee of the new licence may only use that standard access entitlement for the purpose of providing, under the new licence, one or more digital commercial radio broadcasting services in the designated BSA radio area.

(8) Subsection (7) has effect subject to section 118NV.

(9) If a standard access entitlement is transferred to the ACMA under paragraph (7)(c), the ACMA must not use the standard access entitlement.

118NR Standard access entitlements of community broadcasters

Scope

(1) This section applies to a foundation digital radio multiplex transmitter licence for a designated BSA radio area.
Reservation of multiplex capacity

(2) Two-ninths of multiplex capacity under the digital radio multiplex transmitter licence is reserved for digital community radio broadcasting licensees who are or may be nominated in accordance with subsection (3), (7) or (10).

Standard access entitlements—applicable fraction of multiplex capacity

(3) If:

(a) the digital community radio broadcasting representative company for the designated BSA radio area, by written notice given to the licensee of the digital radio multiplex transmitter licence:

(i) nominates 2 or more digital community radio broadcasting licensees for the purposes of this subsection; and

(ii) for each nominated digital community radio broadcasting licensee, determines an applicable fraction; and

(b) the notice is in force;

each nominated digital community radio broadcasting licensee:

(c) is entitled to access to the digital community radio broadcasting licensee’s applicable fraction of the multiplex capacity reserved under subsection (2) (which entitlement is called a standard access entitlement); and

(d) may only use that standard access entitlement for the purpose of providing, under the digital community radio broadcasting licence, one or more digital community radio broadcasting services in the designated BSA radio area; and

(e) is not entitled to transfer the digital community radio broadcasting licensee’s standard access entitlement.

(4) The sum of the applicable fractions determined in a notice under subsection (3) must not be greater than 1.

(5) The applicable fractions determined in a notice under subsection (3) may be the same or different for each nominated digital community radio broadcasting licensee.
(6) A notice given by a digital community radio broadcasting representative company cannot be in force under subsection (3) at the same time as:
   (a) another notice given by the company is in force under subsection (3); or
   (b) a notice given by the company is in force under subsection (7) or (10).

Standard access entitlements—designated fraction of multiplex capacity

(7) If:
   (a) the digital community radio broadcasting representative company for the designated BSA radio area, by written notice given to the licensee of the digital radio multiplex transmitter licence, nominates 2 or more digital community radio broadcasting licensees for the purposes of this subsection; and
   (b) the notice is in force;
   each nominated digital community radio broadcasting licensee:
   (c) is entitled to access to the designated fraction of the multiplex capacity reserved under subsection (2) (which entitlement is called a standard access entitlement); and
   (d) may only use that standard access entitlement for the purpose of providing, under the digital community radio broadcasting licence, one or more digital community radio broadcasting services in the designated BSA radio area; and
   (e) is not entitled to transfer the digital community radio broadcasting licensee’s standard access entitlement.

(8) For the purposes of subsection (7), the designated fraction is as follows:

<table>
<thead>
<tr>
<th>Number of nominated digital community radio broadcasting licensees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

(9) A notice given by a digital community radio broadcasting representative company cannot be in force under subsection (7) at the same time as:
   (a) another notice given by the company is in force under subsection (7); or
(b) a notice given by the company is in force under subsection (3) or (10).

Standard access entitlements—half of multiplex capacity

(10) If:

(a) the digital community radio broadcasting representative company for the designated BSA radio area, by written notice given to the licensee of the digital radio multiplex transmitter licence, nominates a single digital community radio broadcasting licensee for the purposes of this subsection; and

(b) the notice is in force;

the nominated digital community radio broadcasting licensee:

(c) is entitled to access to half of the multiplex capacity reserved under subsection (2) (which entitlement is called a standard access entitlement); and

(d) may only use that standard access entitlement for the purpose of providing, under the digital community radio broadcasting licence, one or more digital community radio broadcasting services in the designated BSA radio area; and

(e) is not entitled to transfer the digital community radio broadcasting licensee’s standard access entitlement.

(11) A notice given by a digital community radio broadcasting representative company cannot be in force under subsection (10) at the same time as:

(a) another notice given by the company is in force under subsection (10); or

(b) a notice given by the company is in force under subsection (3) or (7).

Subsequent notices

(12) If:

(a) a digital community radio broadcasting representative company gives a notice (the first notice) under subsection (3); and

(b) the first notice is in force;

the company must not give another notice under subsection (3) or a notice under subsection (7) or (10) unless the other notice under
subsection (3) or the notice under subsection (7) or (10), as the case may be:

(c) is accompanied by a notice under subsection (15) revoking the first notice; and

(d) is expressed to take effect immediately after the revocation of the first notice.

(13) If:

(a) a digital community radio broadcasting representative company gives a notice (the *first notice*) under subsection (7); and

(b) the first notice is in force;

the company must not give another notice under subsection (7) or a notice under subsection (3) or (10) unless the other notice under subsection (7) or the notice under subsection (3) or (10), as the case may be:

(c) is accompanied by a notice under subsection (15) revoking the first notice; and

(d) is expressed to take effect immediately after the revocation of the first notice.

(14) If:

(a) a digital community radio broadcasting representative company gives a notice (the *first notice*) under subsection (10); and

(b) the first notice is in force;

the company must not give another notice under subsection (10) or a notice under subsection (3) or (7) unless the other notice under subsection (10) or the notice under subsection (3) or (7), as the case may be:

(c) is accompanied by a notice under subsection (15) revoking the first notice; and

(d) is expressed to take effect immediately after the revocation of the first notice.

Revocation of notices

(15) If a notice given by a digital community radio broadcasting representative company under subsection (3), (7) or (10) is in force:
(a) the company may, by written notice given to the licensee of the digital radio multiplex transmitter licence, revoke the notice given under subsection (3), (7) or (10), as the case may be; and

(b) the revocation takes effect at the start of the 30th day after the day on which the notice of revocation is given.

(16) A notice of revocation under subsection (15) has no effect unless the digital community radio broadcasting representative company also gives the licensee of the digital radio multiplex transmitter licence:

(a) if the notice of revocation relates to a notice (the original notice) given under subsection (3)—either:
   (i) a fresh notice under subsection (3) that is expressed to take effect immediately after the revocation of the original notice; or
   (ii) a notice under subsection (7) or (10) that is expressed to take effect immediately after the revocation of the original notice; and

(b) if the notice of revocation relates to a notice (the original notice) given under subsection (7)—either:
   (i) a fresh notice under subsection (7) that is expressed to take effect immediately after the revocation of the original notice; or
   (ii) a notice under subsection (3) or (10) that is expressed to take effect immediately after the revocation of the original notice; and

(c) if the notice of revocation relates to a notice (the original notice) given under subsection (10)—either:
   (i) a fresh notice under subsection (10) that is expressed to take effect immediately after the revocation of the original notice; or
   (ii) a notice under subsection (3) or (7) that is expressed to take effect immediately after the revocation of the original notice.

(17) If:

(a) a digital community radio broadcasting licensee is nominated in a notice under subsection (3), (7) or (10); and

(b) the notice is revoked under subsection (15);
this section does not prevent that digital community radio broadcasting licensee from being nominated in:

(c) in the case of the revocation of a notice given under subsection (3):
   (i) a fresh notice under subsection (3); or
   (ii) a notice under subsection (7) or (10); and

(d) in the case of the revocation of a notice given under subsection (7):
   (i) a fresh notice under subsection (7); or
   (ii) a notice under subsection (3) or (10); and

(e) in the case of the revocation of a notice given under subsection (10):
   (i) a fresh notice under subsection (10); or
   (ii) a notice under subsection (3) or (7).

No variation of notices

(18) A notice under subsection (3), (7) or (10) cannot be varied.

Limit on nomination

(19) The nomination of a digital community radio broadcasting licensee for the purposes of subsection (3), (7) or (10) has no effect if the licensee has already been nominated for the purposes of any of those subsections in the subsection’s application to another digital radio multiplex transmitter licence for the designated BSA radio area.

Transitional

(20) For the purposes of the application of this section before the digital radio start-up day for the designated BSA radio area, *digital community radio broadcasting licensee* includes an incumbent digital community radio broadcasting licensee.

118NS Standard access entitlements of national broadcasters

Scope

(1) This section applies to a foundation category 2 digital radio multiplex transmitter licence for a designated BSA radio area.
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Part 3.3  Apparatus licences
Division 4B  Access to digital radio multiplex transmitter licences

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Standard access entitlements

(2) Each national broadcaster:

(a) is entitled to access to one-ninth of multiplex capacity under the digital radio multiplex transmitter licence (which entitlement is called a standard access entitlement); and

(b) may only use that standard access entitlement for the purpose of providing one or more digital national radio broadcasting services in the designated BSA radio area; and

(c) may transfer the national broadcaster’s standard access entitlement to the other national broadcaster.

(3) If a standard access entitlement is transferred as mentioned in paragraph (2)(c):

(a) the standard access entitlement may be further transferred, or successively transferred, so long as the holder for the time being of the standard access entitlement is a national broadcaster; and

(b) the holder for the time being of the standard access entitlement is entitled to access to one-ninth of multiplex capacity under the digital radio multiplex transmitter licence for the purpose of providing one or more digital national radio broadcasting services in the designated BSA radio area.

118NT  Excess-capacity access entitlements etc.

Scope

(1) This section applies to a foundation digital radio multiplex transmitter licence for a designated BSA radio area if:

(a) on the digital start-up day for the area, the multiplex capacity available under the digital radio multiplex transmitter licence exceeds the aggregate of:

(i) the fractions of multiplex capacity relating to standard access entitlements that have come into existence under subsections 118NQ(2) and 118NS(2); and

(ii) the fractions of multiplex capacity reserved under subsection 118NR(2); or

(b) at any time after the 12-month period beginning on the digital start-up day for the area, the multiplex capacity available...
under the digital radio multiplex transmitter licence exceeds
the aggregate of:

(i) the fractions of multiplex capacity relating to standard
access entitlements that have come into existence under
subsections 118NQ(2) and 118NS(2); and

(ii) the fractions of multiplex capacity reserved under
subsection 118NR(2);

and an access undertaking is in force in relation to the licence.

Initial level of demand for access to excess multiplex capacity must be ascertained

(2) If paragraph (1)(a) applies, the digital radio multiplex transmitter
licensee must:

(a) within 90 days after the digital radio start-up day for the
designated BSA radio area, ascertain the level of demand for
access to that excess multiplex capacity from content service
providers who are entitled to provide one or more content
services in the designated BSA radio area; and

(b) by notice published on the licensee’s website:

(i) give at least 30 days notice of the licensee’s intention to
ascertain the level of demand as mentioned in
paragraph (a); and

(ii) invite content service providers to express an interest in
having access to that excess multiplex capacity.

Subsequent level of demand for access to excess multiplex capacity may be ascertained

(3) If paragraph (1)(b) applies, the following provisions have effect:

(a) the digital radio multiplex transmitter licensee may ascertain
the level of demand for access to that excess multiplex
capacity from content service providers who are entitled to
provide one or more content services in the designated BSA
radio area; and

(b) if the licensee proposes to ascertain the level of demand as
mentioned in paragraph (a)—the digital radio multiplex
transmitter licensee must, by notice published on the
licensee’s website:
(i) give at least 30 days notice of the licensee’s intention to ascertain the level of demand as mentioned in paragraph (a); and
(ii) invite content service providers to express an interest in having access to that excess multiplex capacity.

Demand falls short of excess multiplex capacity

(4) If the demand from interested content service providers for access to that excess multiplex capacity, as ascertained under whichever of subsection (2) or (3) is applicable, falls short of that excess multiplex capacity—each interested content service provider:
   (a) is entitled to access to the fraction of multiplex capacity sought by the interested content service provider (which entitlement is called an excess-capacity access entitlement); and
   (b) may only use that excess-capacity access entitlement for the purpose of providing one or more content services in the designated BSA radio area; and
   (c) may transfer that excess-capacity access entitlement to another content service provider who is entitled to provide one or more content services in the designated BSA radio area.

(5) The excess-capacity access entitlement referred to in paragraph (4)(a) commences:
   (a) at the end of the 30-day period beginning on the day on which the demand from interested content service providers is ascertained under whichever of subsection (2) or (3) is applicable; or
   (b) if the digital radio multiplex transmitter licensee agrees to an earlier time—at that earlier time.

Demand is greater than excess multiplex capacity

(6) If the demand from interested content service providers for access to that excess multiplex capacity, as ascertained under whichever of subsection (2) or (3) is applicable, is greater than that excess multiplex capacity, the digital radio multiplex transmitter licensee must:
   (a) use an open and transparent auction process to determine which content service providers are to have access to which
fractions of multiplex capacity for the purpose of providing one or more content services in the designated BSA radio area; and

(b) do so before the end of the 60-day period beginning on the day on which the demand from interested content service providers is ascertained under whichever of subsection (2) or (3) is applicable.

(7) If, as a result of an auction process mentioned in subsection (6), a content service provider is to have access to a particular fraction of multiplex capacity, the content service provider:

(a) is entitled to access to that fraction of multiplex capacity (which entitlement is called an excess-capacity access entitlement); and

(b) may only use that excess-capacity access entitlement for the purpose of providing one or more content services in the designated BSA radio area; and

(c) may transfer that excess-capacity access entitlement to another content service provider who is entitled to provide one or more content services in the designated BSA radio area.

(8) The excess-capacity access entitlement referred to in paragraph (7)(a) commences:

(a) at the end of the 30-day period beginning on the day on which the auction process mentioned in subsection (6) is completed; or

(b) if the digital radio multiplex transmitter licensee agrees to an earlier time—at that earlier time.

(9) For the purposes of the application of paragraph (8)(a) to a content service provider, the auction process mentioned in subsection (6) is completed when the content service provider makes the relevant auction payment.

(10) If an excess-capacity access entitlement is transferred as mentioned in paragraph (4)(c) or (7)(c):

(a) the excess-capacity access entitlement may be further transferred, or successively transferred, so long as the holder for the time being of the excess-capacity access entitlement is a content service provider who is entitled to provide content services in the designated BSA radio area; and
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(b) the holder for the time being of the excess-capacity access entitlement is entitled to access to the relevant fraction of multiplex capacity under the digital radio multiplex transmitter licence for the purpose of providing one or more content services in the designated BSA radio area.

(11) This section has effect subject to section 118NV.

118NU Distributed-capacity access entitlements etc.

Scope

(1) This section applies to a non-foundation digital radio multiplex transmitter licence for a designated BSA radio area if an access undertaking is in force for the licence.

Initial level of demand for access to multiplex capacity must be ascertained

(2) The following provisions have effect:

(a) the digital radio multiplex transmitter licensee must, before commencing to transmit a content service, ascertain the level of demand for access to multiplex capacity from content service providers who are entitled to provide one or more content services in the designated BSA radio area; and

(b) if the licensee proposes to ascertain the level of demand as mentioned in paragraph (a)—the digital radio multiplex transmitter licensee must, by notice published on the licensee’s website:

(i) give at least 30 days notice of the licensee’s intention to ascertain the level of demand as mentioned in paragraph (a); and

(ii) invite content service providers to express an interest in having access to that multiplex capacity.

Subsequent level of demand for access to multiplex capacity may be ascertained

(3) The following provisions have effect:

(a) the digital radio multiplex transmitter licensee may, at any time after commencing to transmit a content service, ascertain the level of demand for access to multiplex capacity
from content service providers who are entitled to provide one or more content services in the designated BSA radio area; and

(b) if the licensee proposes to ascertain the level of demand as mentioned in paragraph (a)—the digital radio multiplex transmitter licensee must, by notice published on the licensee’s website:

(i) give at least 30 days notice of the licensee’s intention to ascertain the level of demand as mentioned in paragraph (a); and

(ii) invite content service providers to express an interest in having access to that multiplex capacity.

Demand falls short of multiplex capacity

(4) If the demand from interested content service providers for access to multiplex capacity, as ascertained under whichever of subsection (2) or (3) is applicable, falls short of the multiplex capacity—each interested content service provider:

(a) is entitled to access to the fraction of multiplex capacity sought by the interested content service provider (which entitlement is called a distributed-capacity access entitlement); and

(b) may only use that distributed-capacity access entitlement for the purpose of providing one or more content services in the designated BSA radio area; and

(c) may transfer that distributed-capacity access entitlement to another content service provider who is entitled to provide one or more content services in the designated BSA radio area.

(5) The distributed-capacity access entitlement referred to in paragraph (4)(a) commences:

(a) at the end of the 30-day period beginning on the day on which the demand from interested content service providers is ascertained under whichever of subsection (2) or (3) is applicable; or

(b) if the digital radio multiplex transmitter licensee agrees to an earlier time—at that earlier time.
Demand is greater than multiplex capacity

(6) If the demand from interested content service providers for access to multiplex capacity, as ascertained under whichever of subsection (2) or (3) is applicable, is greater than the multiplex capacity, the digital radio multiplex transmitter licensee must:
(a) use an open and transparent auction process to determine which content service providers are to have access to which fractions of multiplex capacity for the purpose of providing one or more content services in the designated BSA radio area; and
(b) do so before the end of the 60-day period beginning on the day on which the demand from interested content service providers is ascertained under whichever of subsection (2) or (3) is applicable.

(7) If, as a result of an auction process mentioned in subsection (6), a content service provider is to have access to a particular fraction of multiplex capacity, the content service provider:
(a) is entitled to access to that fraction of multiplex capacity (which entitlement is called a distributed-capacity access entitlement); and
(b) may only use that distributed-capacity access entitlement for the purpose of providing one or more content services in the designated BSA radio area; and
(c) may transfer that distributed-capacity access entitlement to another content service provider who is entitled to provide one or more content services in the designated BSA radio area.

(8) The distributed-capacity access entitlement referred to in paragraph (7)(a) commences:
(a) at the end of the 30-day period beginning on the day on which the auction process mentioned in subsection (6) is completed; or
(b) if the digital radio multiplex transmitter licensee agrees to an earlier time—at that earlier time.

(9) For the purposes of the application of paragraph (8)(a) to a content service provider, the auction process mentioned in subsection (6) is completed when the content service provider makes the relevant auction payment.
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(10) If a distributed-capacity access entitlement is transferred as mentioned in paragraph (4)(c) or (7)(c):

(a) the distributed-capacity access entitlement may be further transferred, or successively transferred, so long as the holder for the time being of the distributed-capacity access entitlement is a content service provider who is entitled to provide content services in the designated BSA radio area; and

(b) the holder for the time being of the distributed-capacity access entitlement is entitled to access to the relevant fraction of multiplex capacity under the digital radio multiplex transmitter licence for the purpose of providing one or more content services in the designated BSA radio area.

(11) This section has effect subject to section 118NV.

118NV Capacity cap—digital commercial radio broadcasting licensees

(1) If there is only one digital radio multiplex transmitter licence for a designated BSA radio area, a digital commercial radio broadcasting licensee is not entitled to access to more than two-ninths of multiplex capacity under the digital radio multiplex transmitter licence for the purposes of providing, under the digital commercial radio broadcasting licence, one or more digital commercial digital radio broadcasting services in the designated BSA radio area.

(2) If there are 2 or more digital radio multiplex transmitter licences for a designated BSA radio area, a digital commercial radio broadcasting licensee is not entitled to access to more than the designated fraction of the total multiplex capacities under those digital radio multiplex transmitter licences for the purposes of providing, under the digital commercial radio broadcasting licence, one or more digital commercial digital radio broadcasting services in the designated BSA radio area.

(3) For the purposes of subsection (2), the designated fraction of the total multiplex capacities under those digital radio multiplex transmitter licences is as follows:
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**118NW Suspension of access entitlements**

(1) A standard access entitlement that relates to a digital radio multiplex transmitter licence is suspended while the licence is suspended.

(2) An excess-capacity access entitlement that relates to a digital radio multiplex transmitter licence is suspended while the licence is suspended.

(3) A distributed-capacity access entitlement that relates to a digital radio multiplex transmitter licence is suspended while the licence is suspended.

**118NX Transfer of digital radio multiplex transmitter licence**

*Standard access entitlement*

(1) To avoid doubt, if:

   (a) a content service provider has a standard access entitlement in relation to a fraction of multiplex capacity under a digital radio multiplex transmitter licence; and
   (b) the licence is transferred;

the transfer does not affect the continuity of the standard access entitlement.

(2) Subsection (1) does not prevent:

   (a) the transfer of a standard access entitlement under subsection 118NQ(7) or 118NS(2) or (3); or
   (b) the revocation of a notice given under subsection 118NR(3), (7) or (10).

*Excess-capacity access entitlement*

(3) To avoid doubt, if:

   (a) a content service provider has an excess-capacity access entitlement in relation to a fraction of multiplex capacity under a digital radio multiplex transmitter licence; and
(b) the licence is transferred;
the transfer does not affect the continuity of the excess-capacity
access entitlement.

(4) Subsection (3) does not prevent the transfer of an excess-capacity
access entitlement.

Distributed-capacity access entitlement

(5) To avoid doubt, if:
(a) a content service provider has a distributed-capacity access
entitlement in relation to a fraction of multiplex capacity
under a digital radio multiplex transmitter licence; and
(b) the licence is transferred;
the transfer does not affect the continuity of the
distributed-capacity access entitlement.

(6) Subsection (5) does not prevent the transfer of a
distributed-capacity access entitlement.

118NY Renewal of digital radio multiplex transmitter licence

Standard access entitlement

(1) If:
(a) a digital radio multiplex transmitter licence is renewed; and
(b) immediately before the expiry of the original licence, a
content service provider held a standard access entitlement in
relation to a fraction of multiplex capacity under the licence;
the entitlement remains in existence while the new licence is in
force, as if it were a standard access entitlement in relation to the
new licence.

(2) Subsection (1) does not prevent:
(a) the transfer of a standard access entitlement under subsection
118NQ(7) or 118NS(2) or (3); or
(b) the revocation of a notice given under subsection 118NR(3),
(7) or (10).
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Excess-capacity access entitlement

(3) If:
   (a) a digital radio multiplex transmitter licence is renewed; and
   (b) immediately before the expiry of the original licence, a content service provider held an excess-capacity access entitlement in relation to a fraction of multiplex capacity under the licence;
the entitlement remains in existence while the new licence is in force, as if it were an excess-capacity access entitlement in relation to the new licence.

(4) Subsection (3) does not prevent the transfer of an excess-capacity access entitlement.

Distributed-capacity access entitlement

(5) If:
   (a) a digital radio multiplex transmitter licence is renewed; and
   (b) immediately before the expiry of the original licence, a content service provider held a distributed-capacity access entitlement in relation to a fraction of multiplex capacity under the licence;
the entitlement remains in existence while the new licence is in force, as if it were a distributed-capacity access entitlement in relation to the new licence.

(6) Subsection (5) does not prevent the transfer of a distributed-capacity access entitlement.

Subdivision D—Enforcement

118NZ  Judicial enforcement of access obligations etc.

(1) If the Federal Court is satisfied that a digital radio multiplex transmitter licensee, or a person authorised by a digital radio multiplex transmitter licensee to operate a multiplex transmitter under the licence, has contravened any of the following obligations:
   (a) the standard access obligations (if any) that are applicable to the licence;

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(b) the excess-capacity access obligations (if any) that are applicable to the licence;
(c) the distributed-capacity access obligations (if any) that are applicable to the licence;
(d) the obligations that are applicable to the licence under section 118NP;

the Court may, on the application of:
(e) the ACCC; or
(f) any person whose interests are affected by the contravention;

make all or any of the following orders:
(g) an order directing the licensee or the person so authorised to comply with the obligation;
(h) an order directing the licensee or the person so authorised to compensate any other person who had suffered loss or damage as a result of the contravention;
(i) any other order that the Court thinks appropriate.

(2) The Federal Court may discharge or vary an order granted under this section.

118P Enforcement of access undertakings

(1) This section applies if an access undertaking is in force in relation to a digital radio multiplex transmitter licence.

(2) If:
(a) the ACCC; or
(b) a person (the affected person) whose interests are affected by the access undertaking;

thinks that another person (the third person) has breached the access undertaking, the ACCC or the affected person may apply to the Federal Court for an order under subsection (3).

(3) If the Federal Court is satisfied that the third person has breached the access undertaking, the Court may make all or any of the following orders:
(a) an order directing the third person to comply with the access undertaking;
(b) an order directing the third person to compensate any other person who has suffered loss or damage as a result of the breach;
(c) any other order that the Court thinks appropriate.

(4) The Federal Court may discharge or vary an order granted under this section.

Subdivision E—External audits

118PA External audits

Scope

(1) This section applies if:

(a) an access undertaking is in force in relation to a digital radio multiplex transmitter licence; and

(b) a person is:

(i) the licensee of the licence; or

(ii) a person authorised by the licensee to operate a multiplex transmitter under the licence; and

(c) the ACCC has reasonable grounds to suspect that the person has breached, is breaching, or is proposing to breach:

(i) the access undertaking; or

(ii) any of the standard access obligations (if any) that are applicable to the licence; or

(iii) any of the excess-capacity access obligations (if any) that are applicable to the licence; or

(iv) any of the distributed-capacity access obligations (if any) that are applicable to the licence; or

(v) the obligations that are applicable to the licence under section 118NP.

Requirement

(2) The ACCC may, by written notice given to the person, require the person to:

(a) appoint an external auditor; and

(b) arrange for the external auditor to carry out an external audit of whichever of the following is specified in the notice:

(i) the person’s compliance with the access undertaking; or

(ii) one or more specified aspects of the person’s compliance with the access undertaking; or
(iii) the person’s compliance with the standard access obligations (if any) that are applicable to the licence; or
(iv) one or more specified aspects of the person’s compliance with the standard access obligations (if any) that are applicable to the licence; or
(v) the person’s compliance with the excess-capacity access obligations (if any) that are applicable to the licence; or
(vi) one or more specified aspects of the person’s compliance with the excess-capacity access obligations (if any) that are applicable to the licence; or
(vii) the person’s compliance with the distributed-capacity access obligations (if any) that are applicable to the licence; or
(viii) one or more specified aspects of the person’s compliance with the distributed-capacity access obligations (if any) that are applicable to the licence; or
(ix) the person’s compliance with the obligations that are applicable to the licence under section 118NP; or
(x) one or more specified aspects of the person’s compliance with the obligations that are applicable to the licence under section 118NP; and
(c) arrange for the external auditor to give the person a written report (the audit report) setting out the results of the audit; and
(d) give the ACCC a copy of the audit report within:
   (i) the period specified in the notice; or
   (ii) if the ACCC allows a longer period—that longer period.

(3) The notice must specify:
   (a) the matters to be covered by the audit; and
   (b) the form of the audit report and the kinds of details it is to contain.

(4) The matters that may be specified under paragraph (3)(a) may include any or all of the following:
   (a) an assessment of the person’s existing capacity to comply with the access undertaking;
   (b) an assessment of what the person will need to do, or continue to do, to comply with the access undertaking;

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(c) an assessment of the person’s existing capacity to comply with the standard access obligations (if any) that are applicable to the licence;
(d) an assessment of what the person will need to do, or continue to do, to comply with the standard access obligations (if any) that are applicable to the licence;
(e) an assessment of the person’s existing capacity to comply with the excess-capacity obligations (if any) that are applicable to the licence;
(f) an assessment of what the person will need to do, or continue to do, to comply with the excess-capacity obligations (if any) that are applicable to the licence;
(g) an assessment of the person’s existing capacity to comply with the distributed-capacity obligations (if any) that are applicable to the licence;
(h) an assessment of what the person will need to do, or continue to do, to comply with the distributed-capacity obligations (if any) that are applicable to the licence;
(i) an assessment of the person’s existing capacity to comply with the obligations that are applicable to the licence under section 118NP;
(j) an assessment of what the person will need to do, or continue to do, to comply with the obligations that are applicable to the licence under section 118NP.

(5) Subsection (4) does not limit paragraph (3)(a).

Compliance

(6) The person must comply with a notice under subsection (2).

118PB  Eligibility for appointment

(1) An individual is not eligible to be appointed by a person (the first person) in accordance with a requirement covered by paragraph 118PA(2)(a) if the individual is an officer, employee or agent of:
(a) the first person; or
(b) another person who is in a position to exercise control of the digital radio multiplex transmitter licence concerned; or
(c) a company, where another person is in a position to exercise control of the company and the digital radio multiplex transmitter licence concerned.

Application of control rules

(2) Schedule 1 to the Broadcasting Services Act 1992 applies for the purposes of paragraphs (1)(b) and (c) in a corresponding way to the way in which it applies for the purposes of Part 5 of that Act.

118PC External auditor may have regard to the results of previous audit

In carrying out an external audit in accordance with a notice under section 118PA, an external auditor may, if:

(a) an external audit was completed under that section within the last preceding 2 years; and

(b) the external auditor is satisfied that the previous audit is still relevant;

have regard to the results of the previous audit.

118PD External auditors

(1) The ACCC may, by writing, authorise a specified individual to be an external auditor for the purposes of this Division.

Note 1: For specification by class, see subsection 46(3) of the Acts Interpretation Act 1901.

Note 2: For variation and revocation, see subsection 33(3) of the Acts Interpretation Act 1901.

(2) An authorisation under subsection (1) is not a legislative instrument.

Subdivision F—Review of decisions

118PE Review by Australian Competition Tribunal

(1) A person whose interests are affected by a decision of the ACCC under subsection 118NF(2) or (5) or 118NH(3), (6) or (11) may apply in writing to the Australian Competition Tribunal for a review of the decision.
(2) The application must be made within 21 days after the ACCC made the decision.

(3) The Australian Competition Tribunal must review the decision.

118PF Functions and powers of Australian Competition Tribunal

Decision on review

(1) On a review of a decision of the ACCC under subsection 118NF(2) or (5) or 118NH(3), (6) or (11), the Australian Competition Tribunal may make a decision:

(a) in any case—affirming the ACCC’s decision; or

(b) in the case of a review of a decision of the ACCC under subsection 118NF(2) to accept an access undertaking—setting aside the ACCC’s decision; or

(c) in the case of a review of a decision of the ACCC under subsection 118NF(2) to reject an access undertaking—both:

(i) setting aside the ACCC’s decision; and

(ii) in substitution for the decision so set aside, to accept the undertaking; or

(d) in the case of a review of a decision of the ACCC to make a determination under subsection 118NF(5)—setting aside the ACCC’s decision; or

(e) in the case of a review of a decision of the ACCC to make a determination under subsection 118NF(5)—both:

(i) setting aside the ACCC’s decision; and

(ii) in substitution for the decision so set aside, to make a determination under that subsection; or

(f) in the case of a review of a decision of the ACCC under subsection 118NH(3) to accept a variation of an access undertaking—setting aside the ACCC’s decision; or

(g) in the case of a review of a decision of the ACCC under subsection 118NH(3) to reject a variation of an access undertaking—both:

(i) setting aside the ACCC’s decision; and

(ii) in substitution for the decision so set aside, to accept the variation; or
(h) in the case of a review of a decision of the ACCC to make a determination under subsection 118NH(6) or (11)—setting aside the ACCC’s decision; or

(i) in the case of a review of a decision of the ACCC to make a determination under subsection 118NH(6) or (11)—both:
   (i) setting aside the ACCC’s decision; and
   (ii) in substitution for the decision so set aside, to make a determination under that subsection;

and, for the purposes of the review, the Australian Competition Tribunal may perform all the functions and exercise all the powers of the ACCC.

(2) A decision by the Australian Competition Tribunal:
   (a) affirming a decision of the ACCC; or
   (b) setting aside a decision of the ACCC; or
   (c) made in substitution for a decision of the ACCC;

is taken, for the purposes of this Act (other than section 118PE or this section), to be a decision of the ACCC.

Conduct of review

(3) For the purposes of a review by the Australian Competition Tribunal, the member of the Australian Competition Tribunal presiding at the review may require the ACCC to give such information, make such reports and provide such other assistance to the Australian Competition Tribunal as the member specifies.

(4) For the purposes of a review, the Australian Competition Tribunal may have regard only to:
   (a) any information given, documents produced or evidence given to the ACCC in connection with the making of the decision to which the review relates; and
   (b) any other information that was referred to in the ACCC’s reasons for making the decision to which the review relates.

Australian Competition Tribunal to make decision within 6 months

(5) If:
   (a) a person applies to the Australian Competition Tribunal for a review of a decision of the ACCC under subsection 118NF(2) or (5) or 118NH(3), (6) or (11); and
(b) the Australian Competition Tribunal does not make a
decision under subsection (1) of this section on the review
within 6 months after receiving the application for review;
the Australian Competition Tribunal is taken to have made, at the
end of that 6-month period, whichever of the following decisions is
applicable:

(c) in the case of a review of a decision of the ACCC under
subsection 118NF(2) to accept an access undertaking—a
decision setting aside the ACCC’s decision;

(d) in the case of a review of a decision of the ACCC under
subsection 118NF(2) to reject an access undertaking:
(i) a decision setting aside the ACCC’s decision; and
(ii) in substitution for the decision so set aside, a decision to
accept the undertaking;

(e) in the case of a review of a decision of the ACCC to make a
determination under subsection 118NF(5)—a decision setting
aside the ACCC’s decision; or

(f) in the case of a review of a decision of the ACCC under
subsection 118NH(3) to accept a variation of an access
undertaking—a decision setting aside the ACCC’s decision;

(g) in the case of a review of a decision of the ACCC under
subsection 118NH(3) to reject a variation of an access
undertaking:
(i) a decision setting aside the ACCC’s decision; and
(ii) in substitution for the decision so set aside, a decision to
accept the variation;

(h) in the case of a review of a decision of the ACCC to make a
determination under subsection 118NH(6) or (11)—a
decision setting aside the ACCC’s decision.

Extension of decision-making period

(6) The Australian Competition Tribunal may, by written notice given
to the applicant for review, extend or further extend the 6-month
period referred to in subsection (5), so long as:

(a) the extension or further extension is for a period of not more
than 3 months; and

(b) the notice includes a statement explaining why the Australian
Competition Tribunal has been unable to make a decision on

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the review within that 6-month period or that 6-month period
as previously extended, as the case may be.

(7) As soon as practicable after the Australian Competition Tribunal
gives a notice under subsection (6), the Australian Competition
Tribunal must cause a copy of the notice to be made available on
the internet.

*Time of acceptance of undertaking*

(8) To avoid doubt, if the Australian Competition Tribunal makes a
decision to accept an access undertaking, the time of acceptance of
the undertaking is the time when the Australian Competition
Tribunal made its decision.

Note: Division 2 of Part IX of the *Competition and Consumer Act 2010*
applies to proceedings before the Australian Competition Tribunal.

### 118PG Provisions that do not apply in relation to a Australian
Competition Tribunal review

Division 1 of Part IX of the *Competition and Consumer Act 2010*
does not apply in relation to a review by the Australian
Competition Tribunal of a decision made by the ACCC under
subsection 118NF(2) or (5) or 118NH(3), (6) or (11).

### 118PH Statement of reasons for reviewable decision—specification
of documents

(1) If the ACCC:
   (a) makes a decision referred to in section 118PE; and
   (b) gives a person a written statement setting out the reasons for
       the decision;
       the statement must specify the documents that the ACCC examined
       in the course of making the decision.

(2) If a document is specified under subsection (1), information in the
document is taken, for the purposes of paragraph 118PF(4)(b), to
be referred to in the ACCC’s reasons for making the decision.
Subdivision G—Injunctions

118PI Injunctions

Restraining injunctions

(1) If:
   (a) a person is:
       (i) a digital radio multiplex transmitter licensee; or
       (ii) a person authorised by a digital radio multiplex
            transmitter licensee to operate a multiplex transmitter
            under the licence; and
   (b) the person has engaged, is engaging or is proposing to
       engage, in any conduct in contravention of this Division;
       the Federal Court may, on the application of the ACCC, grant an
       injunction:
       (c) restraining the person from engaging in the conduct; and
       (d) if, in the court’s opinion, it is desirable to do so—requiring
           the person to do something.

Performance injunctions

(2) If:
   (a) a person is:
       (i) a digital radio multiplex transmitter licensee; or
       (ii) a person authorised by a digital radio multiplex
            transmitter licensee to operate a multiplex transmitter
            under the licence; and
   (b) the person has refused or failed, or is refusing or failing, or is
       proposing to refuse or fail, to do an act or thing; and
   (c) the refusal or failure was, is or would be a contravention of
       this Division;
       the Federal Court may, on the application of the ACCC, grant an
       injunction requiring the person to do that act or thing.
118PJ Interim injunctions

Grant of interim injunction

(1) If an application is made to the Federal Court for an injunction under section 118PI against a person who is:
   (a) a digital radio multiplex transmitter licensee; or
   (b) a person authorised by a digital radio multiplex transmitter licensee to operate a multiplex transmitter under the licence;
the court may, before considering the application, grant an interim injunction restraining the person from engaging in conduct of a kind referred to in that section.

No undertakings as to damages

(2) The Federal Court is not to require an applicant for an injunction under section 118PI, as a condition of granting an interim injunction, to give any undertakings as to damages.

118PK Discharge or variation of injunctions

The Federal Court may discharge or vary an injunction granted under this Subdivision.

118PL Certain limits on granting injunctions not to apply

Restraining injunctions

(1) The power of the Federal Court under this Subdivision to grant an injunction restraining a person from engaging in conduct of a particular kind may be exercised:
   (a) if the court is satisfied that the person has engaged in conduct of that kind—whether or not it appears to the court that the person intends to engage again, or to continue to engage, in conduct of that kind; or
   (b) if it appears to the court that, if an injunction is not granted, it is likely that the person will engage in conduct of that kind—whether or not the person has previously engaged in conduct of that kind and whether or not there is an imminent danger of substantial damage to any person if the person engages in conduct of that kind.
Performance injunctions

(2) The power of the Federal Court to grant an injunction requiring a person to do an act or thing may be exercised:

(a) if the court is satisfied that the person has refused or failed to do that act or thing—whether or not it appears to the court that the person intends to refuse or fail again, or to continue to refuse or fail, to do that act or thing; or

(b) if it appears to the court that, if an injunction is not granted, it is likely that the person will refuse or fail to do that act or thing—whether or not the person has previously refused or failed to do that act or thing and whether or not there is an imminent danger of substantial damage to any person if the person refuses or fails to do that act or thing.

118PM Other powers of the Federal Court unaffected

The powers conferred on the Federal Court under this Subdivision are in addition to, and not instead of, any other powers of the court, whether conferred by this Act or otherwise.

Subdivision H—Miscellaneous

118PN Annual reports

(1) This section applies if an access undertaking in relation to a digital radio multiplex transmitter licence was in force during the whole or a part of a financial year.

(2) The licensee must, within 60 days after the end of the financial year, give the ACCC a report about such matters as:

(a) are specified in the Procedural Rules; and

(b) relate to:

(i) compliance during that financial year with the access undertaking; or

(ii) compliance during that financial year with the standard access obligations (if any) applicable to the licence; or

(iii) compliance during that financial year with the excess-capacity access obligations (if any) applicable to the licence; or
(iv) compliance during that financial year with the distributed-capacity access obligations (if any) applicable to the licence; or

(v) compliance during that financial year with the obligations that are applicable to the licence under section 118NP.

118PO Procedural Rules

(1) The ACCC may, by legislative instrument, make rules:
   (a) making provision for, or in relation to, the practice and procedure to be followed by the ACCC in performing functions, or exercising powers, under this Division; or
   (b) making provision for, or in relation to, all matters and things incidental to any such practice or procedure, or necessary or convenient to be prescribed for the conduct of any business of the ACCC under this Division; or
   (c) prescribing matters required or permitted by any other provision of this Division to be prescribed by the Procedural Rules.

(2) Rules under subsection (1) are to be known as Procedural Rules.

(3) The Procedural Rules may make provision for, or in relation to, any or all of the following:
   (a) the confidentiality of information or documents given to the ACCC by a person who gave the ACCC an access undertaking or a variation of an access undertaking;
   (b) the form and content of access undertakings, variations or other documents given to the ACCC under this Division;
   (c) requiring the ACCC to give information to the ACMA about the operation of this Division;
   (d) requiring the ACMA to give information to the ACCC that is relevant to the operation of this Division.

(4) The Procedural Rules may make provision for, or in relation to, a matter by empowering the ACCC to make decisions of an administrative character.
(5) The Procedural Rules may provide that the ACCC may refuse to consider an access undertaking if:
   (a) the ACCC is satisfied that the access undertaking:
       (i) is frivolous; or
       (ii) is vexatious; or
       (iii) was not given in good faith; or
   (b) the ACCC has reason to believe that the access undertaking was given for the purpose, or for purposes that include the purpose, of frustrating or undermining the effective administration of this Division.

(6) Subsections (3), (4) and (5) do not limit subsection (1).

118PP  Constitutional safety net

(1) If the operation of this Division or section 109C would result in an acquisition of property from a person otherwise than on just terms, the Commonwealth is liable to pay a reasonable amount of compensation to the person.

(2) If the Commonwealth and the person do not agree on the amount of the compensation, the person may institute proceedings in the Federal Court for the recovery from the Commonwealth of such reasonable amount of compensation as the court determines.

(3) In this section:

   *acquisition of property* has the same meaning as in paragraph 51(xxxi) of the Constitution.

   *just terms* has the same meaning as in paragraph 51(xxxi) of the Constitution.
Division 4C—Access to broadcasting transmission towers etc. by digital radio multiplex transmitter licensees and authorised persons

Subdivision A—Introduction

118Q  Simplified outline

The following is a simplified outline of this Division:

- The owner or operator of a broadcasting transmission tower must provide the following persons with access to the tower:
  - (a) digital radio multiplex transmitter licensees;
  - (b) persons authorised by digital radio multiplex transmitter licensees under section 114.

- The owner or operator of a designated associated facility must provide the following persons with access to the facility:
  - (a) digital radio multiplex transmitter licensees;
  - (b) persons authorised by digital radio multiplex transmitter licensees under section 114.

- The owner or operator of a broadcasting transmission tower must provide the following persons with access to the site of the tower:
  - (a) digital radio multiplex transmitter licensees;
  - (b) persons authorised by digital radio multiplex transmitter licensees under section 114.
Chapter 3  Licensing of radiocommunications
Part 3.3  Apparatus licences
Division 4C  Access to broadcasting transmission towers etc. by digital radio multiplex transmitter licensees and authorised persons

Section 118QA

118QA Definitions

In this Division:

broadcasting transmission tower has the same meaning as in Schedule 4 to the Broadcasting Services Act 1992.

business day means a day that is not a Saturday, a Sunday or a public holiday in the place concerned.

designated associated facility has the meaning given by section 118QB.

designated content service means a service mentioned in paragraph 109B(1)(f), (g) or (h).

facility includes apparatus, equipment, a structure, a line or an electricity cable or wire.

site means:

(a) land; or
(b) a building on land; or
(c) a structure on land.

118QB Designated associated facilities

For the purposes of this Division, a designated associated facility means any of the following facilities:

(a) an antenna;
(b) a combiner;
(c) a feeder system;
(d) a facility of a kind specified in the regulations;
where:
(e) the facility is, or is to be, associated with a radiocommunications transmitter; and
(f) the facility is used, or capable of being used, in connection with the transmission of one or more designated content services.

206  Radiocommunications Act 1992
118QC  Extended meaning of *access*

(1) For the purposes of this Division, *giving access* to a broadcasting transmission tower includes replacing the tower with another tower located on the same site and giving access to the replacement tower.

(2) For the purposes of this Division, *giving access* to a designated associated facility includes:
   (a) replacing the facility with another facility located on the same site and giving access to the replacement facility; or
   (b) giving access to a service provided by means of the designated associated facility.

(3) For the purposes of this Division, *giving access* to a site on which is situated a broadcasting transmission tower includes replacing the tower with another tower located on the site.

Subdivision B—Access to broadcasting transmission towers etc. by digital radio multiplex transmitter licensees

118QD  Access to broadcasting transmission towers

(1) The owner or operator of a broadcasting transmission tower must, if requested to do so by a person (the *access seeker*) who is:
   (a) a digital radio multiplex transmitter licensee; or
   (b) a person authorised by a digital radio multiplex transmitter licensee under section 114;
   give the access seeker access to the tower.

(2) The owner or operator of the broadcasting transmission tower is not required to comply with subsection (1) unless:
   (a) the access is provided for the sole purpose of enabling the access seeker to install or maintain either or both of the following:
      (i) a multiplex transmitter;
      (ii) associated facilities;
   used, or for use, wholly or principally in connection with the transmission of one or more designated content services in accordance with the digital radio multiplex transmitter licence concerned; and
Section 118QE

(b) the access seeker gives the owner or operator reasonable notice that the access seeker requires the access.

Compliance not technically feasible

(3) The owner or operator of a broadcasting transmission tower is not required to comply with subsection (1) if there is in force a written certificate issued by the ACMA stating that, in the ACMA’s opinion, compliance with subsection (1) in relation to that tower is not technically feasible.

(4) In determining whether compliance with subsection (1) in relation to a tower is technically feasible, the ACMA must have regard to:
(a) whether compliance is likely to result in significant difficulties of a technical or engineering nature; and
(b) whether compliance is likely to result in a significant threat to the health or safety of persons who operate, or work on, the tower; and
(c) if compliance is likely to have a result referred to in paragraph (a) or (b)—whether there are practicable means of avoiding such a result, including (but not limited to):
(i) changing the configuration or operating parameters of a facility situated on the tower; and
(ii) making alterations to the tower; and
(d) such other matters (if any) as the ACMA considers relevant.

Issue of certificate

(5) If the ACMA receives a request to make a decision about the issue of a certificate under subsection (3), the ACMA must use its best endeavours to make that decision within 10 business days after the request was made.

118QE Access to designated associated facilities

Scope

(1) This section applies to a designated associated facility if the facility is situated on, at, in or under:
(a) a broadcasting transmission tower; or
(b) the site on which a broadcasting transmission tower is situated.

208 Radiocommunications Act 1992
Access to designated associated facilities

(2) The owner or operator of the designated associated facility must, if requested to do so by a person (the access seeker) who is:
   (a) a digital radio multiplex transmitter licensee; or
   (b) a person authorised by a digital radio multiplex transmitter licensee under section 114;

give the access seeker access to the facility.

(3) The owner or operator of the designated associated facility is not required to comply with subsection (2) unless:
   (a) the access is provided for the sole purpose of enabling the access seeker to use:
      (i) the facility; or
      (ii) a service provided by means of the facility;

wholly or principally in connection with the transmission of one or more designated content services in accordance with the digital radio multiplex transmitter licence concerned; and

(b) the access seeker gives the owner or operator reasonable notice that the access seeker requires the access.

Compliance not technically feasible

(4) The owner or operator of a designated associated facility is not required to comply with subsection (2) if there is in force a written certificate issued by the ACMA stating that, in the ACMA’s opinion, compliance with subsection (2) in relation to that facility is not technically feasible.

(5) In determining whether compliance with subsection (2) in relation to a facility is technically feasible, the ACMA must have regard to:
   (a) whether compliance is likely to result in significant difficulties of a technical or engineering nature; and
   (b) whether compliance is likely to result in a significant threat to the health or safety of persons who operate, or work on, a facility situated on the site; and

(c) if compliance is likely to have a result referred to in paragraph (a) or (b)—whether there are practicable means of avoiding such a result, including (but not limited to):
   (i) changing the configuration or operating parameters of a facility situated on the site; and
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Section 118QF

(ii) making alterations to a facility situated on the site; and
(d) such other matters (if any) as the ACMA considers relevant.

Issue of certificate

(6) If the ACMA receives a request to make a decision about the issue of a certificate under subsection (4), the ACMA must use its best endeavours to make that decision within 10 business days after the request was made.

Exemptions

(7) The regulations may provide for exemptions from subsection (2).

(8) Regulations made for the purposes of subsection (7) may make provision with respect to a matter by conferring on the ACCC a power to make a decision of an administrative character.

118QF  Access to sites of broadcasting transmission towers

(1) The owner or operator of a broadcasting transmission tower must, if requested to do so by a person (the access seeker) who is:
(a) a digital radio multiplex transmitter licensee; or
(b) a person authorised by a digital radio multiplex transmitter licensee under section 114;
give the access seeker access to a site if:
(c) the tower is situated on the site; and
(d) either:
   (i) the site is owned, occupied or controlled by the owner or operator of the tower; or
   (ii) the owner or operator of the tower has a right (either conditional or unconditional) to use the site.

(2) The owner or operator of the broadcasting transmission tower is not required to comply with subsection (1) unless:
(a) the access is provided for the sole purpose of enabling the access seeker to install or maintain either or both of the following:
   (i) a multiplex transmitter;
   (ii) associated facilities;
used, or for use, wholly or principally in connection with the transmission of one or more designated content services in accordance with the digital radio multiplex transmitter licence concerned; and

(b) the access seeker gives the owner or operator reasonable notice that the access seeker requires the access.

Compliance not technically feasible

(3) The owner or operator of a broadcasting transmission tower is not required to comply with subsection (1) if there is in force a written certificate issued by the ACMA stating that, in the ACMA’s opinion, compliance with subsection (1) in relation to that tower is not technically feasible.

(4) In determining whether compliance with subsection (1) in relation to a site is technically feasible, the ACMA must have regard to:

(a) whether compliance is likely to result in significant difficulties of a technical or engineering nature; and

(b) whether compliance is likely to result in a significant threat to the health or safety of persons who operate, or work on, a facility situated on the site; and

(c) if compliance is likely to have a result referred to in paragraph (a) or (b)—whether there are practicable means of avoiding such a result, including (but not limited to):

(i) changing the configuration or operating parameters of a facility situated on the site; and

(ii) making alterations to a facility situated on the site; and

(d) such other matters (if any) as the ACMA considers relevant.

Issue of certificate

(5) If the ACMA receives a request to make a decision about the issue of a certificate under subsection (3), the ACMA must use its best endeavours to make that decision within 10 business days after the request was made.
Section 118QG

118QG Terms and conditions of access

Access to broadcasting transmission towers

(1) The owner or operator of a broadcasting transmission tower must comply with subsection 118QD(1) on such terms and conditions as are:
   (a) agreed between the following parties:
       (i) the owner or operator;
       (ii) the access seeker (within the meaning of that subsection); or
   (b) failing agreement, determined by an arbitrator appointed by the parties.

If the parties fail to agree on the appointment of an arbitrator, the ACCC is to be the arbitrator.

Access to designated associated facilities

(2) The owner or operator of a designated associated facility must comply with subsection 118QE(2) on such terms and conditions as are:
   (a) agreed between the following parties:
       (i) the owner or operator;
       (ii) the access seeker (within the meaning of that subsection); or
   (b) failing agreement, determined by an arbitrator appointed by the parties.

If the parties fail to agree on the appointment of an arbitrator, the ACCC is to be the arbitrator.

Access to sites of broadcasting transmission towers

(3) The owner or operator of a broadcasting transmission tower must comply with subsection 118QF(1) on such terms and conditions as are:
   (a) agreed between the following parties:
       (i) the owner or operator;
       (ii) the access seeker (within the meaning of that subsection); or
Section 118QH

(b) failing agreement, determined by an arbitrator appointed by the parties.

If the parties fail to agree on the appointment of an arbitrator, the ACCC is to be the arbitrator.

**Conduct of arbitration**

(4) The regulations may make provision for and in relation to the conduct of an arbitration under this section.

(5) The regulations may provide that, for the purposes of a particular arbitration conducted by the ACCC under this section, the ACCC may be constituted by a single member, or a specified number of members, of the ACCC. For each such arbitration, that member or those members are to be nominated in writing by the Chair of the ACCC.

(6) Subsection (5) does not limit subsection (4).

**118QH Code relating to access**

(1) The ACCC may, by legislative instrument, make a Code setting out conditions that are to be complied with in relation to the provision of access under this Division.

(2) Before making an instrument under subsection (1), the ACCC must consult:
   (a) digital radio multiplex transmitter licensees; and
   (b) owners and operators of broadcasting transmission towers; and
   (c) owners and operators of designated associated facilities.

(3) An access seeker (within the meaning of subsection 118QD(1), 118QE(2) or 118QF(1)) must comply with the Code.

(4) The owner or operator of a broadcasting transmission tower must comply with the Code, to the extent to which the Code relates to the provision of access under section 118QD or 118QF.

(5) The owner or operator of a designated associated facility must comply with the Code, to the extent to which the Code relates to the provision of access under section 118QE.
Section 118QI

Subdivision C—Miscellaneous

**118QI Arbitration—acquisition of property**

(1) This section applies to a provision of this Division that authorises the conduct of an arbitration (whether by the ACCC or another person).

(2) The provision has no effect to the extent (if any) to which it purports to authorise the acquisition of property if that acquisition:
   (a) is otherwise than on just terms; and
   (b) would be invalid because of paragraph 51(xxxi) of the Constitution.

(3) In this section:

   - *acquisition of property* has the same meaning as in paragraph 51(xxxi) of the Constitution.
   - *just terms* has the same meaning as in paragraph 51(xxxi) of the Constitution.

**118QJ Relationship between this Division and the National Transmission Network Sale Act 1998**

Part 3 of the *National Transmission Network Sale Act 1998* does not apply in relation to an access seeker seeking access to:
   (a) a broadcasting transmission tower; or
   (b) a site;

   to the extent to which this Division applies in relation to the access seeker seeking access to that tower or site.
Division 5—Qualified operators

119 ACMA to determine the need for qualified operators

The ACMA may determine, by written instrument, that persons operating transmitters under transmitter licences included in a class of transmitter licences specified in the instrument must be qualified operators.

120 Applications for certificates of proficiency

(1) A person who wishes to be a qualified operator in relation to one or more such classes of transmitter licences may apply to the ACMA for a certificate of proficiency.

(2) The application must be in a form approved by the ACMA.

121 Issuing certificates of proficiency

(1) Subject to section 122, the ACMA may issue to the applicant a certificate of proficiency in writing certifying that the holder of the certificate is taken to be a qualified operator in relation to a specified class of transmitter licences.

(2) The classes of transmitter licences so specified are to be any or all of the classes of transmitter licences for which determinations under section 119 are in force.

(3) If the ACMA refuses to issue a certificate of proficiency, it must give the applicant a written notice of the refusal together with a statement of its reasons.

Note: Refusals to issue certificates of proficiency are reviewable under Part 5.6.

122 Restrictions on issuing certificates of proficiency

(1) The ACMA must not issue a certificate of proficiency unless:

(a) the ACMA is satisfied that the applicant has reached the minimum age in relation to the class of certificates in which the certificate is included; and
(b) the ACMA:
   (i) is satisfied that the applicant has achieved satisfactory results in approved examinations or in examinations conducted under the regulations; or
   (ii) is satisfied, upon reasonable grounds, that the applicant would probably achieve such results.

(2) In this section:

approved examination means an examination conducted by:
   (a) the ACMA; or
   (b) a body or organisation approved by the ACMA, by written instrument, for the purposes of this section; or
   (c) an examination approved by the ACMA, by written instrument, for the purposes of this section.

minimum age, in relation to a class of certificates, means the age that the ACMA, by notice published in the Gazette, declares to be the minimum age for the purposes of this section in relation to that class.

122A Delegating the power to issue certificates of proficiency

(1) The ACMA may, by writing, delegate the power to issue a certificate of proficiency under section 121 to a body or organisation approved by the ACMA as mentioned in paragraph (b) of the definition of approved examination in subsection 122(2).

(1A) If, under section 50 of the Australian Communications and Media Authority Act 2005, the ACMA has delegated the power referred to in subsection (1) of this section to a Division of the ACMA, the following provisions have effect:
   (a) the Division may delegate the power to a body or organisation referred to in subsection (1) of this section;
   (b) subsections 52(2), (3), (4), (5) and (6) of the Australian Communications and Media Authority Act 2005 have effect as if the delegation by the Division were a delegation under section 52 of that Act.
(2) However, the delegate is not entitled to make a final decision refusing to issue a certificate of proficiency. If the delegate decides not to issue the certificate, the delegate must refer the application, for a final decision, to:
   (a) the ACMA, if the delegation to the delegate was under subsection (1); or
   (b) the Division that delegated the power, if the delegation to the delegate was under subsection (1A).

(3) The powers conferred on the ACMA by subsection (1), and on a Division of the ACMA by subsection (1A), are in addition to the powers conferred by section 238 of this Act and by sections 50, 51 and 52 of the Australian Communications and Media Authority Act 2005.

123 Re-examination of qualified operators

(1) If, at any time:
   (a) the ACMA has reasonable grounds for believing that a qualified operator will probably be unable to achieve satisfactory results in an examination of the kind referred to in paragraph 122(1)(b);
the ACMA may:
   (b) give to the operator a written request that the operator submit himself or herself to an examination, or a further examination, of that kind.

(2) The request must set out:
   (a) particulars of the examination in question; and
   (b) the time and place of the examination; and
   (c) the effect of subparagraph 124(3)(b)(iii).

124 Cancelling certificates of proficiency

(1) The ACMA may, by written notice given to a qualified operator, cancel the operator’s certificate of proficiency.

(2) The notice must give the reasons for the cancellation.

(3) In deciding whether to cancel the certificate, the ACMA must have regard to:
   (a) all matters that it considers relevant; and
(b) without limiting paragraph (a), the following matters:
   (i) any matters to which the ACMA must have regard in deciding whether to issue a certificate of proficiency;
   (ii) whether the ACMA is satisfied, that the operator has failed to achieve satisfactory results in an examination or further examination referred to in section 123;
   (iii) whether the operator has refused or failed, without reasonable excuse, to comply with a request under section 123;
   (iv) whether the operator has been convicted of an offence against the regulations;
   (iva) whether the operator has been convicted of an offence against section 136.1 or 137.1 of the Criminal Code that relates to this Act;
   (v) whether the ACMA is satisfied that the operator has contravened rules relating to the conduct or administration of an examination of the kind referred to in paragraph 122(1)(b).

Note: Cancellations of certificates of proficiency are reviewable under Part 5.6.

(4) If:
   (a) a person has been issued with a certificate of proficiency; and
   (b) the ACMA subsequently cancels the certificate;
the person must not fail to return the certificate to the ACMA, either by hand or by certified mail, within 7 days after receiving notification of the cancellation.

Penalty: 20 penalty units.

(5) Subsection (4) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (5) (see subsection 13.3(3) of the Criminal Code).

(6) Subsection (4) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.
Division 6—Suspending and cancelling apparatus licences:
general

Subdivision A—General provisions

125 Application of this Subdivision

(1) Subject to subsection (2), this Subdivision applies to an apparatus licence if the ACMA is satisfied that the licensee, or a person authorised by the licensee to operate a radiocommunications device under the licence, has:

(a) contravened a condition of the licence (other than a condition set out in paragraph 109A(1)(g), (ga), (i), (ia), (ib), (ic), (id), (ie), (if), (ij) or (j) or subsection 109A(2) or (3)), or in any other way contravened this Act; or

(b) operated a radiocommunications device under the licence, or purportedly under the licence:

(i) in contravention of any other law (whether written or unwritten) of the Commonwealth, a State or a Territory; or

(ii) in the course of contravening such a law.

(2) This Subdivision does not apply to transmitter licences issued under section 101A, 101B, 101C, 102 or 102A.

126 Suspending apparatus licences

(1) The ACMA may, by written notice given to the licensee, suspend the apparatus licence.

Note: Suspensions of apparatus licences are reviewable under Part 5.6.

(2) The notice must give the reasons for suspending the licence.

(3) The ACMA may, at any time, by written notice given to the licensee, revoke the suspension of the licence.
Section 127

127 Period of suspension

(1) Subject to subsection (2), the suspension of the apparatus licence, unless it is sooner revoked, ceases:

(a) if, within 28 days after the suspension, proceedings for an offence against this Act are instituted against the licensee, or against a person authorised by the licensee to operate a radiocommunications device under the licence, and he or she is convicted of the offence—on the expiration of 14 days after the date of the conviction; or

(b) if such proceedings are instituted within 28 days after the suspension and he or she is not convicted of the offence—on the completion of the proceedings; or

(c) in any other case—on the expiration of 28 days after the suspension.

(2) If:

(a) the notice of suspension specifies a day as the day on which the suspension of the apparatus licence ceases; and

(b) that day occurs before the day fixed under subsection (1);

the suspension of the licence, unless it is sooner revoked, ceases on the day so specified.

(3) In subsection (1):

proceedings does not include proceedings by way of appeal or review.

128 Cancelling apparatus licences

(1) The ACMA may, by written notice given to the licensee, cancel the apparatus licence.

Note: Cancellations of apparatus licences are reviewable under Part 5.6.

(2) The notice must give the reasons for cancelling the licence.
Subdivision B—International broadcasting services

128A Application of this Subdivision

This Subdivision applies to a transmitter licence if:

(a) the licence authorises the operation of a radiocommunications transmitter for transmitting one or more international broadcasting services; and

(b) each international broadcasting licence that authorised the provision of those international broadcasting services has been surrendered or cancelled.

128B Cancelling transmitter licences

(1) The ACMA must, by written notice given to the holder of the transmitter licence, cancel the transmitter licence.

(2) The notice must give the reasons for cancelling the licence.
Chapter 3  Licensing of radiocommunications
Part 3.3  Apparatus licences
Division 6A  Suspending and cancelling datacasting transmitter licences

Section 128C

Division 6A—Suspending and cancelling datacasting transmitter licences

128C  Suspending datacasting transmitter licences

(1) If the ACMA is satisfied that:
   (a) the licensee of a datacasting transmitter licence; or
   (b) a person authorised by the licensee to operate a radiocommunications transmitter under the licence;

   has contravened a condition of the licence set out in paragraph 109A(1)(g), (ga), (i), (ia), (ib), (ic), (id), (ie), (if), (ij) or (j) or subsection 109A(2) or (3), the ACMA may, by written notice given to the licensee, suspend the licence.

(2) The notice of suspension must specify, as the day on which the suspension ceases, the first day after the end of the period specified in the notice.

(3) The ACMA may, at any time, by written notice given to the licensee, revoke the suspension of the licence.

(4) Section 127 applies to a suspension under this section in a corresponding way to the way in which it applies to a suspension under section 126.

128D  Cancelling datacasting transmitter licences

If the ACMA is satisfied that:
   (a) the licensee of a datacasting transmitter licence; or
   (b) a person authorised by the licensee to operate a radiocommunications transmitter under the licence;

   has contravened a condition of the licence set out in paragraph 109A(1)(g), (ga), (i), (ia), (ib), (ic), (id), (ie), (if), (ij) or (j) or subsection 109A(2) or (3), the ACMA may, by written notice given to the licensee, cancel the licence.
Division 7—Renewing apparatus licences

129 Applications for renewal of apparatus licences

(1) A licensee of an apparatus licence (other than a transmitter licence issued under section 101A, 101B, 101C, 102 or 102A or a non-foundation digital radio multiplex transmitter licence) may, at any time during the period beginning 6 months before the licence is due to expire and ending 60 days after it expires, apply in writing to the ACMA for the licence to be renewed.

(2) The application must be in a form approved by the ACMA.

(3) The ACMA may approve different forms for renewal of different types of apparatus licence.

130 Renewing apparatus licences

(1) When an application is made, the ACMA may renew the licence by issuing to the applicant a new apparatus licence.

(2) The conditions of the new apparatus licence need not be the same as those of the licence that it replaces.

(2A) The ACMA must not renew the licence if:
   (a) under section 153D, the licence is affected by a spectrum re-allocation declaration; and
   (b) the licence is due to expire after the end of the re-allocation period for the spectrum re-allocation declaration.

(2B) The ACMA must not renew the licence if:
   (a) the licence is a datacasting transmitter licence; and
   (b) the licence has already been renewed on a previous occasion.

(3) In deciding whether to renew the licence, the ACMA:
   (a) except in the case of a licence issued under section 100B—must have regard to the same matters to which it must have regard under subsections 100(4) and (6) in deciding whether to issue such a licence; and
(b) except in the case of a licence issued under section 100B—may have regard to the same matters to which it may have regard under subsection 100(5) in deciding whether to issue such a licence; and
(c) in the case of a licence issued under section 100B—must have regard to the scheme in force under clause 19 of Schedule 4 to the Broadcasting Services Act 1992.

(4) The new licence comes into force, or is taken to have come into force, immediately after the expiration of the licence that it replaces.

(4A) If:
   (a) the ACMA renews the licence by issuing a new apparatus licence; and
   (b) under section 153D, the new licence is affected by a spectrum re-allocation declaration;
the period specified in the new licence for the purposes of subsection 103(2) must end before the end of the re-allocation period for the spectrum re-allocation declaration.

(5) If the ACMA:
   (a) refuses to renew the licence; or
   (b) renews the licence but not on the same conditions;
the ACMA must give the licensee a written notice stating that fact.

Note: Refusals to renew apparatus licences, and changes to licence conditions on renewal, are reviewable under Part 5.6.

(6) The notice given under subsection (5) must specify that:
   (a) the licensee may request a statement of reasons for the decision; and
   (b) a request must be made within 28 days of receipt of the notice.

(7) A person receiving a notice under subsection (5) may request a statement of reasons for the decision within 28 days of receiving the notice.

(8) If the ACMA receives a request in accordance with subsection (7), it must give the person a statement of reasons within 28 days of receipt of the request.
131 Application of other provisions

(1) Section 101, subsections 103(2), (3) and (6) and sections 104 and 105 apply to renewing an apparatus licence in the same way that they apply to issuing an apparatus licence.

(2) Subsection 103(5) applies to renewing a datacasting transmitter licence as if a reference in that subsection to 10 years were a reference to 5 years.
Division 8—Transfer of apparatus licences

131AA Applications for transfer of apparatus licences

(1) Subject to section 131AC, a licensee of an apparatus licence may, at any time before the licence is due to expire, apply in writing to the ACMA for the licence to be transferred to another person.

(2) The application must be in a form approved by the ACMA and must be signed by both the licensee and the proposed transferee.

(3) The ACMA may approve different forms for transfer of different types of apparatus licence.

(4) An NBS transmitter licence cannot be transferred to any person other than:
   (a) the Australian Broadcasting Corporation; or
   (b) the Special Broadcasting Service Corporation; or
   (c) the Commonwealth.

(5) A category 1 digital radio multiplex transmitter licence must not be transferred to a person unless:
   (a) the person is a qualified company; and
   (b) an access undertaking is in force under Division 4B in relation to the licence.

(6) A category 2 digital radio multiplex transmitter licence must not be transferred to a person unless:
   (a) the person is a qualified company; and
   (b) an access undertaking is in force under Division 4B in relation to the licence.

(7) A category 3 digital radio multiplex transmitter licence must not be transferred to a person unless the person is a qualified company, and:
   (a) both:
       (i) each national broadcaster beneficially owns shares in the company; and
       (ii) there are no other beneficial owners of shares in the company; or
Section 131AB

(b) both:
   (i) a single national broadcaster beneficially owns all the shares in the company; and
   (ii) the other national broadcaster has consented to that beneficial ownership.

(8) If a foundation digital radio multiplex transmitter licence was issued otherwise than in accordance with a price-based allocation system determined under section 106, the licence must not be transferred to a person unless the digital radio moratorium period for the designated BSA radio area concerned has ended.

131AB Transfer of apparatus licences

(1) Subject to sections 131AC and 131ACA, when an application is made, the ACMA may transfer the licence into the name of the transferee.

(2) In deciding whether to transfer the licence, the ACMA:
   (a) except in the case of a licence issued under section 100B—must have regard to the same matters to which it must have regard under subsections 100(4) and (6) in deciding whether to issue such a licence; and
   (b) except in the case of a licence issued under section 100B—may have regard to the same matters to which it may have regard under subsection 100(5) in deciding whether to issue such a licence; and
   (c) in the case of a licence issued under section 100B—must have regard to the scheme in force under clause 19 of Schedule 4 to the Broadcasting Services Act 1992.

(3) The transferred licence:
   (a) subject to Divisions 6 and 6A, continues in force until the end of the period for which the licence is in force when issued to the initial licensee; and
   (b) subject to section 111, continues on the same conditions as those which applied immediately before the transfer.
Section 131AC

131AC  Apparatus licences not transferable in certain circumstances

1. The ACMA may determine, by written instrument:
   (a) that particular types of apparatus licence are not transferable under this Division; and
   (b) that in specified circumstances an apparatus licence is not transferable under this Division.

2. A determination is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

131ACA  Datacasting transmitter licences

The ACMA must not transfer a datacasting transmitter licence to a person unless:
   (a) the person is a qualified company; and
   (b) the ACMA is satisfied that the transfer would not result in a breach of any of the BSA control rules.

228  *Radiocommunications Act 1992*
Division 10—Provisional international broadcasting certificates

131AE  Applications for certificates

(1) If a person proposes to make an application for a transmitter licence authorising operation of a radiocommunications transmitter for transmitting an international broadcasting service, the person may apply in writing to the ACMA for a provisional international broadcasting certificate in relation to the proposed application for the transmitter licence.

(2) An application under subsection (1) must be in a form approved by the ACMA.

131AF  Issuing certificates

(1) After considering an application under section 131AE, the ACMA may issue to the applicant a provisional international broadcasting certificate in relation to the proposed application for the transmitter licence.

(2) The certificate must state that, if the following conditions are satisfied:

   (a) the applicant applies for the transmitter licence when the certificate is in force;
   (b) at the time when the application for the transmitter licence is made:
       (i) there is in force an international broadcasting licence that authorises the provision of the international broadcasting service concerned; and
       (ii) spectrum is available for use for the provision of that service;
   (c) such other conditions (if any) as are specified in the certificate;

the ACMA will be disposed to issue the transmitter licence.
(3) In deciding whether to issue a provisional international broadcasting certificate, the ACMA:
   (a) must have regard to all of the matters to which it would be required to have regard when deciding whether to issue the transmitter licence concerned (other than the matter mentioned in subsection 100(3B)); and
   (b) may have regard to:
      (i) any other matters to which it would be permitted to have regard when deciding whether to issue the transmitter licence concerned; and
      (ii) such other matters as the ACMA considers relevant.

(4) If the ACMA refuses to issue a provisional international broadcasting certificate to a person, the ACMA must give written notice of the refusal to the person, together with a statement of its reasons.

131AG Duration of certificates

(1) A provisional international broadcasting certificate comes into force on the day on which it was issued and remains in force for 240 days.

(2) If a provisional international broadcasting certificate expires, subsection (1) does not prevent the making of a fresh application for a new certificate.

230 Radiocommunications Act 1992
Part 3.4—Class licences

Division 1—General

132 ACMA may issue class licences

(1) The ACMA may, by notice published in the Gazette, issue class licences.

(2) A class licence authorises any person:
   (a) to operate a radiocommunications device of a specified kind; or
   (b) to operate a radiocommunications device for a specified purpose; or
   (c) to operate a radiocommunications device of a specified kind for a specified purpose.

(3) Operation of a radiocommunications device is not authorised by a class licence if it is not in accordance with the conditions of the licence.

(4) A class licence comes into force:
   (a) on the day specified for the purpose in the notice published under subsection (1); or
   (b) if no such day is specified in the notice—on the day on which the notice is published.

133 Conditions of class licences

(1) The ACMA may include in a class licence such conditions as it thinks fit.

(2) The conditions may, for example, include all or any of the following:
   (a) a condition specifying the frequencies at which operation of radiocommunications devices is authorised under the licence;
   (b) a condition specifying other technical requirements about operation of radiocommunications devices under the licence;
   (c) a condition specifying the area within which operation of radiocommunications devices is authorised under the licence;
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(d) a condition specifying the periods during which operation of radiocommunications devices is authorised under the licence;
(e) a condition that any radiocommunications device operated under the licence must comply with all the standards applicable to it.

(3) The notice published in the Gazette must include all the conditions of the licence.

134 Varying class licences

Subject to section 136, the ACMA may, by notice published in the Gazette, vary a class licence by:
(a) including one or more further conditions; or
(b) revoking or varying any conditions of the licence.

135 Revoking class licences

Subject to section 136, the ACMA may, by notice published in the Gazette, revoke a class licence.

136 Consultation on variations and revocations

(1) Before varying a class licence, the ACMA must cause to be published in the Gazette a written notice that:
(a) states that it proposes to vary the licence; and
(b) states the subject matter of the proposed variation; and
(c) specifies a place at which copies of the licence and of the proposed variation can be bought; and
(d) invites interested persons to make representations about the proposed variation by a specified date that is at least one month after the date of publication of the notice; and
(e) specifies an address or addresses to which representations may be sent.

(1A) In addition to subsection (1), if the variation of a class licence would affect the spectrum allocated, to be allocated or to be re-allocated by issuing or re-issuing spectrum licences, before varying the class licence:
(a) the ACMA must be satisfied that:
(i) the variation of the class licence would not result in unacceptable levels of interference to the operation of radiocommunications devices operated, or likely to be operated, under spectrum licences; and

(ii) the variation of the class licence would be in the public interest; and

(b) the ACMA must consult all licensees of spectrum licences who may be affected by the proposed variation of the class licence.

(2) Before revoking a class licence, the ACMA must cause to be published in the *Gazette* a written notice that:

(a) states that it proposes to revoke the licence; and

(b) specifies a place at which copies of the licence may be bought; and

(c) invites interested persons to make representations about the proposed revocation by a specified date that is at least one month after the date of publication of the notice; and

(d) specifies an address or addresses to which representations may be sent.

(3) A person may, not later than the date specified in a notice under subsection (1) or (2), make representations to the ACMA about the proposed variation or revocation.

(4) The ACMA must, before varying or revoking the licence, give due consideration to any representations so made.

(5) Failure to comply strictly with subsection (1), (1A) or (2) does not affect the validity of the notice, or the validity of the variation or revocation of the class licence, if the requirements of that subsection are substantially complied with.

(6) This section does not apply to variation or revocation of a class licence if the ACMA is satisfied that the variation or revocation is a matter of urgency.

### 137 Compliance with plans

The ACMA must not issue a class licence that is inconsistent with the spectrum plan or any relevant frequency band plan.

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138 Parts of the spectrum allocated for spectrum licences

(1) The ACMA must not issue a class licence that authorises the operation of radiocommunications devices at frequencies that are within a part of the spectrum that is:
   (a) designated under section 36 to be allocated by issuing spectrum licences; or
   (b) specified in a spectrum re-allocation declaration that gives effect to paragraph 153B(6)(a); unless subsection (2) is satisfied.

(2) Before issuing a class licence:
   (a) the ACMA must be satisfied that:
       (i) issuing the class licence would not result in unacceptable levels of interference to the operation of radiocommunications devices operated, or likely to be operated, under spectrum licences; and
       (ii) issuing the class licence would be in the public interest; and
   (b) the ACMA must consult all licensees of spectrum licences who may be affected by the proposed class licence.

139 Disallowance of class licences

A class licence is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
Division 2—Requests for advice

140 Requests for advice on operation of radiocommunications devices

(1) A person who operates, or is proposing to operate, a radiocommunications device may give to the ACMA a written request for advice on whether operation of the device is authorised under the class licence specified in the request.

(2) The request may be limited to advice on operation of the device in the circumstances specified in the request.

(3) The circumstances so specified may include the way in which the device is operated.

(4) The request must be in a form approved by the ACMA.

141 ACMA to advise on the operation of radiocommunications devices

(1) The ACMA is to give, to a person who requests advice under section 140, written advice on whether it thinks the operation of the radiocommunications device, as specified in the request, is authorised under the class licence in question.

(2) The advice may state that operation of the device is authorised under the class licence only if, or unless, the device is operated in the circumstances specified in the advice.

(3) The circumstances so specified may include the way in which the device is operated.

142 The effect of the ACMA’s advice

(1) If:

(a) the advice states that the operation of the device is authorised under the class licence; and

(b) the device is operated only in accordance with the advice;
neither the ACMA nor any other authority of the Commonwealth may take any action against the person to whom the advice was given, during the period of 5 years commencing on the day the advice was given, on the basis that operation of the device is not so authorised.

(2) This Division does not imply that operation of a radiocommunications device is not authorised under a class licence unless it is in accordance with advice given under this Division.
Part 3.5—Registration of licences

143 The Register of Radiocommunications Licences

(1) There is to be a register known as the Register of Radiocommunications Licences.

(2) The Register is to be established and kept by the ACMA.

(3) The Register may be kept by electronic means.

(4) The Register may consist of 2 or more registers, each of which contains so much of the information that is required to be entered in the Register as the ACMA determines.

144 Contents of the Register—spectrum licences

(1) The Register is to contain the following information for each spectrum licence:
   (a) the licensee’s name and postal address;
   (b) the date of issue and date of expiry of the licence;
   (c) such details as the ACMA determines, in writing, about the conditions of spectrum licences;
   (d) such details as the ACMA determines, in writing, about authorisations by licensees for other persons to operate radiocommunications devices under spectrum licences;
   (e) such details as the ACMA determines, in writing, about radiocommunications devices that are operated under spectrum licences.

(2) The ACMA may include in the Register such other details about spectrum licences as it thinks necessary or convenient for the purposes of this Act.
Section 145

145 Refusal to register radiocommunications transmitters for operation under spectrum licences

(1) The ACMA may:

(a) refuse to include in the Register under paragraph 144(1)(e) details of a radiocommunications transmitter that is proposed to be operated under a spectrum licence;

if the ACMA is satisfied that:

(b) operation of the transmitter could cause an unacceptable level of interference to the operation of other radiocommunications devices under that or any other spectrum licence, or any other licence.

Note: Operation of a radiocommunications transmitter without registration of its details may breach a licence condition under section 69.

(2) If the ACMA refuses an application to include in the Register details of such a transmitter, it must give the applicant written notice of the refusal, together with a statement of its reasons.

Note: Refusals to include in the Register such details are reviewable decisions under Part 5.6.

(3) The ACMA may require that, before such details are included in the Register, there be presented to the ACMA a certificate, issued by a person accredited under section 263 to issue certificates for the purposes of this section, stating that operation of the device under the licence satisfies any conditions that are required to be satisfied, in relation to the issue of such a certificate, under a determination made under section 266A.

(4) The ACMA may determine, by written instrument, what are unacceptable levels of interference for the purposes of this section.

146 Updating the Register to take variations etc. of spectrum licences into account

(1) Subject to subsection (2), the ACMA must, as soon as practicable, make the changes to the information in the Register about a spectrum licence that the ACMA considers are necessary or convenient for taking into account:

(a) any variation of the licence under section 72, 73, 87, 90 or 92; or

(b) any suspension of the licence under section 75; or
(c) any cancellation of the licence under section 77 or 87, or any cancellation of the licence that, under section 307, is taken to have occurred on acceptance of a surrender of the licence; or
(d) any assignment of the licence under section 85; or
(e) any resumption of the licence under section 89 or 91.

(2) The ACMA need not make such changes in order to take into account an assignment of the licence under section 85, or a variation of the licence under section 87 that relates to the assignment, unless:
(a) the ACMA has been given the information required under section 86; and
(b) the appropriate charge fixed by determination made under section 60 of the *Australian Communications and Media Authority Act 2005* has been paid.

### 147 Contents of the Register—apparatus licences

(1) The Register is to contain the following information for each apparatus licence:

(a) the licensee’s name and postal address;
(b) the date of issue and date of expiry of the licence;
(c) such details as the ACMA determines, in writing, about the conditions of apparatus licences;
(d) such details as the ACMA determines, in writing, about authorisations by licensees for other persons to operate radiocommunications devices under apparatus licences;
(e) such details as the ACMA determines, in writing, about radiocommunications devices that are operated under apparatus licences; and
(f) if, under section 153D, the licence is affected by a spectrum re-allocation declaration—a note to that effect.

(2) The ACMA may include in the Register such other details about apparatus licences as it thinks necessary or convenient for the purposes of this Act.
Chapter 3  Licensing of radiocommunications
Part 3.5  Registration of licences

Section 148

148 Updating the Register to take variations etc. of apparatus licences into account

The ACMA must, as soon as practicable, make the changes to the information in the Register about an apparatus licence that the ACMA considers are necessary or convenient in order to take into account:

(a) any variation of the licence under section 111; or
(b) any suspension of the licence under section 126 or 128C; or
(c) any cancellation of the licence under section 128 or 128B or 128D, or any cancellation of the licence that, under section 307, is taken to have occurred on acceptance of a surrender of the licence; or
(d) any transfer of the licence under section 131AB.

149 Contents of the Register—class licences

(1) The Register is to contain, for each class licence, such details as the ACMA determines, in writing, about class licences.

(2) The ACMA may include in the Register such other details about class licences as it thinks necessary or convenient for the purposes of this Act.

150 Updating the Register to take variations etc. of class licences into account

The ACMA must, as soon as practicable, make the changes to the information in the Register about a class licence that the ACMA considers are necessary or convenient in order to take into account:

(a) any variation of the licence under section 134; or
(b) any revocation of the licence under section 135.

151 Inspection of the Register

(1) Subject to section 152, the ACMA must ensure that the Register is available for inspection by any person during the hours that the ACMA is open for business.

(2) If the Register is kept wholly or partly by use of a computer, subsection (1) is taken to be complied with, so far as the Register is so kept, by giving members of the public access to a computer

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terminal that they can use to inspect the Register, either on a screen or in the form of a computer print-out.

152 Parts of the Register may be kept confidential

Section 151 does not apply in relation to a part of the Register if the ACMA is satisfied that it would not be in the national interest (for example, for defence or security reasons) for information in that part of the Register to be available to the public.

153 Correction of the Register

(1) The ACMA may, at any time, correct information in the Register.

(2) The correction may be made:
   (a) in any case—on the ACMA’s own initiative; or
   (b) if the information is about a spectrum licence or an apparatus licence—on the application of the licensee or a person authorised by the licensee to operate radiocommunications devices under the licence.

(3) An application under paragraph (2)(b) must be in a form approved by the ACMA.

(4) On making a correction, the ACMA must give written notice of the correction to:
   (a) the licensee; and
   (b) if an application was made under paragraph (2)(b) by a person (other than the licensee) for the information to be corrected—that person; and
   (c) any other person who has given written notice to the ACMA under subsection (6) in relation to the licence to which the correction relates.

(5) On refusing an application for a correction, the ACMA must give to the applicant written notice of the refusal, together with a statement of its reasons.

Note: Refusals to correct the Register are reviewable decisions under Part 5.6.

(6) A person may give a written notice to the ACMA stating that the person wishes to be notified about corrections to the Register in relation to specified licences.

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Part 3.6—Re-allocation of encumbered spectrum

153A Outline of this Part

(1) This Part is about the re-allocation of spectrum.

(2) Section 153B allows the Minister to make a declaration that one or more specified parts of the spectrum are subject to re-allocation. The declaration is called a spectrum re-allocation declaration.

(3) A spectrum re-allocation declaration may provide that the part or parts of the spectrum should be re-allocated:
   (a) by issuing spectrum licences under Subdivision B of Division 1 of Part 3.2 (see section 153L); or
   (b) by issuing apparatus licences under Division 2 of Part 3.3 (see section 153M).

(4) Certain apparatus licences that are affected by a spectrum re-allocation declaration will be cancelled at the end of the period specified in the declaration (see section 153H).

153B Spectrum re-allocation declaration

(1) The Minister may make a written declaration that one or more specified parts of the spectrum are subject to re-allocation under this Part in relation to a specified period (the re-allocation period).

(2) The declaration is called a spectrum re-allocation declaration.

(3) For each part of the spectrum specified in the declaration, the declaration must be expressed to apply with respect to one or more specified areas.

(4) The re-allocation period must:
   (a) begin within 28 days after the declaration is made; and
   (b) run for at least 2 years.

(5) The declaration must specify a time as the re-allocation deadline for the declaration. That time must be at least 12 months before the end of the re-allocation period.
Section 153C

(6) For each part of the spectrum specified in the declaration, the declaration must state whether the part of the spectrum should be re-allocated:
   (a) by issuing spectrum licences under Subdivision B of Division 1 of Part 3.2 (see section 153L); or
   (b) by issuing apparatus licences under Division 2 of Part 3.3 (see section 153M).

(7) The declaration must not specify a particular part of the spectrum with respect to a particular area if, at the time of the declaration, a spectrum licence is in force authorising the operation of radiocommunications devices:
   (a) at frequencies that are wholly or partly within that part of the spectrum; and
   (b) within that area.

(8) A particular part of the spectrum may be specified in the declaration whether or not any apparatus licences are in force authorising the operation of radiocommunications devices at frequencies that are wholly or partly within that part of the spectrum.

(9) A particular part of the spectrum may be specified in the declaration even if it adjoins:
   (a) another part of the spectrum that is also specified in the declaration; or
   (b) 2 other parts of the spectrum that are also specified in the declaration.

153C Spectrum re-allocation declaration—ancillary provisions

(1) The Minister must give a copy of a spectrum re-allocation declaration to the ACMA.

(2) As soon as practicable after receiving a copy of the declaration, the ACMA must:
   (a) prepare a written notice stating:
      (i) that the declaration has been made; and
      (ii) that affected apparatus licensees can get a free copy of the declaration from any office of the ACMA; and

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(b) both:
   (i) as far as practicable, make reasonable efforts to give each affected apparatus licensee a copy of the notice; and
   (ii) cause a copy of the notice to be published in one or more newspapers circulating generally in the capital city of each State; and

(c) make copies of the declaration available in accordance with the notice.

Note: **Affected apparatus licensee** has the meaning given by section 153D.

(3) A spectrum re-allocation declaration is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

(4) In this section:

**State** includes the Northern Territory and the Australian Capital Territory.

### 153D Affected apparatus licences and licensees

(1) For the purposes of this Part, an apparatus licence is **affected** by a spectrum re-allocation declaration if the licence authorises the operation of radiocommunications devices:
   (a) at frequencies that are wholly or partly within the part or parts of the spectrum specified in the declaration; and
   (b) within the area or areas specified in the declaration with respect to that part or those parts.

(2) In this Part:

**affected apparatus licensee** means the licensee of an affected apparatus licence.

### 153E Minister may make a spectrum re-allocation declaration only after receiving the ACMA’s recommendation

(1) The Minister must not make a spectrum re-allocation declaration in relation to a particular part or parts of the spectrum unless, during the previous 180 days, the ACMA has given the Minister a recommendation under section 153F in relation to that part, or those parts, of the spectrum.
(2) In deciding whether to make the declaration, the Minister must have regard to the recommendation.

(3) Subsection (2) does not, by implication, limit the matters to which the Minister may have regard.

153F ACMA may recommend that the Minister make a spectrum re-allocation declaration

(1) The ACMA may give the Minister a written recommendation to make a spectrum re-allocation declaration in relation to one or more specified parts of the spectrum.

(2) The recommendation must specify the period that, in the ACMA’s opinion, the declaration should specify as the re-allocation period.

(3) Subsection (2) does not, by implication, limit the matters that may be dealt with by the recommendation.

153G Comments by potentially-affected apparatus licensees on recommendation

(1) Before giving the Minister a recommendation under section 153F to make a spectrum re-allocation declaration, the ACMA must:
   (a) prepare a written notice:
      (i) stating that the ACMA has prepared a draft version of the recommendation; and
      (ii) setting out the terms of the draft version; and
   (b) both:
      (i) as far as practicable, make reasonable efforts to give each potentially-affected apparatus licensee a copy of the notice; and
      (ii) cause a copy of the notice to be published in one or more newspapers circulating generally in the capital city of each State.

(2) The notice must invite each potentially-affected apparatus licensee to give written comments to the ACMA about the draft version of the recommendation within the specified period after either:
   (a) the licensee receives the notice; or
   (b) the publication of the notice;
Section 153H

as the case may be. The specified period must run for at least 28 days.

(3) If a potentially-affected apparatus licensee has given comments in accordance with a notice under this section, then, in preparing the final version of the recommendation, the ACMA must have regard to the comments.

(4) Subsection (3) does not, by implication, limit the matters to which the ACMA may have regard.

(5) If the Minister is satisfied that:
   (a) at a time during the period:
      (i) beginning on 1 July 1996; and
      (ii) ending immediately before the commencement of this section;
      the ACMA began a process of consultation about a particular proposal to re-allocate a part of the spectrum; and
   (b) the process may reasonably be regarded as equivalent to the process set out in subsections (1), (2), (3) and (4) that would otherwise have applied in relation to a recommendation corresponding to the proposal;
   the Minister may, by written notice given to the ACMA, exempt the ACMA from compliance with those subsections in relation to a recommendation under section 153F that corresponds to the proposal.

(6) In this section:

   potentially-affected apparatus licensee means the licensee of an apparatus licence, where the licensee would become an affected apparatus licensee if the spectrum re-allocation declaration were to be made in accordance with the recommendation.

   State includes the Northern Territory and the Australian Capital Territory.

153H  Effect of spectrum re-allocation declaration

(1) This section applies to an apparatus licence if:
   (a) immediately before the end of the re-allocation period for a spectrum re-allocation declaration, the licence is affected by the declaration; and
(b) the licence came into force after the commencement of this section; and

(c) the licence is not:
   (i) an NBS transmitter licence; or
   (ii) a transmitter licence issued under section 101B; or
   (iii) a transmitter licence issued under section 101C; or
   (iv) a transmitter licence issued under section 102.

(2) The licence is cancelled under this section at the end of the re-allocation period.

153J Revocation and variation of spectrum re-allocation declaration

(1) The Minister must not revoke a spectrum re-allocation declaration if:
   (a) the declaration states that a particular part of the spectrum should be re-allocated by issuing licences; and
   (b) the ACMA has begun allocating any or all of those licences.

(2) The Minister must not vary a spectrum re-allocation declaration if:
   (a) the declaration states that a particular part of the spectrum should be re-allocated by issuing licences; and
   (b) the ACMA has begun allocating any or all of those licences with respect to a particular area; and
   (c) the variation relates to the whole or a part of that area.

(3) For the purposes of this section, the ACMA is taken to begin allocating licences if, and only if:
   (a) in a case where the licences are to be allocated by auction—the ACMA publishes an advertisement for that auction; or
   (b) in a case where the licences are to be allocated by tender—the ACMA publishes an advertisement calling for suitable tenders; or
   (c) in any other case—the ACMA invites applications for the allocation of the licences.

(4) This section does not prevent the Minister from varying a spectrum re-allocation declaration so as to extend the re-allocation deadline if the Minister is of the opinion that there are special circumstances.
Section 153K

153K Automatic revocation of spectrum re-allocation declaration if no licences allocated by re-allocation deadline

(1) This section applies if:
   (a) a spectrum re-allocation declaration states that a particular part of the spectrum should be re-allocated by issuing licences; and
   (b) no such licences are allocated before the re-allocation deadline for the declaration.

(2) The declaration is taken to have been revoked immediately after the re-allocation deadline.

(3) As soon as practicable after the re-allocation deadline, the ACMA must give each affected apparatus licensee a written notice stating that the declaration is taken to have been revoked.

(4) Subsection (2) applies despite subsection 153J(1).

(5) This section does not, by implication, limit the Minister’s power to revoke a spectrum re-allocation declaration in accordance with subsection 33(3) of the Acts Interpretation Act 1901.

153L Re-allocation by means of issuing spectrum licences

(1) This section applies if a spectrum re-allocation declaration states that a part or parts of the spectrum should be re-allocated by issuing spectrum licences.

(2) The licences must be issued under Subdivision B of Division 1 of Part 3.2 in accordance with a marketing plan prepared under section 39A.

153M Re-allocation by means of issuing apparatus licences

(1) This section applies if a spectrum re-allocation declaration states that a part or parts of the spectrum should be re-allocated by issuing apparatus licences.

(2) The licences must be issued under Division 2 of Part 3.3 in accordance with a price-based allocation system determined under section 106.
153N  Restriction on issuing spectrum licences for parts of the spectrum subject to re-allocation

(1) This section applies if the Minister makes a spectrum re-allocation declaration under section 153B in relation to a particular part or parts of the spectrum.

(2) During the re-allocation period, the ACMA must not issue a spectrum licence that authorises the operation of radiocommunications devices:
   (a) at frequencies that are within that part, or those parts, of the spectrum; and
   (b) within the area or areas specified in the declaration; unless:
   (c) the licence is issued as mentioned in section 153L (which deals with re-allocation of spectrum by issuing spectrum licences); or
   (d) at the start of the re-allocation period, the licence had already been allocated under subsection 62(1).

153P  Restriction on issuing apparatus licences for parts of the spectrum subject to re-allocation

(1) This section applies if a spectrum re-allocation declaration is in force in relation to a particular part or parts of the spectrum.

(2) During the re-allocation period, the ACMA must not issue an apparatus licence that authorises the operation of radiocommunications devices:
   (a) at frequencies that are within that part, or those parts, of the spectrum; and
   (b) within the area or areas specified in the declaration; unless:
   (c) the licence is issued as mentioned in section 153M (which deals with re-allocation of spectrum by issuing apparatus licences); or
   (d) the licence is issued by way of renewal of an apparatus licence (see Division 7 of Part 3.3); or
   (da) the licence is issued to a body covered by any of paragraphs 27(1)(b) to (be) for the purpose of investigations or operations conducted by the body; or
Section 153P

(d) both:
   (i) the licence is a transmitter licence that authorises the operation of one or more radiocommunications transmitters for transmitting one or more broadcasting services (within the meaning of the Broadcasting Services Act 1992) in digital mode in a BSA licence area; and
   (ii) the transmitter licence is issued during the interim period worked out in relation to the BSA licence area under subsection (4); or
   (e) the ACMA is satisfied that the special circumstances of the particular case justify the issuing of the licence.

(3) After the end of the re-allocation period, the ACMA must not issue an apparatus licence that authorises the operation of radiocommunications devices:
   (a) at frequencies that are within that part, or those parts, of the spectrum; and
   (b) within the area or areas specified in the declaration;
   unless:
   (c) the licence is issued to a body covered by any of paragraphs 27(1)(b) to (be) for the purpose of investigations or operations conducted by the body; or
   (d) the ACMA is satisfied that the special circumstances of the case justify the issuing of the licence.

(4) For the purposes of the application of paragraph (2)(db) to a BSA licence area, the **interim period** is the period:
   (a) beginning at the commencement of this subsection; and
   (b) ending at the start of the designated re-stack day (within the meaning of the Broadcasting Services Act 1992) for the BSA licence area.
Chapter 4—General regulatory provisions

154 Outline of this Chapter

(1) This Chapter imposes requirements that relate both to radiocommunications and to radio emissions in general.

(2) Part 4.1 is about standards applicable to, and other technical regulation of, equipment that uses, or is affected by, radio emissions.

(3) Part 4.2 contains offence provisions relating to radio emissions, in particular offences aimed at containing various kinds of interference with radiocommunications.

(4) Part 4.3 establishes a conciliation process for the settlement of interference disputes.

(5) Part 4.4 enables certain restrictions to be imposed by restrictive orders made during declared periods of emergency.
Part 4.1—Standards and other technical regulation

Division 1—Preliminary

155 The object of this Part

(1) The object of this Part is to establish an efficient, flexible and responsive system for technical regulation of equipment that uses, or is affected by, radio emissions.

(2) The system is intended to:

(a) benefit users of the equipment by promoting the electromagnetic compatibility of equipment; and

(b) contain interference within acceptable limits; and

(c) establish standards for the equipment and for services provided using the equipment; and

(d) control sale or supply of non-standard devices; and

(e) enable efficient management of compliance and enforcement, including, in particular, industry self-certification for compliance with standards; and

(f) protect the health and safety of persons who:

(i) operate radiocommunications transmitters or radiocommunications receivers; or

(ii) work on radiocommunications transmitters or radiocommunications receivers; or

(iii) use services supplied by means of radiocommunications transmitters or radiocommunications receivers; or

(iv) are reasonably likely to be affected by the operation of radiocommunications transmitters or radiocommunications receivers.

156 Outline of this Part

In order to achieve this object:

(a) Division 2 imposes prohibitions relating to non-standard devices, subject to exceptions in Divisions 4 and 5;

(b) Division 3 enables the ACMA to make standards for devices (including the radio emissions made by devices);
(c) Division 4 enables the ACMA to issue permits that exempt non-standard transmitters from Division 2;
(d) Division 5 sets out the other ways in which non-standard devices can be exempt from Division 2;
(f) Division 7 enables the ACMA to require that devices be labelled to indicate whether they comply with standards or class licences;
(g) Division 8 enables devices to be prohibited because of their effect on radiocommunications.
Division 2—Non-standard devices

157 Emissions from non-standard transmitters

(1) Subject to Divisions 4 and 5, a person must not cause a radio emission to be made by a transmitter that the person knows is a non-standard transmitter.

Penalty:

(a) if the offender is an individual—120 penalty units; or

(b) otherwise—1,500 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) If the transmitter referred to in subsection (1) is a non-standard transmitter solely because of non-compliance with an EMC standard, subsection (1) does not apply to the transmitter unless:

(a) the person referred to in that subsection is a corporation to which paragraph 51(xx) of the Constitution applies; or

(b) the radio emission referred to in that subsection was made as a result of the device being operated in the course of, or in relation to:

(i) trade or commerce between Australia and places outside Australia; or

(ii) trade or commerce among the States; or

(iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or

(iv) the supply of goods or services to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory; or

(v) the defence of Australia; or

(vi) the operation of lighthouses, lightships, beacons or buoys; or
(vii) astronomical or meteorological observations; or
(viii) an activity of a corporation to which paragraph 51(xx)
of the Constitution applies; or
(ix) banking, other than State banking; or
(x) insurance, other than State insurance; or
(xi) weighing or measuring; or
(c) the radio emission referred to in that subsection was likely to
interfere with the operation of another device, where that
operation was in the course of, or in relation to:
(i) trade or commerce between Australia and places outside
Australia; or
(ii) trade or commerce among the States; or
(iii) trade or commerce within a Territory, between a State
and a Territory or between 2 Territories; or
(iv) the supply of goods or services to the Commonwealth,
to a Territory or to an authority or instrumentality of the
Commonwealth or of a Territory; or
(v) the defence of Australia; or
(vi) the operation of lighthouses, lightships, beacons or
buoys; or
(vii) astronomical or meteorological observations; or
(viii) an activity of a corporation to which paragraph 51(xx)
of the Constitution applies; or
(ix) banking, other than State banking; or
(x) insurance, other than State insurance; or
(xi) weighing or measuring; or
(d) the radio emission referred to in that subsection was likely to
interfere with:
(i) radiocommunications; or
(ii) broadcasting services (within the meaning of the
Broadcasting Services Act 1992); or
(iii) carriage services (within the meaning of the
Telecommunications Act 1997); or
(iv) any other postal, telegraphic, telephonic or other like
service.

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(3) The following diagram shows how this Part (other than Division 8) applies to radio emissions.

Note: Chapter 3 imposes additional requirements on operation of radiocommunications devices.

158 Possession of non-standard devices

(1) Subject to Divisions 4 and 5, a person must not have in his or her possession for the purpose of operation a device that the person knows is a non-standard device.

Penalty:
(a) if the offender is an individual—120 penalty units; or
(b) otherwise—1,500 penalty units.
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(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) If the device referred to in subsection (1) is a non-standard device solely because of non-compliance with an EMC standard, subsection (1) does not apply to the possession of the device unless:

(a) the person referred to in that subsection is a corporation to which paragraph 51(xx) of the Constitution applies; or

(b) the operation referred to in that subsection is in the course of, or in relation to:

   (i) trade or commerce between Australia and places outside Australia; or

   (ii) trade or commerce among the States; or

   (iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or

   (iv) the supply of goods or services to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory; or

   (v) the defence of Australia; or

   (vi) the operation of lighthouses, lightships, beacons or buoys; or

   (vii) astronomical or meteorological observations; or

   (viii) an activity of a corporation to which paragraph 51(xx) of the Constitution applies; or

   (ix) banking, other than State banking; or

   (x) insurance, other than State insurance; or

   (xi) weighing or measuring; or

(c) the operation referred to in that subsection was likely to interfere with the operation of another device, where the operation of that other device was in the course of, or in relation to:

   (i) trade or commerce between Australia and places outside Australia; or
(ii) trade or commerce among the States; or
(iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or
(iv) the supply of goods or services to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory; or
(v) the defence of Australia; or
(vi) the operation of lighthouses, lightships, beacons or buoys; or
(vii) astronomical or meteorological observations; or
(viii) an activity of a corporation to which paragraph 51(xx) of the Constitution applies; or
(ix) banking, other than State banking; or
(x) insurance, other than State insurance; or
(xi) weighing or measuring; or

(d) the operation referred to in that subsection was likely to interfere with:
   (i) radiocommunications; or
   (ii) broadcasting services (within the meaning of the Broadcasting Services Act 1992); or
   (iii) carriage services (within the meaning of the Telecommunications Act 1997); or
   (iv) any other postal, telegraphic, telephonic or other like service.
Section 158

(3) The following diagram shows how this Part (other than Division 8) applies to possession of devices.

```
Does the device contravene a standard?  
(See Division 3)  
Yes  
No

Is the possession in accordance with a permit?  
(See Division 4)  
Yes  
No

Is the situation one of emergency?  
(See section 172)  
Yes  
No

Is the device intended for use solely outside Australia?  
(See section 173)  
Yes  
No

The possession is permitted

SECTION 158 MAY PROHIBIT POSSESSION OF THE DEVICE FOR THE PURPOSES OF OPERATION
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Section 159

Note: Chapter 3 imposes additional requirements on possession of radiocommunications devices.

159 Additional provisions about possession of devices

(1) Without limiting section 158, a person is taken, for the purposes of that section, to have a device in his or her possession for the purpose of operation if it is in his or her possession, otherwise than for the purpose of supply to another person, and can be operated by merely doing one or more of the following:

(a) connecting the device to an electric power supply by means of an electric plug or other electric connection;
(b) connecting a microphone to the device by inserting a microphone plug into the device;
(c) switching on the device;
(d) switching on any other equipment relevant to the device’s operation;
(e) adjusting settings by manipulating the device’s external switches, dials or other controls;
(f) connecting the device to an antenna.

(2) Subsection (1) only applies in the absence of any evidence to the contrary.

(3) A reference in this section to a person having a device in his or her possession includes a reference to the person having it under control in any place whatever, whether for the use or benefit of that person or another person, and although another person has the actual possession or custody of it.

160 Supply of non-standard devices

(1) Subject to Division 5, a person must not supply a device that the person knows is a non-standard device.

Penalty:

(a) if the offender is an individual—120 penalty units; or
(b) otherwise—1,500 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.
General regulatory provisions  Chapter 4  
Standards and other technical regulation  Part 4.1  
Non-standard devices  Division 2  

Section 160  

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) If the device referred to in subsection (1) is a non-standard device solely because of non-compliance with an EMC standard, subsection (1) does not apply to the supply of the device unless:

(a) the person referred to in that subsection is a corporation to which paragraph 51(xx) of the Constitution applies; or

(b) the supply referred to in that subsection was:

(i) supply in the course of, or in relation to, trade or commerce between Australia and places outside Australia; or

(ii) supply in the course of, or in relation to, trade or commerce among the States; or

(iii) supply in the course of, or in relation to, trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or

(iv) supply to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory.

(3) The following diagram shows how this Part (other than Division 8) applies to supply of devices.
Does the device contravene a standard? (See Division 3)

Yes

Is the device intended for use solely outside Australia? (See section 173)

No

Has permission for the supply been given? (See section 174)

No

Is the supply for the purpose of modification etc.? (See section 175)

No

Is the supply for the purpose of re-export? (See section 176)

No

SECTION 160 MAY PROHIBIT THE SUPPLY

Yes

THE SUPPLY IS PERMITTED

Yes

Yes

Yes

No

No

No

No

No
161  Imputed knowledge

For the purposes of establishing a contravention of section 157, 158 or 160, if, having regard to:

(a) a person’s abilities, experience, qualifications and other attributes; and

(b) all the circumstances surrounding the alleged contravention; the person ought reasonably to have known that the transmitter or device in question was a non-standard transmitter or non-standard device, the person is taken to have known that it was a non-standard transmitter or non-standard device.
Division 3—Standards

162 The ACMA’s power to make standards

(1) The ACMA may, by written instrument, make standards for:
   (a) the performance of specified devices; or
   (b) the maximum permitted level of radio emissions from devices (other than radiocommunications from radiocommunications devices in accordance with Chapter 3) within specified parts of the spectrum.

(2) A standard:
   (a) may be of general application or may be limited as provided in the standard; and
   (b) without limiting paragraph (a), may apply:
      (i) with respect to one or more specified areas; or
      (ii) with respect to one or more specified parts of the spectrum.

(3) Standards are to consist only of such requirements as are necessary or convenient for:
   (a) containing interference to radiocommunications; or
   (b) containing interference to any uses or functions of devices; or
   (c) establishing for the operation of radiocommunications transmitters or radiocommunications receivers an adequate level of immunity from electromagnetic disturbance caused by the use of devices (including other radiocommunications transmitters or radiocommunications receivers); or
   (d) establishing for the uses or functions of devices an adequate level of immunity from electromagnetic disturbances caused by the operation of radiocommunications transmitters; or
   (e) establishing for the uses or functions of devices an adequate level of immunity from electromagnetic disturbances caused by the use of other devices; or
   (f) protecting the health or safety of persons who:
      (i) operate radiocommunications transmitters or radiocommunications receivers; or
      (ii) work on radiocommunications transmitters or radiocommunications receivers; or
(iii) use services supplied by means of radiocommunications transmitters or radiocommunications receivers; or
(iv) are reasonably likely to be affected by the operation of radiocommunications transmitters or radiocommunications receivers.

163 Procedures for making standards

(1) Before making a standard, the ACMA must, so far as is practicable, try to ensure that:

(a) interested persons have had adequate opportunity to make representations about the proposed standard (either directly, or indirectly by means of a report under paragraph (2)(g)); and

(b) due consideration has been given to any representations so made.

Note: This subsection has effect subject to section 163A (which deals with the ACMA’s power to make standards in cases of urgency).

(2) The ACMA may make an arrangement with any of the following bodies or associations:

(a) Standards Australia International Limited;

(b) a body or association approved in writing by Standards Australia International Limited for the purposes of this subsection;

(c) a body or association specified in a written determination made by the ACMA for the purposes of this subsection; under which the body or association:

(d) prepares a draft of a standard; and

(e) publishes the draft standard; and

(f) undertakes a process of public consultation on the draft standard; and

(g) reports to the ACMA on the results of that process of public consultation.

(3) A copy of an approval under paragraph (2)(b) is to be published in the Gazette.

(4) A copy of a determination under paragraph (2)(c) is to be published in the Gazette.
Section 163A

163A Making standards in cases of urgency

(1) The ACMA is not required to comply with subsection 163(1) in relation to the making of a particular standard if the ACMA is satisfied that it is necessary to make the standard as a matter of urgency in order to protect the health or safety of persons who:

(a) operate radiocommunications transmitters or radiocommunications receivers; or
(b) work on radiocommunications transmitters or radiocommunications receivers; or
(c) use services supplied by means of radiocommunications transmitters or radiocommunications receivers; or
(d) are reasonably likely to be affected by the operation of radiocommunications transmitters or radiocommunications receivers.

(2) If subsection (1) applies to a standard (the urgent standard), the urgent standard ceases to have effect 12 months after it came into operation. However, this rule does not prevent the ACMA from revoking the urgent standard and making another standard under section 162 that:

(a) is not a standard to which subsection (1) applies; and
(b) deals with the same subject matter as the urgent standard.

164 Date of effect of standards

A standard takes effect:

(a) if the instrument making the standard specifies a day for the purpose—on that day; or
(b) otherwise—on the day on which a copy of the instrument was notified in the Gazette.

165 Disallowance etc. of standards

(1) A standard is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
Division 4—Permits for non-standard devices

166 The effect of permits

A person does not:

(a) contravene section 157 by causing a non-standard transmitter
to make a radio emission; or

(b) contravene section 158 by having in his or her possession a
non-standard device;

if causing the emission or possessing the device is in accordance
with a permit.

167 The ACMA may issue permits

(1) A person may apply to the ACMA, in a form approved by the
ACMA, for a permit.

(2) The ACMA may, in writing, issue to the person a permit
authorising the person and, if the permit so specifies, his or her
agents:

(a) to have in his, her or their possession specified non-standard
devices; and

(b) if, and only if, the permit so specifies—to cause such devices
to make radio emissions.

(3) In deciding whether to issue a permit, the ACMA may have regard
to whether the purpose for which the permit is sought is a purpose
related to:

(a) education or research; or

(b) testing of devices; or

(c) demonstration of devices.

(3A) In deciding whether to issue a permit, the ACMA must have regard
to the protection of the health or safety of persons who:

(a) operate devices; or

(b) work on devices; or

(c) use services supplied by means of devices; or

(d) are otherwise reasonably likely to be affected by the
operation of devices.
Section 168

(3B) Subsections (3) and (3A) do not, by implication, limit the matters to which the ACMA may have regard.

(4) If the ACMA refuses to issue the permit, it must give the person a written notice of the refusal, together with a statement of its reasons.

Note: Refusals to issue permits are reviewable under Part 5.6.

168 Conditions of permits

(1) A permit is subject to the following conditions:
   (a) a condition that a person to whom the permit relates must comply with this Act; and
   (b) any other conditions specified in the permit.

(2) The ACMA may, by written notice given to the person to whom the permit was issued:
   (a) impose one or more further conditions to which the permit was issued; or
   (b) vary or revoke any conditions:
      (i) imposed under paragraph (a); or
      (ii) specified under paragraph (1)(b).

Note: Decisions about permit conditions are reviewable under Part 5.6.

169 Duration of permits

(1) A permit comes into force on the day on which it is issued.

(2) A permit that authorises radio emission:
   (a) must specify a day of expiration; and
   (b) subject to section 171, remains in force until the end of that day.

(3) Subject to section 171, a permit that does not authorise radio emission remains in force:
   (a) if it specifies a day of expiration—until the end of that day; or
   (b) otherwise—indefinitely.
(4) A day of expiration specified under paragraph (2)(a) or (3)(a) must be:

(a) if:

(i) there is in force a written determination made by the ACMA that is expressed to apply in relation to all permits or in relation to a class of permits in which the permit is included; and
(ii) the determination specifies a period longer than 12 months in relation to all permits or in relation to a class of permits in which the permit is included;

a day within that longer period; or

(b) otherwise:

(i) if the permit was issued in a month other than December—a day within 12 months after the permit was granted; or
(ii) if the permit was issued in December of a particular year—a day not later than 31 December in the next year.

(5) A determination under paragraph (4)(a) is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

(6) The ACMA may, by written notice given to the holder of a permit, declare that the permit has effect as if the permit had specified a day specified in the notice as the day of expiration of the permit. The declaration has effect accordingly.

(7) The day specified in a notice under subsection (5) must:

(a) be later than the day on which the notice was given to the holder; and

(b) comply with the rules set out in subsection (4).

169A Compensation—constitutional safety-net

(1) If:

(a) apart from this section, the operation of subsection 169(6) would result in the acquisition of property from a person otherwise than on just terms; and
(b) the acquisition would be invalid because of paragraph 51(xxxi) of the Constitution;
the Commonwealth is liable to pay compensation of a reasonable amount to the person in respect of the acquisition.

(2) If the Commonwealth and the person do not agree on the amount of the compensation, the person may institute proceedings in the Federal Court for the recovery from the Commonwealth of such reasonable amount of compensation as the court determines.

(3) In this section:

*acquisition of property* has the same meaning as in paragraph 51(xxxi) of the Constitution.

*just terms* has the same meaning as in paragraph 51(xxxi) of the Constitution.

### 170 Contraventions of permit conditions

(1) A person is guilty of an offence if:

(a) a permit relates to the person; and

(b) the person engages in conduct; and

(c) the person’s conduct contravenes a condition of the permit.

Penalty: 100 penalty units.

(2) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

(3) In this section:

*engage in conduct* means:

(a) do an act; or

(b) omit to perform an act.

### 171 Cancelling permits

(1) The ACMA may, by written notice given to the holder of a permit, cancel the permit.

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(2) The notice must give the reasons for cancelling the permit.

(3) In deciding whether to cancel a permit, the ACMA:

(a) must have regard to all matters that it considers relevant; and

(b) without limiting paragraph (a), may have regard to:

(i) any matter to which the ACMA may, under subsection 167(3), have regard in deciding whether to issue a permit; and

(ii) whether or not the holder of the permit or an agent of the holder has been convicted of an offence under section 170; and

(iii) whether or not the holder of the permit or an agent of the holder has been convicted of an offence against section 136.1 or 137.1 of the *Criminal Code* that relates to this Act.

Note: Cancellations of permits are reviewable under Part 5.6.
Division 5—Other exemptions from Division 2

172 Emergency transmissions etc.

A person does not contravene section 157 or 158 by causing a radio transmission to be made by a non-standard transmitter, or having a non-standard device in his or her possession, in the reasonable belief that the emission or possession was necessary for the purpose of:

(a) securing the safety of a vessel, aircraft or space object that was in danger; or
(b) dealing with an emergency involving a serious threat to the environment; or
(c) dealing with an emergency involving risk of death of, or injury to, persons; or
(d) dealing with an emergency involving risk of substantial loss of, or damage to, property.

173 Possession or supply for use solely outside Australia

(1) A person does not:

(a) contravene section 158 by having a non-standard device in his or her possession; or
(b) contravene section 160 by supplying a non-standard device;

if the device is intended to be used solely outside Australia.

(2) If there is applied to a device:

(a) a statement that the device is for export only; or
(b) a statement indicating, by use of words authorised for the purposes of this subsection by the regulations, that the device is intended to be used solely outside Australia;

it is presumed for the purposes of this section, unless the contrary is established, that the device is intended to be so used.

(3) For the purposes of subsection (2), a statement is taken to be applied to a device if:

(a) the statement is impressed on, worked into, or annexed or affixed to, the device; or

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(b) the statement is applied to a covering (including a box, case, frame or wrapper), label or thing in or with which the device is supplied.

174 Supply with permission

(1) A person does not contravene section 160 by supplying a non-standard device in accordance with the ACMA’s written permission.

(2) If the ACMA decides to refuse to give such permission to a person who has applied to the ACMA for it in a form approved by the ACMA, the ACMA must give to the person a written notice setting out its decision.

Note: Refusals to give permission are reviewable under Part 5.6.

175 Supply for modification etc.

A person does not contravene section 160 by supplying a non-standard device for the purposes of modifying or altering it so that it would comply with all standards applicable to it at the time of the alteration or modification.

176 Supply for re-export

A person does not contravene section 160 by supplying a non-standard device if:

(a) the device was imported; and

(b) the person supplied it for the purposes of re-export.

177 Burden of proof

(1) In proceedings for an offence against section 157 or 158, the burden of proving any of the matters referred to in section 172 lies on the defendant.

(2) In proceedings for an offence against section 158 or 160, the burden of proving the absence of any of the matters referred to in section 173, 174, 175 or 176 lies on the prosecution.

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Section 178

178  Reasonable excuse

    Nothing in this Division limits the scope of the expression
    “reasonable excuse” in subsection 157(1A), 158(1A) or 160(1A).
Division 7—Labelling of devices

182 Requirements to apply labels etc.

(1) The ACMA may, by notice published in the Gazette, require any person who manufactures or imports a device included in a specified class of devices to apply to each such device a label that indicates either or both of the following:
   (a) whether the device meets the requirements of the standards specified in the notice;
   (c) if the device is a radiocommunications device—whether the device complies with the class licence specified in the notice.

(1A) The notice may require a manufacturer or importer of a device included in a class of devices specified in the notice:
   (a) to conduct quality assurance programs; or
   (b) to satisfy himself or herself that quality assurance programs have been conducted;
   in respect of the device.

(1B) The notice may require a manufacturer or importer of a device, after having regard to the results of the quality assurance program, to apply a label to each such device that indicates either or both of the following:
   (a) whether the device meets the requirements of the standards specified in the notice;
   (c) if the device is a radiocommunications device—whether the device complies with the class licence specified in the notice.

(2) The label must be in the form specified by the ACMA in the notice.

(2A) The method of applying the label to the device must be as specified by the ACMA in the instrument.

(3) The notice may state that the requirement does not apply to an imported device if there is affixed a label of a specified kind that indicates that the device complies with requirements of:
   (a) a specified law of a foreign country; or
(b) a specified instrument in force under a law of a foreign country; or
(c) a specified convention, treaty or international agreement; or
(d) a specified instrument in force under a specified convention, treaty or international agreement.

(4) The notice may specify requirements that must be met before a label can be applied, including (but not limited to):
   (a) a requirement that, before a manufacturer or importer applies the label, the manufacturer or importer must have obtained a written statement from a certification body certifying that the device complies with the standard or class licence specified in the notice; and
   (b) a requirement that, before a manufacturer or importer applies the label, the device must have been tested by a recognised testing authority for compliance with the standard or class licence specified in the notice; and
   (c) a requirement that, before a manufacturer or importer applies the label, the manufacturer or importer must have obtained a written statement from a competent body certifying that reasonable efforts have been made to avoid contravention of the standard or class licence specified in the notice; and
   (d) a requirement that, before a manufacturer or importer applies the label, the manufacturer or importer must make a written declaration in relation to the device, being a declaration in a form specified in the notice.

Note 1: Certification body is defined by section 183A.
Note 2: Competent body is defined by section 183.
Note 3: Recognised testing authority is defined by section 183.

(4A) The notice may also specify requirements that must be met after a label has been applied to a device, including a requirement that a manufacturer or importer retain for inspection, for the period specified in the notice:
   (a) records of the quality assurance programs conducted in accordance with a notice under subsection (1) in respect of that device; and
   (b) records of any results of any tests conducted in relation to compliance with relevant standards or the class licence; and

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Section 183

(c) a declaration, or a copy of the declaration, made as mentioned in paragraph (4)(d).

(5) A notice is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.

183 Recognised testing authorities

(1) The ACMA may, by notice in the Gazette, determine that a specified person or association is an accreditation body for the purposes of this section. The determination has effect accordingly.

(2) An accreditation body may, by written instrument, determine that a specified person is a recognised testing authority for the purposes of this Division. The determination has effect accordingly.

(3) An accreditation body may, by written instrument, determine that a specified person or association is a competent body for the purposes of this Division. The determination has effect accordingly.

183A Certification bodies

(1) The ACMA may, by notice published in the Gazette, determine that a specified person or association is an approving body for the purposes of this section. The determination has effect accordingly.

(2) An approving body may, by written instrument, determine that a specified person or association is a certification body for the purposes of this Division. The determination has effect accordingly.

186 Sale etc. of devices without labels

(1) If a person:
   (a) has manufactured or imported a device; and
   (b) knows that he or she is required under section 182 to apply to it a label in a particular form;
the person must not supply the device unless a label in that form has been applied to the device.

Penalty: 100 penalty units.
Chapter 4  General regulatory provisions
Part 4.1  Standards and other technical regulation
Division 7  Labelling of devices

Section 187

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a device were, by express provision, confined to:
(a) a radiocommunications transmitter; or
(b) a radiocommunications receiver; or
(c) a device, where the operation of the device is likely to interfere with radiocommunications; or
(d) a device, where the uses or functions of the device are likely to be interfered with by the operation of radiocommunications transmitters.

(3) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a person were, by express provision, confined to a corporation to which paragraph 51(xx) of the Constitution applies.

(4) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to supply were, by express provision, confined to supply:
(a) in the course of, or in relation to:
   (i) trade or commerce between Australia and places outside Australia; or
   (ii) trade or commerce among the States; or
   (iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or
(b) to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory.

187 Applying labels before satisfying requirements under subsection 182(4)

(1) If a person knows that he or she must satisfy requirements that have been specified under subsection 182(4) before applying a particular label to a device under subsection 182(1), the person must not apply:

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(a) the label; or
(b) a label that purports to be such a label;
before he or she satisfies those requirements.

Penalty: 100 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if the reference in that subsection to a device were, by express provision, confined to:
(a) a radiocommunications transmitter; or
(b) a radiocommunications receiver; or
(c) a device, where the operation of the device is likely to interfere with radiocommunications; or
(d) a device, where the uses or functions of the device are likely to be interfered with by the operation of radiocommunications transmitters.

(3) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a person were, by express provision, confined to a corporation to which paragraph 51(xx) of the Constitution applies.

(4) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a person were, by express provision, confined to a person who manufactured or imported the device for the purposes of supply:
(a) in the course of, or in relation to:
   (i) trade or commerce between Australia and places outside Australia; or
   (ii) trade or commerce among the States; or
   (iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or
(b) to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory.
Chapter 4  General regulatory provisions
Part 4.1  Standards and other technical regulation
Division 7  Labelling of devices

Section 187A

187A  Failure to retain records

(1) If the ACMA publishes a notice under subsection 182(1) that specifies requirements to be met after a label has been applied, a manufacturer or importer must not fail to comply with requirements specified in the notice.

Penalty: 20 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(1B) Subsection (1) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.

(2) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a device were, by express provision, confined to:

(a) a radiocommunications transmitter; or
(b) a radiocommunications receiver; or
(c) a device, where the operation of the device is likely to interfere with radiocommunications; or
(d) a device, where the uses or functions of the device are likely to be interfered with by the operation of radiocommunications transmitters.

(3) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if the reference in that subsection to a manufacturer or importer were, by express provision, confined to a manufacturer, or an importer, that is a corporation to which paragraph 51(xx) of the Constitution applies.

(4) In addition to its effect apart from this subsection, subsection (1) also has the effect it would have if each reference in that subsection to a manufacturer or importer were, by express provision, confined to a manufacturer, or an importer, who manufactured or imported the device for the purposes of supply:

(a) in the course of, or in relation to:
   (i) trade or commerce between Australia and places outside Australia; or
   (ii)
(ii) trade or commerce among the States; or
(iii) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or
(b) to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory.

188 Imputed knowledge

For the purposes of establishing a contravention of section 186 or 187, if, having regard to:
(a) a person’s abilities, experience, qualifications and other attributes; and
(b) all the circumstances surrounding the alleged contravention; the person ought reasonably to have known that he or she was subject to the requirement in question, the person is taken to have known that he or she was subject to the requirement.

188A Protected symbols

(1) A person must not:
(a) use in relation to a business, trade, profession or occupation; or
(b) apply, as a trade mark or otherwise, to goods imported, manufactured, produced, sold, offered for sale or let on hire; or
(c) use in relation to:
(i) goods or services; or
(ii) the promotion, by any means, of supply or use of goods or services;
a protected symbol, or a symbol so closely resembling a protected symbol as to be likely to be mistaken for it.

(2) A person who contravenes subsection (1) is guilty of an offence punishable on conviction by a fine not exceeding 30 penalty units.

Note: See also sections 4AA and 4B of the Crimes Act 1914.

(3) Nothing in subsection (1) limits anything else in that subsection.
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(4) Nothing in subsection (1), so far as it applies in relation to a protected symbol, affects rights conferred by law on a person in relation to:

(a) a trade mark that is registered under the Trade Marks Act 1995; or

(b) a design that is registered under the Designs Act 2003; and was registered under the Trade Marks Act 1995 or the Designs Act 1906 immediately before 16 August 1996 in relation to the symbol.

(5) Nothing in this section, so far as it applies to a protected symbol, affects the use, or rights conferred by law relating to the use, of the symbol by a person in a particular manner if, immediately before 16 August 1996, the person:

(a) was using the symbol in good faith in that manner; or

(b) would have been entitled to prevent another person from passing off, by means of the use of the symbol or a similar symbol, goods or services as the goods or services of the first-mentioned person.

(6) This section does not apply to a person who uses or applies a protected symbol for the purposes of labelling a device in accordance with section 182 of this Act or labelling customer equipment or customer cabling in accordance with section 407 of the Telecommunications Act 1997.

(7) This section does not apply to a person who uses or applies a protected symbol for a purpose of a kind specified in a written determination made by the ACMA.

(8) A reference in this section to a protected symbol is a reference to:

(a) the symbol known in the radiocommunications community as the C-Tick mark:

(i) the design of which is set out in a written determination made by the ACMA; and

(ii) a purpose of which, after the commencement of this section, is to indicate compliance by a device with:

(A) any applicable standards; and

(B) any applicable class licences; or
Section 188A

(b) a symbol:
   (i) the design of which is set out in a written determination made by the ACMA; and
   (ii) a purpose of which, after the commencement of this section, is to indicate compliance by a device with:
       (A) any applicable standards; and
       (B) any applicable class licences; or

c) a symbol:
   (i) the design of which is set out in a written determination made by the ACMA; and
   (ii) a purpose of which, after the commencement of this section, is to indicate non-compliance by a device with:
       (A) applicable standards; and
       (B) any applicable class licences.

(9) For the purposes of this Division, if:
   (a) a label is applied to a device; and
   (b) the label embodies a symbol referred to in paragraph (8)(a), or (b);

   the label is taken to indicate that the device meets the requirements of:
   (c) each applicable standard; and
   (d) each applicable class licence.

(10) For the purposes of this Division, if:
   (a) a label is applied to a device; and
   (b) the label embodies a symbol referred to in paragraph (8)(c);

   the label is taken to indicate that the device does not meet the requirements of:
   (c) each applicable standard; and
   (d) each applicable class licence.

(11) For the purposes of this section, a standard or class licence is taken to be applicable in relation to a device if, and only if, the standard or licence was specified in the subsection 182(1) notice that dealt with the manufacture or importation of the device.

(12) A determination made by the ACMA under subsection (7) or (8) is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
(13) In addition to its effect apart from this subsection, this section also has the effect it would have if a reference in subsection (1) to a person were, by express provision, confined to a corporation to which paragraph 51(xx) of the Constitution applies.

(14) In addition to its effect apart from this subsection, this section also has the effect it would have if each reference in subsection (1) to use, or to application, were a reference to use or application, as the case may be, in the course of, or in relation to:

(a) trade or commerce between Australia and places outside Australia; or
(b) trade or commerce among the States; or
(c) trade or commerce within a Territory, between a State and a Territory or between 2 Territories; or
(d) the supply of goods or services to the Commonwealth, to a Territory or to an authority or instrumentality of the Commonwealth or of a Territory; or
(e) the defence of Australia; or
(f) the operation of lighthouses, lightships, beacons or buoys; or
(g) astronomical or meteorological observations; or
(h) an activity of a corporation to which paragraph 51(xx) of the Constitution applies; or
(i) banking, other than State banking; or
(j) insurance, other than State insurance; or
(k) weighing or measuring.

(15) In this section:

- **customer cabling** has the same meaning as in the *Telecommunications Act 1997*.
- **customer equipment** has the same meaning as in the *Telecommunications Act 1997*.
- **radiocommunications community** has the same meaning as in the *Australian Communications and Media Authority Act 2005*. 

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*Radiocommunications Act 1992*
Division 8—Prohibited devices

189 Operation etc. of prohibited devices

(1) A person must not:
   (a) operate or supply a device that the person knows is a device in respect of which a declaration is in force under section 190; or
   (b) have a device that the person knows, or ought reasonably to know, is such a device in his or her possession for the purpose of operating or supplying the device.

Penalty:
   (a) if the offender is an individual—imprisonment for 2 years; or
   (b) otherwise—1,500 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the Criminal Code).

(2) For the purposes of establishing a contravention of subsection (1), if, having regard to:
   (a) a person’s abilities, experience, qualifications and other attributes; and
   (b) all the circumstances surrounding the alleged contravention; the person ought reasonably to have known that the device in question was a device in respect of which a declaration under section 190 was in force, the person is taken to have known that it was such a device.

190 Declaration of prohibited devices

(1) Subject to section 191, the ACMA may, by notice published in one or more newspapers circulating generally in the capital city of each State and Territory, declare that operation or supply, or possession for the purpose of operation or supply, of a specified device is prohibited for the reasons set out in the notice.
Section 191

(2) The device must be a device that:
   (a) is designed to have an adverse effect on radiocommunications; or
   (b) would be likely substantially to:
       (i) interfere with radiocommunications; or
       (ii) disrupt or disturb radiocommunications in any other way; or
   (c) is a radiocommunications transmitter, or a radiocommunications receiver, that would be reasonably likely to have an adverse effect on the health or safety of persons who:
       (i) operate the device; or
       (ii) work on the device; or
       (iii) use services supplied by means of the device; or
       (iv) are reasonably likely to be affected by the operation of the device.

(3) Subject to subsection (4), a declaration is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

(4) Despite paragraph 46A(1)(c) of that Act, a declaration is taken to be a statutory rule within the meaning of the *Statutory Rules Publication Act 1903*.

191 Consultation on proposed declarations

(1) Before making the declaration, the ACMA must, by notice published in the *Gazette*:
   (a) describe the device; and
   (b) specify the reasons why the ACMA proposes to make the declaration; and
   (c) invite interested persons to make representations about the proposed declaration within such period, being not less than one month after the date of publication of the notice, as is specified in the notice; and
   (d) specify one or more addresses to which such representations may be sent.

(2) A person may, before the end of the period specified in the notice, make such representations to the ACMA.
(3) The ACMA must give due consideration to any representations so made.

(4) This section does not apply if the ACMA is satisfied that making the declaration is a matter of urgency.
Part 4.2—Offences relating to radio emission

192 Interference likely to prejudice safe operation of vessels, aircraft or space objects

Subject to section 196, a person must not use a transmitter in a way likely to interfere with radiocommunications if the person knows that such interference is likely to prejudice the safe operation of a vessel, aircraft or space object.

Penalty:
(a) if the offender is an individual—imprisonment for 5 years; or
(b) otherwise—5,000 penalty units.

193 Interference in relation to certain radiocommunications

(1) Subject to section 196, a person must not, without the ACMA’s written permission, use a transmitter in a way that the person knows is likely to interfere substantially with radiocommunications carried on by or on behalf of:
(a) an organisation specified in the regulations that is:
   (i) a fire-fighting, civil defence or rescue organisation; or
   (ii) an organisation providing ambulance services; or
   (iii) any other organisation the sole or principal purpose of which is to secure the safety of persons during an emergency; or
(b) the Royal Flying Doctor Service; or
(c) the Australian Federal Police or the police force of a State or Territory.

Penalty:
(a) if the offender is an individual—imprisonment for 5 years; or
(b) otherwise—5,000 penalty units.

(2) If the ACMA refuses to give permission to a person who applied for it, the ACMA must give the person a written notice of the refusal, together with a statement of its reasons.

Note: Refusals to give permission are reviewable decisions under Part 5.6.
194 Interference likely to endanger safety or cause loss or damage

Subject to section 196, a person must not do any act or thing that the person knows is likely to:
(a) interfere substantially with radiocommunications; or
(b) otherwise substantially disrupt or disturb radiocommunications;
if the interference, disruption or disturbance is likely to endanger the safety of another person or to cause another person to suffer or incur substantial loss or damage.

Penalty:
(a) if the offender is an individual—imprisonment for 5 years; or
(b) otherwise—5,000 penalty units.

195 Transmission from foreign vessel, aircraft or space object

(1) Subject to section 196 and subsection (2), a person must not, outside Australia and without the ACMA’s written permission, use a transmitter that is on board a foreign vessel, foreign aircraft or foreign space object:
(a) for the purposes of transmitting to the general public in Australia radio programs or television programs; or
(b) in a manner that the person knows is likely to interfere substantially with radiocommunications:
   (i) within Australia; or
   (ii) between a place in Australia and a place outside Australia.

Penalty:
(a) if the offender is an individual—imprisonment for 2 years; or
(b) otherwise—1,500 penalty units.

(2) This section does not apply to use of a transmitter:
(a) in accordance with an agreement, treaty or convention that:
   (i) is entered into between Australia and any other country or countries; and
   (ii) is specified in the regulations; or
(b) under the direction of a person exercising powers under the law of the Commonwealth or of a State or Territory.
(3) If the ACMA refuses to give permission to a person who applied for it, the ACMA must give the person a written notice of the refusal.

Note: Refusals to give permission are reviewable decisions under Part 5.6.

196 Emergency transmissions etc.

(1) A person does not contravene section 192, 193, 194 or 195 by doing anything that the person reasonably believes was necessary for the purpose of:
   (a) securing the safety of a vessel, aircraft or space object that was in danger; or
   (b) dealing with an emergency involving a serious threat to the environment; or
   (c) dealing with an emergency involving risk of death of, or injury to, persons; or
   (d) dealing with an emergency involving risk of substantial loss of, or substantial damage to, property.

(2) In proceedings for an offence against section 192, 193, 194 or 195, the burden of proving any of the matters referred to in subsection (1) lies on the defendant.

197 Causing interference etc.

(1) A person is guilty of an offence if:
   (a) the person engages in conduct; and
   (b) the person is reckless as to whether the conduct will result in:
      (i) substantial interference with radiocommunications; or
      (ii) substantial disruption or disturbance of radiocommunications.

Penalty: Imprisonment for 1 year.

(2) In this section:

engage in conduct means:
   (a) do an act; or
   (b) omit to perform an act.
198 **Transmission of false information**

A person must not, in a transmission made by a transmitter operated by the person, make a statement, or convey information, with intention of inducing a false belief that:

(a) the person or any other person is dying, has died, is being injured or has been injured; or
(b) property is being, or has been, destroyed or damaged; or
(c) there is a risk of the occurrence of an event referred to in paragraph (a) or (b); or
(d) there has been, is or is to be a plan, proposal, attempt, conspiracy, threat to do, or omit to do, an act, being an act or omission that is likely to result in the occurrence of an event referred to in paragraph (a) or (b).

Penalty:

(a) if the offender is an individual—imprisonment for 5 years; or
(b) otherwise—5,000 penalty units.

199 **Transmission likely to cause explosion**

(1) A person must not use a transmitter in a manner that the person knows is likely to cause an explosion.

Penalty:

(a) if the offender is an individual—imprisonment for 5 years; or
(b) otherwise—5,000 penalty units.

(2) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

200 **Imputed knowledge**

For the purposes of establishing a contravention of section 192, 193 or 194, paragraph 195(1)(b) or section 199, if, having regard to:

(a) a person’s abilities, experience, qualifications and other attributes; and
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(b) all the circumstances surrounding the alleged contravention; the person ought reasonably to have known that using the transmitter in question, or doing the act or thing in question, was a contravention of that provision, the person is taken to have known that using the transmitter, or doing the act or thing, was such a contravention.

201 Operation of laws of States or Territories

This Part is not intended to exclude or limit the concurrent operation of:

(a) the law of a State or Territory; or

(b) regulations, Ordinances or other instruments of a legislative character made under an Act other than this Act.

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Part 4.3—Settlement of interference disputes

Division 1—Conciliators

202 Appointment of a conciliator

(1) The ACMA may appoint a person to be a conciliator.

(2) A conciliator may be appointed on either a full-time or a part-time basis.

(3) A conciliator holds office for such period as is specified in his or her instrument of appointment.

(4) A conciliator’s appointment may be expressed to have effect either generally or as otherwise provided by his or her instrument of appointment.

203 Terms and conditions etc.

(1) The ACMA may:
   (a) subject to section 204, determine the terms and conditions of appointment of a person holding office as a conciliator; and
   (b) terminate such an appointment at any time.

(2) A conciliator may resign by writing signed by the conciliator and delivered to the ACMA.

204 Remuneration and allowances

(1) A conciliator who is not engaged under the Public Service Act 1999 is to be paid such remuneration as is determined by the Remuneration Tribunal.

(2) If a determination of the Remuneration Tribunal in relation to conciliators is not in operation, a conciliator is to be paid such remuneration as is prescribed.

(3) A conciliator is to be paid such allowances as are prescribed.

(4) This section has effect subject to the Remuneration Tribunal Act 1973.
Section 205

Division 2—Referral of matters to conciliators

205 Referral of complaints to conciliators

(1) If a complaint in writing is made to the ACMA to the effect that:
   (a) a person has engaged, is engaging or proposes to engage in
       conduct (including any act and any refusal or omission to act)
       that has caused, is causing or is likely to cause:
       (i) interference or risk of interference to
           radiocommunications; or
       (ii) any other disruption or disturbance, or risk of disruption
           or disturbance, to radiocommunications; and
   (b) the interests of the complainant have been, are or are likely to
       be affected by the conduct;

the ACMA may refer the matter to a conciliator.

(2) If the ACMA decides not to refer a complaint to a conciliator, the
    ACMA must give to the complainant a written notice informing the
    complainant of the decision and the reasons for the decision.

(3) A reference in this section to being engaged in conduct includes a
    reference to being involved in, or contributing to, that conduct.

206 Referral of other matters to conciliators

(1) If it appears to the ACMA that, even though a complaint has not
    been made under subsection 205(1):
    (a) a person has engaged, is engaging or is proposing to engage
        in disputed conduct; and
    (b) the interests of another person have been, are or are likely to
        be affected by the conduct;

the ACMA may refer the matter to a conciliator.

(2) A reference in this section to being engaged in disputed conduct
    includes a reference to being involved in, or contributing to, that
    conduct.
207 Consideration of whether to refer a matter

(1) In considering whether to refer a matter to a conciliator, the ACMA must have regard to all matters it thinks relevant.

(2) Without limiting subsection (1), the ACMA must have regard to:

(a) whether, in the ACMA’s opinion:
   (i) the matter is trivial; or
   (ii) the person whose interests allegedly have been, are being or are likely to be affected does not wish the matter to be referred to a conciliator; and

(b) if the matter arises from a complaint to the ACMA—whether, in the ACMA’s opinion:
   (i) the complaint is frivolous or vexatious or was not made in good faith; or
   (ii) the interests of the complainant have not been, are not being or are not likely to be affected by the conduct in question; or
   (iii) there is some other remedy that is reasonably available to the complainant; or
   (iv) the complainant has made reasonable efforts to negotiate a resolution of the matter.
Division 3—The conciliation process

208 Conciliator may effect settlement in relation to disputed conduct

Subject to section 209, a conciliator to whom a matter is referred under Division 2 must:

(a) inquire into the disputed conduct to which the matter relates; and
(b) try to effect a settlement of the matter; and
(c) if the conciliator cannot effect a settlement—as soon as practicable, give to the ACMA a written report setting out:
   (i) the conciliator’s recommendations for resolving the matter; and
   (ii) the reasons for those recommendations.

209 Conciliator may decide not to make inquiry

(1) A conciliator may decide not to inquire into disputed conduct to which the matter relates, or, if the conciliator has commenced to inquire into the conduct, decide not to continue the inquiry, if:

(a) the conciliator believes that:
   (i) the matter is trivial; or
   (ii) the person whose interests allegedly have been, are being, or are likely to be affected does not wish the inquiry to be made or continued (as the case may be); or

(b) if the inquiry arises from a complaint to the ACMA—the conciliator believes that:
   (i) the complaint is frivolous or vexatious or was not made in good faith; or
   (ii) the interests of the complainant have not been, are not being or are not likely to be affected by the conduct; or
   (iii) there is some other remedy that is reasonably available to the complainant; or
   (iv) the complainant has made reasonable efforts to negotiate a resolution of the matter.
(2) If a conciliator decides not to inquire into, or not to continue to inquire into, conduct in respect of which a complaint was made, the conciliator must:

(a) give the complainant written notice of the decision and the reasons for the decision; and
(b) give to the ACMA a written report on the matter that includes the information referred to in paragraph (a).

(3) A report under paragraph (2)(b) must be given as soon as practicable after it is prepared.

210 Compulsory conference

(1) For the purposes of conducting an inquiry into, or trying to effect a settlement of, a matter under section 208, a conciliator may direct a person referred to in subsection (2) to attend, at a time and place specified in the notice, a conference presided over by the conciliator.

(2) A direction may be given to:

(a) if the matter arose as a result of a complaint under subsection 205(1)—the complainant; or
(b) the person whose disputed conduct led to the inquiry; or
(c) any other person whose presence at the conference the conciliator thinks is reasonably likely to be conducive to settling the matter.

(3) A direction is to be given by written notice given to the person concerned.

(4) The person is entitled to be paid by the Commonwealth any allowances for the expenses of a person’s attendance that are determined by the ACMA and published in the Gazette.

(5) The person must not:

(a) fail to attend as required by the direction; or
(b) fail to attend and report himself or herself from day to day unless excused, or released from further attendance, by the conciliator.

Penalty: $5,000.
Section 211

(5A) Subsection (5) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (5A) (see subsection 13.3(3) of the Criminal Code).

(6) Evidence of anything said or of the production of any document at a conference under this section is not admissible:

(a) in any court (whether or not exercising federal jurisdiction); or

(b) in proceedings before a person authorised by a law of the Commonwealth or of a State or Territory, or by consent of parties, to hear evidence;

except in a prosecution for an offence against section 136.1 or 137.1 of the Criminal Code that relates to this Act.

211 Protection from civil actions

(1) Civil proceedings do not lie against a person in respect of loss, damage or injury of any kind suffered by another person because a statement was made in good faith to a conciliator in connection with an inquiry into disputed conduct.

(2) A reference in subsection (1) to making a statement includes a reference to giving a document or information.
Division 4—Directions

212 ACMA may issue directions

(1) If the ACMA:
   (a) receives a conciliator’s report in relation to a matter under paragraph 208(c); and
   (b) is satisfied that, in order to prevent the disputed conduct to which the matter relates from causing:
       (i) interference, or risk of interference, to radiocommunications; or
       (ii) any other disruption or disturbance, or risk of disruption or disturbance, to radiocommunications;
       a person to whom this section applies must take specified action, or refrain from taking specified action;
       the ACMA may issue a written direction to the person to take that action within a specified period, or to refrain from taking that action, as the case may be.

(2) In issuing a direction the ACMA must have regard to the conciliator’s report.

(3) This section applies to any of the following persons:
   (a) a person who has engaged, is engaging or proposes to engage in the disputed conduct in question;
   (b) if the matter in question arose as a result of a complaint under subsection 205(1)—the complainant.

(4) A reference in this section to being engaged in conduct includes a reference to being involved in, or contributing to, that conduct.

(5) If the ACMA issues a direction to a person, it must give the person notice of the reasons for that direction.

Note: A decision to issue a direction is reviewable under Part 5.6.

213 Complainants to be kept informed

If:

(a) the ACMA receives a conciliator’s report in relation to a matter under paragraph 208(c); and
(b) the matter arose as a result of a complaint under subsection 205(1);

the ACMA must, by written notice, inform the complainant of:

(c) any direction issued under section 212 in relation to the matter (other than a direction issued to the complainant); or

(d) any decision not to issue a direction under section 212 in relation to the matter, together with the reasons for the decision.

214 Contravention of a direction

(1) A person is guilty of an offence if:

(a) the person has been issued with a direction under section 212; and

(b) the person engages in conduct; and

(c) the person’s conduct contravenes the direction.

Penalty: 100 penalty units.

(2) In this section:

engage in conduct means:

(a) do an act; or

(b) omit to perform an act.

215 Commonwealth not liable for costs

The Commonwealth is not liable for any loss, damage or injury suffered by a person as a result of complying with a direction under section 212.
Division 5—Miscellaneous

216 Offences relating to settlement of interference disputes

It is an offence for a person to:

(a) refuse to employ another person; or
(b) dismiss or threaten to dismiss another person from his or her employment; or
(c) prejudice, or threaten to prejudice another person in his or her employment; or
(d) intimidate or coerce or impose any pecuniary or other penalty on, another person;

because that other person:

(e) has made, or proposes to make, a complaint of the kind referred to a conciliator under section 205; or
(f) has given, or proposes to give, information or documents to a third person exercising any power or performing any function under this Part; or
(g) has attended, or proposes to attend, a conference held under section 210.

Penalty: Imprisonment for 6 months.

217 Operation of State and Territory laws

This Part is not intended to affect the operation of a law of a State or Territory if the law is capable of operating concurrently with this Part.

218 Report by ACMA

The ACMA must include in each annual report prepared under section 242 for a financial year a report on the operation of this Part during that year.
Part 4.4—Restricted use zones

Division 1—Declarations of emergency

219 Declaration of period of emergency

(1) Subject to section 220, the Governor-General may, by Proclamation, declare that a period specified in the Proclamation will be a period of emergency.

(2) The period must not be expressed to commence on a day earlier than the day on which the Proclamation is published in the Gazette.

(3) The period may not exceed 3 months.

220 Circumstances in which Proclamation may be made

The Governor-General may not make a Proclamation under section 219 unless satisfied that it is necessary in the public interest to do so due to an emergency involving:

(a) prejudice to the security or defence of Australia; or
(b) a serious threat to the environment; or
(c) risk of death of, or injury to, persons; or
(d) risk of substantial loss of, or substantial damage to, property.

221 Termination of period of emergency

(1) If, at any time during a period of emergency, the Governor-General becomes satisfied that it is no longer necessary in the public interest that the period of emergency should continue, the Governor-General must, by a new Proclamation, revoke the Proclamation that declared the period of emergency.

(2) The revocation terminates the period of emergency.
Division 2—Restrictive orders

222  Restrictive orders

(1) During a period of emergency, the Minister may, in writing, make a restrictive order that prohibits or regulates:
   (a) the use, within a specified area, of radiocommunications transmitters; or
   (b) the operation of transmitters within a specified area if such use is, in the Minister’s view, likely to interfere with radiocommunications.

(2) The Minister:
   (a) must not make the order unless guidelines are in force under section 230; and
   (b) in making the order, must comply with the guidelines in force under section 230.

(3) The order comes into force:
   (a) on the day it is published under subsection 223(1); or
   (b) if a later day (being a day during a period of emergency) is specified in the order—on that later day.

223  Publication of restrictive orders

(1) A copy of the order must be published in the Gazette.

(2) As soon as practicable after making the order, the Minister:
   (a) must cause a copy of the order to be published in one or more newspapers circulating generally in the capital city of the State or Territory in which the order has effect; and
   (b) may, if the Minister thinks fit, cause particulars of the order to be published by radio or television broadcast.

(3) A failure to comply with paragraph (2)(a) does not affect the order’s validity.
Section 224

224 Application of orders to broadcasting

A restrictive order does not apply to:
   (a) a broadcasting station; or
   (b) a fixed transmitter the use or operation of which is essential
to the operation of a broadcasting station;
unless the order is expressed so to apply.

225 Revocation of orders

A restrictive order is taken to be revoked:
   (a) at the end of the period of emergency during which it came
into force; or
   (b) if the order has an extended operation under section 226—at
the end of the last period of emergency during which the
order continues to be in force.

226 Orders may have extended operation

If, during a period of emergency, a Proclamation under subsection
219(1) declares that an emergency will exist during a later period
commencing immediately after the end of the first-mentioned
period, any restrictive order in force immediately before the end of
the first-mentioned period (including an order in force by virtue of
previous applications of this subsection) continues in force unless
it is:
   (a) revoked as provided for by subsection 33(3) of the Acts
Interpretation Act 1901; or
   (b) disallowed under section 48 of that Act as applied by
section 229 of this Act; or
   (c) set aside by a court.

227 Contravention of orders

(1) A person must not contravene a restrictive order.
Penalty: 300 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable
excuse.

Note: A defendant bears an evidential burden in relation to the matter in
subsection (1A) (see subsection 13.3(3) of the Criminal Code).
(2) A person does not contravene subsection (1) if the person contravenes a restrictive order in the reasonable belief that the act or omission constituting the contravention is necessary for the purposes of:
   (a) securing the safety of a vessel, aircraft or space object that was in danger; or
   (b) dealing with an emergency involving a serious threat to the environment; or
   (c) dealing with an emergency involving risk of death of, or injury to, persons; or
   (d) dealing with an emergency involving risk of substantial loss of, or substantial damage to, property.

(3) In proceedings for an offence against subsection (1), the burden of proving any of the matters referred to in subsection (2) lies on the defendant.

(4) Nothing in subsection (2) limits the scope of the expression “reasonable excuse” in subsection (1A).

228 Orders to prevail over inconsistent laws

(1) Subject to subsection (2), a restrictive order has effect despite any law of the Commonwealth (excluding this Act but including regulations made under this Act), or any law of a State or Territory, that is inconsistent with the order.

(2) This Part does not affect the operation of a law of a State or Territory so far as the law is capable of operating concurrently with this Part.

229 Disallowance of restrictive orders

A restrictive order is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
Division 3—Guidelines for making restrictive orders

230 Minister may make guidelines

(1) At any time (whether or not during a period of emergency) the Minister may, by instrument in writing:
   (a) make guidelines with respect to the exercise of the Minister’s powers under section 222 to make restrictive orders; or
   (b) vary or revoke guidelines made by the Minister under this subsection (including guidelines varied by virtue of one or more previous applications of this subsection).

(2) A guideline is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
Chapter 5—Administration and enforcement

231 Outline of this Chapter

(1) This Chapter provides for various matters dealing with the administration and enforcement of this Act.

(2) Part 5.1 provides for the ACMA to delegate certain powers to authorities of the Commonwealth.

(3) Part 5.2 provides for the ACMA to hold public inquiries into management of the radiofrequency spectrum and other aspects of radiocommunication.

(4) Part 5.3 allows the ACMA to make advisory guidelines about any aspect of radiocommunication or radio emission.

(5) Part 5.4 provides for persons to be accredited to issue certificates under this Act.

(6) Part 5.5 provides for inspectors to be appointed and confers investigative powers on them.

(7) Part 5.6 enables specified decisions under this Act to be reconsidered by the ACMA and reviewed by the AAT.

(8) Part 5.7 provides for the ACMA to determine charges for things done by the ACMA, including spectrum access charges for spectrum licences.

(9) Part 5.8 provides that a person may give the ACMA an enforceable undertaking about compliance with this Act.
Chapter 5  Administration and enforcement
Part 5.1  Delegation

Section 238

Part 5.1—Delegation

238 Delegation

(1) The powers conferred on the ACMA by subsection (2), and on a Division of the ACMA by subsection (3), are in addition to the powers conferred by sections 50, 51 and 52 of the *Australian Communications and Media Authority Act 2005*.

(2) The ACMA may, by writing, delegate to an authority of the Commonwealth the ACMA’s power to issue or cancel certificates of proficiency under Division 5 of Part 3.3 or to make standards under Part 4.1.

(3) If, under section 50 of the *Australian Communications and Media Authority Act 2005*, the ACMA has delegated the power referred to in subsection (2) to a Division of the ACMA, the following provisions have effect:
   (a) the Division may delegate the power to an authority of the Commonwealth;
   (b) subsections 52(2), (3), (4), (5) and (6) of the *Australian Communications and Media Authority Act 2005* have effect as if the delegation by the Division were a delegation under section 52 of that Act.

(4) If:
   (a) a power of the ACMA is delegated to an authority of the Commonwealth under subsection (2) or (3); and
   (b) the authority is established under an Act that permits the authority’s powers under that Act to be delegated to another person or body;
the power of the ACMA in question may be further delegated under that Act as if it were one of the authority’s powers under that Act.

308  Radiocommunications Act 1992
Part 5.2—Public inquiries

255 ACMA may hold inquiry

(1) The ACMA may hold a public inquiry about any matter relating to:
   (a) management of the radiofrequency spectrum; or
   (b) any other aspect of radio emissions.

(2) The ACMA must not hold a public inquiry about a matter relating to the operation, or proposed operation, of a broadcasting station unless the matter is about:
   (a) interference, or risk of interference, to radiocommunications (other than transmission or reception of radio or television programs delivered by a broadcasting service), if the interference is attributable to operation of a broadcasting station; or
   (b) interference, or risk of interference, to transmission or reception of radio or television programs delivered by a broadcasting service, if the interference is not attributable to operation of a broadcasting station.

(3) Nothing in this Part applies to an inquiry held by the ACMA under another Act.

256 ACMA to hold inquiry when directed

(1) The ACMA must hold a public inquiry about a particular matter relating to:
   (a) management of the radiofrequency spectrum; or
   (b) any other aspect of radio emissions;
   if the Minister directs the ACMA in writing to hold a public inquiry about that matter.

(2) The Minister must not direct the ACMA to hold a public inquiry that it could not hold under section 255.
Section 257

257 Informing the public about an inquiry

(1) If the ACMA holds a public inquiry, it must publish, in whatever ways it thinks appropriate, notice of:
   (a) the fact that it is holding the inquiry; and
   (b) the period during which the inquiry is to be held; and
   (c) the nature of the matter to which the inquiry relates; and
   (d) the period within which and the form in which members of the public may make submissions to the ACMA about that matter; and
   (e) the address or addresses to which submissions may be sent.

(2) The ACMA may also include in the notice a statement of the matters that the ACMA would like submissions to deal with.

(3) The ACMA need not publish at the same time or in the same way notice of all the matters referred to in subsection (1).

258 Discussion paper

(1) The ACMA may cause to be prepared a discussion paper that:
   (a) identifies the issues that the ACMA thinks are relevant to the matter to which a public inquiry relates; and
   (b) sets out such background material about, and discussion of, those issues as the ACMA thinks is appropriate.

(2) The ACMA must make copies of the discussion paper available at each of the ACMA’s offices. The ACMA may charge a reasonable price for supplying copies of the discussion paper in accordance with this subsection.

(3) The ACMA may otherwise publish the discussion paper, including in electronic form. The ACMA may charge for supplying a publication under this subsection in accordance with a determination under section 60 of the Australian Communications and Media Authority Act 2005.

259 Written submissions

(1) The ACMA must provide a reasonable opportunity for any member of the public to make a written submission to the ACMA about the matter to which a public inquiry relates.
(2) For the purposes of subsection (1), the ACMA is taken not to have provided a reasonable opportunity to make submissions unless there is a period of at least 28 days during which the submissions could be made.

260 Protection from civil actions

(1) Civil proceedings do not lie against a person in respect of loss, damage or injury of any kind suffered by another person because a statement was made in good faith, in connection with a written submission or a public hearing, to the ACMA in connection with a public inquiry under this Division.

(2) A reference in subsection (1) to making of a statement includes a reference to the giving of a document or information.

261 Hearings

(1) The ACMA may hold hearings for the purposes of a public inquiry.

(2) Hearings may be held, for example:
   (a) in order to receive submissions about the matter to which the inquiry relates; or
   (b) in order to provide a forum for public discussion of issues relevant to that matter.

(3) At a hearing, the ACMA may be constituted by:
   (a) a member or members determined in writing by the Chair for the purposes of that hearing, or
   (b) if the functions or powers of the ACMA in relation to the hearing have been delegated to a person, or to a Division of the ACMA, under section 50, 51 or 52 of the Australian Communications and Media Authority Act 2005—that person or Division.

(4) The Chair is to preside at all hearings at which he or she is present.

(5) If the Chair is not present at a hearing, the hearing is to be presided over by:
   (a) if paragraph (3)(a) applies—the member, specified in an instrument under that paragraph, as the member who is to preside at the hearing; or
Chapter 5  Administration and enforcement
Part 5.2  Public inquiries

Section 261A

(b) if paragraph (3)(b) applies and the delegation is to a person—that person; or
(c) if paragraph (3)(b) applies and the delegation is to a Division of the ACMA—a member of the Division chosen by the Division.

(6) The ACMA may regulate the conduct of proceedings at a hearing as it thinks appropriate.

261A  Hearing to be in public except in exceptional cases

(1) This section applies to a hearing conducted under this Part.

(2) The basic rule is that the hearing must take place in public.

(3) However, the hearing, or a part of the hearing, may be conducted in private if the ACMA is satisfied that:
   (a) evidence that may be given, or a matter that may arise, during the hearing or a part of the hearing is of a confidential nature; or
   (b) hearing a matter, or part of a matter, in public would not be conducive to the due administration of this Act.

(4) If the hearing is to be conducted in public, the ACMA must give reasonable public notice of the conduct of the hearing.

261B  Confidential material not to be published

(1) This section applies to a hearing conducted under this Part.

(2) If:
   (a) the hearing, or a part of the hearing, takes place in public; and
   (b) the ACMA is of the opinion that:
       (i) evidence or other material presented to the hearing; or
       (ii) material in a written submission lodged with the ACMA;
       is of a confidential nature;

   the ACMA may order that:
   (c) the evidence or material not be published; or
   (d) its disclosure be restricted.
Section 261C

(3) A person must not fail to comply with an order under subsection (2).

(4) A person is guilty of an offence if:
   (a) the ACMA has made an order under subsection (2); and
   (b) the person engages in conduct; and
   (c) the person’s conduct contravenes the order.

   Penalty: 50 penalty units.

(5) Subsections (3) and (4) do not apply if the person has a reasonable excuse.

   Note: A defendant bears an evidential burden in relation to the matter in subsection (5) (see subsection 13.3(3) of the Criminal Code).

(6) In this section:

   engage in conduct means:
   (a) do an act; or
   (b) omit to perform an act.

261C Direction about private hearings

(1) This section applies to a hearing conducted under this Part.

(2) If the hearing, or a part of the hearing, takes place in private, the ACMA:
   (a) must give directions as to the persons who may be present at the hearing or the part of the hearing; and
   (b) may give directions restricting the disclosure of evidence or other material presented at the hearing or the part of the hearing.

(3) A person must not fail to comply with a direction under subsection (2).

(4) A person is guilty of an offence if:
   (a) the ACMA has given a direction under paragraph (2)(a); and
   (b) the person engages in conduct; and
   (c) the person’s conduct contravenes the direction.

   Penalty: 10 penalty units.
Section 261D

(5) A person is guilty of an offence if:
   (a) the ACMA has given a direction under paragraph (2)(b); and
   (b) the person engages in conduct; and
   (c) the person’s conduct contravenes the direction.

Penalty: 50 penalty units.

(6) Subsections (3), (4) and (5) do not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (6) (see subsection 13.3(3) of the Criminal Code).

(7) In this section:

engage in conduct means:
   (a) do an act; or
   (b) omit to perform an act.

261D Reports on inquiries

(1) If the ACMA holds a public inquiry, the ACMA must prepare a report setting out its findings as a result of the inquiry.

(2) If the inquiry was held because of a direction given by the Minister under section 256, the ACMA must give a copy of the report to the Minister.

(3) If the inquiry was held otherwise than because of a direction given by the Minister under section 256, the ACMA must publish the report.

(4) The ACMA is not required to include in a report any material:
   (a) that is of a confidential nature; or
   (b) the disclosure of which is likely to prejudice the fair trial of a person; or
   (c) that is the subject of an order or direction under section 261B or 261C.

314 Radiocommunications Act 1992
Part 5.3—Advisory guidelines

262 ACMA may make advisory guidelines

(1) The ACMA may make written advisory guidelines about any aspect of radiocommunication or radio emissions.

(2) Advisory guidelines, for example, may be made about:
   (a) any matter in respect of which standards may be made under Part 4.1; or
   (b) the use, construction, design or performance of any thing; or
   (c) interference with radiocommunications; or
   (d) frequency allocation and coordination.

(3) The ACMA must:
   (a) give a copy of each advisory guideline it makes to the Minister; and
   (b) publish each such advisory guideline in the way it thinks fit.
Chapter 5  Administration and enforcement
Part 5.4  Accreditation

Section 263

Part 5.4—Accreditation

263 ACMA may accredit persons

(1) The ACMA may, by written instrument, give to a person an accreditation of a particular kind if:
   (a) the person applies, in the form approved by the ACMA, to the ACMA for an accreditation of that kind; and
   (b) the appropriate charge fixed by determination made under section 60 of the Australian Communications and Media Authority Act 2005 has been paid.

(2) The instrument must state the kind of certificates that a person who is given an accreditation of that kind is permitted to issue under this Act.

(2A) The instrument is given subject to such conditions relating to the issuing of certificates as the ACMA determines under section 266A or specifies in the instrument.

(2B) A condition may relate to matters existing or arising at, before or after the time when a certificate is issued.

(3) In deciding whether to give to a person an accreditation, the ACMA must apply the principles determined under section 266.

(4) An accreditation takes effect on the day specified in the instrument.

Note: A decision not to give an accreditation is reviewable under Part 5.6.

264 Withdrawal of accreditation

The ACMA may, by notice in writing to a person, withdraw an accreditation given to the person if the ACMA is satisfied that:
   (a) the accreditation is no longer in accordance with the principles determined under section 266, as in force at the time the notice is given (whether or not the principles have been varied since the accreditation was given); or
   (b) the person has been incorrectly issuing certificates under this Act; or
265 Procedure for withdrawing accreditation

(1) Before withdrawing a person’s accreditation, the ACMA must give the person written notice:
   (a) stating that the ACMA is considering withdrawing the accreditation; and
   (b) inviting the person to make representations to the ACMA about the matter on or before the day specified in the notice.

(2) The day specified under paragraph (1)(b) must be at least 14 days after the day on which the notice is given.

(3) The ACMA must give due consideration to any representations made by or on behalf of the person on or before that day.

266 Accreditation principles

(1) The ACMA may, by written instrument, determine principles that:
   (a) govern the accreditation process; and
   (b) specify the matters for which the ACMA may accredit persons.

(2) Without limiting the matters with which the principles may deal, the principles must provide for:
   (a) the form of applications under section 263; and
   (b) procedures that must be followed in relation to deciding whether to accredit, or withdraw the accreditation of, persons; and
   (c) the kinds of accreditation; and
   (d) in respect of each kind of accreditation—the qualifications and other requirements required before a person can be given that kind of accreditation.
Section 266A

(2A) Qualifications and other requirements provided for in principles determined as mentioned in paragraph (2)(d) may relate to matters existing or arising at, before or after the time of accreditation.

(3) The principles take effect on the day specified in the instrument.

(4) Principles are disallowable instruments for the purposes of section 46A of the Acts Interpretation Act 1901.

266A ACMA determination in relation to certificates

(1) The ACMA may determine, by instrument in writing, the conditions that are to apply in relation to the issuing of a certificate under this Act.

(2) A determination is a disallowable instrument for the purposes of section 46A of the Acts Interpretation Act 1901.
Part 5.5—Enforcement

Division 1—Inspectors

267 Inspectors

(1) Subject to subsection (2), a person is an inspector for the purposes of this Act if the person is:

(a) a Commonwealth officer or a State officer appointed by the ACMA, by written instrument, to be an inspector; or

(b) an officer included in a class of officers appointed by the ACMA, by written instrument published in the Gazette, to be inspectors for the purposes of this Act; or

(c) a member (other than a special member) of the Australian Federal Police or of the police force of a Territory.

(2) An instrument under paragraph (1)(a) or (b) may specify provisions of this Act in relation to which appointments made by the instrument are to apply, and any such limitation has effect accordingly.

268 Identity cards

(1) The ACMA may cause an identity card to be issued to an inspector, other than a member of a police force, in a form approved by the ACMA by written instrument.

(2) A person who ceases to be an inspector must, as soon as is practicable, return his or her identity card to the ACMA.

(3) A person must not contravene subsection (2).

Penalty: 5 penalty units.

(4) Subsection (3) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (4) (see subsection 13.3(3) of the Criminal Code).

(5) Subsection (3) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.
Division 2—Search warrants

269 Magistrate may issue warrant

(1) If:

(a) an information on oath is laid before a magistrate alleging that an inspector suspects on reasonable grounds that there may be on any land, or on or in any premises, vessel, aircraft, space object or vehicle:
   (i) anything in respect of which an offence against this Act has been committed; or
   (ii) anything that may afford evidence about the commission of an offence against this Act; or
   (iii) anything that was used, or is intended to be used, for the purpose of committing an offence against this Act; and
(b) the information sets out those grounds;
the magistrate may issue a search warrant authorising an inspector named in the warrant, with such assistance, and by such force, as is necessary and reasonable, to enter the land, premises, vessel, aircraft, space object or vehicle and exercise the powers referred to in paragraphs 272(2)(b), (c) and (d) in respect of the thing.

(2) The magistrate is not to issue the warrant unless:

(a) the informant or some other person has given to the magistrate, either orally or by affidavit, such further information (if any) as the magistrate requires concerning the grounds on which the issue of the warrant is being sought; and
(b) the magistrate is satisfied that there are reasonable grounds for issuing the warrant.

(3) There must be stated in the warrant:

(a) the purpose for which the warrant is issued, and the nature of the offence in relation to which the entry and search are authorised; and
(b) whether entry is authorised to be made at any time of the day or night or during specified hours of the day or night; and
(c) a description of the kind of things to be seized; and

Radiocommunications Act 1992
(d) a day, not later than 7 days after the day of issue of the warrant, upon which the warrant ceases to have effect.

270 Warrants may be issued by telephone or other electronic means

(1) If, because of circumstances of urgency, an inspector thinks it necessary to do so, the inspector may apply to a magistrate for a warrant under subsection 269(1) by telephone, telex, fax or other electronic means under this section.

(2) Before applying, the inspector must prepare an information of a kind referred to in subsection 269(1) that sets out the grounds on which the issue of the warrant is being sought, but may, if it is necessary to do so, make the application before the information has been sworn.

(3) If the magistrate to whom an application under subsection (1) is made is satisfied:

(a) after having considered the terms of the information prepared under subsection (2); and

(b) after having received such further information (if any) as the magistrate requires concerning the grounds on which the issue of the warrant is being sought;

that there are reasonable grounds for issuing the warrant, the magistrate must complete and sign such a search warrant as the magistrate would issue under section 269 if the application had been made under that section.

(4) If the magistrate signs a warrant under subsection (3):

(a) the magistrate must:

(i) inform the inspector of the terms of the warrant; and

(ii) inform the inspector of the day on which and the time at which the warrant was signed; and

(iii) inform the inspector of the day (not more than 7 days after the magistrate completes and signs the warrant) on which the warrant ceases to have effect; and

(iv) record on the warrant the reasons for issuing the warrant; and

(b) the inspector must:

(i) complete a form of warrant in the same terms as the warrant completed and signed by the magistrate; and
(ii) write on it the magistrate’s name and the day on which and the time at which the warrant was signed.

(5) The inspector must, not later than the day after the date of expiry or execution of the warrant, whichever is the earlier, send to the magistrate:

(a) the form of warrant completed by the inspector; and

(b) the information duly sworn in connection with the warrant.

(6) On receiving the documents referred to in subsection (5), the magistrate must:

(a) attach to them the warrant signed by the magistrate; and

(b) deal with the documents in the way in which the magistrate would have dealt with the information if the application for the warrant had been made under section 269.

(7) A form of warrant duly completed by an inspector under subsection (4), if it is in accordance with the terms of the warrant signed by the magistrate, is authority for any entry, search, seizure or other exercise of a power that the warrant so signed authorises.

(8) If:

(a) it is material in any proceedings for a court to be satisfied that an entry, search, seizure or other exercise of power was authorised in accordance with this section; and

(b) the warrant signed by a magistrate under this section authorising the entry, search, seizure or other exercise of power is not produced in evidence;

the court is to assume, unless the contrary is proved, that the entry, search, seizure or other exercise of power was not authorised by such a warrant.
Division 3—Searches and seizures

271 References to connection with an offence

For the purposes of this Division, a thing is connected with a particular offence if it is:

(a) a thing with respect to which the offence has been committed; or
(b) a thing that will afford evidence of the commission of the offence; or
(c) a thing that was used, or is intended to be used, for the purpose of committing the offence.

272 General offence related searches and seizures

(1) This section applies if an inspector suspects on reasonable grounds that there is on any land, or on or in any premises, vessel, aircraft, space object or vehicle anything connected with a particular offence against this Act.

(2) The inspector may, with the consent of the owner or occupier of the land, premises, vessel, aircraft, space object or vehicle, or in accordance with a warrant issued under Division 2:

(a) enter the land, premises, vessel, aircraft, space object or vehicle; and
(b) search the land, premises, vessel, aircraft, space object or vehicle; and
(c) break open and search a cupboard, drawer, chest, trunk, box, package or other receptacle, whether a fixture or not, in which the inspector suspects on reasonable grounds there to be anything of a kind referred to in subsection (1); and
(d) examine and seize anything that the inspector suspects on reasonable grounds to be connected with the offence.

(3) If an inspector may enter a vessel, aircraft, space object or vehicle under subsection (2), the inspector may, for that purpose and for the purpose of exercising a power referred to in paragraph (2)(b), (c) or (d), stop and detain the vessel, aircraft, space object or vehicle.
Section 273

273 Evidence about the commission of other offences

If:

(a) in the course of searching, in accordance with a warrant, for a particular thing in relation to a particular offence, an inspector finds a thing that the inspector believes on reasonable grounds to be:
   (i) a thing that is connected with the offence, although not the thing specified in the warrant; or
   (ii) a thing that is connected with another offence against this Act; and

(b) the inspector believes, on reasonable grounds, that it is necessary to seize that thing in order to prevent its concealment, loss or destruction, or its use in committing, continuing or repeating the offence or the other offence;

the warrant is taken to authorise the inspector to seize that thing.

274 Production of identity card etc.

(1) An inspector (other than a member of a police force who is in uniform) who proposes to enter land or premises under subsection 272(2) must:

(a) in the case of a member of a police force—produce, for inspection by the owner or occupier of the land or premises, written evidence of the fact that the inspector is a member of a police force; or

(b) in any other case—produce the inspector’s identity card for inspection by the owner or occupier;

and, if the inspector fails to do so, he or she is not authorised to enter the land or premises.

(2) If the entry is in accordance with a warrant issued under Division 2, the inspector is taken not to have complied with subsection (1) unless he or she also produces the warrant for inspection by the owner or occupier.
275 Emergency searches and seizures

(1) Subject to subsection (4), if an inspector has reasonable grounds to believe:
   (a) that a person is carrying anything that is connected with an offence against this Act; and
   (b) that the exercise of powers under this section is necessary to prevent the concealment, loss or destruction of the thing;
the inspector may:
   (c) search the person, the person’s clothing and any property in the person’s immediate control; and
   (d) seize any such thing found in the course of the search.

(2) Subject to subsection (4), if an inspector has reasonable grounds to believe:
   (a) that there is on any land or on or in any premises, vessel, aircraft, space object or vehicle anything that is connected with an offence against this Act; and
   (b) that the exercise of powers under this section is necessary to prevent the concealment, loss or destruction of the article or thing;
the inspector may, with such assistance as the inspector thinks fit, and if necessary by force:
   (c) enter the land, premises, vessel, aircraft, space object or vehicle; and
   (d) search for the thing; and
   (e) seize any such thing found in the course of the search.

(3) If an inspector may enter a vessel, aircraft, space object or vehicle under subsection (2), the inspector may, for that purpose and for the purpose of exercising a power referred to in paragraph (2)(d) or (e), stop and detain the vessel, aircraft or vehicle.

(4) An inspector must not exercise powers under subsection (1) or (2) unless the power is exercised in circumstances of such seriousness and urgency as to require and justify the immediate exercise of those powers without the authority of a warrant issued under Division 2.
Section 276

276 Retention of thing seized

(1) If an inspector seizes a thing under this Division, the inspector or the ACMA may retain it until:

(a) the end of the period of 60 days after the seizure; or
(b) if proceedings for an offence against this Act in respect of which the thing may afford evidence are instituted within that period—the proceedings (including any appeal to a court in relation to those proceedings) are completed.

(2) The ACMA may, by written instrument, authorise a thing seized under this Division to be released to the owner, or to the person from whom it was seized, either:

(a) unconditionally; or
(b) on such conditions as the ACMA thinks fit, including conditions as to giving security for payment of its value if it is forfeited under section 280.
Division 4—Powers of inspectors

277 Power of inspectors to enter premises and adjust transmitters in emergencies

(1) If an inspector has reasonable grounds to believe that:
   (a) a transmitter is operating on any land, or on or in any premises, vessel, aircraft, space object or vehicle; and
   (b) the land, premises, vessel, aircraft, space object or vehicle is or are unoccupied; and
   (c) the operation of the transmitter is:
      (i) interfering with radiocommunications that are essential to the safety of human life; or
      (ii) interfering substantially with the operation of an organisation specified in regulations made for the purposes of paragraph 193(1)(a); or
      (iii) interfering substantially with the operation of an organisation referred to in paragraph 193(1)(b) or (c); or
      (iv) causing substantial loss or damage;
   the inspector may:
   (d) enter the land, premises, vessel, aircraft, space object or vehicle, if the entry is made in circumstances of such seriousness and urgency as to require and justify entry without the authority of an order of a court or of a warrant issued under this Act; and
   (e) subject to subsection (2), take such action as the inspector considers necessary to cause the transmitter to:
      (i) cease operating; or
      (ii) operate in such a way that no longer gives rise to one or more of the consequences set out in paragraph (c).

(2) In exercising a power conferred by paragraph (1)(e) in relation to a transmitter, an inspector must try to ensure that any disruption caused to the performance of the transmitter is no greater than is necessary to prevent the interference with radiocommunications as mentioned in paragraph (1)(c).
(3) If an inspector has, under a power conferred by this section, entered any land, premises, vessel, aircraft, space object or vehicle, and taken any action in respect of a transmitter, the inspector must, as soon as practicable, take all reasonable steps to notify the owner of the transmitter that the action has been taken.

278 Powers of inspectors to require operation of transmitters

(1) Subject to subsection (2), if an inspector has reasonable grounds to believe that a transmitter has been, is being or may be operated so as to cause interference to radiocommunications, the inspector may, for the purpose of investigating the interference or risk of interference, direct a person to operate the transmitter.

(2) An inspector must not direct that a transmitter be operated if that operation is likely to endanger the safety of a person or cause damage to property.

(3) The operation of a transmitter in accordance with a direction does not give rise to an offence under this Act.

(4) A person must not refuse to comply with a direction.

Penalty: 20 penalty units.

(5) Subsection (4) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (5) (see subsection 13.3(3) of the Criminal Code).

(6) Subsection (4) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.

279 General powers of inspectors

(1) An inspector may:

(a) require a person whom he or she suspects on reasonable grounds of having done an act in respect of which the person is required to hold a licence, authority under section 114, certificate or permit to produce the licence, authority, certificate or permit or evidence of its existence and contents; and
(b) require the holder of a licence whom he or she suspects on reasonable grounds of having given an authority under section 114 to produce a copy of that authority; and

(c) require a person whom he or she suspects on reasonable grounds of having recorded particulars relating to the supply of a receiver or transmitter in a document under section 301 to produce that document; and

(d) require a person to produce evidence of having applied a label to a transmitter in accordance with an obligation imposed on the person under section 300; and

(e) require a person who has been required to retain records by a notice under subsection 182(1) for a specified period to produce such records at any time during that period.

(2) A person must not fail to comply with a requirement under this section.

Penalty: 20 penalty units.

(3) Subsection (2) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (3) (see subsection 13.3(3) of the Criminal Code).

(4) Subsection (2) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the Criminal Code.
Division 5—Forfeiture

280 Court may order forfeiture

If a court convicts a person of an offence against this Act, the court may order the forfeiture to the Commonwealth of anything used or otherwise involved in the commission of the offence.

281 Forfeited goods may be sold

A thing forfeited under section 280:

(a) may be sold or otherwise disposed of in accordance with the directions of the ACMA; and

(b) pending such directions, must be kept in such custody as the ACMA directs.
Division 6—Miscellaneous

282 Act not to affect performance of duties by inspectors

Nothing in Chapter 3 or Part 4.1 or 4.2 prohibits the doing of any act or thing by an inspector in the performance of his or her duties under this Act.

283 Inspectors not authorised to enter or search certain land or premises used for defence purposes

Nothing in Division 2 or 3 authorises an inspector to enter or to search:

(a) land or premises that are:
   (i) occupied or used for the purposes of defence; and
   (ii) specified in the regulations or included in a class of land or premises specified in the regulations; or
(b) a vessel, aircraft, space object or vehicle that is in the possession or control of the Defence Force or a part of the Defence Force;

unless:

(c) permission to do so has been given by the person for the time being in charge of those premises or that land, vessel, aircraft, space object or vehicle; or

(d) if it is not reasonably practicable to obtain permission of the kind mentioned in paragraph (c), the entry and search is supervised by a member of the Defence Force, or an officer of the Defence Department, authorised to have access to those premises or that land, vessel, aircraft, space object or vehicle.

284 Offences that are going to be committed

If:

(a) there are reasonable grounds for suspecting that an offence against this Act is going to be committed; and
(b) the commission of that offence would pose a threat to the safety of human life or cause substantial loss or damage; this Part applies in relation to the offence as if there were reasonable grounds for suspecting that it had been committed.
Part 5.6—Review of decisions

Division 1—Decisions subject to internal reconsideration before AAT review

285 Decisions that may be subject to reconsideration by the ACMA

An application may be made to the ACMA for reconsideration of any of the following decisions:

(a) variation of a spectrum licence under section 73 or 87 or paragraph 92(2)(b);
(b) suspension of a spectrum licence under section 75;
(c) cancellation of a spectrum licence under section 77 or 87;
(d) change in the core conditions of a spectrum licence on its re-issue under section 82;
(e) refusal to issue an apparatus licence under section 100;
(ea) refusal to issue a transmitter licence under section 101A;
(eb) refusal to issue a datacasting transmitter licence under section 102B otherwise than because of a decision under paragraph 102B(b);
(f) inclusion of conditions in an apparatus licence under paragraph 107(1)(g), 108A(1)(f), 109(1)(f), 109A(1)(k) or 109B(1)(l);
(g) a decision under section 111 concerning the conditions of an apparatus licence;
(h) directions under subsection 116(1) to revoke an authorisation under section 114;
(i) refusal to issue a certificate of proficiency under section 121;
(j) cancellation of a certificate of proficiency under section 124;
(k) suspension of an apparatus licence under section 126;
(l) cancellation of an apparatus licence under section 128;
(m) refusal to renew an apparatus licence, or renewal of an apparatus licence with different conditions, under section 130;
(ma) refusal to transfer an apparatus licence under section 131AB otherwise than because of a decision under paragraph 131ACA(b);
Chapter 5  Administration and enforcement
Part 5.6  Review of decisions
Division 1  Decisions subject to internal reconsideration before AAT review

Section 286

(mb) refusal to issue a provisional international broadcasting certificate under section 131AF;
(n) refusal to include in the Register under section 145 details of a radiocommunications transmitter;
(o) refusal to correct the Register under section 153;
(p) refusal to issue a permit under section 167;
(q) a decision under section 168 about the conditions of a permit;
(qa) giving a notice under subsection 169(6);
(r) cancellation of a permit under section 171;
(s) refusal to give permission under section 174 to supply a non-standard device;
(t) refusal to give permission under subsection 193(1) or 195(1) to use a transmitter;
(u) directions under section 212 in relation to the settlement of an interference dispute;
(v) refusal to give to a person an accreditation under section 263;
(w) withdrawal of a person’s accreditation under section 264;
(x) making of a pre-acquisition declaration under Part 1 of the Schedule.

286  Deadlines for reaching certain decisions

(1) If this Act provides for a person to make an application to the ACMA for such a decision, the ACMA must make the decision:
(a) within 90 days after receiving the application; or
(b) if the ACMA has, within those 90 days, given the applicant a written request for further information about the application—within 90 days after receiving that further information.

(2) The ACMA is taken, for the purposes of this Part, to have made a decision to refuse the application if it has not informed the applicant of its decision before the end of the relevant period of 90 days.

287  Statements to accompany notification of decisions

(1) If the ACMA makes a decision of a kind referred to in section 285 and gives written notice of the decision to a person whose interests it affects, the notice must include:

334  Radiocommunications Act 1992
(a) a statement to the effect that a person affected by the decision may, if he or she is dissatisfied with the decision, seek a reconsideration of the decision by the ACMA under subsection 288(1); and

(b) a statement to the effect that, if a person who has applied for a reconsideration is dissatisfied with the ACMA’s decision on the reconsideration, application may, subject to the Administrative Appeals Tribunal Act 1975 be made to the AAT for review of the decision on that reconsideration.

(2) Failure to comply with this section does not affect the validity of a decision.

288 Applications for reconsideration of decisions

(1) A person affected by a decision of a kind referred to in section 285 who is dissatisfied with the decision may apply to the ACMA for the ACMA to reconsider the decision.

(2) The application must:
(a) be in a form approved by the ACMA; and
(b) set out the reasons for the application.

(3) The application must be made within:
(a) 28 days after the applicant is informed of the decision; or
(b) if, either before or after the expiration of that period of 28 days, the ACMA extends the period within which the application may be made—the extended period for making the application.

(4) An approved form of an application may provide for verification by statutory declaration of statements in applications.

289 Reconsideration by the ACMA

(1) Upon receiving such an application the ACMA must:
(a) reconsider the decision; and
(b) affirm, vary or revoke the decision.

(2) The ACMA’s decision on reconsideration of a decision has effect as if it had been made under the application under which the original decision was made.
Section 290

(3) The ACMA must give to the applicant a notice stating its decision on the reconsideration together with a statement of its reasons for its decision.

290 Deadlines for reconsiderations

(1) The ACMA must make its decision on reconsideration of a decision within 90 days after receiving an application for reconsideration.

(2) The ACMA is taken, for the purposes of this Part, to have made a decision affirming the original decision if it has not informed the applicant of its decision on the reconsideration before the end of the period of 90 days.

291 Statements to accompany notification of decisions on reconsideration

(1) A notice under subsection 289(3) notifying the applicant that a decision has been affirmed or varied must include:

(a) a statement to the effect that a person affected by the decision so affirmed or varied may, subject to the Administrative Appeals Tribunal Act 1975, if he or she is dissatisfied with the decision so affirmed or varied, apply to the AAT for review of the decision; and

(b) a statement to the effect that the person may request a statement under section 28 of that Act in relation to the decision so affirmed or varied.

(2) Failure to comply with this section does not affect the validity of a decision.

292 Review by the AAT

Applications may be made to the AAT to review a decision of a kind referred to in section 285 if the ACMA has affirmed or varied the decision under section 289.

336 Radiocommunications Act 1992
Division 2—Decisions not subject to internal reconsideration before AAT review

292A  Review by the AAT

An application may be made to the AAT for a review of any of the following decisions made by the ACMA:

(a) a decision under paragraph 102B(b);
(b) a decision under subsection 106(6A);
(c) a decision to give a direction under subsection 114(3C);
(d) a decision under subsection 128C(1);
(e) a decision under section 128D;
(f) a decision under paragraph 131ACA(b).

292B  Notification of decisions to include notification of reasons and appeal rights

If the ACMA makes a decision that is reviewable under section 292A, the ACMA is to include in the document by which the decision is notified:

(a) a statement setting out the reasons for the decision; and
(b) a statement to the effect that an application may be made to the AAT for a review of the decision.
Chapter 5  Administration and enforcement
Part 5.7  Charges

Section 294

Part 5.7—Charges

294 Spectrum access charges

(1) The ACMA may, by written instrument, make determinations:
   (a) fixing spectrum access charges payable by licensees for
       issuing spectrum licences; and
   (b) specifying the times when spectrum access charges are
       payable.

(2) The Minister may give written directions to the ACMA about the
    matters dealt with in determinations.

(3) Directions may, for example, require that:
   (a) the level of spectrum access charges payable in respect of
       one or more specified classes of public or community
       services is to be a specified portion only of the level of
       spectrum access charges otherwise payable; or
   (b) spectrum access charges are not to be payable in respect of a
       specified class of public or community services; or
   (c) persons are to be permitted to pay in instalments, as specified
       in the direction, the spectrum access charges payable in
       respect of a specified class of public or community services;
       or
   (d) a spectrum access charge reflect the amount that the Minister
       considers to be the value of the spectrum.

(4) The ACMA must ensure that its determinations comply with any
    directions in force under this section.

(5) A direction made under subsection (2) is not a legislative
    instrument.

295 Publication of determinations

Determinations are to be made public in the way the ACMA thinks
appropriate.

338  Radiocommunications Act 1992
296 Collection of charges on behalf of the ACMA

The ACMA may enter into arrangements with persons or other bodies under which those persons or other bodies may, on the ACMA’s behalf, receive from persons payments of charges under this Part.

297 Limits on charges

The amount or rate of a charge fixed by a determination must not be such as to amount to taxation.

298 Recovery of charges

A charge fixed by a determination may be recovered as a debt due to the Commonwealth.

298A Fees imposed by certain bodies

(1) The ACMA may, by notice published in the *Gazette*, determine that:

   (a) a specified body or organisation approved by the ACMA as mentioned in paragraph (b) of the definition of *approved examination* in subsection 122(2); or
   (b) a specified accreditation body determined under subsection 183(1); or
   (c) a specified approving body determined under subsection 183A(1);

   may charge fees for performing its functions under this Act.

(2) Such a fee must not be such as to amount to taxation.
Section 298B

**Part 5.8—Enforceable undertakings**

**298B  Simplified outline**

The following is a simplified outline of this Part:

- A person may give the ACMA an enforceable undertaking about compliance with this Act.

**298C  Acceptance of undertakings**

(1) The ACMA may accept any of the following undertakings:

(a) a written undertaking given by a person that the person will, in order to comply with this Act, take specified action;

(b) a written undertaking given by a person that the person will, in order to comply with this Act, refrain from taking specified action;

(c) a written undertaking given by a person that the person will take specified action directed towards ensuring that the person does not contravene this Act, or is unlikely to contravene this Act, in the future.

(2) The undertaking must be expressed to be an undertaking under this section.

(3) The person may withdraw or vary the undertaking at any time, but only with the consent of the ACMA.

(4) The ACMA may, by written notice given to the person, cancel the undertaking.

(5) The ACMA may publish the undertaking on its website.

**298D  Enforcement of undertakings**

(1) If:

(a) a person has given an undertaking under section 298C; and

(b) the undertaking has not been withdrawn or cancelled; and
(c) the ACMA considers that the person has breached the undertaking;

the ACMA may apply to the Federal Court for an order under subsection (2).

(2) If the Federal Court is satisfied that the person has breached the undertaking, the Court may make any or all of the following orders:

(a) an order directing the person to comply with the undertaking;

(b) an order directing the person to pay to the ACMA, on behalf of the Commonwealth, an amount up to the amount of any financial benefit that the person has obtained directly or indirectly and that is reasonably attributable to the breach;

(c) any order that the court considers appropriate directing the person to compensate any other person who has suffered loss or damage as a result of the breach;

(d) any other order that the court considers appropriate.
299  International agreements etc.

(1) A person or body exercising a power conferred under this Act (other than Part 4.4 or 5.5) must have regard to:
   (a) any agreement, treaty or convention, between Australia and another country or countries, that makes provision in relation to radio emission; and
   (b) any instrument or writing specified in the regulations.

(2) Nothing in subsection (1) limits the kinds of matters to which the person or body may have regard in exercising those powers.

(3) Regulations made for the purposes of paragraph (1)(b) may prescribe a specified instrument or writing:
   (a) as in force or existence at the time when the regulations come into effect; or
   (b) as amended or altered from time to time.

300  Labelling of radiocommunications transmitters for purposes of identification

(1) The ACMA may, by determination in writing, require any person who operates a radiocommunications transmitter under a licence to apply to that transmitter a label setting out the information specified in the determination.

(2) Without limiting the generality of subsection (1), the determination may specify the following information:
   (a) details about the licence under which the radiocommunications transmitter is being operated;
   (b) the name and address of the licensee.

(3) The label must be in the form specified by the determination.

(4) A person required by a determination to apply a label to a radiocommunications transmitter must comply with the determination.
Penalty: 100 penalty units.

(5) A determination is a disallowable instrument for the purposes of section 46A of the *Acts Interpretation Act 1901*.

### 301 Supply of radiocommunications devices to unlicensed persons

(1) Subject to subsection (2), a person (the *supplier*) who carries on the business of supplying radiocommunications devices to persons intending to operate them must not supply another person with an eligible radiocommunications device in the course of carrying on that business unless:

(a) the other person presents to the supplier a licence, or a duplicate of the licence, that authorises the other person to operate the device; and

(b) the supplier causes such particulars relating to supply of the device as are specified in the regulations to be recorded in a document kept for the purposes of this Act.

Penalty: 20 penalty units.

(1A) Subsection (1) does not apply if the person has a reasonable excuse.

Note: A defendant bears an evidential burden in relation to the matter in subsection (1A) (see subsection 13.3(3) of the *Criminal Code*).

(1B) Subsection (1) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the *Criminal Code*.

(2) It is a defence if the supplier believed on reasonable grounds that a document that the other person presented to the supplier was a licence that authorised the other person to operate the radiocommunications device.

(3) The supplier must retain the document in which particulars of the supply were recorded under subsection (1) for at least 2 years after the supply.

Penalty: 20 penalty units.

(3A) Subsection (3) is an offence of strict liability.

Note: For strict liability, see section 6.1 of the *Criminal Code*.
Section 303

(4) In subsection (1):

eligible radiocommunications device means a radiocommunications device included in a class of radiocommunications devices specified in the regulations.

303  Compilation etc. of information

The ACMA may:

(a) conduct research into; and
(b) compile, and publish in any way it thinks fit, information about;

any of the following:

(c) allocation and use of the spectrum;
(d) market demand for, and prices paid for allocation of, parts of the spectrum;
(e) charges fixed by the ACMA, including any discounts or exemptions in respect of public or community services;
(f) social, economic and environmental effects of radio transmission;
(g) supply, manufacture and operation of devices;
(h) standards;
(i) any other matter relating to radiocommunications or radio emissions.

304  Applications etc. in electronic form

(1) The ACMA may:

(a) receive an application under this Act from a person in an electronic form; and
(b) give a person an instrument under this Act in an electronic form;

if it is practicable and convenient, for both the ACMA and the person, for the ACMA to do so.

(2) This section does not enable the ACMA to require applications to be made in an electronic form.
305 Evidentiary certificates

(1) A Commonwealth officer who holds such qualifications as are specified in the regulations may issue a certificate, signed by the officer, setting out such facts as he or she considers relevant with respect to:
   (a) his or her qualifications; and
   (b) an examination he or she has made of a device.

(2) A certificate purporting to be issued under subsection (1) and to be duly signed is, in proceedings under or arising out of this Act or the Customs Act 1901, prima facie evidence of the facts stated in it.

(3) The ACMA may issue a certificate, signed by a person authorised by the ACMA for the purposes of this subsection, stating that at a specified time, or during a specified period, a specified person was, or was not, the holder of a specified kind of radiocommunications instrument.

(4) A certificate purporting to be issued under subsection (3) and to be duly signed is, in proceedings under or arising out of this Act, prima facie evidence of the facts stated in it.

(5) In this section:
   
   radiocommunications instrument means a licence, certificate or permit issued under this Act, and includes a permission issued under section 174.

306 Conduct by directors, servants and agents

(1) If, in proceedings for an offence against this Act, it is necessary to establish the state of mind of a body corporate in relation to particular conduct, it is sufficient to show:
   (a) that the conduct was engaged in by a director, servant or agent of the body corporate within the scope of his or her actual or apparent authority; and
   (b) that the director, servant or agent had the state of mind.

(2) Any conduct engaged in on behalf of a body corporate by a director, servant or agent of the body corporate within the scope of his or her actual or apparent authority is taken, for the purposes of a prosecution for an offence against this Act, to have been engaged
in also by the body corporate unless the body corporate establishes that the body corporate took reasonable precautions and exercised due diligence to avoid the conduct.

(3) If, in proceedings for an offence against this Act, it is necessary to establish the state of mind of a person other than a body corporate in relation to particular conduct, it is sufficient to show:
   (a) that the conduct was engaged in by a servant or agent of the person within the scope of his or her actual or apparent authority; and
   (b) that the servant or agent had the state of mind.

(4) Any conduct engaged in on behalf of a person other than a body corporate by a servant or agent of the person within the scope of his or her actual or apparent authority is taken, for the purposes of a prosecution for an offence against this Act, to have been engaged in also by the first-mentioned person unless the first-mentioned person establishes that the first-mentioned person took reasonable precautions and exercised due diligence to avoid the conduct.

(5) If:
   (a) a person other than a body corporate is convicted of an offence; and
   (b) the person would not have been convicted of the offence if subsections (3) and (4) had not been enacted;
the person is not liable to be punished by imprisonment for that offence.

(6) A reference in subsection (1) or (3) to the state of mind of a person includes a reference to:
   (a) the knowledge, intention, opinion, belief or purpose of the person; and
   (b) the person’s reasons for the intention, opinion, belief or purpose.

(7) A reference in this section to a director of a body corporate includes a reference to a constituent member of a body corporate incorporated for a public purpose by a law of the Commonwealth, of a State or of a Territory.

(8) A reference in this section to engaging in conduct includes a reference to failing or refusing to engage in conduct.
(9) Part 2.5 of the *Criminal Code* does not apply to an offence against this Act.

Note: Part 2.5 of the *Criminal Code* deals with corporate criminal responsibility.

### 307 Surrender of licences, certificates and permits

If the holder of a licence, certificate or permit surrenders it, it is taken, for the purposes of this Act (except where otherwise provided), to have been cancelled upon acceptance of the surrender by the ACMA.

### 308 No compensation for suspensions and cancellations

A person is not entitled to compensation from the Commonwealth solely because of:

(a) suspension or cancellation of, or variation of the conditions of, a licence, certificate or permit; or

(b) withdrawal of an accreditation under section 264.

### 309 Officers and employees of governments and authorities

The Governor-General may make arrangements with the Governor of a State or the Administrator of a Territory for performance of functions and exercise of powers under this Act by officers or employees of that State or Territory or of an authority of that State or Territory.

### 310 Operation of this Act in relation to the Broadcasting Services Act

(1) Regulations under this Act have effect despite any regulation made under the *Broadcasting Services Act 1992*.

(2) This Act is not intended to limit or exclude the operation of any regulation made under the *Broadcasting Services Act 1992* so far as the regulation can operate concurrently with this Act.
Section 311

311 Act not to affect performance of functions by States or certain Territories

(1) The ACMA must not exercise its powers under Chapter 3 in a way that prevents exercise of the powers, or performance of the functions, of government of a State, the Australian Capital Territory, the Northern Territory or Norfolk Island.

(2) A restrictive order has no effect so far as it would, but for this subsection, prevent exercise of the powers, or performance of the functions, of government of a State, the Australian Capital Territory, the Northern Territory or Norfolk Island.

312 Application of the Competition and Consumer Act

Nothing in Part 3.2 or 3.3 is to be taken as specifically authorising or approving any act or thing for the purposes of subsection 51(1) of the Competition and Consumer Act 2010.

313 Legislation of the Australian Antarctic Territory

This Act does not affect the Governor-General’s power under section 11 of the Australian Antarctic Territory Act 1954 to make Ordinances prohibiting or regulating use of radiocommunications devices the operation of which is authorised under class licences.

313A Application of the Criminal Code

Chapter 2 of the Criminal Code (except Part 2.5) applies to all offences against this Act.

Note: Chapter 2 of the Criminal Code sets out the general principles of criminal responsibility.

313B Review

(1) Before 1 January 2014, the Minister must cause to be conducted a review of the following matters:

(a) the use of spectrum for the transmission of:

   (i) digital radio broadcasting services; and

   (ii) restricted datacasting services;

   in Australia;
(b) the availability of additional frequency channels for the transmission of:
   (i) digital radio broadcasting services; and
   (ii) restricted datacasting services;
in Australia;
(c) the operation of this Act in so far as it deals with licensing and regulation in relation to the transmission of:
   (i) digital radio broadcasting services; and
   (ii) restricted datacasting services;
(d) the operation of the following provisions:
   (i) section 109C;
   (ii) Division 4A of Part 3.3;
   (iii) Division 4B of Part 3.3;
(e) whether any of the provisions mentioned in paragraph (d) should be amended or repealed.

(2) The Minister must cause to be prepared a report of a review under subsection (1).

(3) The Minister must cause copies of a report to be tabled in each House of the Parliament within 15 sitting days of that House after the completion of the report.

(4) In this section:

digital radio broadcasting service means:
   (a) a digital commercial radio broadcasting service; or
   (b) a digital community radio broadcasting service; or
   (c) a digital national radio broadcasting service.

314 Regulations

(1) The Governor-General may make regulations prescribing all matters:
   (a) required or permitted by this Act to be prescribed; or
   (b) necessary or convenient to be prescribed for carrying out or giving effect to this Act.
Section 314

(2) Without limiting subsection (1), the regulations may make provision in relation to:

(a) prohibiting or regulating any act or thing likely to cause interference, or risk of interference, to radiocommunications; or

(b) prohibiting or regulating making of radio emissions from a place within a specified area; or

(c) prohibiting or regulating making of radio emissions in a way likely to cause an explosion; or

(d) enabling a person who is alleged to have committed an offence of a kind referred to in the table in subsection 315(1) to pay to the Commonwealth, as an alternative to prosecution, a penalty of an amount worked out in accordance with section 315; or

(e) prescribing the forms of warrants for the purposes of section 269; or

(f) functions and powers to be conferred, and duties to be imposed, upon inspectors; or

(g) refund of charges on surrender of certificates or licences; or

(h) issue and return of duplicates of licences, certificates and permits, and of licences granted under the regulations; or

(i) any matter incidental to or connected with any of the foregoing.

(3) The power to make regulations in relation to a matter is not limited merely by the fact that:

(a) this Act makes provision in relation to the matter; or

(b) this Act expressly allows such provision to be made:

(i) by standards, advisory guidelines or orders; or

(ii) by specifying conditions to which licences or permits are subject.

(4) Paragraph (2)(c) is not intended to limit or exclude concurrent operation of a law of a State or Territory.

(5) The regulations may provide, in respect of an offence against the regulations, for imposition of a fine not exceeding 10 penalty units.

(6) The limitation imposed by subsection (5) on the penalties that the regulations may prescribe does not prevent the regulations from requiring a person to make a statutory declaration.

350 Radiocommunications Act 1992
314A Instruments under this Act may provide for matters by reference to other instruments

(1) An instrument under this Act may make provision in relation to a matter by applying, adopting or incorporating (with or without modifications) provisions of any Act:
   (a) as in force at a particular time; or
   (b) as in force from time to time.

(2) An instrument under this Act may make provision in relation to a matter by applying, adopting or incorporating (with or without modifications) matter contained in any other instrument or writing whatever:
   (a) as in force or existing at a particular time; or
   (b) as in force or existing from time to time;
   even if the other instrument or writing does not yet exist when the instrument under this Act is made.

(3) A reference in subsection (2) to any other instrument or writing includes a reference to an instrument or writing:
   (a) made by any person or body in Australia or elsewhere (including, for example, the Commonwealth, a State or Territory, an officer or authority of the Commonwealth or of a State or Territory or an overseas entity); and
   (b) whether of a legislative, administrative or other official nature or of any other nature; and
   (c) whether or not having any legal force or effect;
   for example:
   (d) regulations or rules under an Act; or
   (e) a State Act, a law of a Territory, or regulations or any other instrument made under such an Act or law; or
   (f) an international technical standard or performance indicator; or
   (g) a written agreement or arrangement or an instrument or writing made unilaterally.

(4) Nothing in this section limits the generality of anything else in it.

(5) Subsections (1) and (2) have effect despite anything in:
   (a) the Acts Interpretation Act 1901; or
   (b) the Legislative Instruments Act 1997.
Section 315

(6) In this section:

*instrument under this Act* means:

(a) the regulations; or
(b) any other instrument made under this Act.

315 Penalties payable instead of prosecution

(1) The amount of penalty payable to the Commonwealth under regulations made for the purposes of paragraph 314(2)(d) in respect of an offence is determined using the following table:

<table>
<thead>
<tr>
<th>Item</th>
<th>Provision alleged to have been contravened</th>
<th>Penalty for individual</th>
<th>Penalty for body corporate</th>
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<tbody>
<tr>
<td>1</td>
<td>section 46</td>
<td>see subsection (2) of this section</td>
<td>see subsection (3) of this section</td>
</tr>
<tr>
<td>2</td>
<td>section 47</td>
<td>see subsection (2) of this section</td>
<td>see subsection (3) of this section</td>
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<tr>
<td>3</td>
<td>section 113</td>
<td>2 penalty units</td>
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<td>4</td>
<td>section 117</td>
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<tr>
<td>5</td>
<td>section 118</td>
<td>2 penalty units</td>
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<td>6</td>
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<td>section 186</td>
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<td>section 187</td>
<td>3 penalty units</td>
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<td>section 187A</td>
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<td>10</td>
<td>section 197</td>
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<td>12</td>
<td>section 279</td>
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<td>13</td>
<td>subsection 300(4)</td>
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<td>14</td>
<td>subsection 301(3)</td>
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<tr>
<td>15</td>
<td>the regulations</td>
<td>2 penalty units</td>
<td>10 penalty units</td>
</tr>
</tbody>
</table>

(2) The amount of penalty payable to the Commonwealth under regulations made for the purposes of paragraph 314(2)(d) in respect of an offence an individual is alleged to have committed against section 46 or 47, in relation to a particular radiocommunications device, is:
(a) if the radiocommunications device was of a kind covered by a class licence at the time the offence was allegedly committed—2 penalty units; or
(b) in any other case—3 penalty units.

(3) The amount of penalty payable to the Commonwealth under regulations made for the purposes of paragraph 314(2)(d) in respect of an offence a body corporate is alleged to have committed against section 46 or 47, in relation to a particular radiocommunications device, is:
(a) if the radiocommunications device was of a kind covered by a class licence at the time the offence was allegedly committed—10 penalty units; or
(b) in any other case—15 penalty units.
Schedule—Resuming spectrum licences by compulsory process

Sections 91 and 93

Part 1—Resumption Procedures

1 Pre-acquisition declarations

(1) The ACMA must cause to be published in the Gazette a pre-acquisition declaration for the spectrum licence, or the part of the spectrum licence, that it wishes to resume.

(2) The pre-acquisition declaration must contain:
   (a) a description of the licence, or the part of the licence, to be resumed; and
   (b) a statement of the ACMA’s reasons for the resumption.

2 Service on licensees and third party users

(1) Within 14 days after publication in the Gazette, the ACMA must serve the declaration on the licensee by registered post sent to the address of the place of residence or business of the licensee last known to the ACMA.

(2) The licensee must, within 7 days after being so served, give a written notice of the proposed resumption to:
   (a) if the whole of the licence is to be resumed—each person (if any) authorised by the licensee to operate a radiocommunications device under the licence; or
   (b) if a part of the licence is to be resumed—each person (if any) so authorised whose interests would be affected by resumption of that part of the licence.

(3) Failure to comply with the requirements of this clause does not affect the validity of the pre-acquisition declaration.

Note: A pre-acquisition declaration is reviewable under Part 5.6.
3 Resumption notices

(1) If the pre-acquisition declaration is in force at the end of the review period, the ACMA must cause to be published in the Gazette a notice that the licence, or the part of the licence, is resumed.

(2) The review period commences when the pre-acquisition declaration is made and ends:
   (a) if the period for applying under Part 5.6 for reconsideration of the pre-acquisition declaration has expired without such an application being made—at the end of the period for applying for reconsideration; or
   (b) if the pre-acquisition declaration was reconsidered under Part 5.6 and the period for applying under that Part for review by the AAT of the reconsideration has expired without such an application being made—at the end of the period for applying for review by the AAT; or
   (c) if review by the AAT was applied for within that period—when the review, and any appeals or other proceedings arising from the review, have been finally disposed of.

4 Date of effect of resumptions

The resumption takes effect:
   (a) if the resumption notice specifies a day for the purpose—on that day; or
   (b) otherwise—14 days after the day on which the resumption notice was published.

5 Notification of licensees

Within 14 days after the resumption notice was published, the ACMA must give to the licensee a written notice that:
   (a) sets out a copy of the resumption notice; and
   (b) sets out particulars of:
       (i) the licensee’s right to claim compensation for the resumption; and
       (ii) how a claim is to be made; and
   (c) includes the form, approved by the ACMA, on which such a claim is to be made.
Part 2—Compensation

1 The basis on which compensation is payable

(1) If a spectrum licence or a part of a spectrum licence is resumed under section 91, the compensation payable to the licensee under section 93 and this Part is compensation for:
   (a) the market value of the licence, or the part of the licence, on the day before the day on which the pre-acquisition declaration was published; and
   (b) any loss, injury or damage suffered, or expense reasonably incurred, as a direct, natural and reasonable consequence of the resumption.

(2) The market value of the licence, or the part of the licence, at a particular time is the amount that would have been paid for it if it had been sold at that time by a willing but not anxious seller to a willing but not anxious buyer.

(3) If the market value is assessed upon the basis that the licence, or the part of the licence, had potential to be used for a purpose other than the purpose for which it was used at the relevant time, compensation is not payable in respect of any loss or damage that would necessarily have been suffered, or expense that would necessarily have been incurred, in realising that potential.

(4) If:
   (a) a pre-acquisition declaration is published for resumption of a spectrum licence or a part of a spectrum licence; and
   (b) the pre-acquisition declaration is revoked before the resumption takes place;
the compensation payable to the licensee under section 93 and this Part is compensation for any loss, injury or damage suffered, or expense reasonably incurred, as a direct, natural and reasonable consequence of the publication of the pre-acquisition declaration.
2 Amounts of compensation payable

(1) The amount of compensation payable to the licensee is:
   (a) the amount of compensation agreed by the ACMA under paragraph 4(a); or
   (b) the amount of compensation specified in an offer of the ACMA that is accepted by the licensee under subclause 6(1); or
   (c) the amount of compensation determined by the AAT under clause 7; or
   (d) the amount of compensation determined by the Federal Court under clause 8; or
   (e) the amount of compensation determined by an independent valuer under clause 9;
whichever is applicable.

(2) Once the amount of compensation is fixed under one of the paragraphs in subclause (1), the other paragraphs are no longer capable of application in fixing the amount of compensation.

3 Claims for compensation

The licensee may claim compensation by giving to the ACMA a written claim in a form approved by the ACMA.

4 Consideration of claims by the ACMA

The ACMA must consider the claim and, by written notice given to the licensee:
   (a) agree to pay the amount of compensation specified in the claim; or
   (b) offer to pay an amount of compensation different to the amount specified in the claim; or
   (c) reject the claim.

5 Deadline for consideration of claims

(1) The ACMA must give the notice to the licensee within 42 days, or such longer period as is agreed between the ACMA and the licensee, after receiving the claim.
Clause 6

(2) The ACMA is taken to have rejected the claim if it has not informed the licensee of its decision on the claim before the end of the period within which the notice must be given.

6 Consideration of offers by licensees

(1) If the ACMA offers under paragraph 4(b) to pay an amount of compensation to the licensee, the licensee may, in writing, accept the offer at any time during the period of 42 days, or such longer period as is agreed between the ACMA and the licensee, after the offer was made.

(2) The licensee is taken to have rejected the offer if:
   (a) during the period during which the licensee may accept the offer, the licensee informs the ACMA, in writing, that the offer is rejected; or
   (b) the period ends and the licensee has not accepted the offer.

7 Determination of compensation by the AAT

(1) Subject to subclause (5), if:
   (a) under paragraph 4(c), the ACMA has rejected the claim; or
   (b) under subclause 5(2), the ACMA is taken to have rejected the claim; or
   (c) under subclause 6(2), the licensee is taken to have rejected an offer by the ACMA;

   the licensee may apply to the AAT to review the ACMA’s decision to reject the claim, or make the offer, as the case requires.

(2) Subject to subclauses (3) and (4), the Administrative Appeals Tribunal Act 1975 applies to the application.

(3) Section 29 of that Act applies to the application as if the prescribed time for lodging the application with the AAT were the period of 90 days beginning on the day on which the ACMA rejected the claim, or the ACMA’s offer was taken to be rejected, as the case requires.

(4) The AAT must make a decision on the application determining the amount of compensation.

358 Radiocommunications Act 1992
(5) An application cannot be made to the AAT if an application has already been made under clause 8 to the Federal Court to determine the amount of compensation.

8 Determination of compensation by the Federal Court

(1) Subject to subsection (3), if:
   (a) under paragraph 4(c), the ACMA has rejected the claim; or
   (b) under subclause 5(2), the ACMA is taken to have rejected the claim; or
   (c) under subclause 6(2), the licensee is taken to have rejected an offer by the ACMA;
       the licensee may apply to the Federal Court to determine the amount of compensation to which the licensee is entitled.

(2) On the application, the Federal Court must determine the amount of compensation.

(3) An application cannot be made to the Federal Court if an application has already been made under clause 7 to the AAT to review the ACMA’s decision to reject the claim or to make the offer, as the case requires.

9 Determination of compensation by independent valuers

(1) Subject to subclause (4), the ACMA and the licensee may agree on appointment of an independent valuer to determine the amount of compensation.

(2) Clauses 3 to 8 no longer apply once an independent valuer is appointed under the agreement.

(3) The independent valuer must determine the amount of compensation.

(4) Agreement on appointment of an independent valuer has no effect if an application related to the amount of compensation has already been made to the AAT under clause 7 or to the Federal Court under clause 8.
Notes to the Radiocommunications Act 1992

Note 1

The Radiocommunications Act 1992 as shown in this compilation comprises Act No. 174, 1992 amended as indicated in the Tables below.

For application, saving or transitional provisions made by the Australian Communications and Media Authority (Consequential and Transitional Provisions) Act 2005, see Act No. 45, 2005.

For all other relevant information pertaining to application, saving or transitional provisions see Table A.

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<td>Communications and the Arts Legislation Amendment (Application of Criminal Code) Act 2001</td>
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<td>Sch. 2 (item 226) S. 2(1) (item 5) (am. by 41, 2003, Sch. 2 [item 1AA])</td>
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<td>Australian Communications and Media Authority (Consequential and Transitional Provisions) Act 2005</td>
<td>45, 2005</td>
<td>1 Apr 2005</td>
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<td>Offshore Petroleum (Repeals and Consequential Amendments) Act 2006</td>
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<td>3 July 2008</td>
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<td><strong>Corporations (NZ Closer Economic Relations) and Other Legislation Amendment Act 2007</strong></td>
<td>85, 2007</td>
<td>21 June 2007</td>
<td>Schedule 3 (items 1, 2): 19 July 2007</td>
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<td>Statute Law Revision Act 2010</td>
<td>8, 2010</td>
<td>1 Mar 2010</td>
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<td>Trade Practices Amendment (Australian Consumer Law) Act (No. 2) 2010</td>
<td>103, 2010</td>
<td>13 July 2010</td>
<td>Schedule 6 (items 1, 90–95, 189): 1 Jan 2011</td>
<td>—</td>
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<td>Radiocommunications Amendment Act 2010</td>
<td>146, 2010</td>
<td>16 Dec 2010</td>
<td>17 Dec 2010</td>
<td>Sch. 1 (item 11)</td>
</tr>
</tbody>
</table>

**Radiocommunications Act 1992** 365
Notes to the Radiocommunications Act 1992

Act Notes

(a) Section 2 of the Transport and Communications Legislation Amendment Act 1993 provides as follows:

1. Subject to subsection (2), this Act commences on the day on which it receives the Royal Assent.
2. The amendments of the Radiocommunications Act 1992 (other than the amendments of sections 187, 314 and 315) set out in the Schedule are taken to have commenced immediately after the commencement of that Act.


(b) The Radiocommunications Act 1992 was amended by Schedule 2 only of the Telecommunications (Transitional Provisions and Consequential Amendments) Act 1997, subsection 2(2)(e) of which provides as follows:

2. The following provisions commence on 1 July 1997:
   (e) Schedule 2;

(c) The Radiocommunications Act 1992 was amended by Schedule 1 (items 6–8) only of the Radiocommunications Legislation Amendment Act 1997, subsection 2(1) of which provides as follows:

1. Subject to this section, this Act commences on the day on which it receives the Royal Assent.

(d) The Radiocommunications Act 1992 was amended by Schedule 1 (items 761–763) only of the Public Employment (Consequential and Transitional) Amendment Act 1999, subsections 2(1) and (2) of which provide as follows:

1. In this Act, commencing time means the time when the Public Service Act 1999 commences.
2. Subject to this section, this Act commences at the commencing time.

(e) The Radiocommunications Act 1992 was amended by Schedule 2 only of the Broadcasting Services Amendment (Digital Television and Datacasting) Act 2000, subsection 2(2) of which provides as follows:

2. Subject to subsection (3), the remaining provisions of this Act commence on a day to be fixed by Proclamation.

(f) Subsection 2(2) of the Broadcasting Services Amendment Act 2000 provides as follows:

2. Schedule 2 commences immediately after the commencement of item 140 of Schedule 1 to the Broadcasting Services Amendment (Digital Television and Datacasting) Act 2000.

Item 140 commenced on 1 January 2001 (see Gazette 2000, No. GN50).

(g) The Radiocommunications Act 1992 was amended by Schedule 1 (items 50–100) only of the Communications and the Arts Legislation Amendment (Application of Criminal Code) Act 2001, subsection 2(1)(a) of which provides as follows:

1. Subject to this section, this Act commences at the latest of the following times:
   (a) immediately after the commencement of item 15 of Schedule 1 to the Criminal Code Amendment (Thief, Fraud, Bribery and Related Offences) Act 2000.


(h) Subsection 2(1) (item 5) of the Australian Crime Commission Establishment Act 2002 provides as follows:

1. Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, on the day or at the time specified in column 2 of the table.
## Commencement information

<table>
<thead>
<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Schedule 2, item 118</td>
<td>The later of: (a) the start of the day on which Schedule 1 to this Act commences; and (b) immediately after the commencement of Schedule 3 to the Communications Legislation Amendment Act (No. 1) 2003</td>
<td>28 November 2003 (paragraph (b) applies)</td>
</tr>
</tbody>
</table>

(l) Subsection 2(1) (item 4A) of the Crimes Legislation Enhancement Act 2003 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, on the day or at the time specified in column 2 of the table.

<table>
<thead>
<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
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</thead>
<tbody>
<tr>
<td>4A. Schedule 2, item 1AA</td>
<td>Immediately after the commencement of section 2 of the Australian Crime Commission Establishment Act 2002</td>
<td>10 December 2002</td>
</tr>
</tbody>
</table>

(l) Subsection 2(1) (item 2) of the Designs (Consequential Amendments) Act 2003 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, on the day or at the time specified in column 2 of the table.

<table>
<thead>
<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
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<tbody>
<tr>
<td>2. Schedules 1 and 2</td>
<td>Immediately after the commencement of section 4 of the Designs Act 2003.</td>
<td>17 June 2004</td>
</tr>
</tbody>
</table>

(k) Subsection 2(1) (items 2, 3 and 10) of the Australian Communications and Media Authority (Consequential and Transitional Provisions) Act 2005 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

<table>
<thead>
<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
</tr>
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<tbody>
<tr>
<td>2. Schedule 1</td>
<td>At the same time as section 6 of the Australian Communications and Media Authority Act 2005 commences.</td>
<td>1 July 2005</td>
</tr>
<tr>
<td>3. Schedule 2</td>
<td>Immediately after the commencement of the provision(s) covered by table item 2.</td>
<td>1 July 2005</td>
</tr>
<tr>
<td>10. Schedule 4</td>
<td>At the same time as section 6 of the Australian Communications and Media Authority Act 2005 commences.</td>
<td>1 July 2005</td>
</tr>
</tbody>
</table>
Notes to the Radiocommunications Act 1992

Act Notes

1. Subsection 2(1) (item 2) of the Offshore Petroleum Amendment (Greater Sunrise) Act 2007 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

<table>
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<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
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<tbody>
<tr>
<td>2. Schedule 1</td>
<td>Immediately after the commencement of section 3 of the Offshore Petroleum Act 2006.</td>
<td>1 July 2008</td>
</tr>
</tbody>
</table>

2. Subsection 2(1) (item 3) of the Broadcasting Legislation Amendment (Digital Radio) Act 2007 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

<table>
<thead>
<tr>
<th>Provision(s)</th>
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<th>Date/Details</th>
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<tr>
<td>3. Schedule 2</td>
<td>The later of: (a) immediately after the commencement of Schedule 1 to this Act; and (b) immediately after the commencement of section 155AAA of the Trade Practices Act 1974. However, the provision(s) do not commence at all if the event mentioned in paragraph (b) does not occur.</td>
<td>19 July 2007 (paragraph (b) applies)</td>
</tr>
</tbody>
</table>

3. Subsection 2(1) (item 44) of the Statute Law Revision Act 2008 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

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<tr>
<td>44. Schedule 2, item 1</td>
<td>Immediately after the time specified in the Broadcasting Legislation Amendment (Digital Radio) Act 2007 for the commencement of item 148 of Schedule 1 to that Act.</td>
<td>29 May 2007</td>
</tr>
</tbody>
</table>

4. Subsection 2(1) (items 31 and 38) of the Statute Law Revision Act 2010 provides as follows:

(1) Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

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<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
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<tr>
<td>31. Schedule 5, items 1 to 51</td>
<td>The day this Act receives the Royal Assent.</td>
<td>1 March 2010</td>
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<tr>
<td>38. Schedule 5, Parts 2 and 3</td>
<td>Immediately after the provision(s) covered by table item 31.</td>
<td>1 March 2010</td>
</tr>
</tbody>
</table>

368 Radiocommunications Act 1992
Subsection 2(1) (item 2) of the *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Act 2010* provides as follows:

1. Each provision of this Act specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

<table>
<thead>
<tr>
<th>Provision(s)</th>
<th>Commencement</th>
<th>Date/Details</th>
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<tr>
<td>2. Schedule 1, Part 1, Division 1</td>
<td>The later of: (a) the start of the day after this Act receives the Royal Assent; and (b) immediately after the commencement of item 2 of Schedule 5 to the <em>Trade Practices Amendment (Australian Consumer Law) Act (No. 2) 2010</em>.</td>
<td>1 January 2011 (paragraph (b) applies)</td>
</tr>
</tbody>
</table>
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<td>am. No. 125, 2002; No. 114, 2003; No. 45, 2005; No. 86, 2006</td>
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<td>am. No. 59, 1997; No. 45, 2005; No. 140, 2010</td>
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<td>ad. No. 41, 1997 am. No. 103, 2010</td>
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<td>ad. No. 41, 1997 am. No. 103, 2010</td>
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<td>am. No. 32, 1995; No. 59, 1997; No. 45, 2005</td>
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<td>Ss. 91, 92</td>
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Table A

Application, saving or transitional provisions

*Radiocommunications Amendment Act 1997* (No. 41, 1997)

Schedule 1

92 **Continuity of section 60 determinations**

The amendments of section 60 of the *Radiocommunications Act 1992* made by this Schedule do not affect the continuity of a determination that was in force under that section immediately before the commencement of this item.

93 **Continuity of section 106 determinations**

The amendments of section 106 of the *Radiocommunications Act 1992* made by this Schedule do not affect the continuity of a determination that was in force under that section immediately before the commencement of this item.

94 **Continuity of section 293 determinations**

The amendments of section 293 of the *Radiocommunications Act 1992* made by this Schedule do not affect the continuity of a determination that was in force under that section immediately before the commencement of this item.


Schedule 2

21 **Transitional—charge determinations**

(1) This item applies to a determination that:

(a) was in force under section 293 of the *Radiocommunications Act 1992* immediately before the commencement of this item; and
Notes to the *Radiocommunications Act 1992*

### Table A

(b) related to a matter in relation to which expenses are incurred by the SMA under that Act or under regulations under that Act.

(2) The *Australian Communications Authority Act 1997* has effect, after the commencement of this item, as if:

(a) the determination had been made by the ACA under section 53 of that Act immediately after the commencement of this item; and

(b) each reference in the determination to the SMA were a reference to the ACA.

(3) This item does not prevent the variation or revocation of the determination.

### 71 Transitional—procedures for making standards

The amendments of section 163 of the *Radiocommunications Act 1992* made by this Schedule do not apply in relation to a standard made before 1 July 1998 if the SMA had taken any action in relation to the standard under that section before the commencement of this item.

### 72 Transitional—section 186 of the Radiocommunications Act 1992

(1) This item applies to the amendment of section 186 of the *Radiocommunications Act 1992* made by this Schedule, being the amendment that omits the expression “sell or”.

(2) The amendment does not imply that the expression “supply”, when used in a provision of the *Radiocommunications Act 1992*, does not include supply by way of sale.

---


### 4 Industry action agenda

(1) Not later than 6 months after the commencement of this Act, the Minister for Communications, the Information Economy and the Arts, in consultation with the Minister for Industry, Science and Tourism, must cause to be prepared an industry action agenda to assist the development of the Australian broadcasting electronics industry.

386 *Radiocommunications Act 1992*
(2) An agenda prepared under subsection (1) must be directed towards ensuring the achievement of the following policy objectives:

(a) the objective that the Australian broadcasting electronics industry be efficient, competitive and responsive to the needs of the Australian community;

(b) the objective of encouraging investment in innovation and value-adding activities in the broadcasting electronics industry;

(c) the objective of providing effective support for Australian exporters of broadcasting electronics technology in gaining access to markets;

(d) the objective of encouraging technology transfers throughout the broadcasting electronics industry;

(e) the objective of establishing links between educational institutions and the broadcasting electronics industry to improve the skills base for the industry;

(f) the objective of promoting strategic commercial relationships between the Australian broadcasting electronics industry and international telecommunications industries.

(3) An agenda prepared under subsection (1) is a disallowable instrument.

---

Australian Federal Police Legislation Amendment Act 2000 (No. 9, 2000)

**Schedule 3**

**20 Definition**

In this Part:

*commencing time* means the time when this Part commences.

**30 Amendment of the Radiocommunications Act 1992**

The *Radiocommunications Act 1992* as in force at and after the commencing time applies to a certificate issued under section 305 of that Act at any time before the commencing time by a member or special member of the Australian Federal Police in the same way as it does to a certificate given under that section at or after the commencing time.
Table A

34 Warrants or writs etc. may continue to be executed

If, immediately before the commencing time, any warrant, writ, order, permission or other instrument (the authority) issued under a law of the Commonwealth, a State or a Territory could be executed by a person who was at that time a member, staff member or special member of the Australian Federal Police, the authority continues to be able to be executed at and after the commencing time by the person in his or her capacity as:

(a) the Commissioner of the Australian Federal Police; or
(b) a Deputy Commissioner of the Australian Federal Police; or
(c) an AFP employee; or
(d) a special member of the Australian Federal Police;

(all within the meaning of the Australian Federal Police Act 1979 as in force at and after the commencing time).

Note: A person who is a member or staff member of the Australian Federal Police immediately before the commencing time is taken to be engaged as an AFP employee. Similarly, a person who is a special member of the Australian Federal Police immediately before the commencing time is taken to be appointed as a special member. See item 2 of this Schedule.

35 Regulations dealing with matters of a transitional or saving nature

(1) The Governor-General may make regulations, not inconsistent with any other provision of this Schedule, prescribing matters of a transitional or saving nature in relation to the amendments made by Schedule 1 or 2.

(2) Regulations made under this item within one year after the commencement of this item may commence on a day earlier than the day on which they are made, but not earlier than the commencement of this item.

Radiocommunications Legislation Amendment Act 2000 (No. 34, 2000)

Schedule 3

1 Income tax treatment of spectrum licences

The amendments made by items 8 and 9 of Schedule 2 apply in relation to the issue of licences on or after 11 March 1998.
Table A

2 Amendments relating to the issue of licences
The amendments made by items 11, 12, 14 and 15 of Schedule 2 apply in relation to the issue of licences after those items commence.

3 Civil penalties
The amendments made by items 22 and 23 of Schedule 2 apply in relation to all offences (whether alleged to have been committed before or after those items commence) in respect of which no penalty had yet been imposed as at the time of that commencement.

4 Time tax becomes payable
The amendments made by items 24, 25 and 26 of Schedule 2 apply in relation to the imposition of tax in respect of an instrument, if both:
(a) the relevant anniversary of the issue of the instrument; and
(b) the corresponding anniversary of the instrument coming into force;
occur after the commencement of those items.


Schedule 2

51 Transitional—regulations
(1) The regulations may make provision for matters of a transitional nature arising from the amendments made by Part 1 of this Schedule.
(2) The Governor-General may make regulations for the purposes of subitem (1).
Table A


Schedule 2

418 Transitional—pre-commencement offences

(1) Despite the amendment or repeal of a provision by this Schedule, that provision continues to apply, after the commencement of this item, in relation to:

(a) an offence committed before the commencement of this item; or
(b) proceedings for an offence alleged to have been committed before the commencement of this item; or
(c) any matter connected with, or arising out of, such proceedings;

as if the amendment or repeal had not been made.

(2) Subitem (1) does not limit the operation of section 8 of the _Acts Interpretation Act 1901_.

419 Transitional—pre-commencement notices

If:

(a) a provision in force immediately before the commencement of this item required that a notice set out the effect of one or more other provisions; and
(b) any or all of those other provisions are repealed by this Schedule; and
(c) the first-mentioned provision is amended by this Schedule;

the amendment of the first-mentioned provision by this Schedule does not affect the validity of such a notice that was given before the commencement of this item.
Schedule 1

36 Transitional—existing providers of international broadcasting services

(1) If a person was providing an international broadcasting service immediately before the commencement of this item, sections 121FG and 121FH of the Broadcasting Services Act 1992 and paragraph 108(2)(da) of the Radiocommunications Act 1992 do not apply to the provision of the service by the person at any time during the period:

(a) beginning at the commencement of this item; and

(b) ending at whichever of the following times is applicable:

(i) if the person does not apply for an international broadcasting licence for the service within 30 days after the commencement of this item—the end of 30 days after the commencement of this item;

(ii) if the person applies for an international broadcasting licence for the service within 30 days after the commencement of this item, but an international broadcasting licence is not allocated to the person—the time when the person receives the relevant notification under subsection 121FB(3) or (7) or 121FD(6) of the Broadcasting Services Act 1992;

(iii) if the person applies for an international broadcasting licence for the service within 30 days after the commencement of this item and such a licence is allocated to the person—the time when the licence is allocated.

Communications and the Arts Legislation Amendment (Application of Criminal Code) Act 2001 (No. 5, 2001)

4 Application of amendments

(1) Each amendment made by this Act applies to acts and omissions that take place after the amendment commences.
Table A

(2) For the purposes of this section, if an act or omission is alleged to have taken place between 2 dates, one before and one on or after the day on which a particular amendment commences, the act or omission is alleged to have taken place before the amendment commences.


Schedule 2

226 Transitional regulations

(1) The Governor-General may make regulations prescribing matters of a transitional nature (including prescribing any saving or application provisions) arising out of the amendments made by this Schedule.

(2) Despite subsection 48(2) of the Acts Interpretation Act 1901, regulations made under this item within 1 year after commencement of this item may commence on a day earlier than the day on which they are made, but not earlier than the commencement of this item.

Broadcasting Legislation Amendment (Digital Television) Act 2006
(No. 128, 2006)

Schedule 1

28A Variation of national television conversion scheme

(1) This item applies to a variation by the ACMA of the national television conversion scheme if:

(a) the variation deals with transitional and/or consequential matters in connection with the amendments made by this Schedule; and

(b) the variation is made within 30 days after the commencement of this item.

(2) Clause 33 of Schedule 4 to the Broadcasting Services Act 1992 does not apply to the variation.

(3) Section 17 of the Legislative Instruments Act 2003 does not apply to the variation.

392 Radiocommunications Act 1992
Table A

(4) The ACMA must not make the variation unless a copy of the proposed variation was made available on the ACMA’s Internet site for a period of at least 5 business days.

29 NBS transmitter licences issued under section 100B of the Radiocommunications Act 1992

(1) This item applies to an NBS transmitter licence that:
   (a) was in force immediately before the commencement of this Schedule; and
   (b) was issued under subsection 100B(1) of the Radiocommunications Act 1992.

(2) To avoid doubt, the amendment of subsection 100B(1) of the Radiocommunications Act 1992 made by this Schedule does not affect the continuity of the NBS transmitter licence.

Schedule 2

93C Variation of program standards

(1) This item applies to a variation by the ACMA of a program standard if:
   (a) the variation deals with transitional and/or consequential matters in connection with the amendments made by this Schedule; and
   (b) either:
       (i) the variation was made before the commencement of this item in accordance with section 4 of the Acts Interpretation Act 1901; or
       (ii) the variation is made within 30 days after the commencement of this item.

(2) Section 126 of the Broadcasting Services Act 1992 does not apply to the variation.

(3) Section 17 of the Legislative Instruments Act 2003 does not apply to the variation.

(4) The ACMA must not make the variation unless a copy of the proposed variation was made available on the ACMA’s Internet site for a period of at least 5 business days.
93D Variation of commercial television conversion scheme

(1) This item applies to a variation by the ACMA of the commercial television conversion scheme if:
   (a) the variation deals with transitional and/or consequential matters in connection with the amendments made by this Schedule; and
   (b) either:
      (i) the variation was made before the commencement of this item in accordance with section 4 of the Acts Interpretation Act 1901; or
      (ii) the variation is made within 30 days after the commencement of this item.

(2) Clause 18 of Schedule 4 to the Broadcasting Services Act 1992 does not apply to the variation.

(3) Section 17 of the Legislative Instruments Act 2003 does not apply to the variation.

(4) The ACMA must not make the variation unless a copy of the proposed variation was made available on the ACMA’s Internet site for a period of at least 5 business days.

93E Variation of national television conversion scheme

(1) This item applies to a variation by the ACMA of the national television conversion scheme if:
   (a) the variation deals with transitional and/or consequential matters in connection with the amendments made by this Schedule; and
   (b) either:
      (i) the variation was made before the commencement of this item in accordance with section 4 of the Acts Interpretation Act 1901; or
      (ii) the variation is made within 30 days after the commencement of this item.

(2) Clause 33 of Schedule 4 to the Broadcasting Services Act 1992 does not apply to the variation.

(3) Section 17 of the Legislative Instruments Act 2003 does not apply to the variation.
Notes to the *Radiocommunications Act 1992*

Table A

(4) The ACMA must not make the variation unless a copy of the proposed variation was made available on the ACMA’s Internet site for a period of at least 5 business days.

94 **Transmitter licences issued under section 102 of the *Radiocommunications Act 1992***

(1) This item applies to a transmitter licence that:
   (a) was in force immediately before 1 January 2007; and
   (b) was issued under subsection 102(1) of the *Radiocommunications Act 1992*.

(2) To avoid doubt, the amendment of subsection 102(1) of the *Radiocommunications Act 1992* made by this Schedule does not affect the continuity of the transmitter licence.

95 **Transmitter licences issued under section 102A of the *Radiocommunications Act 1992***

(1) This item applies to a transmitter licence that:
   (a) was in force immediately before 1 January 2007; and
   (b) was issued under subsection 102A(1) of the *Radiocommunications Act 1992*.

(2) To avoid doubt, the amendment of subsection 102A(1) of the *Radiocommunications Act 1992* made by this Schedule does not affect the continuity of the transmitter licence.


**Schedule 1**

183 **Frequency allotment plan prepared under section 25 of the *Broadcasting Services Act 1992***

(1) This item applies to a frequency allotment plan that:
   (a) was in force immediately before the commencement of this item; and
   (b) was prepared under subsection 25(1) of the *Broadcasting Services Act 1992*.
Table A

(2) The amendments of:
   (a) section 25 of the Broadcasting Services Act 1992; and
   (b) section 31 of the Radiocommunications Act 1992;
made by this Schedule do not affect the continuity of the frequency allotment plan.

184 Instrument made under subsection 31(1) of the Radiocommunications Act 1992

(1) This item applies to an instrument that:
   (a) was in force immediately before the commencement of this item; and
   (b) was made under subsection 31(1) of the Radiocommunications Act 1992.

(2) The amendments of:
   (a) section 31 of the Radiocommunications Act 1992; and
   (b) section 25 of the Broadcasting Services Act 1992;
made by this Schedule do not affect the continuity of the instrument.

186 Pre-commencement transmitter licences issued under the Radiocommunications Act 1992

(1) This item applies to a transmitter licence that:
   (a) was in force immediately before the commencement of this item; and
   (b) authorises operation of a radiocommunications transmitter within a part of the spectrum designated under subsection 31(1A) of the Radiocommunications Act 1992.

(2) The amendments of section 31 of the Radiocommunications Act 1992 made by this Schedule do not affect:
   (a) the continuity of the licence; or
   (b) the operations authorised by the licence; or
   (c) the renewal of the licence.
Notes to the  Radiocommunications Act 1992

Table A

Radiocommunications Amendment Act 2010 (No. 146, 2010)

Schedule 1

11 Application

(1) The amendment made by item 1 applies to a notice published in the Gazette on or after the day this item commences.

(2) The amendment made by item 4 applies to a determination made by the Minister on or after the day this item commences.

(3) The amendment made by item 7 applies:
   (a) in respect of spectrum for which a spectrum licence is not in force on the day this item commences—to the issue of a class licence on or after the day this item commences; and
   (b) in respect of spectrum for which a spectrum licence is in force on the day this item commences—to the issue of a class licence:
      (i) after the day the spectrum licence expires; or
      (ii) on or after the day the spectrum licence is re-issued.

(4) The amendment made by item 9 applies in relation to a direction made on or after the day this item commences.

(5) The amendment made by item 10 applies to a direction made on or after the day this item commences.
Embargo No. 41

EMBARGO NO: 41

STATUS: CURRENT

BAND: 100 MHz – 25.25 GHz

SUBJECT: EMBARGO FOR A RADIO QUIET ZONE

DATE OF EFFECT: 11 April 2005 (Revised 30 November 2005 and 27 April 2007)

COVERAGE: For the frequency range 100 – 230 MHz, within 150 km radius, and for the frequency range 230 MHz – 25.25 GHz, within 100 km radius, of Latitude 26° 42’ 15” South, longitude 116° 39’ 32” East¹ (Near Boolardy Station, Western Australia).

TIME FRAME: Ongoing

INSTRUCTIONS: No new assignments are to be made within the frequency range 100 – 230 MHz, within 150 km radius, and for the frequency range 230 MHz – 25.25 GHz, within 100 km radius, of Latitude 26° 42’ 15” South, longitude 116° 39’ 32” East¹. The embargo applies to all apparatus licensed, coordinated terrestrial stations and earth stations that are located within the specified zone². Existing licensed services may continue to operate. However, assignment proposals that seek to expand or modify existing apparatus licensed services are subject to the embargo.

Exceptions to this embargo require case-by-case consideration and the approval of the Manager, Spectrum Planning and Engineering Section. For cases involving the bands managed under the Broadcasting Services Act 1992, approval must be obtained from the Manager, Broadcast Engineering Section. Sections 100B, 102 and 102A of the Radiocommunications Act 1992 continue to apply.

¹GDA94 datum
²Stations as defined in Article 1, ITU Radio Regulations (2004).
EXPLANATION: This embargo establishes a Radio Quiet Zone (RQZ) within the areas described above, facilitating the development and use of new radio astronomy technologies. Subject to planning processes this embargo may be replaced by more detailed policy documents.

On 30 November 2005, subject to sections 100B, 102 and 102A of the Radiocommunications Act 1992, the scope of the embargo was extended to include the bands managed under the Broadcasting Services Act 1992, and the centre coordinates of the embargoed areas was adjusted to more accurately define the RQZ area.

On 30 April 2007 the central coordinates of the embargoed areas were changed to accommodate potential interference issues with new mining operations near the original site.

EMBARGO AUTHORISATION:

[Signature]
Giles Tanner
General Manager
Inputs to Industry Division
Australian Communications and Media Authority

7 May 2007
COORDINATION OF APPARATUS LICENSED SERVICES WITHIN THE MID WEST RADIO QUIET ZONE
DISCLAIMER

The Australian Communications and Media Authority (ACMA) advises that these instructions reflect the current policies of ACMA.

Prospective applicants for licences should take all necessary steps to ensure that they have access to appropriate technical and other specialist advice independently of ACMA concerning their applications, the operation of radiocommunications equipment and services, and any other matters relevant to the operation of transmitters and services under the licences in question.

The policies of ACMA and the laws of the Commonwealth may change from time to time, and prospective licensees should ensure that they have informed themselves of the current policies of ACMA and of any relevant legislation (including subordinate instruments). Prospective applicants for licences should not rely on statements made in these instructions about the policies that may be followed by other government authorities or entities, nor about the effect of legislation. These instructions are not a substitute for independent advice (legal or otherwise) tailored to the circumstances of individual applicants.

Radiocommunications Assignment and Licensing Instructions are subject to periodic review and are amended as ACMA considers necessary. To keep abreast of developments, it is important that users ensure that they are in possession of the latest edition.

No liability is or will be accepted by the Minister or Department of Communications, Information Technology and the Arts, ACMA, the Commonwealth of Australia, or its officers, servants or agents for any loss suffered, whether arising directly or indirectly, due to reliance on the accuracy or contents of these instructions.

Suggestions for improvements to Radiocommunications Assignment and Licensing Instructions may be addressed to The Manager, Spectrum Engineering, ACMA at PO Box 78, Belconnen, ACT, 2616. It would be appreciated if notification to ACMA of any inaccuracy or ambiguity found be made without delay in order that the matter may be investigated and appropriate action taken.
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COORDINATION OF APPARATUS-LICENSED SERVICES WITHIN THE MID WEST RADIO QUIET ZONE

1.0 Introduction

1.1 Purpose

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) is to provide processes for coordination with the Mid West Radio Quiet Zone (RQZ).

The Mid West RQZ consists of inner restricted zones where new frequency assignments are not usually permitted (with exceptions assessed on a case-by-case basis), and outer coordination zones where new frequency assignments require coordination with the RQZ.

Prospective frequency assignments for transmitters that lie within the outer coordination zones are analysed to determine whether the use of a planned transmitter at a location might produce signal levels above prescribed thresholds at the centre of the RQZ. If the analysis finds that potential signals are above the prescribed threshold then the licensee must take reasonable measures to reduce the signal level reaching the centre of the RQZ to below the threshold. For example, transmitter antennas may be modified, alternative transmitter locations may be used to take advantage of terrain shielding, or transmitter EIRP may be reduced.

In those cases where the potential signal level reaching the centre of the RQZ from transmitters within the outer coordination zones (as determined by the method prescribed in this RALI) cannot be reduced below the threshold the prospective licensee shall enter discussions with the users of facilities within the RQZ to achieve a mutually agreeable solution\(^1\). Where agreement is not possible ACMA will prescribe a solution.

1.2 Background

The radio astronomy service uses extremely sensitive radio receiving systems to detect very weak signals of cosmic origin, at much lower power levels than are generally used in other radiocommunications services. It is highly susceptible to interference from emissions by other radiocommunications services. To minimise such interference, radio astronomy antennas are usually operated in geographically remote locations.

1.3 Radio Quiet Zones

Generally speaking, a radio quiet zone (RQZ) is a geographic area within which signal levels from radiocommunications stations are controlled in some way to minimise the strength of electromagnetic energy within the area.

RQZs exist in other parts of the world. The United States established the National Radio Quiet Zone (NRQZ) in 1958, to minimise possible harmful interference to the National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia, and the radio receiving

\(^1\) The intention of the negotiations is not to change the regulatory status of the services, but rather to encourage mutually acceptable technical solutions that would prevent avoidable interference to the radio astronomy service without imposing undue impost on non-radio astronomy services. ACMA would not normally become involved in these negotiations.
facilities for the United States Navy in Sugar Grove, West Virginia. Rectangular in shape, the NRQZ has an area of approximately 33,000 square kilometres.

An RQZ also exists around the Arecibo Observatory in Puerto Rico. Licensees in the area must make "reasonable efforts" to protect the Observatory from interference.

1.4 The Mid West Radio Quiet Zone

The Mid West RQZ provides protection for facilities within a radio astronomy site within Boolardy Station in the mid west region of Western Australia. A site at the centre of the RQZ has been set aside specifically for the purposes of radio astronomy. It is geographically isolated, exceptionally radio-quiet and exhibits good ionospheric and tropospheric conditions for radio astronomy. It is the chosen site for a number of projects run by the CSIRO, as well as a number of other radio astronomy experiments.

The site is also Australia's nominated site for the core of the Square Kilometre Array (SKA) telescope\(^2\).

2.0 Scope

A potential assignment falls within the scope of this RALI if -

- the assignment is for an apparatus-licensed, coordinated terrestrial service station or earth station; and

- its frequency and geographical position lies within one of the prescribed zones.

This RALI does not apply to:

- assignments to radiocommunications systems that operate in an itinerant fashion, i.e. systems that have an area wide licence (e.g. Australia wide) and that may operate within the coordination zones from time to time,

- existing transmitters authorised for use by apparatus licences,

- transmitters whose use is authorised by spectrum or class licences within the band 100 MHz to 25.25 GHz,

- assignments to licences whose details would be kept confidential under section 152 of the Radiocommunications Act 1992,

- assignments to stations in the aeronautical service (mobile or fixed) or associated services supporting the operation of aircraft (e.g. radionavigation), and

- assignments to space licences

3.0 Zones

The zones consists of inner restricted zones where new frequency assignments are not usually permitted (with exceptions assessed on a case-by-case basis), and outer coordination zones

where new frequency assignments may require coordination with the RQZ.

3.1 Restricted Zones

The restricted zones are the frequency range 100–230 MHz, within a 150 km radius, and for the frequency range 230 MHz–25.25 GHz, within a 100 km radius, of latitude 26° 42’ 15” South, longitude 116° 39’ 32” East (GDA94 datum).

3.2 Coordination Zones

The coordination zones consist of annuli with the inner radius being the relevant restricted zone radius and the outer radius being the coordination zone radius. The radii for various frequency bands are provided in Table 1. The centre of the zones is the same as that used for the Restricted Zones.

4.0 Procedures

4.1 Restricted Zones

Within the restricted zones, unless there are exceptional circumstances (see 5.0):

- no new assignments to apparatus-licensed coordinated terrestrial stations and earth stations are to be made;
- existing licensed services may continue to operate; and
- assignment proposals that seek to expand or modify existing apparatus-licensed services are not permitted.

4.2 Coordination Zones

If a proposed assignment lies within a coordination zone then an assessment must occur of the expected signal level reaching the centre of the RQZ.

4.2.1 Assessment

Assessment is based on the following method of determining the signal level from the proposed transmitter arriving at the centre of the RQZ:

\[
\text{Tx PSD}_{\text{diff/t}} - \text{PPL} - 3.9 \geq \text{Threshold Level}
\]

Where:

\[
\text{Tx PSD}_{\text{diff/t}} \quad \text{Transmitter power spectral density}^3
\]

PPL = Propagation Path Loss

Relevant threshold level: see Table 2.

---

\[^3\text{A relatively uniform emission level is assumed. For less uniform emissions (e.g. analogue television signal) refer to the CSIRO for advice.}\]
Transmitter power spectral density (Tx PSD) in the direction of the centre of the RQZ is determined by:

\[
\text{Tx PSD}_{(\text{dBm/Hz})} = \text{Tx}_{(\text{dBm})} - 10\log(\text{BW}_{(\text{Hz})}) + G_{(\text{dB})}
\]

Where:
density
BW = Bandwidth in Hertz
G = Antenna Gain relative to an isotropic radiator towards the centre of the RQZ
Tx = Transmitter Power into the antenna (peak for pulsed transmitters)

Propagation Path Loss is determined as follows (a "K factor" of 4/3 is assumed):
- For cases where the path is unobstructed:

\[
\text{PPL} = \text{Free Space Loss} + 10 \text{ dB}
\]

- For cases where the path is obstructed, PPL is determined by use of any appropriate method described in section 4 of ITU-R P.526 (versions 4 through 9). Other methods for determining the propagation path loss may also be used pending ACMA agreement.
- A 9 second digital elevation model (such as RadDEM) or better should be used. An effective antenna height of 15 metres shall be assumed for facilities within the RQZ.

<table>
<thead>
<tr>
<th>Frequency Range (MHz)</th>
<th>Restricted Zone Radius (km)</th>
<th>Coordination Zone Radius (km)</th>
<th>Threshold (dBm/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100–230</td>
<td>150</td>
<td>260</td>
<td>-214</td>
</tr>
<tr>
<td>230–400</td>
<td>100</td>
<td>180</td>
<td>-222</td>
</tr>
<tr>
<td>400–520</td>
<td>100</td>
<td>165</td>
<td>-224</td>
</tr>
<tr>
<td>520–820</td>
<td>100</td>
<td>190</td>
<td>-224</td>
</tr>
<tr>
<td>820–1000</td>
<td>100</td>
<td>145</td>
<td>-228</td>
</tr>
<tr>
<td>1000–2300</td>
<td>100</td>
<td>140</td>
<td>-230</td>
</tr>
<tr>
<td>2300–6000</td>
<td>100</td>
<td>120</td>
<td>-232</td>
</tr>
<tr>
<td>6000–10000</td>
<td>100</td>
<td>Not required</td>
<td>-232</td>
</tr>
<tr>
<td>10000–25250</td>
<td>100</td>
<td>Not required</td>
<td>-236</td>
</tr>
</tbody>
</table>

Table 1: Radio Quiet Zone Parameters (centre latitude 26° 42' 15" South, longitude 116° 39' 32" East (GDA94 datum).

\(^4\) The ratio of the effective Earth radius to the actual Earth radius.
\(^5\) Lower limit exclusive, upper limit inclusive.
If the calculated signal level is above the threshold level, then reasonable measures (examples provided below) shall be taken to reduce the expected signal level to below the threshold.

In cases where the potential signal level reaching the centre of the RQZ (as calculated by the method prescribed in this RALI) cannot be reduced below the threshold, the prospective licensee will require agreement by the CSIRO before the frequency assignment is accepted by ACMA.

Agreement on a way ahead should be achieved within 15 working days\(^5\), or within a timeframe agreed to between the prospective licensee and the CSIRO. Documents confirming and describing any agreement shall accompany the frequency assignment application.

If no agreement can be made then ACMA will prescribe a solution taking into account the requirements of all stakeholders. Documents describing the reasons why agreement could not be reached must be forwarded to the Manager, Spectrum Engineering Section, ACMA\(^7\).

Contact details for the CSIRO are:

Email: atnf-spectrum@csiro.au

### 4.2.2 Reasonable Measures

Measures such as power reduction, site relocation, advantageous use of antenna directivity or notches are available to reduce the signal in the direction of the centre of the RQZ.

Operational agreements may also be made with the CSIRO. For example a licensee that only requires occasional use of a system within the RQZ may make an agreement whereby the CSIRO is informed in advance of any requirement to use the system.

Interference mitigation techniques available to the users of radio astronomy facilities may also need to be examined in cases where the signal incident on the centre of the RQZ cannot be otherwise reduced.

It may also be feasible for radiocommunications users to use alternative information transport systems, such as optical fibre.

### 5.0 Exceptions

Exceptions to the requirements of this RALI for prospective assignments in the restricted or coordination zones require case-by-case consideration by the Manager, Spectrum Engineering Section\(^5\), or for cases involving the bands managed under the Broadcasting Services Act 1992, approval must be obtained from the Manager, Broadcast Spectrum Strategy Section\(^8\). Sections 100B, 102 and 102A of the Radiocommunications Act 1992 continue to apply.

A request for exemption from the requirements of this RALI that is accompanied with evidence

---

\(^5\) "Working day" means any day other than a Saturday, Sunday or public holiday (including public service holidays) for the whole of the State or Territory in which the assignee's registered office is located, and any day other than those between 25 December and 1 January.

\(^7\) Manager, Spectrum Engineering Section, ACMA, PO Box 78 Belconnen ACT 2616.

\(^8\) Manager, Broadcast Spectrum Strategy Section, ACMA, PO Box 78 Belconnen ACT 2616.
of CSIRO support would normally be approved by ACMA.

6.0 RALI Authorisation

........................................12/09/2007

Andrew Kerans
Executive Manager
Spectrum Planning Branch
Australian Communications and Media Authority
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
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<tr>
<td>EIRP</td>
<td>Equivalent Isotropically Radiated Power</td>
</tr>
<tr>
<td>NRQZ</td>
<td>National Radio Quiet Zone - United States of America</td>
</tr>
<tr>
<td>RALI</td>
<td>Radiocommunications Assignment and Licensing Instruction</td>
</tr>
<tr>
<td>RQZ</td>
<td>Radio Quiet Zone</td>
</tr>
<tr>
<td>SKA</td>
<td>Square Kilometre Array</td>
</tr>
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</table>
Council resolved that an exemption to this notice applies to land zoned rural residential under the City of Mandurah Town Planning Scheme No. 3. This exemption is restricted to the declared “Restricted Burning Times” of 1 April to 30 November annually in accordance with Section 18 of the Bush Fires Act 1964. “Permits to Burn” are required between 1 April and 30 November annually. No burning is permitted between 1 December and 31 March annually.

“Limited Burning Times” means—

Restricted Burning Times: 1 April to 30 November inclusive annually—Permits To Burn Required;

Prohibited Burning Times: 1 December to 31 March inclusive annually—No Burning Anytime.

This prohibition does not apply to devices specifically designed and used for the purpose of cooking or heating.

This notice remains in effect indefinitely.

Enquiries on this issue should be directed to Ranger and Emergency Services on 9650 3630.

MARK NEWMAN, Chief Executive Officer.

---

**MARINE/MARITIME**

MA401*

**WESTERN AUSTRALIAN MARINE ACT 1982**

**NAVIGABLE WATERS REGULATIONS 1958**

**PROHIBITED SWIMMING AREA**

City of Mandurah

Mandurah Estuary

Department of Transport, Fremantle WA, 11 March 2011.

Acting pursuant to the powers conferred by Regulation 10A of the Navigable Waters Regulations 1958, the Department of Transport hereby declares the following area a swimming prohibited area—

Mandurah Estuary: All the waters within a 250 metre radius around the firing point, located on the southern foreshore (adjacent to the War Memorial), at the entrance to the Mandurah Canals, are closed to swimming between 8:00pm and 9:00pm on Saturday 12 March 2011.

DAVID HAREOD FNI, General Manager, Marine Safety, Department of Transport.

---

**MINERALS AND PETROLEUM**

MP401*

Commonwealth of Australia

**OFFSHORE PETROLEUM AND GREENHOUSE GAS STORAGE ACT 2006**

**RENEWAL OF PETROLEUM EXPLORATION PERMIT WA-341-P**

Renewal of Petroleum Exploration Permit No. WA-341-P has been granted to Inpex Browse Ltd and Total E&P Australia to have effect for a period of five (5) years from and including 3 March 2011.

B. BOWER, A/Executive Director, Petroleum Division.

---

MP402*

**MINING ACT 1978**

**INSTRUMENT OF VARIATION TO EXEMPTION OF LAND**

The Minister responsible for the Mining Act 1978, pursuant to the powers conferred on him by Section 19 of the Mining Act 1978, hereby VARIES the exemption of land designated 819/188 in Tengraph by including that portion of land described hereunder (not being private land or land that is the subject of a mining tenement or an application for a mining tenement).
Description of Land
Land designated as Meekatharra 1:1,000,000 plan, Primary number 2048, Graticules b,m,n,r,s,n,v,w and Primary number 2120, Graticules a,b in Tengraph.
A geospatial description of this land is also filed on Department of Mines and Petroleum File No. A2107/201001.

Area of Additional Land
2762 hectares
Locality
Mt Dugol

Dated at Perth this 25th day of February 2011.

NORMAN MOORE MLC, Minister for Mines and Petroleum.

---

MINING ACT 1978
INSTRUMENT OF EXEMPTION OF LAND EXTENSION OF PERIOD

The Minister responsible for the Mining Act 1978, pursuant to the powers conferred on him by section 19 of the Mining Act 1978, hereby extends the exemption originally declared on 1 June 2001 and published in Government Gazette dated 22 June 2001, with the most recent extension granted until 31 May 2011, of that area described hereunder (not being private land or land that is the subject of a mining tenement or an application therefore) from Divisions 1 to 5 of Part IV of the Mining Act 1978.

Description of Land S19/157:
That land, not being private land or land the subject of a mining tenement or application for a mining tenement, shaded 'red' on the plan on Department of Mines and Petroleum File No. A2107/201001 and designated 'S19/157' in Tengraph.
Area: 794.681 hectares approximately
Period of Extension: 1 June 2011 to 31 May 2013

Description of Land S19/158:
That land, not being private land or land the subject of a mining tenement or application for a mining tenement, shaded 'red' on the plan on Department of Mines and Petroleum File No. A2107/201001 and designated 'S19/158' in Tengraph.
Area: 919.714 hectares approximately
Period of Extension: 1 June 2011 to 31 May 2013

Dated at Perth this 25th day of February 2011.

NORMAN MOORE MLC, Minister for Mines and Petroleum.

---

MINING ACT 1978
APPLICATION FOR AN ORDER FOR FORFEITURE

Department of Mines and Petroleum,
Kalgoorlie WA 6430.

In accordance with Regulation 49(2)(c) of the Mining Act, 1978 notice is hereby given that the Prospecting Licences are liable to forfeiture under the provisions of Section 96(1)(a) for breach of covenant, via. non payment of rent.

G. BENN, Warden.

To be heard in the Warden's Court, Kalgoorlie on the 8th April 2011.

NORTH EAST COOLGARDIE

27/1963 West River Pty Ltd
27/1964 West River Pty Ltd
27/1965 West River Pty Ltd
RFI Standards for Equipment to be Deployed on the MRO

ASKAP-MRO-0001
Version 1.1
2010/10/15
Project: ASKAP

Prepared by: Carol Wilson
Reviewed by: Ron Beresford, Brian Boyle, Michelle Storey
Approved by: Antony Schinckel, Michelle Storey
Review reference (Redmine num.): #2956
Keywords: RFI, standards, radio frequency interference
Enquiries should be addressed to:

neale.morison@csiro.au

Document history

<table>
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<th>AUTHOR</th>
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<td>ddb</td>
<td>Minor changes in on-going compliance</td>
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<td>cdw/gra</td>
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<td></td>
<td>ndm</td>
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Image Cover: Artist's impression of ASKAP at the Murchison Radio-astronomy Observatory (MRO). Credit: Swinburne Astronomy Productions. Design data provided by CSIRO.
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1. MRO RFI Standards

Any electrical or electronic equipment in the vicinity of the Murchison Radio-astronomy Observatory (MRO) has the potential to create harmful Radio Frequency Interference (RFI) which could contaminate the radioastronomy observations. This applies to equipment used by the observatory operations as well as that used by external parties.

RFI from other users (telecommunications carrier, mining operations, tourists) is addressed in other documentation. This document sets limits on the equipment to be deployed on the MRO site itself. Measurement of very low levels which are nevertheless harmful to radioastronomy is difficult. The Military Standard MIL-STD-461F (RE102 “Navy Mobile and Army” curve) is used as the basis of assessment, as shown in the Table 1 below. For equipment within 10 km of the MRO facilities, control of RFI requires the use of additional screening to get to the appropriate level.

This document sets limits on the interference between one installation (telescope, experiment, or other equipment) and another (for example, ASKAP interference to MWA and vice versa). It is not intended to define limits for interference within a single installation.

The SKA, which may be co-located with the MRO in the future, is specified to operate from 70 MHz to 25.25 GHz, and the Australian Communications and Media Authority is proposing to extend the Mid-West Radio Quiet Zone to cover the same range. However, noting the difficulty in measuring RFI over wide frequency ranges, and bearing in mind that with increasing frequency spuriously generated noise typically decreases in magnitude, and attenuation increases, it should be possible to ensure compliance at the higher frequencies through analysis rather than measurement.

It is therefore required to test the RFI compliance of equipment on the site from 70 MHz to 5 GHz. Testing at frequencies above 5 GHz should only be performed if there is a specific reason to expect that the emissions will exceed the threshold, such as (a) there is a known component (such as a microprocessor) which has an intrinsic frequency greater than 5 GHz and/or (b) the measured levels at 5 GHz are within 10 dB of the allowed levels, in which case testing should be extended upwards until the margin between measurement and threshold is 10 dB.
### Table 1 - Fundamental thresholds for emissions as a function of frequency

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>Target emissions</th>
<th>Means of compliance</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>d&gt;10</td>
<td>Less than or equal to levels defined in Military standard MIL-STD-461F category RE102, Navy Mobile and Army (Figure RE102-4)</td>
<td>Equipment should be tested to MIL-STD-461F, and if required, additional screening provided to meet target emissions level.</td>
<td></td>
</tr>
<tr>
<td>10&gt;d&gt;1</td>
<td>Less than or equal to 20 dB below Military standard MIL-STD-461F.</td>
<td>Equipment should be tested to MIL-STD-461F, and if required, additional screening provided to meet target emissions level.</td>
<td>Need to take great care with equipment connections to maintain RFI screening between tested components</td>
</tr>
<tr>
<td>d&lt;1</td>
<td>Less than or equal to 80 dB below Military standard MIL-STD-461F.</td>
<td>Equipment should be tested to MIL-STD-461F, and if required, additional screening provided to meet target emissions level.</td>
<td>Only permitted on a case-by-case basis with careful testing</td>
</tr>
</tbody>
</table>

It should be understood that these two components together (the emission level and the additional screening) define an overall RFI limit, which may be met by various combinations. Equipment whose RFI emissions are higher than the military standard threshold will require additional screening to reduce the total RFI to the value described in Table 1. Equipment whose RFI emission is well below the military standard threshold may be acceptable with less screening.

The distance (km) refers to the minimum separation between the position of the proposed equipment at the MRO and the nearest facility of another experiment on the site. Appendix 1 gives the derivation of these shielding levels and distances to assist in evaluating equipment on a case-by-case basis. A facility may include a single antenna system, multi-element array or any other electrical/electronic equipment(s).

2. **Acceptance protocol for equipment on the site.**

Proponents will be required to have entire systems or subsystems tested in a qualified EMC lab and results assessed by the CSIRO as MRO Management to ensure that equipment meets the standards in Table 1, appropriate to the equipment site on the MRO.
A subsystem shall, as practically as possible, replicate the situation that will be deployed in the field. The subsystem should be connected with typical input or output signal lines and typical terminations on those lines. The subsystem should be as large a functional block as practically possible, operating in an active mode and with typical power consumption and loads. Where several functional modes are possible, a representative set of measurements for each operational mode should be made and assessed individually, and the equipment will be required to pass the criteria in each mode.

In general, where equipment is replicated only the prototype and a representative production sample need to be tested.

3. Procedure for approval

Before formal testing is undertaken, consultation with the MRO Management will be required to reach agreement on the level of subsystem to be tested and the specific test requirements for any particular instrument, thus minimising the need for retesting.

The MRO Management require that EMC laboratory reports, certificates obtained, and plots of equipment test results be prepared and presented to the MRO management to enable characterisation and assessment of the proposed equipment to be deployed on the MRO.

Test reports must be supplied before installation of equipment commences, and all parties are advised to wait for MRO approval before further equipment acquisition. MRO Management will advise within 15 working days if the equipment has been satisfactorily tested and meets the requirements shown in Table 1.

CSIRO reserves the right to require equipment to be checked for compliance to MIL-STD-461F and additional screening after commissioning on the MRO site.

Equipment which has been tested and is in compliance will be tagged accordingly to enable future management of site RFI.

4. Testing of screened enclosures

From Table 1, screened enclosures may be required for equipment within 10 km of another experiment. These should be tested separately from the equipment to be screened, by placing a known source inside the screened enclosure and measuring the attenuation of the signal. As shown in the analysis in Appendix 1, the enclosure should meet the specified level of screening (20 dB or 80 dB) over at least the frequency range from 70 MHz to 5 GHz.

IEEE standard 299-2006 on measuring screened rooms may be used for measuring screened enclosures greater than 2 m in each dimension. Procedures for measuring smaller screened enclosures are being investigated. In the interim, the use of commercially available screened enclosures is recommended.

5. Equipment used during construction phase

During periods of construction activity on the MRO site, power tools, welding equipment, heavy vehicles, communication systems and other equipment will be used which will exceed the limits described above. Such equipment is exempt from the
compliance regime described above, but should be tagged appropriately and may need to be removed from the site following construction.

6. **Ongoing compliance**

If, in the future, any equipment is found to exceed the threshold limits in Table 1, then the owners and users of the equipment may be required to immediately switch off the equipment so that it ceases to emit RFI. The equipment may need to be either modified so that its levels of emission are within the thresholds defined, or removed from the site.

Furthermore, if, in the future, any equipment is found to compromise research activities by exceeding the thresholds specified in the table, over the same receiving bands or in different receiving bands, it will be the responsibility of the owner of the equipment to minimise or mitigate emission levels to meet the required standards.
References


Appendix 1

Derivation of 20 and 80 dB shielding requirements

The threshold for RALI MS 32 is used as a standard for the level of permissible RFI. The MIL-STD-461F [1] levels for the same frequency breakpoints are derived and converted to dBm/Hz. The difference between the two levels represents the loss which must be achieved either through separation (free-space loss) or additional shielding. A value of 20 dB additional shielding results in separation distances of less than 1 km for most frequency points, while a value of 80 dB shielding brings the required separation down to a few metres. The antenna RFT for ASKAP also specified MIL-STD-461F plus 80 dB.

<table>
<thead>
<tr>
<th>RALI threshold (MHz)</th>
<th>PSD (dBm/Hz)</th>
<th>Limit dBuV/m</th>
<th>Measurement distance (m)</th>
<th>Bandwidth (kHz)</th>
<th>PSD (dBm/Hz)</th>
<th>Loss needed (dB)</th>
<th>Distance needed (km)</th>
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<tr>
<td>100</td>
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<td>1000</td>
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<td>127</td>
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<td>1</td>
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<tr>
<td>10000</td>
<td>-232</td>
<td>64</td>
<td>1.0</td>
<td>1000</td>
<td>-101</td>
<td>131</td>
<td>0.9</td>
<td>1</td>
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<td>69</td>
<td>1.0</td>
<td>1000</td>
<td>-96</td>
<td>140</td>
<td>1.0</td>
<td>1</td>
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</table>
Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011

Radiocommunications Act 1992


Dated 11 July 2011

Chris Chapman
[signed]
Member

Richard Bean
[signed]
General Manager/Member

Australian Communications and Media Authority

1 Name of Frequency Band Plan

This Frequency Band Plan is the Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011.

2 Commencement

This Frequency Band Plan commences on the day after it is registered.

Note All legislative instruments and compilations are registered on the Federal Register of Legislative Instruments kept under the Legislative Instruments Act 2003. See http://www.frli.gov.au.

3 Purpose of this Frequency Band Plan

(1) The purpose of this Frequency Band Plan is to establish a radio quiet zone, and provide for the establishment of supplementary radio quite zones, to prevent harmful interference to radio astronomy services.
(2) In particular, this Frequency Band Plan makes provision for the purposes for which applicable frequency bands may be used in the RQZ or in any supplementary RQZ.

4 Definitions

In this Frequency Band Plan:


_applicable frequency band_ has the meaning given by section 5.

_MRO entity_ means the entity responsible for operating the Murchison Radioastronomy Observatory.

_radio astronomy_ has the same meaning as in the Spectrum Plan.

_radio astronomy service_ has the same meaning as in the Spectrum Plan.

_RQZ_ means that part of the radio quiet zone:

(a) described in columns 2 to 4 of item 1 in the Schedule; and

(b) described in columns 2 to 4 of item 2 in the Schedule.

_Spectrum Plan_ means the Australian Radiofrequency Spectrum Plan 2009.

_supplementary RQZ_ means that part of any radio quiet zone described in columns 2 to 4 of an item (other than item 1 or 2) in the Schedule.

Note The following expressions in this Frequency Band Plan are defined in the Act:

- ACMA
- apparatus licence.

5 Meaning of applicable frequency band

(1) A frequency band is an _applicable frequency band_ for an area if it is applicable to the area under section 6.

(2) However, subsection (1) does not apply to a part of the spectrum in a frequency band for an area if, before the commencement of this Frequency Band Plan, that part of the spectrum:

(a) was designated for allocation with respect to the area by notice under subsection 36 (1) of the Act; or

(b) was specified in a spectrum re-allocation declaration with respect to the area under subsection 153B (1) of the Act.

6 Applicable frequency band

(1) The frequency band applicable to the part of the RQZ described in columns 2 to 4 of item 1 in the Schedule is the range set out in column 5 of the item.

(2) The frequency band applicable to the part of the RQZ described in columns 2 to 4 of item 2 in the Schedule is the range set out in column 5 of the item.
(3) The frequency band applicable to any supplementary RQZ described in columns 2 to 4 of an item (other than items 1 and 2) in the Schedule is the range set out in column 5 of the item.

7 Permitted purposes

(1) An applicable frequency band:
   (a) may be used for 1 or more of the following:
       (i) radio astronomy services; or
       (ii) any additional services mentioned in section 8; and
   (b) may be reserved for prevention or control of interference with radio astronomy services.

(2) For an instrument made under the Act, a service mentioned in subparagraph (1) (a) (ii) that is authorised to operate in the part of the RQZ described in columns 2 to 4 of item 1 in the Schedule in an applicable frequency band is taken to be a secondary service in relation to a service mentioned in subparagraph (1) (a) (i).

8 Additional services

(1) An applicable frequency band may also be used for services provided under an apparatus licence whether issued before or after the commencement of this Frequency Band Plan.

(2) The use under subsection (1) must not be inconsistent with the Spectrum Plan or another frequency band plan.

(3) If a licence is issued after the commencement of this Frequency Band Plan, subsection (1) only applies for services under the licence if the applicant for the licence consults with the MRO entity about those services before applying for the licence.

(4) However, the ACMA may decide that an applicant need not consult with the MRO entity.
## Schedule

### Description of radio quiet zone

(sections 4, 6 and 7)

<table>
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<tr>
<th>Item</th>
<th>Name or description</th>
<th>Central location or coordinates</th>
<th>Radius</th>
<th>Frequency range</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>RQZ (inner)</td>
<td>latitude 26.704167 South, longitude 116.658889 East (GDA94 datum)</td>
<td>70 km</td>
<td>70 MHz — 25.25 GHz</td>
</tr>
<tr>
<td>2</td>
<td>RQZ (outer)</td>
<td>latitude 26.704167 South, longitude 116.658889 East (GDA94 datum)</td>
<td>70 - 150 km</td>
<td>70 MHz — 25.25 GHz</td>
</tr>
</tbody>
</table>
EXPLANATORY STATEMENT
Issued by the Australian Communications and Media Authority

Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011
Radiocommunications Act 1992

Purpose
The Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011 (the Band Plan) establishes a radio quiet zone (RQZ) in the Mid-West region of Western Australia.

Legislative Provisions
The Band Plan is made under section 32 of the Radiocommunications Act 1992 (the Act) which provides that the Australian Communications and Media Authority (ACMA) may, by written instrument, prepare frequency band plans, each relating to one or more frequency bands.

A frequency band plan is a legislative instrument for the purposes of the Legislative Instruments Act 2003 (the LIA).

Background
The ACMA established the Mid West RQZ on 11 April 2005 with the introduction of Embargo 41. The RQZ aims to maintain the ‘radio-quietness’ of a site in remote Western Australia, near Boolardy Station, around 300 km North West of Geraldton. The area has very low levels of radiofrequency energy because of its low population and remote location.

The purpose of the RQZ is to facilitate the development and use of new radioastronomy technologies at that location, and support Australia’s bid to host the Square Kilometre Array (SKA). In the period since 2005, the Murchison Radioastronomy Observatory (MRO) has been developed at the centre of the RQZ.¹ Major national and international radioastronomy projects are already under construction at that site.

A frequency band plan made under section 32 of the Act must set out the purpose or purposes for which the frequency band or bands mentioned in it can be used. The use of a frequency band may include the reservation of spectrum in that band for the prevention or control of interference to radiocommunications.

The enhanced protections introduced by the Band Plan are designed to provide adequate protection for radioastronomy activities in the RQZ to support the development of the premier radioastronomy facility in the world, while imposing the lowest feasible regulatory burdens and compliance costs on other spectrum users in the region.

Operation
This Band Plan sets out the purposes for which the frequency bands mentioned in it can be used. These purposes primarily relate to radioastronomy services. The Band Plan also provides that additional services that operate in the inner zone of the RQZ, are to be taken to be secondary services to radioastronomy services.

Finally, the Band Plan requires that in general, applicants for apparatus licences after the commencement of the Band Plan must consult with the MRO before applying for that licence.

¹ The site is located in the Murchison Shire near the Boolardy station, centred 26.704167 South, 116.658889 East (GDA94 datum).
Consultation

Section 17 of the LIA requires the ACMA to be satisfied that any consultation it considers to be appropriate and that is reasonably practicable to undertake has been undertaken before making a legislative instrument. Section 33 of the Act also requires that a Gazette notice explaining the frequency band plan be published and a period of at least one month be provided for public comment.

On 8 October 2010, the ACMA commenced a public consultation process to explore a proposal to strengthen existing measures to protect the Mid West RQZ around the MRO. The ACMA made a media release and published a page on its website describing the issue for comment, the process for contributing to the consultation and providing a copy of a discussion paper.

The discussion paper proposed that the ACMA introduce a legislative basis for the existing administrative arrangements around the Mid West RQZ in order to provide greater certainty for all parties. This would include action to:

- introduce a Mid West RQZ frequency band plan that would, among other things, replace Embargo 41 and largely duplicate its provisions
- extend the lower boundary of the protected frequency range from 100 MHz to 70 MHz to enable the requirements of the SKA bid to be met
- make consequential amendments to the Australian Radiofrequency Spectrum Plan to enable the introduction of the band plan
- leave the existing RALI MS32 in place
- further highlight the protection mechanisms by cross-referencing them in relevant spectrum, class and apparatus licence conditions.

On 12 October 2010, a Gazette notice (No. S171) was published setting out the ACMA’s intention to make a new frequency band plan, as per its proposal in the discussion paper and seeking public comments about the proposal.

Submissions to the consultation were initially due on 17 November 2010, but at the request of stakeholders the deadline was extended to 17 December 2010. Twenty responses were received, including 19 from the stakeholders listed below and one confidential submission. They are available on the ACMA website.

**Government**
- Department of Defence
- Department of Innovation, Industry, Science and Research (DIISR)
- Government of Western Australia

**Miners and infrastructure developers**
- Crosslands Resources
- Jabiru Metals Ltd
- Sinosteel Midwest Corporation
- Talisman Mining Ltd
- Australasian Railway Association
- Oakajee Port and Rail

**Telecommunications carriers**
- Optus
- Telstra

**Satellite service providers**
- AeroMobile
- Global VSAT Forum
- Inmarsat
- Intelsat
- Iridium
- Pivotel

**Astronomers**
- International Centre for Radio Astronomy Research (ICRAR)
- CSIRO

Submissions indicated a diverse group of stakeholders with polarised and complex concerns regarding the ACMA proposal. Stakeholders, while generally supportive of the SKA, raised a
number of concerns regarding the potential impacts of the proposed measures, which were addressed in the revised approach.

In particular, some key themes emerged from the responses as follows:

- **certainty**—a desire for greater technical and regulatory certainty, particularly around the role of the MRO;
- **access to spectrum**—ensuring that arrangements did not unnecessarily restrict access to spectrum by other users in the region, particularly major mining and infrastructure projects;
- **SKA bid**—ensuring that the technical and radio quiet requirements for the SKA project are met.

In addition, stakeholders raised a number of specific issues including:

- the perceived potential for the impact of the proposed class licence conditions on other services to be more significant than intended, especially with respect to satellite services; and
- recognition of a ‘co-existence agreement’ being negotiated by Western Australian and Australian Government agencies; and
- a request for a full regulatory impact assessment of the RQZ.

Following its consideration of the diverse comments of stakeholders on its discussion paper, and further, targeted consultation on proposed revisions to the package of measures, the ACMA implemented revised arrangements to enhance regulatory protections for radio quiet in the Mid West RQZ. In particular, a more targeted approach to licence conditions was taken and the key elements of the ‘co-existence’ agreement were incorporated into this Band Plan.

**Regulatory Impact**

The Office of Best Practice and Regulation (OBPR) has considered the matter and formed the opinion that no regulatory impact analysis is required for the Band Plan. The OBPR reference number is ID12615.

**Band Plan Details**

Further details of the Band Plan are provided in the Attachment.
NOTES ON SECTIONS

Section 1  Name of Band Plan
Section 1 provides the name of the Band Plan.

Section 2  Commencement
Section 2 provides that the Band Plan commences on the day after it is registered.

Section 3  Purpose of the Band Plan
Section 3 provides that the purpose of the Band Plan is to establish a radio quiet zone (RQZ) and provide for the establishment of supplementary radio quite zones, to prevent harmful interference to radioastronomy services. In particular it sets out the purposes for which frequency bands may be used in the RQZ or any supplementary RQZ.

Section 4  Definitions
Section 4 provides definitions for terms used in the Band Plan.

The definitions of "radio astronomy" and "radio astronomy service" state that they have the same meaning as in the Australian Radiofrequency Spectrum Plan 2009 (Spectrum Plan). Essentially, as provided for in subsection 3(1) of the Spectrum Plan, a radioastronomy service is a radiocommunication service that is used for radioastronomy. Radioastronomy is defined as astronomy based on the reception of waves of cosmic origin.

Section 4 also provides definitions for the RQZ and supplementary RQZ. These definitions form the basis upon which applicable frequency bands are determined and define the areas in which services permitted by the Band Plan are permitted to be used.

Section 5  Meaning of applicable frequency band
Section 5 provides the meaning of applicable frequency bands for the purposes of the Band Plan. An applicable frequency band will not apply to the extent that, prior to the commencement of the Band Plan, parts of the spectrum coming within that band were subject to either a designation under section 36(1) of the Act or a spectrum re-allocation declaration under subsection 153B(1) of the Act that provide for the allocation of that spectrum by issuing spectrum licences.

This prevents the Band Plan from applying to spectrum that has been previously designated or reallocated by the Minister for spectrum licensing.

Section 6  Applicable frequency band
Section 6 sets out the applicable frequency bands under the Band Plan. Section 6 refers to the table in the Schedule, which lists the geographic area affected, and the particular frequency range of the applicable frequency bands. The Schedule provides for two frequency bands each with a frequency range of 70 MHz and 25.25 GHz and a specified geographic zone. There is an inner zone with a radius of 70 kilometres from the MRO; and an outer zone with a radius of 70-150 kilometres from the MRO.

Future, supplementary RQZ areas and applicable frequency bands may be added by listing them in further items in the table in the Schedule.
Section 7  Permitted purposes
Section 7 provides that an applicable frequency band, as described in section 6 may be used for
> radioastronomy services; or
> additional services as provided in section 8.

Section 7 clarifies that an applicable frequency band may be reserved from use for the purpose of preventing interference with radioastronomy services.

Section 7 provides that additional services that may operate in the inner zone of the RQZ, are to be taken to be secondary services to radioastronomy services.

Essentially, as provided for in section 12 of the Spectrum Plan, secondary services have a lower priority than primary services. Secondary services are required to not cause harmful interference to primary services and cannot claim protection from harmful interference from primary services.

Section 8  Additional services
Section 8 provides for the circumstances in which services other than radioastronomy services can use an applicable frequency band.

If an apparatus licence was issued before the commencement of the Band Plan, the service to which it applies may continue to operate under this Band Plan so long as its use is not inconsistent with the Spectrum Plan or another frequency band plan.

If an apparatus licence is sought after the commencement of this Band Plan, the service can only operate in an applicable frequency band if the licence applicant consults with the MRO entity about those services before applying for the licence. However, the ACMA may decide that an applicant need not consult with the MRO entity.

The intent of the requirement to consult with the MRO entity is that the licence applicant and the MRO entity would come to an agreement about appropriate technical solutions to ensure that radioastronomy services are protected from harmful interference while maximising the opportunities for other spectrum users to use the spectrum in the RQZ. The ACMA will consider all relevant circumstances, including the consultation that has been undertaken, when considering whether to grant an apparatus licence.

In conducting such consultations, reference may be made to a voluntary management framework agreed between the Australian and Western Australian Governments, which sets out their agreed position on the purpose of the RQZ, the roles and obligations of parties in the RQZ and dispute resolution mechanisms for proponents. In the alternative, the parties may develop other standing or ad hoc consultation arrangements.

Schedule 1  Description of radio quiet zone

Table
As referenced in section 6, Schedule 1 provides a description of two parts of the RQZ.

Both zones incorporate the frequency range 70 MHz to 25.25 GHz. The inner zone incorporates the area within a 70 kilometre radius of the MRO, which is located at latitude 26.704167 South, longitude 116.658889 East (GDA94 datum). The outer zone incorporates the area within a 70 to 150 kilometre radius of the MRO.
Attachment 9
Mid West Radio Quiet Zone
Response to submissions on proposed regulatory measures

JULY 2011
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Executive summary

In October 2010, the Australian Communications and Media Authority (the ACMA) released a public discussion paper canvassing regulatory measures to provide enhanced protection for the Mid West Radio Quiet Zone (the RQZ) in remote Western Australia, and to further support Australia’s bid for hosting the Square Kilometre Array (SKA). These proposals were primarily designed to upgrade the status of existing regulatory measures from administrative status to subordinate legislation.

The ACMA received 20 submissions on the October discussion paper and engaged in extensive, ongoing discussions with stakeholders about the proposed arrangements. The key themes that emerged from the responses were:

- **certainty**—a desire for greater technical and regulatory certainty, particularly around the role of the Murchison Radioastronomy Observatory (MRO)
- **access to spectrum**—ensuring that arrangements did not unnecessarily restrict access to spectrum by other users in the region, particularly major mining and infrastructure projects
- **SKA bid**—ensuring that the technical and radio quiet requirements for the SKA project are met.

In addition, stakeholders raised a number of specific issues including:

- the perceived potential for the impact of the proposed class licence conditions on other services to be more significant than intended, especially for satellite services
- recognition of a ‘co-existence agreement’ being negotiated by Western Australian and Australian Government agencies
- a request for a full regulatory impact assessment of the RQZ.

The ACMA has introduced a revised regulatory framework for the RQZ to:

- introduce an RQZ frequency band plan that creates an inner and outer zone
- extend the lower boundary of the protected frequency range from 100 MHz to 70 MHz to enable the requirements of the SKA to be met
- make consequential amendments to the Australian Radiofrequency Spectrum Plan to enable the introduction of the band plan
- amend the existing RALI MS32 to reflect the new band plan
- support the protection mechanisms by reflecting them as necessary in relevant class licence conditions.

This paper provides the rationale and policy basis for the ACMA’s decision to introduce this regulatory framework, which was informed by a formal consultation process and ongoing discussions with stakeholders.

Further information about these matters is available:

By email: Spectrum.Outlook@acma.gov.au

By mail: Project Manager, Mid West Radio Quiet Zone Spectrum Outlook and Review Section Australian Communications and Media Authority PO Box 78 Belconnen ACT 2616
Background

The Mid West Radio Quiet Zone

The ACMA established the RQZ, Australia's first radio quiet zone, on 11 April 2005. The RQZ aims to maintain the 'radio quietness' of a site in remote Western Australia, near Boolardy Station, around 300 kilometres north-west of Geraldton. The area has very low levels of radiofrequency energy because of its sparse population and remote location.

The purpose of the RQZ is to facilitate the development and use of new radioastronomy technologies at that location, and to support Australia's bid to host the Square Kilometre Array (SKA) radio telescope.

Since 2005, the Murchison Radioastronomy Observatory (MRO) has been developed at the centre of the RQZ. Major national and international radioastronomy projects already under construction at that site include:

- the Australian SKA Pathfinder (ASKAP)—a test facility for SKA technology
- the Murchison Widefield Array (MWA) telescope.

The Square Kilometre Array (SKA)

The RQZ covers the proposed core site for the Australian-New Zealand bid to host the SKA radio telescope. The SKA is a €1.5 billion project and is expected to be operational in 2020, with a 30 to 50-year lifespan. The SKA is being planned and developed by an internationally funded consortium from twenty countries. Australia and South Africa have been shortlisted in the competitive process for the opportunity to host the SKA. The final decision on location will be made in 2012.

The SKA will have a collecting area of one square kilometre. The design criteria call for a large central collecting antenna array and additional receiving arrays remote from the central cluster. The SKA is planned to operate over a frequency range of 70 MHz to 25 GHz and to have 50 times the sensitivity of the best radioastronomy telescopes currently in use. The broad mission of the SKA is to address fundamental questions in research on the origin and evolution of the universe.

The Australian Government, in cooperation with the Western Australian Government, has made a significant commitment to the Australian-New Zealand bid to host the proposed square kilometre array (SKA). It has done so on the understanding that the SKA project will provide a significant boost to innovation across Australia, building capacity that will benefit the research community and industry, intensifying international collaboration and creating high-skill, high-wage jobs for half a century.

Other activity in the RQZ

Several townships and a number of farms and pastoral leases are located in the RQZ. There are also current and potential mining sites, including the Jack Hills and Weld Range iron ore mines to the west and the north-west of the MRO site. An associated

1 The site is located in the Murchison Shire near the Boolardy Station centred latitude 26 degrees, 42 minutes, 15 seconds south; longitude 116 degrees, 39 minutes, 32 seconds east (GDA94).
railway line to service these mines is also being planned by Oakajee Port and Rail Pty Ltd (OPR) under agreement with the Western Australian Government.³

The ACMA’s role

The ACMA is an independent regulator that manages the radiofrequency spectrum in accordance with the Australian Communications and Media Authority Act 2005, the Radiocommunications Act 1992 (the Act) and its Principles for Spectrum Management. The ACMA’s key strategic intent is to make communications work in Australia’s public interest.⁴

The Act states, among other things, that the radiofrequency spectrum should be managed to maximise the overall public benefit derived from its use by ensuring that it is allocated and used efficiently.

In light of the Australian Government’s policy goal to host the SKA, the ACMA’s role includes to develop, as far as possible, mutually acceptable protection measures to restrict radiofrequency emissions—and potentially harmful interference—in the area around the MRO. The enhanced protections outlined in this paper are designed to provide adequate protection for radioastronomy activities in the RQZ to support the development of the premier radioastronomy facility in the world. The protections are also designed to impose the lowest feasible regulatory burdens and compliance costs on other spectrum users in the region.

The ACMA does not intend that its radio-quiet protection arrangements should impede the use of radiocommunications services within the RQZ in the event of an emergency. The emergency operation of radiocommunications devices is specifically authorised by section 49 of the Act.

Similarly, the ACMA does not intend to restrict existing services in the RQZ, which will continue to be licensed. Indeed, the ACMA anticipates that the Commonwealth Scientific and Industrial Research Organisation (CSIRO), as the manager of the MRO, will work constructively under the band plan with the ACMA and spectrum seekers to maximise the extent to which other services can operate in the RQZ without compromising radioastronomy activities. This may include working with licence applicants to develop technical solutions that minimise interference.

Previous RQZ protection arrangements

For several years before the introduction of the RQZ band plan and associated amendments, two administrative instruments provided radio-quiet protections for the RQZ—Embargo 41 and Radiocommunications Assignment and Licensing Instruction (RALI) MS32.

Embargo 41

First introduced in 2005, this embargo applied to the granting of licences in the frequency ranges:

- 100–230 MHz within a 150-kilometre radius
- 230 MHz-25.25 GHz within a 100-kilometre radius

of the SKA site.

³ Further information on OPR can be found at www.opandr.com.
The embargo applied to all apparatus-licensed, coordinated terrestrial stations and earth stations located within the specified zone. Under the embargo, existing licensed services could continue to operate. However, assignment proposals that sought to expand or modify existing apparatus-licensed services were subject to the embargo. Exceptions to this embargo, as with all embargoes, required a case-by-case consideration and approval by the Manager of the Spectrum Engineering Section of the ACMA.

Radiocommunications Assignment and Licensing Instruction MS32
RALI MS 32 set out processes to coordinate apparatus-licensed services with the RQZ and provided criteria for assessment of proposed assignments located within a coordination zone.

Introduced in 2007, RALI MS 32 identified a ‘restricted zone,’ covered by Embargo 41, where new frequency assignments were not usually permitted (with exceptions assessed on a case-by-case basis) and ‘coordination zones’ of up to 260 kilometres from the SKA core site, where new frequency assignments might require coordination with the MRO and the ACMA, depending on the frequency.

The criteria for assessment consisted of a threshold power density at the centre of the RQZ and a method of estimating the power density at the centre. A table in the RALI provided the definitions of the various zones and the respective threshold power densities.

These two instruments will be amended with the introduction of the revised regulatory framework, as discussed below under ‘New arrangements for the RQZ’.

Independent agreements between stakeholders
In addition to the formal regulatory actions it has taken, the ACMA understands that some key stakeholders with an interest in the RQZ have come to an agreement on principles and processes to guide their interactions and negotiations around the shared use of spectrum in the Western Australian mid-west region.

In general, the ACMA encourages spectrum users to establish arrangements to support their mutual use of spectrum and to provide certainty for all parties. It is desirable for spectrum users, to the extent possible, to self-manage their spectrum-sharing arrangements and, in the first instance, to put in place arrangements to manage interference.

The Department of Innovation, Industry, Science and Research (DIISR), on behalf of the Australian Government, has developed a ‘co-existence agreement’ with the Western Australian Government setting out the broad terms of spectrum management in the RQZ. This includes a memorandum of understanding including a set of principles for coexistence and a management framework setting out processes for cooperation and dispute resolution. This co-existence agreement is designed to provide certainty about future radio quiet for the MRO and future access to spectrum for its industry neighbours. The agreement also highlights the role the ACMA plays as an independent regulator of radiocommunications.

The ACMA supports this agreement but also acknowledges that other stakeholders may have other particular needs and may need to develop separate processes with the CSIRO as required.
Consultation with stakeholders

RQZ discussion paper

In October 2010, the ACMA commenced a public consultation process to explore a proposal to strengthen existing measures to protect the RQZ around the MRO. The rationale for the ACMA proposing these regulatory enhancements was that while the existing levels of protection for the RQZ were broadly appropriate in engineering terms, the policy documents were essentially administrative. The proposed approach would introduce a legislative basis to the arrangements, thereby providing greater certainty for all parties. This certainty was thought to be beneficial both to support the Australian/New Zealand bid to host the SKA and to provide certainty for mining projects seeking funding.

Twenty submissions were received and are available on the ACMA website.

Specifically, the discussion paper proposed that the ACMA introduce a legislative basis for the current administrative arrangements around the RQZ in order to provide greater certainty for all parties. The ACMA would:

> introduce an RQZ frequency band plan that would, among other things, replace Embargo 41 and largely duplicate its provisions
> extend the lower boundary of the protected frequency range from 100 MHz to 70 MHz to enable the requirements of the SKA bid to be fully met
> make consequential amendments to the *Australian Radiofrequency Spectrum Plan* to enable the introduction of the band plan
> leave the existing RALI MS32 in place
> further highlight the protection mechanisms by cross-referencing them in relevant spectrum, class and apparatus licence conditions.

Summary of submissions

Submissions to the consultation were received in December 2010. Submissions indicated a diverse group of stakeholders with polarised and complex concerns regarding the ACMA proposal. Stakeholders, while generally supportive of the SKA, raised a number of concerns regarding the potential impacts of the proposed measures, which have been addressed in the revised approach.

In particular, some key themes emerged from the responses as follows:

> **certainty**—a desire for greater technical and regulatory certainty, particularly around the role of the MRO
> **access to spectrum**—ensuring that arrangements did not unnecessarily restrict access to spectrum by other users in the region, particularly major mining and infrastructure projects
> **SKA bid**—ensuring that the technical and radio-quiet requirements for the SKA project are met.

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In addition, stakeholders raised a number of specific issues including:

> the perceived potential for the impact of the proposed class licence conditions on other services to be more significant than intended, especially for satellite services

> recognition of a ‘coexistence agreement’ negotiated by Western Australian and Australian Government agencies

> a request for a full regulatory impact assessment of the RQZ.
ACMA response to submissions

Comments on the proposed measures
Submissions to the discussion paper responded specifically to the proposals made by the ACMA. They also raised a number of issues relevant to a broader discussion of spectrum management in the RQZ. Below is a summary of the comments made by interested parties about each element of the package of measures proposed in the October 2010 discussion paper, along with the ACMA response.

Band plan
The discussion paper proposed the creation of a frequency band plan for the RQZ that, among other things, would replace Embargo 41 and largely duplicate its provisions.

Responses from the mining and infrastructure industry participants indicate that the creation of the band plan could have implications for spectrum users in the region in addition to those associated with the existing Embargo 41. In particular, concerns were raised about:

- extending the lower spectrum boundary to 70 MHz, which would restrict the retransmission of FM radio and some use of point-to-point communications at mining sites
- granting primary status to radioastronomy within the RQZ, which industry participants were concerned could:
  - impose additional regulatory obligations to avoid interference with the MRO—of particular concern as industry participants felt there was inadequate technical certainty about what kinds of activity could cause such interference
  - give an effective veto power over the granting of apparatus licences in the RQZ to the MRO.

In addition, there was support from the Western Australian Government, DIISR and the mining community for a different set of geographic boundaries. The band plan proposed in the October 2010 discussion paper covered frequencies from 70 MHz to 230 MHz within a 150-kilometre radius and frequencies 230 MHz to 25.25 GHz within a 100-kilometre radius of the centre. The revised geographic boundary of the band plan for all frequencies between 70 MHz and 25.25 GHz is a radius of 150 kilometres. Within a 70 kilometre radius, radioastronomy is deemed to be the primary service, with all other services secondary.

The proposals were acceptable to other stakeholders, as long as new spectrum users could be accommodated and granted licences subject to negotiation and meeting the thresholds set out in RALI MS 32.

Spectrum users, including satellite providers, carriers and miners, requested greater clarity around the extent to which their operations may continue or be expanded. The ACMA has supported and encouraged negotiations between key stakeholders to resolve some of these uncertainties by agreement. Government and mining and infrastructure industry stakeholders supported the development of the co-existence agreement between Western Australian and Australian Government agencies and proposed that the ACMA reflect that agreement in the band plan.

In order to provide both certainty and flexibility in the regulatory arrangements, the ACMA has reflected relevant elements of that co-existence agreement in the revised package of measures through changes to the geographic zones referred to in the
band plan and the detail of consultation arrangements. However, it is not appropriate that the agreement be included in the band plan. The function of a frequency band plan is to outline the purposes for which spectrum may be used in a specified band. It is not appropriate for it to contain an agreement between stakeholders or obligations on specific parties.

Some industry participants raised a specific concern about the imposition of new regulatory obligations. The ACMA’s view is that the additional obligations that attach to the granting of primary status for radiocommunications essentially reflect the effect of the existing administrative arrangements—that is, licences were not previously granted for services that would cause harmful interference to the MRO. An obligation to avoid causing harmful interference achieves the same practical effect of the previous arrangements through a different, clearer, mechanism.

There is no foundation to the concern expressed by some industry participants that the arrangements would give the MRO a veto power over the granting of apparatus licences. The ACMA retains its role, under the Act, as the decision-maker on licensing within the RQZ. While the ACMA may be guided by the outcomes of consultation between the MRO and licence applicants, it is not bound by those outcomes.

**Licence conditions**

The ACMA proposed to further highlight the RQZ protection mechanisms by cross-referencing them in relevant spectrum, class and apparatus licence conditions and requiring that all spectrum users avoid causing harmful interference to radioastronomy services in the RQZ.

Stakeholders raised concerns about the inclusion of an obligation to constrain radiofrequency emissions from services in and around the RQZ. Spectrum users under class licences, particularly satellite service providers, were concerned about the lack of certainty for their operations. In addition, they questioned the need to introduce a requirement to coordinate with terrestrial services for the first time and expressed concern that increased restrictions on their services could have negative repercussions for emergency communications in remote areas.

Considering the range of comments received, the ACMA believes that a more targeted approach to class and apparatus licence conditions is appropriate.

**Class licences**

Generally, class licences are offered on a no-protection, no-interference basis. For this reason, many contain a general obligation to not cause interference to other radiocommunications services, sometimes with specific references to radioastronomy services.

A review of the class licences for which RQZ-specific conditions were proposed in the ACMA discussion paper indicated that existing conditions provided sufficient protections for the following three licences, for which no additional conditions have been imposed:

- Radiocommunications (Cellular Mobile Telecommunications Devices) Class Licence 2002 (see section 7 of that licence)
- Radiocommunications (Overseas Amateurs Visiting Australia) Class Licence 2008 (see section 10 of that licence)
- Radiocommunications (Communication with AUSSAT C 156E GOV Satellite Network) Class Licence 2005 (see section 8 of that licence).
The two class licences below contain specific protections for radioastronomy services. In these cases, the ACMA has added the MRO as another protected facility for completeness:

- Radiocommunications (Communication with Space Object) Class Licence 1998

In order to address concerns raised by satellite providers, the protections afforded to the MRO under the Communication with Space Object class licence are limited only to the range of transmission frequencies that are used by the MRO — no restrictions are placed on frequencies used in the downlink from satellites to terrestrial stations.

One class licence did not contain specific protections that would cover radioastronomy services and so an obligation to avoid interference with the MRO has been inserted:


For the remaining two class licences, the ACMA assessed the likely threat of interference from the devices they covered—cordless telephone handsets. The ACMA determined that, due to the nature and likely location of the devices, they are unlikely to pose significant threat to radioastronomy activities. In these two cases, the ACMA proposes that the MRO should cover the use of these technologies in its discussions with its neighbours about how they might minimise interference with the MRO receivers. The two licences are the:

- Radiocommunications (861–865 MHz Land Stations and Handsets) Class Licence 1996

Apparatus licences
The ACMA has determined that the most appropriate means to impose conditions on apparatus licensees to protect the radio quietness of the RQZ is to impose conditions as appropriate on each licence assigned in the RQZ. This provides a more targeted approach to preventing interference from class-licensed services in the RQZ.

Under the new band plan and the amended RALI MS 32, spectrum seekers in the RQZ are required to consult with the MRO before applying to the ACMA for an apparatus licence. The ACMA intends that relevant technical arrangements negotiated and agreed between the licence applicant and the MRO will be applied to the apparatus licence as a licence condition.

Spectrum licences
To continue to protect the RQZ and support the SKA bid, spectrum licences granted in areas around the RQZ will also be subject to a licence condition designed to prevent harmful interference to radioastronomy services at the site.

The ACMA also intends to exclude the proposed SKA site at the centre of the RQZ from all new spectrum licences that are granted nationally. This will preserve options surrounding apparatus licensing of radioastronomy receivers at the centre of the site.  

Lowering the frequency boundary
The ACMA proposed to extend the lower boundary of the protected frequency range from 100 MHz to 70 MHz to enable the requirements of the SKA bid to be fully met. Most stakeholders did not express significant concerns about the extension of radio-

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6 See, for example, current processes to reallocate spectrum in the 2.5 GHz and 700 MHz bands.
quiet protections to these additional frequencies. SKA proponents noted that it was necessary to include these frequencies to fulfil the SKA specifications. Mining companies noted, however, that this proposal could limit the retransmission of FM radio to mining communities and the use of some point to point communications services within the area covered by RALI MS 32.

On balance the ACMA is of the view that the frequency boundary should be lowered to 70 MHz as proposed.

Consequential ARSP amendments
The ACMA proposed to make consequential amendments to the Australian Radiofrequency Spectrum Plan (ARSP) to enable the introduction of the proposed band plan. In their submissions, stakeholders agreed that consequential amendments should be made to the ARSP as necessary.

Retain RALI MS32
In its discussion paper, the ACMA proposed to leave the existing RALI MS32 in place. Stakeholders generally agreed that the arrangements outlined in this RALI were appropriate and should be retained.

However, to address issues raised in submissions, some amendments to RALI MS 32 are warranted. These principally involve reflecting the key components of the new band plan and elements of the agreement between the Australian and Western Australian Governments, discussed below under ‘coexistence agreement’. The intent of the amendments to the RALI is to ensure that the band plan and the RALI are consistent and to acknowledge the independent agreements of key stakeholders.

Comments on related matters
In addition to addressing elements of the package of measures proposed by the ACMA, submissions to the discussion paper also raised a number of issues relevant to a broader discussion of spectrum management in the RQZ. Below is a summary of the comments made by interested parties, along with the ACMA response.

Regulation impact assessment
The mining and infrastructure industry, along with the West Australian Government, called on the ACMA to conduct a thorough regulation impact assessment including the production of a regulation impact statement (RIS). They argued that this should include an assessment of the social and economic impact of radio-quiet protections on the mid-west region, and involve community and industry consultation. The Western Australian Government also asked the ACMA to conduct an education program and provide briefings for remote communities, regional groups and industry affected by the protection arrangements.

The ACMA consulted the Office of Best Practice Regulation (OBPR) and conducted a preliminary assessment in line with the OBPR’s best practice guidelines. The OBPR advised that a RIS was not required in this instance.

The reason for this advice is that a RIS measures the impact of a proposed regulatory decision, showing the change from the status quo to the proposed outcome. This is not a case where the ACMA is required to measure the impact of instituting a radio-quiet zone in an area where previously there was none. Rather, Embargo 41 is being replaced by a band plan to largely the same effect. That being case, the impact of the changes was assessed to be minor and an extensive exercise in impact analysis was not warranted.
The CSIRO (as manager of the MRO) has educated local communities on the implications of the RQZ—for example, how residents in the region using satellite phones can minimise interference to the MRO. The ACMA’s view is that CSIRO is best placed to educate its neighbours on the interference requirements of its radioastronomy observatory.

Coexistence agreement
The Western Australian and Australian Government agencies have developed a memorandum of understanding (MoU) and management framework. These specify consultation and dispute resolution mechanisms to be used by apparatus licence applicants in the RQZ in their consultations with the MRO. The MoU will be accompanied by technical advisory guidelines, to be developed by the CSIRO, on the operation of radiocommunications equipment in the RQZ. Some stakeholders have argued strongly that their non-binding co-existence agreement should be reflected in the ACMA’s regulatory arrangements. This approach was supported by the mining and infrastructure industry submissions.

In general, the ACMA encourages the users of spectrum to negotiate their mutual use of spectrum. It is desirable for spectrum users, to the extent possible, to self-manage their spectrum-sharing arrangements and in the first instance put in place arrangements to manage interference. For this reason, the ACMA supported the development of the MOU and has reflected key elements of the agreement, such as the geographic boundaries, in its revisions to the originally proposed band plan.
New arrangements for the RQZ

The ACMA has implemented the following arrangements to enhance regulatory protections for radio quiet in the RQZ. This follows consideration of the diverse comments of stakeholders on the discussion paper and further, targeted consultation on proposed revisions to the package of measures.

**Band plan**

The ACMA has introduced a frequency band plan that replaces Embargo 41. The plan outlines the purposes for which spectrum in the frequency range 70 MHz to 25.25 GHz may be used. It also defines geographic zones within 150 kilometres of the MRO, which will operate as follows:

- **Inner zone**—Taking as its central point the site of the MRO, the radius of the restricted zone previously provided in Embargo 41 of 100 kilometres/150 kilometres (depending on frequency) was reduced to 70 kilometres.
  
  Within 70 kilometres of the MRO, radioastronomy services are the primary services in the zone, with other services deemed to be secondary.¹

- **Outer zone**—The new outer zone will operate within a radius of 70 to 150 kilometres from the MRO.

In both zones, the band plan requires applicants for new apparatus licences to consult with the MRO before applying for a licence. The ACMA will retain its discretion to issue a licence without consultation taking place or without an agreement being reached. However, in normal circumstances, the ACMA expects to issue licences in accordance with agreements negotiated between the MRO and a licence applicant.

**Australian Radiofrequency Spectrum Plan**

The ACMA has made consequential amendments to the ARSP to enable the introduction of the band plan.

**RALI MS 32**

The ACMA intends to review and make amendments to RALI MS 32 to update the document and reflect the changes introduced by the band plan, including to lower the frequency boundary to 70 MHz.

**Licence conditions**

**Class licences**

Three class licences have been amended to ensure that appropriate provision exists to protect the MRO from harmful interference:

- Radiocommunications (Communication with Space Object) Class Licence 1998
- Radiocommunications (Low Interference Potential Devices) Class Licence 2000

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¹ Section 12 (2) of the *Australian Radiofrequency Spectrum Plan* (ARSP) states that a secondary service must not cause harmful interference to a primary service. Harmful interference is defined as interference that obstructs, repeatedly interrupts or seriously degrades a radiocommunications service that is operating in accordance with the *Radio Regulations* published by the International Telecommunications Union, or the ARSP.
**Apparatus licences**
Under the new band plan and the amendments proposed for RALI MS 32, spectrum seekers in the RQZ are required to consult with the MRO before applying to the ACMA for an apparatus licence. The ACMA intends that relevant technical arrangements, negotiated and agreed between the licence applicant and the MRO, will be applied to the apparatus licence as a licence condition.

**Spectrum licences**
To continue to protect the RQZ and support the SKA bid, spectrum licences granted in areas around the RQZ will be subject to a licence condition designed to prevent harmful interference to radioastronomy services at the site.

The ACMA also intends to exclude the proposed SKA site at the centre of the RQZ from all new spectrum licences granted nationally. This will preserve options surrounding apparatus licensing of radioastronomy receivers at the centre of the site.
Mask Documentation for the Australian candidate SKA site

Dr Michelle Storey¹ and Mr Martin Russell²

1 CSIRO Astronomy and Space Science
2 Aurecon

Introduction

CSIRO has been working since March 2009 in close collaboration with the international SKA Program Development Office and representatives of the SKA South Africa project team to develop methodology and standards for the determination of radio-frequency interference (both EMI and narrowband transmitter) and geophysical buffer zone parameters for the regions within 180km radius of the SKA candidate sites in both countries. Aurecon has been working under contract to CSIRO to provide data collection and Geophysical Information System expertise to the Australian/NZ team for the determination of masks for the A/NZ candidate site. The analysis to create a data mask over the intermediate area (180km radius from the Murchison Radio-astronomy Observatory (MRO)) in WA involves an evolving constraints analysis, created in the GIS, to define a “no-go” data mask. The mask’s specifications have been defined for the 180km region by the SKA Program Development Office (SPDO). Australia is using a 1:250,000 scale vector database as its base layer, which enables the user to pick up features as small as homesteads and vehicular tracks. This database is called Geodata, available from Geoscience Australia. Data of this quality are the minimum specification throughout the following analysis. Data have been collected for a region of over 200km radius. This is to ensure that infrastructure that lies beyond 180km, but for which the appropriate buffer zone extends to within the 180km boundary, is included in the mask.

The process to determine masks was agreed between SPDO and the site proponents at a meeting over May 11-12 2009, and has been articulated in the document “Meeting on WP3, Configurations Design and RFI Monitoring V1.0 11-6-2009”.

The parties have worked in collaboration to determine appropriate mask parameters and the agreed methodology and set of parameters have been set out in a document co-authored by SPDO and both the Site proponents SKA Mask Specifications (draft version 0.5, 18-2-2010 R.P. Millenaar (SPDO), Michelle Storey (CSIRO), Carol Wilson (CSIRO), Adrian Tiplady (SKASA). A final version of this document is yet to be produced as at 27/8/10. A number of subsidiary input documents have been produced during the development of the SKA Mask Specifications document.

The Australian mask presented below is completely consistent, to the best of our knowledge, with the methodology, standards and mask parameters presented in the SKA Mask Specifications document.
The following sections outline the datasets and supplementary information used, and presents the masks for the individual layers requested by SPDO. A relevant additional mask identified by the Australian/NZ team as being required for full characterisation of the Australian site, is also presented. The ordering follows the format of the SKA Mask Specifications document, which forms the primary reference for the site characterisation work.

**Mask Determination**

**Populated and Industrial Areas**

**Farms**
A database of all homesteads from Landgate Australia was used to identify all homestead sites within 180km of the SKA core. The positional accuracy of the data stored within the data set have been scaled or digitised from 1:250 000 maps. Some coordinates have been sourced from GPS surveys. The Government of Western Australia has had a policy of purchasing, destocking, and rehabilitating land in pastoral leases in the region of the site. Local knowledge from pastoralists and the ASKAP Indigenous Liaison Officer was used to determine that, even though the homesteads on such properties are not permanently occupied, they were occasionally occupied. For this reason, the full homestead buffer zone of 13.5km radius has been applied around such buildings as risk mitigation. A handful of homesteads are permanently unoccupied and these were deleted from the data set. The farmstead mask is presented in Figure 1 below.
Figure 1 – Mask layer appropriate for farmsteads. The Boolardy Station boundary is marked on the map together with the 180km radius. Boolardy Station pastoral lease is held by CSIRO.

**Indigenous Settlements**

A number of indigenous settlements within 180km of the core SKA site have been identified using the Landgate, Western Australia database. The overall scale of the data set is 1:250,000, and the dataset is enhanced by additional government department information. An indigenous settlement is a grouping of indigenous people living in a collection of buildings that is not a homestead nor a town. There are less people and facilities in an indigenous settlement than in a town, with approximately 20-50 people in each settlement. Although indigenous settlements were not discussed using the discussions between site proponents and SPDO, it is important to include all relevant human infrastructure, and so a mask for settlements has been included. It is calculated that a buffer zone of 17km is appropriate for indigenous settlements, based on 10 buildings, with a third of them active at any one time. The indigenous settlements mask is presented in Figure 2 below.
Figure 2. Mask layer appropriate for indigenous settlements.
**Towns**

Town locations were obtained from the dataset from Landgate, Western Australia. The positional accuracy of the data stored within the data set have been scaled or digitised from 1:250 000 maps. Some coordinates have been sourced from GPS surveys. Town population figures were obtained from the Australian Bureau of Statistics supplemented by information from local Councils. The only town within the 180km radius region is Cue with a population of around 300 people with a mask classification of grade 2. Three towns are on the 180km boundary or just outside: Meekatharra with a population nearly 1000 people (grade 3), Mount Magnet with a population below 500 people (grade 2) and Yalgoo with a population around 100 people (grade 1). Masks have been applied according to the town classifications given in [2] and are presented in Figure 3 below. Murchison Settlement, whilst not a town, is a cluster of buildings including the Murchison Council building. To ensure a comprehensive mask, it is included in this Figure with an appropriate mask radius.
Figure 3 - Mask layer appropriate for towns and Murchison Settlement

**Mines**

In 2006, the International Site Selection Advisory Committee recommended that further work be carried out to characterise the risk of RFI from mining for the candidate sites. Detailed information on mining has been obtained from the Western Australian Government Department of Mines and Petroleum, based on information received in mining proposals for operations licenses, records of field operations, and Department knowledge of planned operations in the region. Where operations are planned and not yet implemented, information on equivalent operations in other areas is being used to determine the impact of the planned scope of mining activity. Information has been supplemented with detailed discussions with the managers of planned mines in the area. Masks have been applied appropriate to the activity classifications given in SKA Mask Specifications (draft version 0.5), and are presented in Figure 4 below. Note that buffer zones are included for planned mining activity in the Jack Hills and Weld
Range iron ore mines even though the full mining activity planned has not yet commenced at these mine sites.

There are currently some speculative exploration licenses in the area. These are not currently masked out as there is no confirmed mineral prospectivity in the area. When SKA array-station sites are determined, appropriate protection from mining and other activity will be established around the array-station sites to prevent incompatible mining activity. The following procedure will be followed before array-station sites are confirmed:

1. The site will be identified by latitude and longitude

2. Any nearby mining licenses will be identified on approved databases
3. A geological survey team will be consulted for an assessment of the mineral prospectivity of the area, and the likelihood and scale of any mining development in the future.

4. The appropriateness of buffer zones already established will be checked and adjusted if necessary to protect the array-station site.

5. The array-station site will be adjusted if necessary before being finalised.

The Government of Western Australia has a world-standard geological survey and mapping service, which will be available to respond to queries during the process described above. The appropriate databases in Australia are largely publicly available from the WA Department of Mines and Petroleum website.

Note that the buffer zones defined above do not take into consideration the existing Mineral Resource Management Area controls already implemented by the Government of Western Australia, which require mining operations to be consistent with the radio-quietness requirements of the radio astronomy activities. They thus represent a particularly “safe” conservative approach within 80km radius of the core site.

**Power Lines**

Information on power lines was initially provided by Western Power Corporation, Western Australia, previously owned by the Government of Western Australian. There are no power lines within 180km of the site and no plans to introduce power lines to the region as the population density is too low to justify such infrastructure. A mask for power lines is a null mask.

**Arc welders**

The presence of arc welding for maintenance purposes at mining sites has been assumed and an appropriate buffer zone has been included around the base camps at mine sites. Arc welding for more than 5% of the time at any other location would also require masking. Local knowledge of pastoral activity indicates that arc welding would only occur very occasionally and at less than the 5% level. In the Australian context the arc welding buffer is incorporated with the mining buffer, Figure 4.

**Bodies of Water**

Water features were obtained from the dataset from Landgate, Western Australia. The positional accuracy of the data stored within the data set have been scaled or digitised from 1:250,000 maps. The water bodies and floodplain data set identifies lakes, pools, swamps, claypans, land subject to inundation and land subject to flooding. For water bodies and floodplains, the data were buffered 50m beyond any extent of available water data. The watercourse data set identifies natural drainage lines such as rivers and creeks. The data were derived from two data sets, firstly Geoscience Australia’s 1:250,000 data, for the primary purpose of extracting rivers and creeks by classification; perennial and seasonal, major and
minor, and named. Secondly, Landgate’s 1:100,000 drainage layer was used to extract out additional drainage lines, so that, the Australian drainage layer approach would be similar to the RSA stream order drainage layer approach. The relevant watercourses/drainage line layer was buffered 50m either side of the data.

The mask map for bodies of water and inundation is presented below as Figure 5.

![Figure 5 – Mask layer appropriate for bodies of water and inundation areas.](image)

**High Wind Areas**
The Australian continent is classified into wind regions for the purpose of structural design by Australian Standard AS1170.2. The 180km radius intermediate region falls into Wind Region A, which is the most benign classification, with the western side of the 180km boundary abutting Wind Region B; both Wind Regions are classified as non-cyclonic. There are no areas where wind speeds greater than 160km/hr are expected within 180km of the central site. The mask is a null mask.
**Roads**

The roads dataset has been compiled by Landgate WA by merging the roads layers from 1:25000, 1:50000 and 1:100000 digital datasets (Landgate, WA). The inner 180km region is primarily 1:100,000 scale (+/-25m accuracy). Road traffic density was obtained from local Council officers in the Murchison Council area, who maintain traffic counts for maintenance purposes, from records from the WA Department of Main Roads, and local knowledge from pastoralists in the region.

There are no major roads within the 180km radius zone. Minor roads are masked out according to the agreed specifications in and the mask map is given below in Figure 6.

![Figure 6 – Mask layer appropriate for roads](image-url)
**Railroads**

There are no railroads within 180km of the candidate site. However, there is a proposed railroad to service the mines being developed at Jack Hills and Weld Range. The railroad project, together with the mining projects it will service, are currently undergoing bankable feasibility studies. The Government of Western Australia provided the SKA project with a map of the proposed rail route, and figures for the proposed rail traffic from the rail infrastructure and this information has been used to create an appropriate buffer zone for the rail infrastructure. The mask map is provided as Figure 7 below.

![Figure 7 – Mask layer appropriate for proposed rail](image_url)
Slope, Horizon Limit and Rugged Terrain DEMs were used to create slope, rugged terrain and horizon limit. DEMs were obtained from Landgate, Western Australia; derived from 20m contours at a scale of 1:100,000 to produce a 30m x 30m base DEM and a 1 second (30m x 30m) Shuttle Radar Topography Mission (SRTM) DEM. The DEMs extended 20km beyond the 180km site to allow for horizon limit analysis.

**Slope**

For slope, an existing slope function (within GIS) was used to create a slope DEM. Using degrees as the resulting measurement, all slope 5 degrees and above was isolated and added to the mask.

The resulting mask map for slope is shown in Figure 8.

Figure 8 – Mask layer appropriate for slope
**Horizon Limit**

For horizon limit, an existing hillshade function (within GIS) was used to create a horizon limit DEM. Using modelled shadows as the resulting measurement, an altitude of 15 degrees and varying azimuths of 0, 45, 90, 135, 180, 225, 270, 315, all shadowing was isolated and added to the mask.

The resulting mask map for horizon limit is shown in Figure 9.
**Rugged Terrain**

For rugged terrain, an existing overlapping neighbourhood statistics function (within GIS) was used to create a rugged terrain DEM. Using standard deviation as the resulting measurement with a neighbourhood of 3 x 3 cells, all terrain 6 std. dev. and above was isolated and added to the mask.

The resulting mask map for rugged terrain is shown in Figure 10.

![Mask layer appropriate for rugged terrain](image)

**Environmental and Cultural Exclusion Areas**

Data have been obtained from a number of Government Departments as indicated below, to ensure that SKA array-stations are sited with consideration and respect for the local stakeholders in the area:
- Reserves (National Parks, Nature Reserves, Conservation parks etc) - Landgate WA government
- Environmental Sensitivity (Public Drinking water source areas, Environmentally Sensitive areas) - Department of Environment WA government
- Heritage sites (Aboriginal heritage sites) Department of Indigenous Affairs WA government

Note, after further consultation with the Department of Mines and Petroleum WA government, Geoheritage was deemed not to be a mask category. The environmentally sensitive area site within the geoheritage area was included within this mask.

These areas have been masked out and the mask is provided in Figure 11.

Figure 11 – Mask layer appropriate for environmental, heritage and cultural areas
Industrial Areas (*electricity substations, salt-mining activity, transport hubs etc*)

All industrial areas are included in either the mining or town databases in the Australian context. The land is pastoral land and other activity is not permitted without permission. The mask is a null mask.

**Conclusion**

The mask layers described above are fully compliant with the definitions provided in the agreed reference documents. The scale of the datasets is adequate to map the smallest features required in the EMI and geographic mask. The Australian government has provided access to more accurate DEMs which would enable further analysis of the 180km radius site area in the future.
Wind roses in detail

Wind roses summarise the occurrence of winds at the core, showing their strength, direction and frequency. The percentage of calm conditions is represented by the size of the centre circle—the bigger the circle, the higher the frequency of calm conditions.

The wind rose diagrams presented on the following pages are for the year (annual), and for each month from January to December.

Each branch of the rose represents wind coming from that direction, with north represented at the top of the diagram. Eight directions are used to calculate the direction. The branches are divided into segments of different thickness and colour, which represent wind speed ranges from that direction. Speed ranges of 10 km/h are used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.
3 pm
6776 Total Observations

Calm 11%
3 pm Jan
606 Total Observations

Calm 10%
3 pm Feb
566 Total Observations

Calm 14%
March

3 pm Mar
593 Total Observations

Calm 13%
3 pm Apr
554 Total Observations

Calm 16%
3 pm May
569 Total Observations

Calm 12%
3 pm Jun
568 Total Observations

Calm 11%
3 pm Jul
587 Total Observations

Calm 14%
3 pm Aug
610 Total Observations

Calm 9%
3 pm Sep
559 Total Observations

Calm 8%
3 pm Oct
562 Total Observations

Calm 7%
3 p.m Nov
537 Total Observations

Calm 8%
3 pm Dec
527 Total Observations

Calm 11%
New Zealand physical characteristics

The entirety of New Zealand is a maritime temperate climate under the modified Keoppen classification scheme. Summers in New Zealand are cool and winters are milder than other locations of comparable latitude.

The indicative SKA remote station in New Zealand used in the motivated alternative configuration is located at the southern tip of the South Island in a region of low population density used for conservation and grassland farming. This document gives general physical characteristics for New Zealand along with specifics for the proposed site.

Population density

New Zealand had a population of 4.2 million people in the 2006 census, the majority of whom (76 percent) live on the North Island. The population is highly urbanised with 72 percent living in towns of over 30,000 people. In fact, approximately one third of the population lives in and around Auckland, New Zealand’s largest city. This urban clustering and preference for the North Island is highlighted in the population density map (Figure 1) which shows large areas with less than one person per square kilometre, particularly on the South Island.
Population density for the New Zealand SKA site

Most of the population on the South Island is concentrated in the either Invercargill (population 49,000) or Bluff (population c3,000). The 2006 population density of the mesh block containing the SKA site is one permanent resident per square kilometre. However, as the mesh block is relatively large, a more realistic population density around the site is estimated to be less than half a permanent resident per square kilometre.

Land use in New Zealand

Natural land cover (native forest, vegetation, scrub and rivers and lakes) dominates approximately 50 percent of New Zealand’s total land area (2002). Pastoral land use (sheep, beef, and dairy farming) comprises the largest human activity, accounting for around 37 percent of New Zealand’s total land area (2004).

Land use around the New Zealand SKA site

The proposed site is in a region surrounded by national parks to the northeast and grassland farming to the southwest.

This map shows land use for New Zealand in 2008. The major uses are natural forest (khaki), low producing grassland (cream), high producing grassland (pale green) and plantation forests (dark green).

Figure 2 – Land use for New Zealand (2008). Source: Ministry for the Environment.
Environmental

Air temperature

As New Zealand has a maritime temperate climate, the summers are cool and the winters are mild compared to other locations at similar latitudes. Average daytime maximum summer temperatures range from around 24 °C at the northern tip of the North Island to 19 °C in the lower part of the South Island. In winter, the north averages 8 °C and the south around 1 °C.

![Map showing average temperatures](image)

This map shows average maximum daily temperatures in New Zealand for mid-summer (left) and mid-winter (right).

Figure 3 – Average maximum daily temperatures. Source: National Institute of Water and Atmospheric Research.

Mean maximum and minimum temperatures for the New Zealand SKA site

Table 1 illustrates the maximum air temperatures at the proposed location of the New Zealand array-station, (measured at the nearby Awarua space tracking station or Invercargill airport). Note: the temperature does not vary greatly over the course of the year.

Table 1 – Mean maximum and minimum temperature at the New Zealand SKA site.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean maximum</td>
<td>18.3</td>
<td>18.5</td>
<td>17.1</td>
<td>14.8</td>
<td>12.2</td>
<td>10.0</td>
<td>9.6</td>
<td>10.9</td>
<td>12.8</td>
<td>14.2</td>
<td>15.5</td>
<td>17.2</td>
</tr>
<tr>
<td>Mean minimum</td>
<td>10.1</td>
<td>9.9</td>
<td>8.7</td>
<td>6.6</td>
<td>4.7</td>
<td>2.6</td>
<td>1.8</td>
<td>2.6</td>
<td>4.4</td>
<td>6.1</td>
<td>7.4</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Humidity

The average relative humidity of New Zealand over the period 1971-2000 was 73–92 percent. Humidity at the proposed New Zealand SKA site is similar to the national average at 78–88 percent (as measured at 9:00am on three days per month in 2005).
Table 2 – Mean relative humidity at 9:00am at the New Zealand SKA site.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean relative humidity</td>
<td>81.2</td>
<td>83.1</td>
<td>83.7</td>
<td>85.3</td>
<td>86.7</td>
<td>87.5</td>
<td>88.0</td>
<td>85.7</td>
<td>81.4</td>
<td>79.8</td>
<td>78.3</td>
<td>78.8</td>
</tr>
</tbody>
</table>

Rainfall

Average annual rainfall varies across urban centres from 600 mm to 1.5 metres. In the mountain ranges, annual rainfall can exceed 5 metres and in the Southern Alps it can be more than 10 metres. However, areas to the east of the main ranges, including the proposed SKA remote station, have an average rainfall of less than 600 mm a year, being in (on average) the driest part of New Zealand.

Measurements of the mean monthly rainfall (1971–2000) for the region around the proposed site vary from 70–118 mm per month on average. Variations of the highest daily rainfall range from 49–152 mm. The average number or rainy days is 158 per annum.

This map shows average annual rainfall for New Zealand for the years 1971–2000.

Figure 4 – Average annual rainfall for New Zealand from 1971–2000. Source: National Institute of Water & Atmospheric Research.
Mean rainfall data for the New Zealand SKA site

Table 3 – Mean monthly rainfall, highest ever recorded daily rainfall and number of days with rain in Invercargill (1971–2000).

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean monthly rainfall</td>
<td>110.1</td>
<td>77.6</td>
<td>92.3</td>
<td>104.2</td>
<td>118.2</td>
<td>99.5</td>
<td>85.4</td>
<td>70.6</td>
<td>86.3</td>
<td>96.5</td>
<td>86.1</td>
<td>96.6</td>
</tr>
<tr>
<td>Highest daily rainfall</td>
<td>152.3</td>
<td>63.4</td>
<td>66.1</td>
<td>66.6</td>
<td>49.5</td>
<td>67.2</td>
<td>43.0</td>
<td>60.0</td>
<td>73.6</td>
<td>56.5</td>
<td>52.5</td>
<td>62.3</td>
</tr>
<tr>
<td>Mean days with rain</td>
<td>13</td>
<td>10</td>
<td>12</td>
<td>13</td>
<td>16</td>
<td>151</td>
<td>14</td>
<td>13</td>
<td>12</td>
<td>14</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

Occurrence of ice, hail and pooling of water

The southern parts of New Zealand see hail, frost and snow concentrated on the alpine regions. As with rainfall, moving east of the mountains reduces the frequency of frost, hail and snow. The region around the proposed SKA array-station experiences very little snow (4 days per year) and what falls is very light – accumulations over 5 cm being uncommon and the maximum reliably measured fall was only 8 cm). Hail is also relatively uncommon, at an average of 25 days per year. Frost is the most prevalent form of frozen water and occurs on about 70 days per year, mostly in winter. However, even on the days when frost occurs in mid-winter it quickly dissipates and is often completely gone by mid-morning so does not present any construction or operational issues.

Table 4 – Mean monthly days with hail, frost and snow at the New Zealand SKA site.

<table>
<thead>
<tr>
<th>Hail, frost and snow</th>
<th>All years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean days with hail</td>
<td>1.1</td>
</tr>
<tr>
<td>Mean days with frost</td>
<td>0.8</td>
</tr>
<tr>
<td>Mean days with snow</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Cloud cover

New Zealand experiences a substantial number of cloud free days. Average annual hours of sunshine can exceed 2200 in the northern parts of each island. Even in the southern parts, there are on average 1600 hours of sunshine annually. Correlated to the sunshine hours, 25–40 percent of the days are cloud free.

Cloud cover for the New Zealand SKA site

The region of the SKA site in New Zealand has 25 percent cloud free days and over 1600 hours of sunshine annually. Measurements of the monthly cloud cover in the region show an average of 5.6 oktas at 9:00am for the SKA site.

Table 5 – Mean cloud cover at 9:00am at the New Zealand site.

<table>
<thead>
<tr>
<th>Cloud cover – NZ site</th>
<th>All years (oktas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean cloud cover</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Wind information

While some coastal areas of New Zealand are known for high wind speeds, the vast majority of the country only experiences average annual wind speeds of 5–15 km/h.

The region around Invercargill (60 km from the site) experiences an average of 210 days per year with wind gusts up to 44 km/h, which is classified as a strong breeze on the Beaufort scale. Invercargill also has up to 27 days per year with gale force winds. However the measured average monthly wind speed for the SKA array-station, which is further to the east, has only been 4–6 km/h across the year and the maximum wind gusts are 10–13 km/h.

Wind data for the NZ SKA site

Table 6 – Mean monthly wind speed and direction measured near the New Zealand site, with maximum recorded wind gusts.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>All years (km/h or degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td>Mean wind speed</td>
<td>5.8</td>
</tr>
<tr>
<td>Maximum gust recorded</td>
<td>11.2</td>
</tr>
<tr>
<td>Direction of maximum recorded gust</td>
<td>260</td>
</tr>
</tbody>
</table>
This map shows average annual wind speeds for New Zealand.

Figure 6 – Average annual wind speeds for New Zealand. Source National Institute of Water and Atmospheric Research.

Table 7 – Average number of days with strong breezes (up to 44 km/h) and gale force winds at Invercargill, 60 km west of the site.

<table>
<thead>
<tr>
<th>Days of strong and gale force winds – Invercargill</th>
<th>All years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean days with strong breezes</td>
<td>19.2</td>
</tr>
<tr>
<td>Mean days with gale force wind</td>
<td>2.4</td>
</tr>
</tbody>
</table>

**Solar radiation, daily solar exposure information per month**

New Zealand has many hours of sunshine: an annual average of 12–15 MJ/m² across the country for 1971–2000. January has the most sunshine (18–23 MJ/m²/day), June has the least (4–7 MJ/m²/day).
This map shows average daily solar radiation for New Zealand.

**Figure 7 – Average daily solar radiation for New Zealand. Source National Institute of Water and Atmospheric Research.**

**Solar radiation for the New Zealand SKA site**

The New Zealand SKA site on the South Island experiences a moderate amount of solar radiation: 3.2–21.4 MJ/m²/day. The total annual hours of sunshine is in excess of 1600 a quarter of days are cloud free days (see Figure 5).

**Table 8 – Mean daily solar radiation at the New Zealand SKA site.**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean daily solar radiation</td>
<td>20.6</td>
<td>17.2</td>
<td>12.2</td>
<td>7.6</td>
<td>4.5</td>
<td>3.2</td>
<td>4.2</td>
<td>6.4</td>
<td>11</td>
<td>15.3</td>
<td>18.8</td>
<td>21.4</td>
</tr>
</tbody>
</table>

**Animals, insects and birds from which protection is required**

New Zealand has no flora or fauna which require any particular measures to be taken.
Identify any restrictions due to indigenous use, ownership, or customs, or due to any legislated protection of flora or fauna

All claims for redress by the indigenous peoples for the southern part of the South Island of New Zealand covering the area of the proposed SKA site were resolved with the Ngai Tahu Deed of Settlement in July 1998. The settlement provides full, final and enduring settlement for Ngai Tahu claims, including land claims. The settlement was endorsed by the New Zealand parliament through the *Ngai Tahu Claims Settlement Act 1998*.

Wildfires

Due to the mild temperatures and high relative humidity, wildfires are not a significant issue in New Zealand.

Seismic stability

New Zealand is a landmass formed at the interface of the Pacific and Australian tectonic plates. There are regions of seismic activity along the plate interface, which runs from the southwest to the northeast of the country. Regions in the northwest and southeast (including the proposed SKA site) are unlikely to experience much activity. Maps of both shallow and deep earthquake data for the last decade show only one minor event in the area and there are no known active faults within the vicinity.

Peak Ground Accelerations (PGA) of 0.1–0.3 g can be expected from all earthquake sources with 10 percent probability in 50 years (~475-year return period). In Invercargill (60 km to the west), a 475-year return period earthquake is expected to have a felt intensity of MMVII (Modified Mercalli intensity VII). An Alpine Fault event in the next 50 years is likely to produce lower intensity ground shaking (MMVI), but it has a higher probability (35 percent).

The proposed SKA site is one of the places in New Zealand least likely to experience seismic activity or suffer damage should an event occur, due to its distance from the Alpine Fault and immunity to liquefaction. In addition, the two
volcanoes in the area have been extinct for 1–2 million years, making the possibility of an eruption posing a hazard to the site extremely remote.

Severe weather events

Thunderstorms and lightning

Average annual lightning ground flash density is 0.17 strikes/km² across the entire country, with an annual average of 9–11 days with thunder and lightning in the region of the proposed SKA array-station.

Table 9 – Average number of days per month with thunder and lightning.

<table>
<thead>
<tr>
<th>Days of thunder &amp; lightning</th>
<th>All years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>Jan</td>
</tr>
<tr>
<td>Mean days with thunder</td>
<td>0.9</td>
</tr>
<tr>
<td>Mean days with lightning</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Strong winds (>50 km/h) and tornado or cyclone occurrence

The frequency of vigorous depressions passing over seas south of New Zealand means that situations capable of producing strong winds occur many times each year. There is a high probability that winds with 10 minute mean wind speeds of 48–55 kts will occur near the proposed SKA site in the next 50 years. There is some risk that wind speeds could reach violent storm force (56–63 kts). Brief gusts exceeding 150 km/h (80kts) will probably occur in the region of Invercargill during the strongest wind storms (highest recorded data to date at Invercargill, 142 km/h in May 1994), though the likelihood of such extreme wind speeds decreases towards the SKA site. The recorded mean wind speed in the area is only 6 km/h and the peak measured wind is only 13 km/h.

Flooding, flash flood occurrence

As there are no major rivers in the area, and the site is largely surrounded by 200 m peaks, isolating it from even small creeks, the possibility of flooding is remote.

Dust storms

Dust storms in New Zealand are extremely rare, as is the likelihood of dust crossing the Tasman – estimated to be a once in 70 year event.
Australian and New Zealand Treasury economic forecasts

**Table 1 – Australian Treasury key macroeconomic forecast.**

<table>
<thead>
<tr>
<th></th>
<th>Forecasts</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>2.25</td>
<td>4</td>
</tr>
<tr>
<td>Employment</td>
<td>2.75</td>
<td>1.75</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>5</td>
<td>4.75</td>
</tr>
<tr>
<td>Consumer price index</td>
<td>3.25</td>
<td>2.75</td>
</tr>
</tbody>
</table>

(a) Real GDP is year average growth. Employment and consumer price index are through the year growth to the June quarter. The unemployment rate is the rate in the June quarter. Source: Treasury Budget Paper No. 1, 2011–12.

**Table 2 – Australian Treasury budget forecasts.**

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Estimates</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlying cash balance ($b)</td>
<td>–54.8</td>
<td>–49.4</td>
<td>–22.6</td>
</tr>
<tr>
<td>Per cent of GDP</td>
<td>–4.3</td>
<td>–3.6</td>
<td>–1.5</td>
</tr>
<tr>
<td>Fiscal balance ($b)</td>
<td>–52.9</td>
<td>–45.7</td>
<td>–20.3</td>
</tr>
<tr>
<td>Per cent of GDP</td>
<td>–4.1</td>
<td>–3.3</td>
<td>–1.4</td>
</tr>
</tbody>
</table>


**Table 3 – New Zealand Treasury budget forecasts.**

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Forecasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Employment</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>6.8</td>
<td>5.7</td>
</tr>
<tr>
<td>Consumer Price Index</td>
<td>4.5</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Attachment 14
Free trade agreements

Australia

Free trade agreements (FTA)

Free trade agreements under negotiation

New Zealand

Free trade agreements
Australia, China, Thailand, Singapore, Brunei, Burma, Malaysia, the Philippines, Viet Nam, Lao, Cambodia, Indonesia, Bahrain, Oman, Kuwait, Saudi Arabia, the United Arab Emirates and Qatar.

Free trade agreements under negotiation
United States, India, Russia, Belarus, Kazakhstan and South Korea.

Overview of Australian taxation laws

In Australia, taxes are imposed by the Commonwealth as well as by the States and Territories. Significant taxes and other duties and charges imposed by the Commonwealth include income tax (for individuals and for companies), capital gains tax (CGT), goods and services tax (GST), withholding tax, fringe benefits tax, excise duties and customs duties. The States and Territories impose a range of taxes, including payroll taxes, stamp duties and land tax. Local governments also levy rates on property within the local government area.

Whether the SKA Organisation and its employees are subject to some of these taxes would depend on the particular circumstances. Because of the Commonwealth’s involvement in the organisation and because of its scientific, educational and charitable purposes, various options can be pursued for reducing the tax to which the Organisation may be liable.

Income tax

Individuals and companies are subject to income tax.

Australian residents pay, as a general rule, tax on their Australian source income and any foreign income. Companies and individuals who are non-residents for tax purposes are generally subject to tax on their Australian source income. Deductions are generally permitted for losses and outgoings incurred in gaining or producing assessable income. Tax is levied progressively, up to a highest marginal tax rate of 45 percent (applying to amounts earned over $180,000). There is currently a tax-free threshold of $6,000 for individuals who are Australian residents. However there is no tax-free threshold for companies and for non-resident individuals. A Medicare levy also generally applies to resident taxpayers with an exemption for low income earners, at a rate of 1.5 percent of income. Australian residents are generally able to access a heavily subsidised health system including access to pharmaceuticals. The Medicare levy does not apply to non-residents.

Company income tax (for resident and non-resident companies) is levied at a rate of 30 percent.

Australia’s income tax regime features a CGT on any capital gains made as a result of a number of specified ‘capital gains tax events’ in relation to assets acquired. The most common CGT event is the disposal of an asset. There are a range of concessions and exemptions from CGT under the income tax laws, and non-residents are only required to pay income tax on capital gains in limited circumstances.

Entities may be exempt from income tax if they are scientific, charitable or public educational institutions. The SKA Organisation would be able to pursue designation as one of these entities. Depending on how it is constituted, the SKA Organisation may also be able to pursue exemption from income tax as a ‘public authority’. Australian taxation law allows a generous range of deductions in relation to expenses incurred by employees in earning their income. Items commonly claimed as deductions include: tools of trade, equipment, technical and trade books, travel, self-education and home office costs.

GST

GST is a ‘value added tax’ on most goods and services consumed in Australia, including goods imported into Australia. It applies at a uniform rate of 10 percent to the supply or importation of taxable goods and services. There are a range of exemptions from GST for certain categories of goods and services (including some health supplies, education, and basic food).

GST is levied on businesses at all stages of the production process, and businesses can generally claim a credit for GST they pay on business inputs. That is, businesses include GST in the price of sales to their customers, and claim credits for the GST included in the price of their business purchases.

A business must register for GST if its GST turnover is greater than the ‘GST turnover threshold’ (currently $75,000 per annum or $150,000 per annum for non-profit organisations). A business with a lower turnover can decide whether or not
to register for GST. Businesses that are registered for GST must complete a regular business activity statement in order to report and pay GST on their sales, and claim GST credits for GST included in the price of business purchases.

Withholding tax

Final withholding taxes are also levied on interest, royalties and certain distributions to non-residents from Australian managed investment trusts. These taxes are generally levied on distributions at a flat rate that varies depending on the type of income and whether a tax treaty applies (the amount of tax is generally reduced where a tax treaty applies). Income which is subject to a final withholding tax is excluded from assessable income for the purposes of Australian income tax.

Fringe benefits tax

Australia separately levies a fringe benefits tax. This is a tax on most non-cash benefits provided to employees by an employer in respect of the employee's employment. Fringe benefits tax is levied on employers at the top personal income rate plus the Medicare levy (currently 46.5 percent).

A range of fringe benefits are exempt from fringe benefits tax including minor benefits (which are currently defined as benefits less than $300), certain membership fees and subscriptions, certain work-related items, and certain taxi travel to or from the workplace. In some cases, benefits provided by charitable organisations are exempt from income tax.

Excise duties

Excise duty is payable on certain types of goods produced or manufactured in Australia (including alcohol, tobacco and fuels and oils). Based on the information we currently have, it is unlikely that the SKA Organisation would be liable to pay any duties of excise.

Payroll tax

Each of the States and Territories have laws imposing a payroll tax on employers that have total payments for employee wages and salaries exceeding specified tax-free thresholds (which vary between the States and Territories). In Western Australia, the tax-free threshold is $750,000 per financial year and $62,500 per month. In Western Australia, it is paid at a rate of 5.5 percent on taxable wages. Some wages are exempt, including those paid by approved charitable organisations.

Stamp duties

Each State and Territory levies stamp duties on the transfer of some kinds of property, including land and motor vehicle licences. The duty is usually paid by the purchaser based on the sale price of the property (or its market value if higher). The rate of stamp duty varies depending on the kind of transaction to which the duty applies. As an example, the sale of land in Western Australia attracts a marginal stamp duty of between 2 and 5.4 percent.

Land tax

Land tax is levied by most of the States and Territories. Land tax is payable by the owner of land based on the land’s taxable value. In Western Australia, land tax is payable on the unimproved value of land above the tax-free threshold of $300,000 at progressive marginal rates of between 0.09 and 2.16 percent. Exemptions apply where the owner of land is a charitable, educational or not-for-profit institution.

Local government rates

Local government levies rates on rateable land within the local government area. Rates vary between areas.
Overview of Australian and New Zealand legal systems

Australia

Australia's federal system of government defines exclusive powers for the federal government to make laws on matters such as trade and commerce, taxation, defence, external affairs, and immigration and citizenship and concurrent powers where both tiers of government are able to enact laws. The states and territories have independent legislative power in all matters not specifically assigned to the federal government. Where there is any inconsistency between federal and state or territory laws, federal laws prevail. Federal laws apply to the whole of Australia.

The High Court of Australia interprets and applies the law of Australia, decides cases of special federal significance, including challenges to the constitutional validity of laws, and hears appeals (by special leave) from the federal, state and territory courts. The other federal courts are the Federal Court of Australia, the Family Court of Australia and the Federal Magistrates Court of Australia. Under the Constitution, state and territory courts may be invested with federal jurisdiction. Australian state and territory courts have jurisdiction in all matters brought under state or territory laws.

New Zealand

New Zealand is a unitary state, in which central government has created administrative regions (16 regional councils and 73 local councils) referred to as local government. Central government develops national legislation and policy, and delivers national services (e.g. police, fire fighting, education, defence, border control), while some government departments also have regulatory, advisory or monitoring roles. Regional councils manage resource use, flood control and transportation, with some also managing port and recreational infrastructure. Local councils regulate land use, construction and public health, provide and maintain infrastructure (such as roads, water supply and wastewater disposal) and provide civil defence services.

New Zealand has four level hierarchy of courts, comprising the Supreme Court, Court of Appeal, High Court and District Courts (which including the Environment Court, Maori Land Court, Employment Court, Youth Court and Marital Appeal Court). Appeals against the decision of tribunals, arbitration authorities etc. are first heard in the District Court.

International law dispute resolution mechanisms

Australia and New Zealand have acceded to the Convention of 15 November 1965 on the Service Abroad of Judicial and Extrajudicial Documents in Civil or Commercial Matters. 63 other countries have acceded to this Convention which enables the service of both judicial and extra judicial documents to occur in accordance with the Convention’s recognised and simplified practice;

Australia and New Zealand have acceded to the Convention of 18 March 1970 on the Taking of Evidence Abroad in Civil or Commercial Matters, the 1958 Convention on the Recognition and Enforcement of Foreign Arbitral Awards – the ‘New York’ Convention. In addition, Australia has enacted legislation implementing the UNCITRAL Model Law on International Commercial Arbitration.

Australia has also entered into reciprocal arrangements with other countries, including New Zealand, to allow for simplified recognition and enforcement of foreign and Australian judgments.

Non-court dispute resolutions mechanisms in Australia

Commonwealth, State and Territory law recognises and facilitates alternative dispute resolution (ADR) procedures. The Commonwealth government has established the National Alternative Dispute Resolution Advisory Council (NADRAC) as an independent body to advise the government on the development of ADR. In April 2011, NADRAC prepared a set of National Principles for Resolving Disputes and a Dispute Resolution Guide to encourage consistent ADR usage in Australia and support best practice. The Attorneys-General of the Commonwealth and States and Territories have agreed to implement uniform national commercial arbitration legislation.
ADR procedures available in Australia include facilitative procedures (such as negotiation and mediation), advisory procedures (such as neutral evaluation and some forms of conciliation), determinative procedures (such as arbitration) and combinations of these. Involvement in alternative dispute resolution can come about in many ways. Parties to a dispute may voluntarily agree to engage in ADR in many ways. Parties may voluntarily commit to ADR after the dispute has arisen. Parties may have agreed, under a contract, to attempt ADR before litigating in Court. In addition, Courts ordinarily have the power to direct the parties to a dispute to attempt ADR before continuing in Court. In the Federal Court, parties must consider options for ADR as soon as reasonably practicable, and Court must help implement those options.

In addition to these ADR procedures, there are also a range of administrative tribunals, which have some similarities to courts in terms of their procedure, but which operate relatively informally. At the Commonwealth level, the Administrative Appeals Tribunal, a non-judicial body, has jurisdiction to review administrative decisions by many Australian government bodies and some non-government bodies.
Overview of intellectual property law in Australia

Patents

Patents are protected by the Patents Act 1990. The Act provides for the granting of a patent in respect of an invention which is new, inventive and useful. Subject to the terms of the Patents Act, a patent will give the patentee the exclusive rights to exploit their invention in Australia and to authorise one or more other persons to exploit their invention during the term of the patent.

There are two types of patents available under the Patents Act:

- A standard patent, which provides long-term protection and control over an invention for up to 20 years, and
- An innovation patent, which provides protection and control for eight years.

If a person makes an application for a patent, certain details of the application will be advertised in the Australian Official Journal of Patents. The application for a patent and accompanying specification describing the relevant invention will be assessed by the Commissioner of Patents. If an application is accepted it will be registered on the Register of Patents, which is maintained by IP Australia. Interested parties have an opportunity to oppose the granting of a patent. The patentee will need to pay certain registration fees and renewal fees which are payable under the Act.

Australia is a signatory to the Paris Convention for the Protection of Industrial Property (Paris Convention) and the Patent Cooperation Treaty (PCT). The PCT provides an administrative process whereby a single international patent application is recognised by the national patent offices of each of the PCT signatory countries. A search report and a preliminary examination opinion are prepared for every PCT application.

Copyright

The Copyright Act 1968 protects copyright in original 'works' (literary, dramatic, musical and artistic works) and other subject matter (sound recordings, cinematograph films, television broadcasts and sound broadcasts and published editions of works). The protection of 'literary' works is not limited to literature; it extends to works of written or printed matter. As an example, scientific papers may have copyright protection as 'literary' works.

The Copyright Act protects copyright in works or other subject matter where there is a relevant connection with Australia. For example, copyright will subsist in an original work if the first publication of a work took place in Australia, the author of the work was an Australian citizen or a resident of Australia at the time when the work was first published, or if the author died before the work was first published but was an Australian citizen or a resident of Australia immediately before he or she died. In accordance with international agreements on copyright, Australia also gives effect to the principle of national treatment by providing copyright protection to works and other subject matter first published in convention countries or made by nationals or residents of such counties.

Under the Copyright Act, the copyright owner has certain exclusive rights in relation to original works and other protected subject matter. These exclusive rights vary according to the nature of the material but may include the rights to reproduce, publish, and communicate the work to the public. Subject to the operation of any relevant defences, a third party will infringe copyright where he or she, without the licence of the copyright owner, does in Australia or authorises the doing in Australia of any act comprised in the copyright.

There is no requirement of registration before a work or other subject matter is eligible for registration. There is also no voluntary system for registering copyright.
Trade secrets and confidential information

The common law protects trade secrets and confidential information. The law protects information which is private in nature in the sense of not being common knowledge. To be classified as a confidential trade secret, the information must be of commercial value to the confider. If properly classified as a trade secret, the information is exempt from freedom of information laws (which may otherwise compel disclosure of government-held information). Common law remedies to protect trade secrets and confidential information include injunctions (to restrain disclosure) and damages or an account of profits (after unlawful disclosure).
Attachment 18
Referral of a Proposal to the Environmental Protection Authority under Section 38(1) of the Environmental Protection Act.
Referral by the Proponent

PURPOSE OF THIS FORM

Section 38(1) of the Environmental Protection Act 1986 provides that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the Act.

A referral to the EPA by a proponent under Section 38(1) must be made on this form.

Before completing this form, proponents are encouraged to familiarise themselves with the EPA's General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986 (accessed at the EPA's website at www.epa.wa.gov.au or by contacting the EPA on 6467 5419).

Proponents need to complete Parts A and B of the form by marking the appropriate boxes and providing explanatory or additional information where requested. Part B should be completed based on information known to the proponent. Only those sections of Part B that are pertinent to the proposal need to be completed. If space is insufficient, attach additional pages. Where information is contained in a report that is to be submitted with the referral form, the proponent may complete sections of the form by referring to the pertinent section of the report.

Proponents are encouraged to attach any other environmental information they consider may be relevant to the EPA for making a decision on whether or not to assess the proposal, and, if it is to be assessed, the level of assessment. In general, referrals should contain information on the potential environmental impacts of the proposal, the proposed management mechanisms to be implemented to minimise and mitigate for these impacts, and how the principles of the EP Act have been addressed by the proposal.

In addition to providing a hard copy of referral documentation, proponents are also requested to provide an electronic copy of the referral document, noting that section 39(2) of the EP Act provides for a proponent to request that matters of a confidential nature not be kept on the public record. If confidential matters are included in the referral, proponents are requested to identify the confidential information at this stage of the process, specifically request that it be treated as confidential, and submit the confidential information in a separate hard copy attachment to the referral document. The electronic copy of the referral should be identical to the hard copy of the referral document, excluding any confidential attachment.

You may need to contact government agencies or local authorities to obtain information required by this form. A list of key agencies and their contact details is provided in Attachment 1.

Where the EPA decides that a proposal will be assessed at the level of Public Environmental Review or Environmental Review and Management Programme, it will also require the proponent to prepare an Environmental Scoping Document (refer Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002).

Proponents should also be aware of the need to determine their obligations under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act is separate legislation to the Environmental Protection Act and it identifies a number of matters of national environmental significance which are subject to assessment and approval by the Commonwealth. The matters identified as triggers for the Commonwealth assessment and approval regime are World Heritage properties, Ramsar wetlands, nationally threatened species and ecological communities, migratory species, Commonwealth marine areas, and nuclear actions (refer to the Department of Environment and Water Resources website at www.environment.gov.au). Questions in this referral form that may be relevant to matters of national environmental significance are marked with a #.
PART A - PROPOSED AND PROPOSAL INFORMATION

1. PROPOSAL DETAILS, PROPOSAL DESCRIPTION AND LOCATION

1.1 Proponent information

☐ Proposal title
Australian Square Kilometre Array Pathfinder (ASKAP) Telescope

☐ Name of the Shire in which the proposal is located
Murchison

☐ Name of proponent (Person or entity proposing to implement the proposal)
CSIRO Australia Telescope National Facility

☐ Names of Joint Venture entities (if applicable)
N/A

☐ Address of proponent
PO Box 76, Epping, NSW 1710, Australia

☐ Key contact for the proposal
(Name address and phone/facsimile number and email address. The contact may be a consultant, if one is being used)
Dr David DeBoer
CSIRO Australia Telescope National Facility
PO Box 76, Epping, NSW 1710, Australia
Phone: (02) 9372 4449
Facsimile: (02) 9372 4310
Email: David.DeBoer@csiro.au

☐ Does the proponent own the land on which the proposal is to be established? If not, what other arrangements have been established to access the land?
The Murchison Radio-astronomy Observatory (MRO) site is currently part of the Boolardy Station pastoral lease. The Boolardy Station pastoral lease (3114-406) has been purchased by CSIRO. The vast majority of the lease will be sub-leased back to the former lease-holders to continue pastoral activity. A designated portion of the property (the MRO) will be excised from the pastoral lease, held as WA Government Crown Land and leased back to CSIRO to be developed for construction and operation of ASKAP. The purchase, and the sublease back to the former owners to continue pastoral activity, has been approved by the WA Pastoral Lands Board. The sublease includes appropriate conditions to protect the radio-quietness of the MRO site.

At the time of construction of ASKAP, the MRO will be WA Government crown land leased to CSIRO for the purposes of radio astronomy activities, for a lease period of 30 years, extendable for a further 20 years. An Indigenous Land Use Agreement with the native title claimants has been negotiated. Substantive agreement has been reached with all parties on the land transactions detailed above, and transaction finalisation is near complete.

☐ Is rezoning of any land required before the proposal can be implemented? (please tick) □ Yes □ No  
If yes, please provide details.

☑ No
Is approval required from any Commonwealth or State Government agency or Local Authority for any part of the proposal?

☑ Yes ☐ No If yes, name all Agencies and Local Authorities from which any approval is required.

- Department of the Environment, Water, Heritage and the Arts (DEWHA)
- Western Australian Environmental Protection Authority
- Western Australian Department of Environment and Conservation
- Parliamentary Standing Committee on Public Works

If yes above, have you lodged any of the necessary applications or have you discussed the proposal with any person(s) at the Agency or Local Authority?

☑ Yes ☐ No If yes, name all Agencies and Local Authorities for which applications have been submitted or with whom the proposal has been discussed.

A referral under the Environment Protection and Biodiversity Conservation Act 1999 has been submitted to the Commonwealth Department of the Environment, Water, Heritage and the Arts. The Department has deemed and approved the project as a non-controlled action (particular manner).

The proposal has been discussed at public meetings held at Murchison Shire Council.

What is the current land use on the property, and the extent (area in hectares) of the property?

Boolardy station (the property) is a 346,748 hectare pastoral property and the station homestead is currently occupied. A 12,674 hectare area (3.7%) will be assigned to the radio-astronomy observatory. The property will continue to be run as a pastoral property.

1.2 Proposal Description (Please attach extra pages where necessary)

Provide a description of the proposal.

A comprehensive project description is provided in Attachment A: "Statement of Evidence to the Parliamentary Standing Committee on Public Works: Proposed Australian SKA Pathfinder (ASKAP) Radio Telescope", June 2008. A summary of the project is as follows.

The Australian Square Kilometre Array Pathfinder (ASKAP) project is a response by the Australian Government and Western Australian State Government (facilitated through the CSIRO) to establish one of the world’s largest radio telescope, intended for international research. The ASKAP telescope will facilitate ground breaking scientific programs. The ASKAP telescope will deliver world-leading performance in a wide range of applications including pulsar astronomy, the study of transient radio sources, cosmology, and the structure and magnetic field of our own galaxy. Access to the telescope will be available to the international community on the basis of scientific merit, similar to current practice on Australia’s existing radio-astronomy national facilities.

ASKAP will be operated as part of the suite of radio telescopes managed as national facilities by CSIRO’s Australia Telescope National Facility (including the Parkes radio telescope, the Mopra radio telescope and the Australia Telescope Compact Array). ASKAP will add new and unique capability to the Australian radio astronomy infrastructure and represents a re-investment in radio astronomy infrastructure in Australia.

The ASKAP project will provide a test and demonstration for Australia’s bid to host the international Square Kilometre Array (SKA) project. However the SKA, should it occur, does not form part of this project or referral.

The proposal involves construction of the radio telescope itself as well as support facilities. Components of the proposed action are summarised below, and described in detail thereafter:

- Construction of the radio telescope, known as the Australian Square Kilometre Array Pathfinder (ASKAP), composed of up to 36 antennas distributed over the site (refer Figures 2, 4 and 5 in Attachment B and Figures 6 and 7 of Attachment A for general configuration).
- Construction of a control compound for control and maintenance of ASKAP, including infrastructure for operations, equipment storage, and site services.
Remote power supply, utilizing renewable energy sources, sited within the MRO adjacent to the control compound.

Temporary construction compounds at the MRO site for accommodation for construction workers.

Maintenance of existing roads on Boolardy Station for access to the ASKAP site.

Access corridors to allow access to the antenna sites (Figures 4 and 5 in Attachment B). The indicative width of the access corridors will be 4 metres.

Upgrades to existing structures and power supply at Boolardy Homestead, located 40 kilometres south of the antenna array site, to provide facilities and accommodation for technical and maintenance staff. The upgrades will also allow after-hours monitoring of the equipment at the MRO.

Murchison Radio-astronomy Observatory: the Australian SKA Pathfinder Telescope

The location of the MRO is presented in Figures 1, 2 and 3 of Attachment A.

An array of up to 36 parabolic dish antennas, each of 12 metres diameter, will be arranged across part of the MRO (refer Figure 5 of Attachment A). Individual antennas will be supported on concrete foundations (refer Figures 5, 6 and 7 in Attachment A), with each antenna sweeping out a diameter of 19 metres. Each antenna will be provided with lightning protection in the form of a buried earth mat.

The area of clearing/disturbance required for each antenna is a 25 metre diameter circle (490 square metres). There will be erosion mitigation measures surrounding each antenna as needed. Each antenna may be fenced in order to keep animals away, but stock may still be run throughout the array.

Whilst the locations for the 36 antennas have been identified, the actual surveyed positions will consider detailed site information such as foundation conditions, sensitivity of both flora and fauna and cultural heritage issues, and the locations may as a result be moved within a 100 m buffer (see Figures 4 and 5 of Attachment B).

Buried fibre optic cable will connect each antenna with the control compound. Power for the antennas will be supplied from an on-site power generation facility and will be delivered to each antenna in the same trench as the fibre optic cable. Access corridors for both assembly and maintenance of the antennas will be included in the design, with an indicative width of 4 metres. It is expected that the power and data cabling will run within these access corridors (refer Figure 5 of Attachment A and Figures 4 and 5 of Attachment B).

The telescope will be operated remotely, either from Geraldton, Perth or Sydney, although during the first three years of operation it may be operated locally from the MRO site in order to test and refine its functions.

Control compound

The control compound (refer Figure 5 and 8 of Attachment A) will function for local operation and maintenance of the ASKAP telescope. Features of the compound include:

- a fenced compound of approximately 6.25 hectares (250 metres by 250 metres).
- a main building within the fenced area of approximately 635 square metres. The building will be Radio Frequency Interference shielded and airconditioned. The building will contain:
  - the ‘correlator’, a type of ‘super computer’ which interprets and combines raw astronomical signals from each antenna
  - data and power terminations
  - office, electronics test and maintenance, workshop and kitchenette space and a first aid room. This space will be able to accommodate two to five staff up to four days per week, and up to 10 visiting staff on a short-term basis during working hours only (refer Figures 9 and 10 of Attachment A).
- hardstand area for vehicle manoeuvring and parking
- area for shipping containers and storage
- “carport” type facility for heavy equipment storage and maintenance
- on-site sewage treatment (e.g. EnviroSure or a similar packaged treatment plant) with an assumed 20 person peak load
- a new bore water supply with water quality treatment if required. (water will be sourced from local groundwater bores).
- fire protection, with a firebreak, emergency water supply, fire panel and detection system.

**Power supply adjacent to the control compound**

The base load power requirement for all ASKAP facilities on the MRO is 650 kilowatts. CSIRO is committed to using renewable energy sources, and project timelines dictate the use of existing, mature technologies. The mid-Western Australian location is ideally suited to use solar power. Current ASKAP project plans are for solar photo-voltaic power with diesel supplement and back-up as the power solution. It has been estimated that the solar “farm” would cover an area of 6 hectares, and will be situated adjacent to the control compound. The back-up diesel generator and diesel tank will be situated within this area.

**Access Routes**

Existing roads within Boolardy station will be maintained or improved to be used both during construction and subsequent operation of the ASKAP telescope. These include the track from the Murchison Shire Road to the southern entrance to the MRO (approx. 9km long), and an existing road leading from this entrance in a north westerly direction into the MRO which will be used as a main “trunk” road through the site.

In addition, to gain access to all antenna sites it will be necessary to clear approximately 20 to 25km of access corridors (see Figures 4 and 5 in Attachment B). Light vehicular access for periodic maintenance as per normal pastoral lease management practices will be enabled during ASKAP operation. During rain, access to portions of the site will be restricted to avoid ground surface damage.

**Temporary facilities during construction**

Three temporary construction facilities will be built within the MRO.

1. A fenced compound to house all equipment, materials and offices required for construction of the ASKAP project. Services to this compound will include telephone, internet, water and sanitation.
2. An accommodation block that caters for construction workers (up to 30 workers will be required during construction). Water storage, waste storage and recycling and power generation will be required for the accommodation block.
3. A manned concrete batching plant.

Temporary infrastructure will be pre-built then delivered and assembled on site. It will be in use during ASKAP construction (i.e. for approximately three years), following which the sites will be rehabilitated.

**Upgrades to Boolardy Homestead and surrounding buildings**

To accommodate visiting technical and maintenance staff during operation of the ASKAP telescope, features of the existing Boolardy Homestead will be upgraded. Boolardy Homestead is a group of significant heritage buildings (refer Figures 11, 12 and 13 of Attachment A) used for station operation from the late 1890s onwards. The upgrade will involve work to the F. Wittenoom House, and the adjacent Workers Quarters. The main homestead buildings will remain occupied by the station managers as they continue station operations.

Upgrade works will retain the overall structure and exterior design of the buildings, whilst painting and/or partial cladding of the exterior and renovating the interior as needed. Renovating works may include replacement of roof, gutters, ceilings and floor coverings, installation of new kitchen, servicing and/or replacing windows and doors, refurbishment of bathroom, kitchen and toilet, installation of air conditioning, upgrading the electrical system within the buildings and connecting to a new sustainable power supply. These works have been approved by the Western Australian Heritage Council subject to certain conditions relating to the positioning of the air conditioner and the heritage colour scheme. These conditions will be complied with during the renovation works.

Current power supply to Boolardy homestead includes a small solar array, a wind generator, batteries and a diesel generator. Additional power generation capacity for the visiting staff and their operations will be provided by installation of additional solar photovoltaic cells and an upgrade to the diesel generator.

Additional bore water supply and septic waste water treatment will be provided at Boolardy Homestead. A fire protection system will be installed.
Fibre Optic Cable

A fibre optic cable (OFC), connecting the MRO site to the MRO Support Facility located in Geraldton, will be established. The OFC is approximately 380 kilometres in length and its alignment incorporates road reserves, private property and areas that are predominantly operating pastoral leases. The Department of Environment and Conservation (DEC) has issued a clearing permit for the OFC route (refer to DEC permit CPS 2868/1). The OFC is approved under the *Telecommunications Act 1979* and hence does not form part of this referral.

- What is the proposed ultimate extent (areas in hectares) of the activity?
  
  12,816 hectares (MRO) of which approximately 57 hectares (0.2%) will be developed/cleared (see Section 2.1)

- Provide the timeframe in which the activity or development is proposed to occur. (Include start and finish dates where applicable)
  
  Construction of ASKAP and associated infrastructure is scheduled to commence in late 2009 and be completed by 2012. It is expected that ASKAP will operate for 30 years.

- Provide details of any staging of the proposal.
  
  No staging is included as part of the proposal.

- Indicate whether, and in what way, the proposal is related to other proposals in the region.

  ASKAP will be supported by the MRO Support Facility at Geraldton. The MRO Support Facility will be part of the campus development of Geraldton University Centre, located on a site already cleared of vegetation and currently used as a car park (refer Figures 14, 15, 16 and 17 of Attachment A). The MRO Support Facility will be purpose built and primarily house offices, electronics test and maintenance facilities, data centre and data storage, and an education centre. Additional space will be provided for a kitchenette, first aid room, workshop and other auxiliary rooms. The offices and workspace will accommodate 10-15 full time staff and up to five visiting staff. Security and fire protection systems will be provided. Site services and other access infrastructure will be shared with the University Centre campus.

  ASKAP will be connected to the MRO Support facility by a fibre optic cable (refer Figure 1 in Attachment B. High bandwidth optic-fibre transmission between the MRO and the MRO Support Facility will be provided through underground cable (refer Figure 1). The cable will be located in the road reserve from the Geraldton Universities Centre at Geraldton to the edge of the town, then on private property heading east towards Mullewa. The alignment varies considerably over this section and at times will be in road reserve. From Mullewa it is generally on private property adjacent Mullewa-Carnarvon Rd for approximately 43 kilometres until Greenough River. From this point it is intended to head towards Yuin Station then along the Pindar Rd to Boolardy Station and to the MRO site.

  AARNet (Australia’s Academic and Research Network) Pty Ltd has completed a detailed design study of the fibre optic cable provision between the MRO and Geraldton. The proposed route will primarily follow main roads and highways from Geraldton to Boolardy (refer Figure 1 of Attachment B). The cable will consist of approximately 380 kilometres of conduit and optical fibre cable at a depth of approx 750 millimetres to 1200 millimetres.

  Although this cable is part of the ASKAP project, it will be constructed by AARNet (a licensed telecommunications carrier) as a low impact facility under the *Telecommunications Act 1997* and as such, approval for this element of the project falls under that Act. For informational purposes the fibre optic cable is being submitted in a separate referral under Section 38(1) of the *Environmental Protection Act 1986*.

  The ASKAP radio telescope will be a separate radio telescope operated as one of the suite of radio telescopes managed as national facilities by CSIRO’s Australia Telescope National Facility (including the Parkes radio telescope, the Mopra radio telescope and the Australia Telescope Compact Array). ASKAP will add new and unique capability to the Australian radio astronomy infrastructure and represents a re-investment in radio astronomy infrastructure in Australia. ASKAP will be built and operated in Australia regardless of whether Australia is selected as the site for the international SKA radio telescope.

  The ASKAP project is a stand alone project. The project will be an effective pilot project for the proposed international Square Kilometre Array (SKA) project.

  Successful operation of ASKAP on the MRO will strengthen Australia’s site bid for the SKA through:
• Successful demonstration of radio-quietness of the site through the acquisition of high-quality scientific data
• Successful demonstration of remote operation in the Australian environment
• Successful demonstration of the approvals and joint governmental structures needed to deploy infrastructure and operate a facility on the site

• Successful demonstration of innovative radio astronomy technologies that will facilitate a detailed system design and costing for Phase 1 of the SKA.

In a Memorandum of Understanding on the SKA Project between the Government of Western Australia and the Commonwealth Government the Governments agree to… "Establish and safeguard a radio quiet zone in the Mid West of Western Australia, with appropriate development and other controls for 30 km radius, 70 km radius and up to 260 km radius."

The Mid West Radio Quiet Zone has already been established by the Australian Communications and Media Authority (refer Attachment C), through Spectrum Embargo 41 and Radio communications Assignment and Licensing Instruction MS32, 'Coordination of Apparatus Licensed Services within the Mid West Radio Quiet Zone'.

Although not part of the ASKAP project, ASKAP will however benefit from the Mid West Radio Quiet Zone (ROZ). The ROZ, centred on the MRO, will coordinate and restrict use of devices emitting radio frequencies between 100 megahertz and 25 gigahertz, with graded levels of control for devices within a 30 kilometre, 80 kilometre and 260 kilometre radius from the MRO (refer Figure in Attachment C).

The WA State Government Mining Act Section 19 declaration controls mining activities within a radius of at least 30 kilometres of the core Boolardy site and the WA government has issued a Mineral Resource Management Area notice to control the RFI-emitting activities generated by mining operations within 80 kilometres of the core site.

If SKA does not proceed in Australia, the MRO and the radio-quiet zone will still be maintained for ASKAP and other experiments that may use the site in the future.

1.3 Location information

Provide proposal location details in the following two ways:

a) Electronic spatial data
   GIS or CAD on CD, depicting the proposal extent, geo-referenced and conforming to the following parameters:
   • datum: GDA94
   • projection: Geographic (latitude/longitude) or Map Grid of Australia (MGA)
   • format: Arcview shapefile, Arcinfo coverages, Microstation or AutoCAD.

AND

b) Maps and/or directions

Any maps or diagrams of the proposal, together with the following directions:

• for urban areas: street address, lot number, the suburb and nearest road intersection;

• for remote localities: the nearest town, together with distance and direction from that town to the proposal site.

The project area is a polygon defined by the following co-ordinates:

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<th>Longitude (East)</th>
<th>Zone</th>
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<th>Easting (m)</th>
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</table>

A sequence of maps identifying and locating the components of the project is provided in Figures 1, 2 and 3, in Attachment A.

The MRO site boundaries together with the individual antennae locations is given as an overlay on an aerial photograph of the area, that also shows ephemeral water courses, terrain and land units in Figures 4 and 5 of Attachment B.

A photograph showing typical terrain on Boolardy Station is given as Figure 4 of Attachment A.

**Street address of the sites**

The site is located on Boolardy Station, four kilometres north of the Pindar-Berringarra Road and Manfred Road intersection. Boolardy Station is approximately 60 kilometres west of Murchison town that lies on Mullewa-Carnarvon Road.

*Please also attach the following map/plans, clearly showing the location of the development in its regional and local context.*

- **Locality plan – Broad Scale**
  
  Provide a locality plan (preferably superimposed on an aerial photograph) to identify:
  - proposed development site and any associated infrastructure
  - main roads
  - urban centres
  - wetlands and watercourses
  - remnant native vegetation
  - adjoining land uses (including recreation)
  - sensitive marine areas.

- **Site Plan – Proposal Details**
  
  Provide a site plan to scale and indicate the location of:
  - lot boundaries
  - road frontages
  - extent of the proposed development area
  - extent of the proposed buffer area (if applicable)

- **Site Plan – Existing Environment**
  
  Provide a site plan to scale (the same scale as above) and indicate the location of:
  - lot boundaries
  - road frontages
  - any information required to be shown from Section 2.2 of this form
  - extent of native vegetation of the site (the extent of overlap between the proposed development area and the area of native vegetation must be highlighted)
• extent of hydrological features on the site (this includes wetlands, watercourses, creek lines, seasonal creeks and artificial drainage lines)
• sensitive marine areas
PART B - ENVIRONMENTAL IMPACTS AND MANAGEMENT COMMITMENTS

2. ENVIRONMENTAL IMPACTS

Describe the impacts of the proposal on the following elements of the environment, through the questions below:

(i) flora and vegetation #;
(ii) fauna #;
(iii) rivers, creeks, wetlands and estuaries;
(iv) significant areas and or land features;
(v) coastal zone areas;
(vi) marine areas and biota #;
(vii) water supply and drainage catchments;
(viii) pollution;
(ix) greenhouse gas emissions;
(x) contamination;
(xi) social surroundings; and
(xii) risk.

These features should be shown on the site plan, where appropriate.

For all information, please indicate:

(a) the source of the information; and
(b) the currency of the information.

2.1 Flora and Vegetation

☐ Do you propose to clear any native flora and vegetation as a part of this proposal?

(A proposal to clear native vegetation may require a clearing permit under Part V of the EP Act (Environmental Protection (Clearing of Native Vegetation) Regulations 2004). Please contact the Department of Environment and Conservation (DEC) for more information.

(please tick) ☑ Yes If yes, complete the rest of this section
☐ No If no, go to the next section

☐ How much vegetation are you proposing to clear (in hectares)?

On the MRO the proposed extent of clearing is approximately 57 hectares. This amount is based on a clearing diameter of 25 m for each antenna and a clearing width of 4 m for the access corridors. Clearing for the control compound and temporary work compound would be approximately 37 hectares, although the work compound would be rehabilitated on completion of construction. An indicative clearing figure of 6 hectares has been included for the power supply (including a solar array), although the design has yet to be finalised.

An ecological assessment of the MRO (see Attachment D) identified 11 distinct land units each containing distinct vegetation associations (see Table 1, Page 12 of Attachment D and Figure 5 of Attachment B). Table 1 below shows the extent of potential clearing within each of these land units. The vast majority of the development would occur within land unit 5 (see Table 1). Land unit 5 consists of non-saline stony or gritty plains and is by far the most abundant land unit within the MRO. This land unit contains very scattered to scattered (Percent Foliage Cover 2.5 -15%) mixed height Acacia aneura, A. tetragonophylla, Eremophila platycalyx, E. macmillaniana, other eremophilas, Senna spp. And Pilatus obovatus. The ecological assessment indicated that land unit 5 was suitable for development (see Table 14 of Attachment D).
The final location of the infrastructure of ASKAP would be located within a 100 m buffer of their current proposed locations (see Figures 4 and 5 of Attachment B). This will allow further refinement of the location so as to avoid impacts on native vegetation or areas of environmental sensitivity.

Table 1 - Potential clearing of vegetation within each land unit

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<th>Land units – area of potential clearing (hectares)</th>
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<th>6</th>
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<td>Access corridors</td>
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<td>0.34</td>
<td>0.33</td>
<td>0.13</td>
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Land units – area of potential clearing (hectares)

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<th>4</th>
<th>5</th>
<th>6</th>
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<tr>
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<td>1.56</td>
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<tr>
<td>Area in MRO</td>
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<td>307</td>
<td>922</td>
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<td>3,178</td>
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<td>0.2</td>
<td>0.0</td>
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<td>0.1</td>
<td>0.6</td>
<td>0.0</td>
<td>0.4</td>
</tr>
</tbody>
</table>

* the design of the power supply is still to be finalised.

- Have you submitted an application to clear native vegetation to the DEC (unless you are exempt from such a requirement)?
  - Yes ☑ No □
  - If yes, on what date and to which office was the application submitted of the DEC?
    - 9 June 2009 – Native Vegetation Conservation branch - Bentley

- Are you aware of any recent flora surveys carried out over the area to be disturbed by this proposal?
  - Yes ☑ No □
  - If yes, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey/s. (If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.)

Alexander Holm & Associates (2008). Environmental Assessment: Radio Astronomy Project in Murchison Region of Western Australia involved flora and fauna surveys. This report was prepared for the Department of Industry and Resources and is provided in Attachment D.

- Has a search of DEC records for known occurrences of rare or priority flora or threatened ecological communities been conducted for the site? #
  - Yes ☑ No □
  - If you are proposing to clear native vegetation for any part of your proposal, a search of DEC records of known occurrences of rare or priority flora and threatened ecological communities will be required. Please contact DEC for more information.

Refer Table 6 in Attachment D and Table 1 below.
Are there any known occurrences of rare or priority flora or threatened ecological communities on the site? #

☑ Yes ☐ No If yes, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

Fourteen rare or priority species of plant have been recorded near the project site (Table 2). However only one of these species was recorded during surveys of the site (refer Attachment D). The rest are not expected to occur.

Table 2 Plant species either threatened, rare or listed as a priority for conservation that are known to occur on or near the project site.

<table>
<thead>
<tr>
<th>Threatened, rare and priority plant species</th>
<th>Conservation status</th>
<th>Number of records on or near Boolardy station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angianthus microcephalus</td>
<td>P2</td>
<td>1</td>
</tr>
<tr>
<td>Calytrix verruculosa</td>
<td>P1</td>
<td>3</td>
</tr>
<tr>
<td>Goodenia berringheimii</td>
<td>P4</td>
<td>1</td>
</tr>
<tr>
<td>Goodenia neogoodenia</td>
<td>P4</td>
<td>1</td>
</tr>
<tr>
<td>Grevillea stenostachya</td>
<td>P3</td>
<td>1</td>
</tr>
<tr>
<td>Hemigenia tysonii</td>
<td>P3</td>
<td>4</td>
</tr>
<tr>
<td>Maireana murrayana</td>
<td>P3</td>
<td>2</td>
</tr>
<tr>
<td>Maireana prosthacochea</td>
<td>P3</td>
<td>1</td>
</tr>
<tr>
<td>Micromyrtus placoides</td>
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<td>2</td>
</tr>
<tr>
<td>Neotysonia phyllostegia</td>
<td>P1</td>
<td>1</td>
</tr>
<tr>
<td>Philotheca citrina</td>
<td>P1</td>
<td>3</td>
</tr>
<tr>
<td>Prostanthera tysoniana</td>
<td>P3</td>
<td>1</td>
</tr>
<tr>
<td>Pililotus beardii</td>
<td>P3</td>
<td>1</td>
</tr>
<tr>
<td>Pililotus crosslandii</td>
<td>P3</td>
<td>1</td>
</tr>
<tr>
<td>Verticordia jamiesoni</td>
<td>P3</td>
<td>5</td>
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</tbody>
</table>

**TOTAL number of species** 14


P1 = Priority 1, Poorly known taxa from one or a few populations that are under threat. P2 = Priority 2, Poorly known taxa from one or few populations not all are under threat. P3 = Priority 3, Poorly known taxa from several populations not under threat. P4 = Priority 4, Rare taxa that have been adequately surveyed and are not currently under threat. * = Based on database searches. Further individuals recorded on site.

In late 2007 flora field surveys found ten populations of *Pililotus beardii* across the MRO site, totalling over 20,000 plants (Alexander Holm & Associates 2008 – refer Attachment D). The sole habitat for *Pililotus beardii* was the saline footslopes of breakaways and footslopes of quartz ridges. None of these populations will be affected or compromised by construction and operation of ASKAP, which will avoid these areas and habitats (see Figures 4 and 5 of Attachment B).

☐ If located within the Perth Metropolitan Region, is the proposed development within or adjacent to a listed Bush Forever Site? (You will need to contact the Bush Forever Office, at the Department for Planning and Infrastructure)

☑ Yes ☐ No If yes, please indicate which Bush Forever site is affected (site number and name of site where appropriate).

☐ What is the condition of the vegetation at the site?

Much of Boolardy Station’s 346.748 hectares is either devoid or seriously depleted of native vegetation as a result of grazing. The remaining vegetation is often sparse, consisting of low Mulga woodlands or
shrublands, with occasional grasses. Despite being in a degraded condition due to grazing, no weed species were found on the MRO site during field surveys in 2007. Some vegetation communities on Boolardy are deemed ‘at risk’ from extensive pastoral activity and have a high priority for conservation reservation (Desmond, Cowan and Chant, 2003 in Alexander Holm and Associates 2008 - refer Attachment D).

2.2 Fauna

☐ Do you expect that any fauna or fauna habitat will be impacted by the proposal?

(please tick)  ☑ Yes  If yes, complete the rest of this section

☐ No  If no, go to the next section

☐ Describe the nature and extent of the expected impact.

Direct and indirect impacts of the proposal on the fauna and fauna habitat within the ASKAP sites and surrounding areas may include:

- minor clearing of native vegetation
- death or injury to wildlife through occasional vehicle collision
- minor dust generation
- wildlife disturbance through light, vibration and noise during the construction period.

These impacts have extremely limited potential to change native species abundance and alter predator-prey relationships, herbivore-plant relationships and the genetic viability of populations.

Many of the impacts will be avoided, or where considered necessary, can be appropriately mitigated through the design or construction process. Where the disturbance cannot be avoided, they are unlikely to be ecologically significant.

The project will involve a low level of human presence once construction is completed and ASKAP moves into its operational phase.

The MRO construction will not include large-scale clearing of native vegetation and associated habitats. A total figure for clearing is expected to be approximately 31 hectares (see Table 1 above) or 0.2% of the extent of the MRO. This will not significantly fragment or reduce available habitat (refer Figure 4 of Attachment A for an example photograph of the habitat).

The MRO will not disturb the habitat of significant species, including rare or threatened species. For example, the Western Spiny-tailed Skink, a nationally and state-listed threatened species, inhabits granite outcrops within the MRO along with other regionally significant fauna (refer Attachment D). The outcrops also have a diverse flora. ASKAP antennae and infrastructure will not be built on the granite outcrops and will not therefore disturb significant species.

☐ Are you aware of any recent fauna surveys carried out over the area to be disturbed by this proposal?

☑ Yes  ☐ No  If yes, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey/s. (If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.)
Has a search of DEC records for known occurrences of Specially Protected (Threatened) fauna been conducted for the site?

☑ Yes  ☐ No  (please tick)

Are there any known occurrences of Specially Protected (Threatened) fauna on the site? #

☑ Yes  ☐ No  If yes, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

Specially protected fauna may occur on the project site. Protected fauna may include those threatened and migratory species listed under the Environment Protection and Biodiversity Conservation Act 1999 and rare and priority species listed under the Western Australian Wildlife Conservation Act 1950. Species listed under the Environment Protection and Biodiversity Conservation Act 1999 are predicted to occur in some localities, based on suitable habitat. Those listed under the Wildlife Conservation Act 1950 are based on records of past observations.

Ten specially protected animal species are predicted or known to occur in the vicinity of the MRO (refer Table 3 below). Ecological assessment of Boolardy station and the MRO site suggest that five of these species are likely to occur within the MRO project area.

These are Australian Bustard (Ardeotis australis), Bush Stone Curlew (Burhinus grallarius), Western Spiny-tailed Skink (Egernia stokesii badia), Peregrine Falcon (Falco peregrinus) and Rainbow Bee-eater (Merops ornatus) (Refer Attachment D).

The Western Spiny-tailed Skink was observed in granite outcrops within the MRO during field surveys in October 2007. However as noted above the construction and operation of ASKAP is unlikely to have a significant impact on these species or their habitats.

Table 3 Specially protected animals (threatened, migratory or with priority for conservation) predicted or known to occur within 60 kilometres of the MRO site.

<table>
<thead>
<tr>
<th>Threatened or priority animal species</th>
<th>Conservation status</th>
<th>Prediction or record</th>
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</thead>
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<td></td>
<td>EPBC Act¹</td>
<td>WC Act²</td>
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<tr>
<td><strong>Amphibians</strong></td>
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<tr>
<td>Western Slender-billed Thornbill (Lacan-thiza iridalei)</td>
<td>V</td>
<td>P</td>
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<tr>
<td><strong>Birds</strong></td>
<td></td>
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<tr>
<td>Australian Bustard (Ardeotis australis)</td>
<td>P4</td>
<td>P*</td>
</tr>
<tr>
<td>Bush Stone Curlew (Burhinus grallarius)</td>
<td>P4</td>
<td>P*</td>
</tr>
<tr>
<td>Major Mitchell’s Cockatoo (Cacatua leadbeateri)</td>
<td>S4</td>
<td>O</td>
</tr>
<tr>
<td>Malleefowl (Leipoa ocellata)</td>
<td>V</td>
<td>S1</td>
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<tr>
<td><strong>Migratory Birds</strong></td>
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<tr>
<td>Oriental Plover (Charadrius veredus)</td>
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<td>P</td>
</tr>
<tr>
<td>Peregrine Falcon (Falco peregrinus)</td>
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<td>S4</td>
</tr>
<tr>
<td>Rainbow Bee-eater (Merops ornatus)</td>
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<tr>
<td><strong>Reptiles</strong></td>
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<tr>
<td>Gilled slender bluetongue (Cyclodomorphus branchialis)</td>
<td>S1</td>
<td>O</td>
</tr>
<tr>
<td>Western Spiny-tailed Skink (Egernia stokesii badia)</td>
<td>E</td>
<td>S1</td>
</tr>
<tr>
<td><strong>Total number of species</strong></td>
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</tbody>
</table>

2. Western Australian Wildlife Conservation Act 1950. S1 = Schedule 1, Rare or likely to become extinct
S2 = Schedule 2, Presumed extinct
S3 = Schedule 3, Other specially protected fauna
P1 = Priority 1, Taxa with few, poorly known populations on threatened lands
P2 = Priority 2, Taxa with few, poorly known populations on conservation lands
P3 = Priority 3, Taxa with several, poorly known populations, some on conservation lands
P4 = Priority 4, Taxa in need of monitoring

* = likely to occur based on suitable habitat  **BOLD** = recorded within MRO site during targeted field surveys in 2007.
2.3 Rivers, Creeks, Wetlands and Estuaries

Will the development occur within 200m of a river, creek, wetland or estuary?

☐ Yes  ☑ No  If yes, complete the rest of this section
☐ No  If no, go to the next section

Will the development result in the clearing of vegetation within the 200 m zone?

☐ Yes  ☑ No  If yes, please describe the extent of the expected impact.

Will the development result in the filling or excavation of a river, creek, wetland or estuary?

☐ Yes  ☑ No  If yes, please describe the extent of the expected impact.

Will the development result in the impoundment of a river, creek, wetland or estuary?

☐ Yes  ☑ No  If yes, please describe the extent of the expected impact.

Will the development result in draining to a river, creek, wetland or estuary?

☐ Yes  ☑ No  If yes, please describe the extent of the expected impact.

Are you aware if the proposal will impact on a river, creek, wetland or estuary (or its buffer) within one of the following categories? (please tick)

<table>
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<th>Conservation Category Wetland</th>
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<td>Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004</td>
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</tr>
<tr>
<td>Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998</td>
<td>☐ Yes  ☑ No  ☐ Unsure</td>
</tr>
<tr>
<td>Perth’s Bush Forever site</td>
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</tr>
<tr>
<td>Environmental Protection (Swan &amp; Canning Rivers) Policy 1998</td>
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<tr>
<td>The management area as defined in s4(1) of the Swan River Trust Act 1988</td>
<td>☐ Yes  ☑ No  ☐ Unsure</td>
</tr>
<tr>
<td>Which is subject to an international agreement, because of the importance of the wetland for waterbirds and waterbird habitats (e.g. Ramsar, JAMBA, CAMBA)</td>
<td>☐ Yes  ☑ No  ☐ Unsure</td>
</tr>
</tbody>
</table>
2.4 Significant Areas and/or Land Features

☐ Is the proposed development located within or adjacent to an existing or proposed National Park or Nature Reserve?
   ☐ Yes    ☑ No    If yes, please provide details.

☐ Are you aware of any Environmentally Sensitive Areas (as declared by the Minister under section 51B of the EP Act) that will be impacted by the proposed development?
   ☐ Yes    ☑ No    If yes, please provide details.

☐ Are you aware of any significant natural land features (e.g. caves, ranges etc) that will be impacted by the proposed development?
   ☐ Yes    ☑ No    If yes, please provide details.

2.5 Coastal Zone Areas (Coastal Dunes and Beaches)

☐ Will the development occur within 300m of a coastal area?
   (please tick)    ☐ Yes    If yes, complete the rest of this section
                    ☑ No    If no, go to the next section

☐ What is the expected setback of the development from the high tide level and from the primary dune?

☐ Will the development impact on coastal areas with significant landforms including beach ridge plain, cuspathe headland, coastal dunes or karst?
   ☐ Yes    ☑ No    If yes, please describe the extent of the expected impact.

☐ Is the development likely to impact on mangroves?
   ☐ Yes    ☑ No    If yes, please describe the extent of the expected impact.

2.6 Marine Areas and Biota

☐ Is the development likely to impact on an area of sensitive benthic communities, such as seagrasses, coral reefs or mangroves?
   ☐ Yes    ☑ No    If yes, please describe the extent of the expected impact.

☐ Is the development likely to impact on marine conservation reserves or areas recommended for reservation (as described in A Representative Marine Reserve System for Western Australia, CALM, 1994)?
   ☐ Yes    ☑ No    If yes, please describe the extent of the expected impact.
2.7 Water Supply and Drainage Catchments

Are you in a proclaimed or proposed groundwater or surface water protection area?
(You may need to contact the Department of Water (DoW) for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

- Yes  [ ] No  [x] If yes, please describe what category of area.

The MRO site and the Boolardy homestead are located within the proclaimed Gascoyne groundwater area. No impact on the protection of these areas is anticipated.

Are you in an existing or proposed Underground Water Supply and Pollution Control area?
(You may need to contact the DoW for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

- Yes  [ ] No  [x] If yes, please describe what category of area.

Are you in a Public Drinking Water Supply Area (PDWSA)?
(You may need to contact the DoW for more information or refer to the DoW website. A proposal to clear vegetation within a PDWSA requires approval from DoW.)

- Yes  [ ] No  [x] If yes, please describe what category of area.

Is there sufficient water available for the proposal?
(Please consult with the DoW as to whether approvals are required to source water as you propose. Where necessary, please provide a letter of intent from the DoW)

- Yes  [x] No  [ ] (please tick)

Will the proposal require drainage of the land?

- Yes  [ ] No  [x] If yes, how is the site to be drained and will the drainage be connected to an existing Local Authority or Water Corporation drainage system? Please provide details.

Is there a water requirement for the construction and/ or operation of this proposal?
(please tick)  [ ] Yes  [x] No

If yes, complete the rest of this section
If no, go to the next section
What is the water requirement for the construction and operation of this proposal, in kl/year?

Water required for the proposal will be for consumption and use by construction and technical staff rather than for equipment function or maintenance. For example, water will be required for construction workers in their temporary offices and accommodation on Boolardy as well visiting scientists at their accommodation on Boolardy. It is expected that the water usage will be in the order of 500 kl/year.

What is the proposed source of water for the proposal? (e.g. dam, bore, surface water etc.)

Water for the proposal will be sourced from a mixture of new and existing licensed bores on Boolardy Station for the MRO and residential facility. The proposal will not significantly reduce the quality or availability of either surface or groundwater resources, or change the surface water flows of the site.

2.8 Pollution

Is there likely to be any discharge of pollutants from this development, such as noise, vibration, gaseous emissions, dust, liquid effluent, solid waste or other pollutants?

(please tick)  
☑ Yes  
☐ No

If yes, complete the rest of this section

If no, go to the next section

Is the proposal a prescribed premise, under the Environmental Protection Regulations? (Refer to the EPA General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986 for more information)

☐ Yes  ☑ No

If yes, please describe what category of prescribed premise.

Both power generation and water use are below levels for prescribed premises.

Will the proposal result in gaseous emissions to air?

☑ Yes  ☐ No

If yes, please briefly describe.

Construction of the proposal will involve light and heavy vehicles, which emit gaseous pollutants to the air. In addition, access to the MRO and antenna sites during operation will be by light vehicle.

Power generation at the MRO site will involve some renewable, non-emitting technologies such as new and existing solar photovoltaic systems and existing wind generators. However, diesel generators will be used on the site to supply the remainder of the site's 650KW power needs and peak fill-in.

Have you done any modelling or analysis to demonstrate that air quality standards will be met, including consideration of cumulative impacts from other emission sources?

☐ Yes  ☑ No

If yes, briefly describe.

Will the proposal result in liquid effluent discharge?

☑ Yes  ☐ No

If yes, please briefly describe the nature, concentrations and receiving environment.

The MRO compound will have a septic tank and leach drains installed. Ground conditions of the MRO site appear suitable for septic effluent to be discharged through standard septic tank and leach drains.

Although Boolardy station has an existing septic tank and drain system, an additional system will be installed to accommodate visiting technical staff in the new or refurbished buildings.

If there is likely to be discharges to a watercourse or marine environment, has any analysis been done to demonstrate that the State Water Quality Management Strategy or other appropriate standards will be able to be met?

☐ Yes  ☑ No

If yes, please describe.
Will the proposal produce or result in solid wastes?

Yes ☑ No ☐ If yes, please briefly describe the nature, concentrations and disposal location/ method.

Solid sewage wastes will be disposed of in the same manner as liquid effluent discharge (see above). Domestic waste at the MRO will be collected for disposal in a local managed landfill.

Building waste from construction of the ASKAP facilities will be recycled wherever practicable. Contractors will be given a target to recycle 60% of building waste, with the remaining waste going to landfill.

Will the proposal result in significant off-site noise emissions?

Yes ☐ No ☑ If yes, please briefly describe.

Will the development be subject to the Environmental Protection (Noise) Regulations?

Yes ☐ No ☑ If yes, has any analysis been carried out to demonstrate that the proposal will comply with the Regulations?

Please attach the analysis.

ASKAP will not produce audible noise above the prescribed level during operation.

Construction work will be subject to The Environmental Protection (Noise) Regulations unless certain requirements are adhered to. CSIRO will follow the requirements outlined below:

(2) Regulation 7 does not apply to noise emitted from a construction site as a result of construction work carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises or public place, shows that —

a) the construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b) the equipment used on the premises was the quietest reasonably available; and

c) if the occupier was required to prepare a noise management plan under subregulation (4) in respect of the construction site —

I. the noise management plan was prepared and given in accordance with the requirement, and approved by the Chief Executive Officer; and

II. the construction work was carried out in accordance with the management plan.

(3) Regulation 7 does not apply to noise emitted from a construction site as a result of construction work carried out other than between the hours specified in subregulation (2) if the occupier of the construction site shows that —

a) the construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b) the equipment used on the premises was the quietest reasonably available;

c) the construction work was carried out in accordance with a noise management plan in respect of the construction site —

I. prepared and given to the Chief Executive Officer not later than 7 days before the construction work commenced; and

II. approved by the Chief Executive Officer;

d) at least 24 hours before the construction work commenced, the occupier of the construction site gave written notice of the proposed construction work to the occupiers of
all premises at which noise emissions received were likely to fail to comply with the standard prescribed under regulation 7; and

c) it was reasonably necessary for the construction work to be carried out at that time.

(4) The Chief Executive Officer may require an occupier of a construction site on which it is proposed to carry out construction work to prepare a noise management plan in respect of the premises.

(5) An occupier required to prepare a noise management plan under subregulation (4) must provide the Chief Executive Officer, or another person specified in the notice, with a copy of the plan within the period specified in the notice of requirement.

(6) A noise management plan prepared under subregulation (3)(c) or (4) is to include, but is not limited to—

a) details of, and reasons for, construction work on the construction site that is likely to be carried out other than between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday

b) details of, and the duration of, activities on the construction site likely to result in noise emissions that fail to comply with the standard prescribed under regulation 7

c) predictions of noise emissions on the construction site

d) details of measures to be implemented to control noise (including vibration) emissions

e) procedures to be adopted for monitoring noise (including vibration) emissions

f) complaint response procedures to be adopted.

☐ Does the proposal have the potential to generate off-site, air quality impacts, dust, odour or another pollutant that may affect the amenity of residents and other “sensitive premises” such as schools and hospitals (proposals in this category may include intensive agriculture, aquaculture, marinas, mines and quarries etc.)?

☐ Yes ☑ No If yes, please describe and provide the distance to residences and other “sensitive premises”.

☐ If the proposal has a residential component or involves “sensitive premises”, is it located near a land use that may discharge a pollutant?

☐ Yes ☑ No Not Applicable If yes, please describe and provide the distance to the potential pollution source

2.9 **Greenhouse Gas Emissions**

☐ Is this proposal likely to result in substantial greenhouse gas emissions (greater than 100 000 tonnes per annum of carbon dioxide equivalent emissions)?

☐ Yes ☑ No If yes, please provide an estimate of the annual gross emissions in absolute and in carbon dioxide equivalent figures.

☐ Further, if yes, please describe proposed measures to minimise emissions, and any sink enhancement actions proposed to offset emissions.
2.10 Contamination

- Has the property on which the proposal is to be located been used in the past for activities which may have caused soil or groundwater contamination?
  - Yes
  - No
  - Unsure
  If yes, please describe.

- Has any assessment been done for soil or groundwater contamination on the site?
  - Yes
  - No
  If yes, please describe.

- Has the site been registered as a contaminated site under the Contaminated Sites Act 2003? (on finalisation of the CS Regulations and proclamation of the CS Act)
  - Yes
  - No
  If yes, please describe.

2.11 Social Surroundings

- Is the proposal on a property which contains or is near a site of Aboriginal ethnographic or archaeological significance that may be disturbed?
  - Yes
  - No
  - Unsure
  If yes, please describe.

The Wajarri Yamatji Traditional Owners have an association with Boolardy Station, particularly throughout the 20th century when the station employed local Wajarri Yamatji stockmen.

The ethnographic and archaeological sensitivity at, and adjacent to, each of the proposed antennae locations was assessed. A number of indigenous archaeological sites were found within the ASKAP boundary. These include artefact scatters and rock shelters. A cultural heritage assessment also determined the existence of indigenous cultural sites used for ceremonial purposes and resource extraction, just outside the ASKAP boundary. Antenna locations have been selected by incorporating physical, cultural and biodiversity constraints and will avoid the sensitive areas. In order to prevent indirect impacts on sensitive areas during the construction of antennas and support infrastructure, an indigenous awareness program will be implemented for all CSIRO employees and contractors. A 50-100 metre buffer will be used around archaeological and ethnographic sites to prevent soil and artefact disturbance.

- Is the proposal on a property which contains or is near a site of high public interest (for example, a major recreation area or natural scenic feature)?
  - Yes
  - No
  If yes, please describe.

- Will the proposal result in or require substantial transport of goods, which may affect the amenity of the local area?
  - Yes
  - No
  If yes, please describe.

At the start of construction of ASKAP, labour and materials will need to be transported to Boolardy Station. This will initially increase traffic volumes from Geraldton to the MRO site. During construction of the antennas and support infrastructure, a temporary compound for materials storage, accommodation and offices will be built within a few kilometres of antenna sites, and remain in use for the duration of construction (approximately three years). This will act to contain most traffic between the compound and construction areas on site and reduce the impact of increased traffic on the local area.
2.12 Risk

☐ Is the proposal located near a hazardous industrial plant or high-pressure gas pipeline?
  ☐ Yes  ☑ No  If yes, please describe.

☐ Does the proposal have the potential to generate off-site risk?
  ☐ Yes  ☑ No  If yes, will the proposal be a major hazardous facility regulated under the Explosives and Dangerous Goods Act?

3. MANAGEMENT

3.1 Principles of Environmental Protection

☐ Have you considered how your project gives attention to the following Principles, as set out in section 4A of the EP Act? (For information on the Principles of Environmental Protection, please see EPA Position Statement No. 7, available on the EPA web.)

1. The precautionary principle.  ☑ Yes  ☐ No
2. The principle of intergenerational equity.  ☑ Yes  ☐ No
3. The principle of the conservation of biological diversity and ecological integrity.  ☑ Yes  ☐ No
4. Principles relating to improved valuation, pricing and incentive mechanisms.  ☑ Yes  ☐ No
5. The principle of waste minimisation.  ☑ Yes  ☐ No

☐ Is the proposal consistent with the EPA’s Position Statements (available on the EPA web)?
  ☑ Yes  ☐ No

3.2 Management Commitments

☐ How has the proposal been developed to avoid, minimise and manage potential impacts? Please describe any specific commitments you make as the proponent to minimising the potential environmental impacts of this development.

The principles of environmental management have been followed in the design location and layout for the ASKAP project. This will continue to be followed to:
- avoid impacts where possible
- minimise impacts
- mitigate impacts
- provide offsets for residual impacts of the proposal.

Site selection
The selection of Boolardy Station as Australia's candidate for the SKA, and hence the ASKAP site, included consideration of the likely environmental, cultural and social impacts. The choice of the site was primarily based on its radio quietness and its sustainability as a radio quiet zone. It was then
selected as a site with minimum mature vegetation of ecological importance and competing economic activity.

Siting of Infrastructure
The layout of the antenna array has taken into consideration areas of both cultural and environmental sensitivity. Overlays of topography on areas of cultural and heritage significance and biodiversity constraints were used to guide the positioning of the antenna and avoid impacts on sensitive areas (see Figures 4 and 5 of Attachment B). The precise locations of individual antennas and other infrastructure can be adjusted to avoid site specific impacts and this would be within a 100 m buffer of their current proposed location.

In the final designs areas such as access tracks will be designed to avoid further impacts to the environmental values of the local area. These will adopt the following performance objectives:

- no vegetation communities listed as threatened at either the national or state level will be affected
- no cultural heritage sites will be directly affected by the infrastructure
- impacts on regionally rare vegetation will be minimised
- fragmentation of remnants of vegetation/habitat will be avoided and where possible disturbance will be located at the edge of existing remnants
- where possible, access tracks and other infrastructure will be located in already disturbed areas
- maintain water flow integrity.

Management of impacts
Not all impacts can be avoided though the design process. For example, disturbance to some areas of native vegetation and habitat will be unavoidable during the construction process. In order to avoid further disturbance to areas outside of those already identified for construction, sensitive areas will be clearly identified during the construction process as ‘no-go’ areas. These will be marked on maps provided to contractors, as well as on the ground where necessary using high visibility fencing (barrier mesh). No direct disturbance will occur in these areas, including vehicle access.

As part of the design and prior to construction, detailed mitigation measures will be developed and presented in the environmental assessment documentation and subsequent Construction Environmental Management Plan. The plan will include:

- preliminary design of mitigation measures (e.g. the use of culverts under access tracks to maintain natural flow paths and the use of sediment control measures)
- pre-clearing surveys and habitat salvage
- enhancement of adjoining habitat
- protection of heritage values
- weed and pest management and control
- visitor, employee and contractor inductions addressing relevant requirements for biodiversity, heritage and land management plans
- compliance with biodiversity and land management plans to be included in all construction contracts
- monitoring and review.

Revegetation of areas disturbed by construction of the proposal will be undertaken to increase the habitat value and amenity of the areas. Revegetation of the areas will include:

- planting of a range of locally occurring native shrubs, trees and groundcover species. Discussion would be held with the Environment Protection Agency, Department of Environment and Conservation and the Department of the Environment, Water, Heritage and the Arts regarding the choice of species, particularly in areas where the revegetation will be adjacent to existing areas of native vegetation.
- inclusion of logs, dead trees and stumps in the landscaping rehabilitation works
- increasing the overall vegetation cover within the project areas
- incorporation of existing natural vegetation where possible
- linking of vegetation remnants
- management of exotic weeds through a Weed Management Action Plan as part of the Construction Environmental Management Plan
- exclusion of stock from these areas.

For land-based impacts that cannot be avoided or mitigated (e.g. clearing of native vegetation), a suitable offset package will be developed in consultation with the WA Environment Protection Authority and Department of Environment and Conservation and the Department of the Environment, Water, Heritage and the Arts, following their guidelines. In principle the offsets will be:

- in the same or similar in landform and soil type/s as found within the site to be cleared.
- able to support the same or similar indigenous vegetation association/s as that present within the site to be cleared
- likely to be successfully recreated as the habitats that are disturbed through construction activities.

### 3.3 Consultation

- Has public consultation taken place (such as with other government agencies, community groups or neighbours), or is it intended that consultation shall take place?
  - Yes  □ No  
  
  **If yes**, please list those consulted and attach comments or summarise response on a separate sheet.

Substantive public, government agency and community consultation has been carried out for the ASKAP project as well as other associated projects (e.g. the Radio Quiet Zone and the international SKA Project - refer Attachment E). This consultation has included:

- Native title negotiations with registered native title claimant group
- Meetings with surrounding pastoralists
- Meetings with mining companies
- Public meetings at Murchison Shire Council
- Public talks in the City of Geraldton-Greenough
- Many meetings with City of Geraldton-Greenough officials.
- Web pages: Information on ASKAP and SKA is available through a number of sources, including a website (www.ska.gov.au), regular auSKA newsletters circulated via an extensive e-mail distribution list and available on the SKA website, a range of other websites attached to institutions working on ASKAP and a range of fact sheets and posters providing project information that are available via the Australian SKA website.
- The project also receives regular newspaper and media coverage at National, State and regional levels.
- An international SKA Forum was held in Perth on 9 April 2008. The Forum brought together a range of people who are either actively engaged in SKA preparatory work or who have an interest in learning more about it. The Forum program was designed to provide a comprehensive understanding of this complex and ambitious program, including the ASKAP and its role, and allowed attendees to contribute views and ideas on the possible forward path. Around 200 people participated in the forum including international and domestic participants. Domestic participants included representatives from the Murchison Shire region, industry, members of the registered native title claimant group, Commonwealth, State and Local Government and the current Boolardy pastoral station leaseholder.
• The decision making and advisory structures for the Australian SKA project provide for Advisory Groups reporting to the Australian Square Kilometre Array Coordination Committee (ASCC). Existing groups include the Science and Technology Advisory Group comprising representation from key science and technology advisers and the Industry Participation and Procurement Advisory Group with representation from peak industry groups, Commonwealth and State government industry departments. A Regional Stakeholders Advisory Group is being established; this role will be undertaken by the existing Western Australian Radio Astronomy Committee (WARAC). An Education Advisory Group is also being formed to provide an information conduit to and from educators regarding the projects.

• An international SKA Forum was also held in South Africa in February 2009. The Forum meeting was very well attended by government, scientists and industry, with continued broad support for the SKA from all of these groups.

• Consultation with stakeholders by the Australian Communications and Media Authority relating to the designation of the Radio Quiet Zone in Western Australia (refer Attachment E).
CHECKLIST AND DECLARATION

Before you submit this form, have you:

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Completed all the questions on this form?  ❌  ☐

Have you attached any extra information, such as:

<table>
<thead>
<tr>
<th>Site plans?</th>
<th>YES</th>
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<th>Detailed explanations?</th>
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<th>Comments obtained during consultation?</th>
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Have you included any electronic information, such as:

<table>
<thead>
<tr>
<th>A CD of the referral and documentation, in PDF format, excluding any confidential information?</th>
<th>YES</th>
<th>NO</th>
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<th>Any other relevant information?</th>
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Following a review of the information presented in this form, please consider the following question. (Your response is Optional)

> DO YOU CONSIDER THE PROPOSAL REQUIRES FORMAL ENVIRONMENTAL IMPACT ASSESSMENT? (Information on the levels of environmental impact assessment is available on the EPA website at www.epa.wa.gov.au)

<table>
<thead>
<tr>
<th>YES</th>
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IF YES, WHAT LEVEL OF ASSESSMENT?

<table>
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<th>ASSESSMENT ON REFERRAL INFORMATION</th>
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<th>ENVIRONMENTAL PROTECTION STATEMENT</th>
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<th>PUBLIC ENVIRONMENTAL REVIEW</th>
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| ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME | YES | NO | NOT SURE |
|                                               |     |    |          |

| STRATEGIC ENVIRONMENTAL ASSESSMENT          | YES | NO | NOT SURE |
|                                            |     |    |          |

I, ... David DeBoer................................................. (full name) declare that I have completed all of the questions in this form and attached the requested information and declare that the information contained in this form is, to my knowledge, true and not misleading.

Signature

Name

Position

Date

2/1/17
Government Agency Contact Details

Environmental Protection Authority
Level 8, The Atrium
168 St Georges Tce
PERTH WA 6000

Please mail completed referrals to:
Postal address:
Locked Bag 33
CLOISTERS SQUARE WA 6850
Website: www.epa.wa.gov.au

EPA Service Unit
Level 8, The Atrium
168 St Georges Tce
PERTH WA 6000

Telephone: (08) 6467 5000
Facsimile: (08) 6467 5562
Website: www.dec.wa.gov.au

Contact details for the head offices of the primary agencies involved in development proposals follow. You may need to contact your relevant district or regional office (details of all State Government agencies are available on the website of the Department of the Premier and Cabinet, www.dpc.wa.gov.au). You will also need to contact your Local Government Authority in the first instance. For some proposals, consultation with or referral to Commonwealth agencies may be required.

Department of Environment and Conservation
The Atrium
168 St Georges Tce
Perth WA 6000

For Licensing and Clearing Permits under Part V -
Telephone: (08) 8467 5000
Website: www.dec.wa.gov.au

Department of Water
The Atrium
168 St Georges Terrace
Perth WA 6000

Telephone: (08) 6364 7600
Website: www.water.wa.gov.au

Department of Commerce
Mineral House
100 Plain St
East Perth WA 6004

Telephone: (08) 9327 5555
Website: www.commerce.wa.gov.au

Department of Fisheries
3rd floor, SGIO Atrium
168 St George’s Terrace
Perth WA 6000

Telephone: (08) 9482 7333
Website: www.wa.gov.au/westfish

Department for Planning and Infrastructure (including Bush Forever Office)
Albert Facey House
469 Wellington Street
Perth WA 6000

Telephone: (08) 9264 7777
Telephone: 1800 526 477 (Bush Forever Office)
Website: www.planning.wa.gov.au

Department of Indigenous Affairs
Level 1, 197 St George’s Terrace
PERTH WA 6000

Telephone: (08) 9235 8000
Website: www.dia.wa.gov.au

Health Department of Western Australia
189 Royal St
EAST PERTH WA 6004

Telephone: (08) 9222 4222
Website
Overview of security environment in Australia and New Zealand

Australia and New Zealand have comparatively moderate levels of crime overall. Although crime statistics are not readily comparable across countries, in a category that has a similar definition and reporting rate in most countries, homicide, Australia and New Zealand have rates similar to other OECD countries. Crime statistics for both Australia and Western Australia show that overall crime rates have reduced significantly in the last decade.

Table 1 – Crime statistics.

<table>
<thead>
<tr>
<th>Crime</th>
<th>2000</th>
<th>2009</th>
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<tbody>
<tr>
<td></td>
<td>Australia</td>
<td>Western Australia</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Per 100,000</td>
</tr>
<tr>
<td>Total homicide and related offences</td>
<td>755</td>
<td>3.9</td>
</tr>
<tr>
<td>Assault</td>
<td>155,809</td>
<td>813.3</td>
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<tr>
<td>Total robbery</td>
<td>23,336</td>
<td>121.9</td>
</tr>
<tr>
<td>Total unlawful entry with intent</td>
<td>436,968</td>
<td>2,281.7</td>
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<tr>
<td>Motor vehicle theft</td>
<td>138,912</td>
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<tr>
<td>Other theft</td>
<td>681,268</td>
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</table>

* Western Australia per 100,000 figures are calculated figures using recorded crime statistics and demographic statistics.


Australia and New Zealand both have professional, well-equipped police forces maintaining community safety and order. Policing in Australia comprises two levels of police forces:

- State and territory-based police forces responsible for most law and order including the prevention, detection and investigation of most crimes, and
- An Australian Federal Police force responsible for matters with a national jurisdiction.

Security measures at existing national facilities

Outlined within this section is a summary of the security measures currently implemented at some of CSIRO’s national telescope facilities. Telescopes located within Australia are able to operate with minimal security.

Mopra telescope in northwest New South Wales

The Mopra Telescope is a 22-m single-dish radio telescope located at the edge of the Warrumbungle Mountains near Coonabarabran, about 450 km northwest of Sydney. It is part of CSIRO’s Australia Telescope National Facility. For the past five years the telescope has been operated remotely from astronomer’s desks all over the world. The telescope has no permanent staff presence and is maintained by a team that is based 150 km away, at the site of the Australia Telescope Compact Array near Narrabri. The infrastructure at the Mopra Telescope compound includes the telescope, a shed and a small two-bedroom house, which also houses the computer processors and data machines. The security measures consist of a high fence surrounding the compound, a locked gate, two web cameras (one pointing at the telescope and the other pointing at the gate entrance) and a CSIRO road sign at the turnoff from the main road. The existing alarm procedure only acts in response to important equipment problems. Currently, there is no provision (or any need) for a site security alarm. The alarm procedure consists of an automated phone-call to the on-call staff person based at the Australia Telescope Compact Array near Narrabri.

Figure 1 – The Mopra telescope. A 2.5-m high fence surrounds the compound (indicated by the sealed road area).

Murchison Radio-astronomy Observatory (MRO) in remote Western Australia

The MRO is surrounded by low stock fencing typically used on pastoral stations in the region. For the past four years, during the initial investigation and surveying period, there has been an unlocked gate on the entrance track. Site offices and storage containers have been locked when the site has been unattended, and there are four permanent web cameras. No theft or other security issues have occurred. Existing access control to the MRO site is outlined in the ASKAP Health, Safety and Environment (HSE) Management Plan (ASKAP HSE MANUAL - STAFF) ASKAP-HSE-SOI001 Version 1.1 01/08/2011. A series of road signs on the road leading to the MRO site provide information on the Radio-Quiet Zone and the turn off to the MRO site itself. During construction, when entering the MRO site all staff and affiliates (including contractors engaged by CSIRO) must sign-in and sign-out at either the MRO Site Office or the CET54 Site Hut. The buildings (including site huts and storage areas) are locked on completion of work each day. All keys are signed out from the relevant key-board and signed back into the key-board on completion of the task, activity or work period. Work sites are marked and signposted, but not fenced. In operation, the ASKAP antennas and power station will be monitored by CCTV cameras. There will be a low security fence around the central control building, and around the power station. Entry to these buildings will be controlled by key or a swipe card system. A locked gate will be installed at the entrance to the MRO. These security measures will be adequate given the remote location of the site, the known local community, and the very low numbers of passing motorists.

Figure 2 – Road signs providing information on the radio quiet zone and the turn-off to the MRO.
ASKAP HSE MANAGEMENT PLAN
SPECIFIC OPERATING INSTRUCTIONS
(ASKAP HSE MANUAL - STAFF)
ASKAP-HSE-SOI001
Version 1.1
01/08/2011
Project: ASKAP

Prepared by: Briggs, Brayden (HSE Officer, ASKAP)
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Approval Status: Approved
Keywords: HSE, Safety, Health, Environment, Management
Amendments
This document is to be reviewed bi-annually, in July and December. Questions, queries comments and suggestions should be addressed to:

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| 1.1      | 01/08/2011 | B. BRIGGS | Restrictions to working in hot weather
Insert Confined Space Flowchart
Driving competency amplified

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Image Cover: Artist's impression of ASKAP at the Murchison Radio-astronomy Observatory (MRO). Credit: Swinburne Astronomy Productions. Design data provided by CSIRO.
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1. INTRODUCTION

1.1 CSIRO HSE POLICY STATEMENT

CSIRO is committed to safeguarding the health, safety and wellbeing of our people, our partners and the communities in which we operate. Health, safety and environmental sustainability are fundamental to the way we operate. People are at the heart of CSIRO’s capacity to deliver great science and innovative solutions for industry, society and the environment.

CSIRO aspires to Zero Harm to our people and the environment. We are committed to develop, implement and maintain systems and processes to ensure we:

- uphold our value of a genuine commitment to safety and environment and to improve the health of our people
- establish clear leadership accountabilities for safety and environmental sustainability
- comply with all relevant legislation, policies, procedures, standards, licence conditions and other relevant requirements, and go beyond compliance to achieve the aims of this policy
- identify, assess and manage risks to prevent injuries to our people and harm to the environment
- consult with staff and encourage initiatives that contribute to a safer, cleaner and environmentally sustainable working environment
- report and investigate all injuries, illnesses, near misses and environmental incidents
- seek ways to promote and improve the health of our people and support people in making healthy choices
- establish and achieve challenging environmental sustainability goals including energy efficiency and water usage
- conduct our scientific research in a manner that supports environmental sustainability
- measure, evaluate and report our performance progress against set targets and established policies, procedures and systems
- respect traditional rights and culture of indigenous people
- work with government, industry and other stakeholders to address the challenge of climate change and enhance biodiversity.

We know we are successful when our people arrive home safe and healthy and we are valued for our contribution to sustainable development for Australia and our global future.

Dr Megan Clark
Chief Executive
1.2 SUMMARY

This manual has been developed to assist CSIRO Staff Members and affiliates working on the ASKAP Project understand the expectations of them in maintaining the highest possible standards of safety, health and environmental sustainability in line with wider CSIRO policy and procedures.

1.3 SCOPE

This manual covers the health, safety and environmental sustainability actions that MUST be taken by CSIRO Staff Members and affiliates when planning to and conducting work at the MRO.

This manual is applicable to CSIRO Staff Members and affiliates seconded to or otherwise employed by CSIRO; guidance is given to Staff Members on the management of contractors, however, CSIRO staff engaging contractors should refer to the document “ASKAP HSE Manual - Contractors”.

1.4 FURTHER INFORMATION

Further information on any of CSIRO’s HSE policies, procedures or legal requirements can be obtained from either:

Brayden Briggs, ASKAP HSE Officer (brayden.briggs@csiro.au)

Kylie Fraser, CASS HSE Leader (kylie.fraser@csiro.au)
1.5 **GLOSSARY**

<table>
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<tr>
<td>Adequate Sustenance</td>
<td>means sufficient quantities of food and drink</td>
</tr>
<tr>
<td>ASKAP</td>
<td>Australian SKA Pathfinder</td>
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<td>Competent Person</td>
<td>in relation to a specified task, means a person who has, through a combination of training, education and experience, acquired knowledge and skills that enable the person to perform correctly that task [OHS (Safety Standards) Regulations 1994, Reg 20.01]</td>
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<td>Construction Site</td>
<td>A place where construction work is undertaken; and an area in the vicinity of such a place, where plant or other material that is, or will be, used in connection with the construction work is located during the construction work. Does not include a place where: elements of a structure are manufactured off-site or construction material is stored as stock for sale or hire (ibid. Reg 20.04)</td>
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<tr>
<td>Construction Work</td>
<td>Means work on or in the vicinity of a construction site carried out in connection with the construction, alteration, conversion, fitting out, commissioning, renovation, repair, maintenance, decommissioning, demolition or dismantling of any structure.</td>
</tr>
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<td>Contractor Coordinator</td>
<td>The person responsible for the work being undertaken by the contractor. The Contractor Coordinator may be a CSIRO staff member or an appointed external party.</td>
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<td>Contract Owner</td>
<td>The person who has direct responsibility for the Contract and tasks. A Contract Owner may delegate the management of the contract to the Contractor Coordinator.</td>
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<td>ECO</td>
<td>Emergency Control Organisation</td>
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<td>EPC</td>
<td>Emergency Planning Committee</td>
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<td>Electrical Work</td>
<td>work on electrical machines or instruments, on an electrical installation or on electrical appliances or equipment to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts alternating current or 120 volts ripple free direct current whether or not the thing on which the work is performed is part of, or is connected to or to be connected to, any distribution works or private generating plant and, where work is performed on any appliance, whether or not electricity is supplied or may be supplied thereto through an electric plug socket or socket outlet.</td>
</tr>
<tr>
<td>Electrical Fitting Work</td>
<td>the work of making, maintaining, repairing, altering, assembling, dismantling, connecting or testing electrical machines, electrical appliances, electrical instruments or other electrical equipment, and includes electrical installing work if that work is assembling, maintaining or altering the wiring between electrical components in plant or machinery.</td>
</tr>
<tr>
<td>Electrical Installation</td>
<td>Means electrical equipment that is fixed or intended to be fixed, in, on, under or over land.</td>
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<tr>
<td>Electrical Installing Work</td>
<td>electrical work that consists of assembling and fixing in place, altering or adding to any electrical installation or maintaining, removing, or, connecting to fixed wiring, any electrical equipment.</td>
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<tr>
<td>Escorted Visitor</td>
<td>A person who is visiting a CSIRO site and who will be escorted at all times by an appropriate staff member or CSIRO affiliate. Escorted visitors may include staff members and CSIRO affiliates from other sites.</td>
</tr>
<tr>
<td>Excavation</td>
<td>means a hole in the earth, or a face of earth, formed after rock, sand, soil or other material is removed (such as a trench, ditch, shaft, well, tunnel, pier hole, cutting or caisson or a hole drilled in the earth).</td>
</tr>
<tr>
<td>Excavation Work</td>
<td>means work to make, fill or partly fill an excavation.</td>
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<tr>
<td>Fatigue</td>
<td>the state of feeling tired, weary or sleepy that results from prolonged</td>
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<tr>
<td><strong>Periods Awake</strong></td>
<td>periods awake, loss of normal sleep, mental or physical work, extended periods of anxiety, and exposure to harsh environments</td>
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<td><strong>Fatigue Critical Task</strong></td>
<td>this is a task where there are potentially increased risks of incidents, injury or harm should employees become fatigued, for example during operation of certain plant and/or making critical decisions where there may be significant consequences if errors occur</td>
</tr>
<tr>
<td><strong>Hazardous Waste</strong></td>
<td>the component of the waste stream, which by its characteristics poses a threat or risk to public health, safety or the environment. It includes substances, which are toxic, infectious, mutagenic, teratogenic, explosive, flammable, corrosive, oxidising and radioactive</td>
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<tr>
<td><strong>Health Surveillance</strong></td>
<td>monitoring a person to identify changes in the person's health status from exposure to a hazardous substance</td>
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<tr>
<td><strong>IPT</strong></td>
<td>Integrated Product Team</td>
</tr>
<tr>
<td><strong>High-risk Construction Work</strong></td>
<td>Means any of the following construction work:</td>
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<tr>
<td></td>
<td>• where there is a risk of a person falling more than 2 metres</td>
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<td></td>
<td>• on telecommunications towers’</td>
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<td>• involving demolition</td>
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<td>• involving disturbance or removal of asbestos</td>
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<td>• involving structural alterations that require temporary support to prevent collapse</td>
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<td>• involving a confined space</td>
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<td>• involving excavation to a depth greater than 1.5 metres</td>
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<td></td>
<td>• involving construction of tunnels</td>
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<td>• involving use of explosives</td>
</tr>
<tr>
<td></td>
<td>• in an area that may have a contaminated or flammable atmosphere</td>
</tr>
<tr>
<td></td>
<td>• with tilt-up and precast concrete</td>
</tr>
<tr>
<td></td>
<td>• on, or adjacent to, roadways or railways used by road or rail traffic</td>
</tr>
<tr>
<td></td>
<td>• on construction sites where there is any movement of powered mobile plant</td>
</tr>
<tr>
<td></td>
<td>• in an area where there are artificial extremes of temperature</td>
</tr>
<tr>
<td></td>
<td>• in, over, or adjacent to water or other liquids where there is a risk of drowning</td>
</tr>
<tr>
<td></td>
<td>• involving diving.</td>
</tr>
<tr>
<td><strong>HSE Management Plan</strong></td>
<td>The HSE Management Plan is a site-specific document that details the HSE resources, responsibilities and procedures or practices for a particular project and shall cover all work undertaken by the guest-user and/or contractors.</td>
</tr>
</tbody>
</table>

---

1 Definition taken from: Landfill Waste Classification and Waste Definitions 1996 (as amended), Department of Environment, Western Australia
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
</table>
| Manager | A Staff member or CSIRO affiliate who has responsibility for:  
- conduct of an activity;  
- management of Staff members or CSIRO affiliates; and/or  
- allocation of resources |
| OEM | Original Equipment Manufacturer |
| 'On-duty' | the sum of all periods of activity associated with employment, including reasonable entertainment, that a CSIRO staff member, affiliate or CSIRO contractor performs in a given 24 timeframe. On-duty excludes any breaks from work of one hour duration or more, e.g. lunch break. On-duty includes time spent as crew member (driver, navigator etc) in a vehicle, ship or aircraft used for work purposes |
| Operational Construction Zone | means the area on the site where construction work is undertaken, which generally does not include the site offices, amenities or designated delivery and plant service areas |
| Penetrating Works | Activities that result in a solid object being passed through a structure where there is a risk of electric shock or damage to other services and pipelines |
| Provisional Improvement Notice (PIN) | A formal notice issued to the employer by a Health & Safety Representative requiring them to remedy a contravention to the Act or Regulations |
| Record | A document or object, in any form, created or received in the transaction of business or research by CSIRO and maintained as evidence of those activities or due to the value of the information it contains. |
| Rest period | means the period of time during which a CSIRO staff member, affiliate or CSIRO contractor is relieved of all duties associated with his or her employment |
| RTO | Registered Training Organisation |
| SEMP | Site Emergency Management Plan |
| Sleep debt/deficit | the result of an individual obtaining less than optimum restorative sleep over a given period of time. For example, if an individual requires six hours to maintain appropriate alertness levels and they are deprived of two hours sleep over four consecutive 24hr periods a sleep debt of eight hours exists |
| Structure | any building, steel or reinforced concrete construction, railway line or siding, tramway line, dock, ship, submarine, harbour, inland navigation channel, tunnel, shaft, bridge, viaduct, waterworks, reservoir, pipe or pipe-line (whatever it contains or is intended to contain), structural cable, aqueduct, sewer, sewerage works, gasholder, road, airfield, sea defence works, river works, drainage works, earthworks, constructed lagoon, dam, wall, mast, tower, pylon, underground tank, earth retaining construction, fixed plant, construction designed to preserve or alter any natural feature, and any other similar construction; and any formwork, false work, scaffold or other construction designed or used to provide support or access during construction work. |
| Suitable sleeping accommodation | means a comfortable room with the use of a bed and a comfortable chair, subject to minimum noise levels, well ventilated (with air conditioning if available) and with facilities to control light. |
| Working Alone [at the MRO] | alone at the MRO; or,  
if other people are onsite: Working more than 400metres from another person and/or without access to a vehicle |
| Working Day | means the period between the time a CSIRO staff member, affiliate or CSIRO contractor commences any duties associated with his or her employment until he or she is finally relieved of all such duties and entered into a rest period. |
2. LEADERSHIP & ACCOUNTABILITY

2.1 PURPOSE

- This instruction details the expectations of ASKAP managers with regards to HSE, as presented in the CSIRO HSE Management Standard.

2.2 APPLICATION

- Applicable to all CSIRO Managers and staff members.

2.3 INSTRUCTIONS

2.3.1 CSIRO HSE POLICY STRUCTURE

- CSIRO HSE policy structure is as follows, graphically represented at Enclosure 01, document sponsor shown in brackets:
  
  - HSESC Policy (CEO CSIRO)
  - HSE Management Standard (Executive Team)
  - CSIRO HSE Procedures (HSE General Manager)
  - CSIRO HSE Guidelines (HSE General Manager)
  - CASS Specific Operating Instructions [SOIs] (Business Unit Leader)
  - Project/Site SOIs (Project Leader/Director)
  - Project/Site Safe Work Instructions [SWIs] (Site & Team Leaders)

2.3.2 ACCESS TO THE MRO SITE – INDUCTION

- The purpose of induction is to raise awareness of the safety, health and environment risks and their controls present on the site.

- Three levels of induction exist:
1. General Construction Industry Induction (White Card)

- All staff members and contractors performing work at the MRO must possess a valid White Card (or Worksafe WA accepted equivalent). Exceptions to this requirement include people classed as Escorted Visitors.

2. Site Induction

- Staff members, affiliates and contractors must attend Site Induction. Presently it is delivered in face-to-face format.

- Additionally, all must attend a Cultural Heritage Induction with the Aboriginal Liaison Officer based at Geraldton. Contact details are at Enclosure 09.

  NOTE: The Site HSE Induction contents will change as the MRO moves towards becoming an operational facility; all visitors will need to remain up-to-date with induction and will be advised at time of accommodation booking if they required a refresher.

- There are two levels of MRO Site Induction:
  
  o **Level 1**: Short-term Visitor Induction – Visits under 24hrs, constant escort by an inducted person

    | Documentation                  | ‘Welcome to the MRO’ pamphlet |
    |--------------------------------|-------------------------------|
    | Verbal/Email Brief             | - Emergency Procedures        |
    |                                | - Escort Arrangements; what to do if separated from the group |
    |                                | - MRO Site Rules               |
    |                                | - Reporting safety hazards and incidents |
    | Issue Pass                     | - ‘Visitor’ Hardhat            |

  o **Level 2**: Full Site Induction – All visits >1 day duration

    | Documentation                      | ‘Welcome to the MRO’ pamphlet |
    |------------------------------------|-------------------------------|
    | Verbal Brief                       | - Medical Disclosure Form (Voluntary) |
    |                                    | - Valid ‘White Card’ check |
    |                                    | - Sign onto HSE Risk Management Plan |
    |                                    | - Sign onto relevant SWMS |
    |                                    | - Authorisation to Operate Plant Form (as required) |
    | Imagery                            | MRO Site Induction Checklist & |
    |                                    | Boolardy Accom Facility Induction Checklist |
    | Issue Pass                         | Site Map                      |
    |                                    | - ‘Inducted’ Hardhat          |

- The time and place of induction will be arranged at the time of submitting an MRO Site Visit Application.

- The mode of delivery of the induction during the construction, installation, fit-out and commissioning phases is face-to-face, performed by either:
  
  o MRO Site Manager; or
  
  o HSE Officer / Site Coordination Asst

\[2\] For further detail on White Card competency see Section 8 ‘Training’
FOR INFORMATION: CSIRO staff do not require a separate ‘MacDow’ induction.

3. Task-specific Induction

- This form of induction refers to an induction by a Team Leader or experienced staff member in relation to a system, an item of plant, chemical or area of operation.

- The Team Leader should make a written note of:
  - When the induction was given
  - Who were the recipients
  - Topics covered

- Refer to Section 6: Training for further information

2.3.3 ACCESS CONTROL – PHYSICAL SECURITY

- Staff and affiliates are reminded that the use of CSIRO property is subject to the Code of Conduct, i.e. items are to be returned to their proper place after use and not to be loaned to people outside the organisation without manager/senior manager approval.

- All keys must be signed out from the relevant key-board and signed back into the key-board on completion of the task, activity or work period.

- Keys must not be left in any plant unless for documented safety purpose/s.

- Site huts and storage areas should be locked on completion of work each day, unless otherwise instructed by Site Manager.

2.3.4 IDENTIFICATION & SIGN-IN/OUT

- When operating at a CSIRO-controlled site, staff and affiliates (including contractors engaged by CSIRO) must sign-in and sign-out at their designated location.

- At the MRO, the designated locations are as follows:
  - CSIRO Staff and Affiliates: MRO Site Office
  - CSIRO Contractors: MRO Site Office
  - Antenna Contractors: CETC54 Site Hut
  - MRO Guest Users: Self-manage
## 2.3.5 RESPONSIBILITIES

<table>
<thead>
<tr>
<th>Roles</th>
<th>Specific HSE Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASKAP Project Director</strong> (Antony Schinckel)</td>
<td>Overall responsibility for:</td>
</tr>
<tr>
<td></td>
<td>• The execution of the ASKAP HSE Risk Management Plans</td>
</tr>
<tr>
<td></td>
<td>• Ensuring HSE performance is properly considered in the award of contracts</td>
</tr>
<tr>
<td></td>
<td>• Ensuring the allocation of resources to achieve HSE goals</td>
</tr>
<tr>
<td></td>
<td>• Ensuring compliance with HSE legislation and corporate CSIRO policy and procedure</td>
</tr>
<tr>
<td></td>
<td>• Reporting on HSE performance to the CASS BU Leader, as required by CSIRO procedure</td>
</tr>
<tr>
<td></td>
<td>• Conducting periodic reviews of the HSE management system</td>
</tr>
<tr>
<td><strong>Integrated Product Team (IPT) Leaders &amp; Managers</strong></td>
<td>• Act as Contract Owner (see Section 3) for contracted services under their charge</td>
</tr>
<tr>
<td></td>
<td>• Develop and Implement the HSE Risk Management Plan(s) under their charge</td>
</tr>
<tr>
<td></td>
<td>• Ensuring their staff members receive adequate levels of training and supervision</td>
</tr>
<tr>
<td></td>
<td>• Oversee the preparation of Safe Work Method Statements (SWMS) and Job Safety &amp; Environment Analysis (JSEAs)</td>
</tr>
<tr>
<td><strong>MRO/MSF Site Manager</strong> (Barry Turner)</td>
<td>The MRO Site Manager maintains operational control of all staff and visitors at the MSF and MRO. HSE specific responsibilities include:</td>
</tr>
<tr>
<td></td>
<td>• Develop and Implement the MRO HSE Risk Management Plan</td>
</tr>
<tr>
<td></td>
<td>• Ensure MRO and MSF operations comply with HSE legislation and conform to CSIRO HSE procedures</td>
</tr>
<tr>
<td></td>
<td>• Act as primary CSIRO point-of-contact for contractors onsite</td>
</tr>
<tr>
<td></td>
<td>• Coordinate the MRO/MSF vehicle fleet movements and maintenance</td>
</tr>
<tr>
<td></td>
<td>• With the HSE Officer, conduct routine MRO &amp; MSF HSE Inspections</td>
</tr>
<tr>
<td></td>
<td>• Be the Emergency Coordinator at the MRO (see Section 10)</td>
</tr>
<tr>
<td><strong>Team Leader</strong></td>
<td>A Team Leader is to be nominated on the Site Visit Request Form for each visiting team to the MRO. This person is to act in a supervisory capacity and arrange schedule and resources. Tasks include:</td>
</tr>
<tr>
<td></td>
<td>• Ensure all work is carried out in accordance with this manual and applicable Safe Work Instructions (SWIs)</td>
</tr>
<tr>
<td></td>
<td>• Organise daily logistics (food, water, vehicle arrangements etc) in consultation with Kitchen and CSIRO staff</td>
</tr>
<tr>
<td></td>
<td>• Ensure 100% induction/escort of all persons not inducted</td>
</tr>
<tr>
<td></td>
<td>• Report safety and environmental harm incidents</td>
</tr>
<tr>
<td></td>
<td>• Ensure SWMS are prepared for all high risk tasks</td>
</tr>
<tr>
<td><strong>HSE Officer &amp; MRO Coordination Assistant</strong></td>
<td>• Perform Site Inductions &amp; Toolbox Talks</td>
</tr>
<tr>
<td></td>
<td>• Advise and assist ASKAP staff and affiliates to comply with HSE requirements</td>
</tr>
<tr>
<td></td>
<td>• Provide practical HSE support on-site</td>
</tr>
<tr>
<td></td>
<td>• Assist staff and affiliates to document HSE risks and controls</td>
</tr>
<tr>
<td></td>
<td>• Support the MRO Site Manager to implement the MRO HSE Risk Management Plan</td>
</tr>
</tbody>
</table>
2.4 FURTHER INFORMATION

- CSIRO Health, Safety, Environmental Sustainability & Community Policy
- CSIRO HSE Management Standard
- CSIRO Procedure: HSE Induction for Visitors
2.5 ORGANISATION CHART

[Diagram showing the organisational structure with names and roles of different individuals involved in the ASKAP project, including Phil Diamond, Ant Schinckel, Kylie Fraser, Barry Turner, Brayden Briggs, and others.]
3. **CONTRACTOR MANAGEMENT**

3.1 **PURPOSE**

- The purpose of this instruction is to detail the arrangements and actions required by CSIRO staff members contracting the delivery/supply of goods or services generally.

3.2 **APPLICATION**

- CSIRO staff members who are either a Contract Owner and/or Contractor Coordinator.
- Generally to all ASKAP staff for information.

3.3 **INSTRUCTIONS**

3.3.1 **CONTROL OF THE WORKPLACE**

- The responsibilities for HSE differ depending on who is working on the site, who has control of the work place and how access to the site is being managed. At the MRO, sections of the site will be either CSIRO or Contractor controlled.

**Working on a CSIRO Site (CSIRO Controlled Site)**

- At the MRO, CSIRO retains control of the BETA Antennas and existing CSIRO infrastructure, i.e. Ant#29 Site Hut and BETA compound. Work undertaken at CSIRO controlled areas should be delineated, cordoned-off etc wherever practicable.

- The Contractor will progressively hand-over portions of the MRO and antenna foundations to CSIRO as construction finishes in said areas.

- The MRO Site Manager can provide an up-to-date list of CSIRO controlled areas.

**Contractor Controlled Site**

- The MRO Infrastructure Contractor’s worksite includes the ‘All Weather [Main] Access Track’ from the turnoff at Pindar-Beringarra Rd. Therefore, CSIRO Staff and affiliates access the MRO through or via the Contractor’s Site.

**NOTE:** CSIRO staff members must comply with any safety direction given by the contractor when transiting through or operating within a ‘Contractor Controlled Site’.
3.3.2 THE DEVELOPMENT OF CONTRACTS

- Generally, CSIRO *Contract Owners* must consider contractor HSE performance prior to the award of a contract (of all sizes). Contracts are awarded as per CSIRO Procurement Procedure.

- The hazards involved with contracted work will be identified, assessed and controlled; the rigour of assessment to be commensurate with the level of risk (or perceived risk) of the task/s.

- For safety, there is a great need for Contract Owners, Contract Coordinators and on-site staff, i.e. Site Manager & HSE Officer, to regularly communicate current and future planned contracted works.

- The Site Visit Request Form must be utilised by all contractors visiting the MRO.

**DUTIES OF THE CONTRACT OWNER**

- The *Contract Owner* is responsible for determining the level of risk(s) likely to be involved in the contracted work, refer to Table 1 below.

- The next step is to obtain from the [potential] contractor the relevant risk management documentation.

- Contract Owners are referred to checklist at Enclosure 02 to assist in gathering documents for high & medium risk, capital works >$250 000 and period contracts.

<table>
<thead>
<tr>
<th>RISK CATEGORY</th>
<th>EXAMPLE TASKS</th>
<th>RISK MANAGEMENT DOCUMENTATION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH RISK</strong> (or Capital Works &gt;$250 000)</td>
<td>Work at Heights (&gt;2m fall) Roadwork Asbestos Removal Confined Space Entry Mobile Plant</td>
<td>HSE Management Plan Job Safety Environmental Analysis (JSEA) – for specific tasks Safe Work Method Statement (SWMS) - if working on the defined construction site</td>
</tr>
<tr>
<td><strong>MEDIUM RISK or PERIOD CONTRACTS</strong></td>
<td>Test &amp; Tag Waste Removal Cleaning</td>
<td>HSE Management Plan Job Safety Environmental Analysis (JSEA) – for specific tasks Safe Work Method Statement (SWMS) - if working on the defined construction site</td>
</tr>
<tr>
<td><strong>LOW RISK / SINGLE TRADE</strong></td>
<td>Trainers &amp; Assessors Electrical fit-out Plumbing</td>
<td>Job Safety Environmental Analysis (JSEA) Safe Work Method Statement (SWMS) - if high-risk or if working on the defined construction site</td>
</tr>
</tbody>
</table>

Table 1: HSE Documentation Required for Contracts
THE DAY TO DAY MANAGEMENT OF THE CONTRACT

- The Contract Owner may appoint a Contractor Coordinator to assist with the day to day management of the contract.

- The Contractor Coordinator is the CSIRO Point-of-Contact for the contract; ideally this person should be onsite where the service or goods are being provided.

DUTIES OF THE CONTRACTOR COORDINATOR

- The Contractor Coordinator will confirm the risk assessment documents needed and obtain on the Contract Owner’s behalf.

- Ensure the Contractor is appropriately inducted (see Section 2). The induction will cover the following:
  - Verify the Contractor is suitably qualified and competent to undertake the task/s by sighting licences, qualifications etc.
  - Ensure the Contractor is aware of the need to wear ID at all times.
  - Ensure the Contractor reports all workplace HSE incidents:
    - CSIRO Controlled Site: within 24hrs; serious injury within 2hrs
    - Contractor Controlled Site: within 7 days (non-serious injury)

3.4 FURTHER INFORMATION

- CSIRO Procedure: Contractor HSE Management
4. PURCHASING INSTRUCTIONS

4.1 PURPOSE

• The purpose of this instruction is to detail the actions required by CSIRO managers, staff members and affiliates PRIOR TO purchasing certain items of plant, equipment, chemicals and other substances.

4.2 APPLICATION

• All ASKAP staff members for action.

4.3 INSTRUCTIONS

4.3.1 BACKGROUND

• Many HSE hazards can be eliminated or reduced simply by identifying potential sources of risk before the object is permitted into the workplace.

• Additionally, there are a number of legal and training requirements governing [potentially] hazardous items that must be taken into consideration. Items such as:
  
  o plant, e.g. mobile crane;
  
  o chemicals;
  
  o scheduled poisons; and
  
  o radiation sources.

4.3.2 REQUIREMENTS PRIOR TO ANY PURCHASE

• STEP 1: Determine if the item is listed in the IPT(s) HSE Risk Management Plan.

• STEP 2A. If it is already listed, consider reviewing the existing and proposed risk controls. No further action required.

• STEP 2B. If it is not listed, complete the HSE Pre-purchase Checklist then add the item to the relevant IPT(s) HSE Risk Management Plan.

• STEP 3: After completing the checklist, complete an HSE Pre-Purchase Approval Form.
4.4 FURTHER INFORMATION

- CSIRO Procedure: [HSE in Procurement](#)
5. LEGAL OBLIGATIONS

5.1 PURPOSE

- To ensure all ASKAP staff members and affiliates are aware of the legal framework in which operations and research are conducted.

5.2 APPLICATION

- Generally, to all ASKAP staff and affiliates.

5.3 INSTRUCTIONS

- CSIRO policy requires that all activities be conducted in accordance with the applicable legislative, regulatory and licensing requirements.

- Where there is an apparent difference between Commonwealth and State requirements, further advice must be sought from the HSE Officer, CASS HSE Leader &/or the Regulating Authority, e.g. Comcare [Cw’th], Dept of Commerce [WA].

5.3.1 HEALTH & SAFETY

- There are health and safety topics that Commonwealth OHS legislation does not cover, examples include:
  
  - High-risk work licensing requirements
  - Asbestos removal work
  - Fatigue/work hours management

- Whenever the Commonwealth OHS legislation is silent the relevant State-based legislation, Code of Practice and Guidance Note shall be adopted with the following notes:
  
  - NSW High-risk work licences are valid at the MRO
  - Holders of NSW Electrician licences should apply for a WA licence too

- Commonwealth occupational health and safety (OHS) requirements are described in the OHS Act 1991 [Cw’th], and as a ‘premium paying agency’ operating under the Comcare Scheme of OHS regulatory governance CSIRO is classed as an employer.
• Generally, through a series of delegations CSIRO managers represent the interests of the employer and are referred to as both an employee and may also be, to the level of delegation, an employer.

• It is Comcare’s duty to enforce Commonwealth OHS legislation and provide injured workers with support. Commonwealth OHS legislation includes:

<table>
<thead>
<tr>
<th>Legislative Instrument</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OHS Act 1991</strong></td>
<td>Details employer, manufacturer, supplier, installer and employee responsibilities. Also details responsibilities of Commonwealth Contractors in control of a site.</td>
</tr>
<tr>
<td><strong>OHS (Safety Arrangements) Regulations 1991</strong></td>
<td>Regulations that interpret and prescribe the reporting requirements from employers to Comcare. Also details the process of election of Health &amp; Safety Representatives.</td>
</tr>
<tr>
<td><strong>OHS (Safety Standards) Regulations 1994</strong></td>
<td>Regulations that interpret and ‘prescribe’ the requirements of the OHS Act 1991. These regulations stipulate the risk assessment and control of a variety of workplace hazards.</td>
</tr>
<tr>
<td><strong>OHS Code of Practice 2008</strong></td>
<td>Outlines minimum standards of health and safety in Commonwealth workplaces. Enforceable unless an employer can produce evidence that shows a higher standard has been adopted in their workplace.</td>
</tr>
<tr>
<td><strong>Safety, Rehabilitation and Compensation Act 1988</strong></td>
<td>Details provisions for Government and third parties injured as a result of the undertakings of a Commonwealth agency.</td>
</tr>
</tbody>
</table>

Table 2: H&S Legislative Instrument Summary Table
### ENVIRONMENT & HERITAGE PROTECTION

- Commonwealth, State and Local Government environmental protection legislative requirements include:

<table>
<thead>
<tr>
<th>Legislative Instrument</th>
<th>Summary</th>
</tr>
</thead>
</table>
| Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (C’wlth) | Outlines expectations to:  
  - Identify any threatened species prior to construction of any infrastructure within areas of native vegetation.  
  - Prohibition on the clearing of the species listed in Appendix. |
| Environment Protection Act 1986 (WA) | Although not [required to be] formally assessed under this Act, the EPA Act 1986 did require ASKAP to apply for a vegetation clearing permit. The conditions of this permit include:  
  - Avoid, minimise etc clearing vegetation.  
  - Ensure adequate weed control to earthmoving vehicles, soil, mulch and fill brought into the site.  
  - Maintain adequate records of vegetation cleared.  
  - Report to the EPA CEO before 30 June each year on the undertaking with regards to the permit. |
| Land Administration Act 1997 (WA) | Being the lease holder from the Crown, CSIRO must follow some environmental conditions in this lease agreement, as follows:  
  - Have the Lessor’s agreement to dig, extract etc  
  - Have the Lessor’s agreement to cut down trees  
  - Have the Lessor’s authorisation before conducting any activity, including the Permitted Use  
  - Report to the Lessor any advise environmental contamination or Environmental Notice |
| Aboriginal Heritage Act 1972 (WA) | This Act protects aboriginal sites of significance. Within the MRO site there was no listed Aboriginal Heritage Sites (searched 3/12/2009) however, various sites of significance were identified and recorded. |
| MRO Indigenous Land Use Agreement (2009) | A mutually beneficial partnership with the Wajarri Traditional Owners outlining, amongst other things, the ‘Access Protocol’ (Schedule 4) |

Table 3: Environment & Heritage Legislative Instrument Summary Table
5.4 FURTHER INFORMATION

- **CSIRO HSE Management Standard**

- Further guidance on HSE legislation and licensing can be obtained from the CASS BU HSE Leader, Kylie Fraser.

- Further guidance on heritage protection legislation and the ILUA can be obtained from the Aboriginal Liaison Officer, Robin Boddington or from Michelle Storey.
6. HSE RISK MANAGEMENT & PLANNING

6.1 PURPOSE

- OHS and Environmental legislation requires that HSE risk management be conducted prior to commencing work. The rigour of assessment is naturally commensurate with the risk (or perceived risk) of the task or activity.

- CSIRO expects that staff members and affiliates will perform HSE risk assessment to better appreciate the job ahead and the likely consequences should something go wrong.

- Risk management is a three step process of:
  - Spotting the hazard (HAZARD IDENTIFICATION)
  - Assessing the risk (RISK ASSESSMENT), and
  - Making the changes (RISK CONTROL).

6.2 APPLICATION

6.2.1 IPT LEADER’S/MANAGER’S RESPONSIBILITIES

- Develop and implement an IPT-specific HSE Risk Management Plan that records the HSE risk controls for work or activities for which they are responsible.

- Ensure that all high-risk tasks are covered by a Safe Work Method Statement (SWMS).

- The HSE Officer will assist the IPT Leader and Manager to store the HSE Risk Management Plan in a central repository online.

6.2.2 MANAGER’S RESPONSIBILITIES (INCL. TEAM LEADERS)

- Develop the HSE Risk Management Plan, relevant Risk Control Plans & Safe Work Method Statements in consultation with staff and affiliates.

- Involve HSE staff and specialists in the risk assessment processes to ensure all hazards and related risks are accounted for and appropriate controls are developed for implementation.

- Review risks and controls, and update the HSE Risk Management Plan:
  - Where a change is proposed that could change the level of risk
  - When new people join the group
At least annually (March/April) or more often when the degree of risk indicates this is required.

6.2.3 CSIRO STAFF MEMBERS & AFFILIATES RESPONSIBILITIES

- Contribute as appropriate to the identification of hazards, the assessment of risks and the development of appropriate controls to be recorded in the HSE Risk Management Plan.
- Be aware of HSE hazards and the risk controls developed to protect against the hazards, and sign the HSE Risk Management Plan, or any other risk management/control form.
- Work in accordance with the defined risk controls.

6.3 INSTRUCTIONS

- All ASKAP staff and affiliates must be signed onto relevant and up-to-date HSE Risk Management Plan/s.
- All risk assessments will be performed with reference to the CSIRO Risk Matrix, contained within the HSE Management Plan Template.

6.3.1 HSE RISK MANAGEMENT PLAN (FORMERLY: HSEACW)

- The CSIRO procedure for conducting HSE risk management is centred on the document called an HSE Risk Management Plan (formerly: HSEACW).
- Because the HSE Risk Management Plan is written to cover the tasks performed by a work group it may be necessary to sign onto multiple HSE Risk Management Plans.
- The process for developing the HSE Risk Management Plan remains unchanged from the previous HSEACW procedure, it is as follows:
  - 1. Describe Work Area/Tasks and staff involved
  - 2. H&S Hazard and Environmental Identification Guide
  - 3. HSE Risk Matrix
  - 4. H&S and Environmental Risk Assessment
  - 5. H&S and Environmental Risk Control Guide (Section 5a and 5b)
  - 6. HSE Risk Management Plan - Action sheet
  - 7. HSE Risk Control Plan Closure Form
  - 8. HSE Risk Review Process
6.3.2 ASKAP HSE RISK MANAGEMENT PLANS (HSE-RMPs)

- In the ASKAP Project, many of the HSE risks are present across all IPTs, e.g. collision with mobile plant, vehicle accident, exposure to the natural elements. For this reason many of the IPT-specific HSE Risk Management Plans will be similar.

- Many ASKAP staff work across multiple IPTs meaning that these individuals will simply need to sign onto more than one HSE-RMP.

- IPT Leaders are accountable to the Project Director for the successful implementation of HSE Risk Management Plans.

ASKAP 01 – MRO IPT HSE-RMP
Scope: Tasks performed by MRO IPT & non-ASKAP staff & affiliates at MRO & MSF

ASKAP 03 - ANT IPT HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 04 - ANS IPT HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 05 - CMPT IPT HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 06 - DGS IPT HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 07 – GEOTHERMAL COOLING HSE-RMP
(Specific Risks of the Geothermal Cooling Experiment)

ASKAP 08 – SIGNALS & EMC IPTs HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 09 – SEIC IPT HSE-RMP
(MRO + IPT Specific Risks)

ASKAP 10 – MATES HSE-RMP
(IPT Specific Risks)

ASKAP HSE STRATEGIC PLAN
6.3.3 ADDITIONAL (MANDATORY) RISK ASSESSMENTS

- While the HSE Risk Management Plan serves as an overall assessment of an IPT's general work, additional specific risk control plans must be completed for work comprising of the following hazards/situations:

<table>
<thead>
<tr>
<th>Category of Work or Hazard</th>
<th>When</th>
<th>Type of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant &amp; Equipment (especially lifting ops)</td>
<td>Inherent Risk SIG or HIGH</td>
<td>Plant Risk Control Plan</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Inherent Risk SIG or HIGH</td>
<td>HAZSUB Risk Control Plan</td>
</tr>
<tr>
<td>Gases</td>
<td>Inherent Risk SIG or HIGH</td>
<td>Gas Risk Control Plan</td>
</tr>
<tr>
<td>Electrical Work</td>
<td>Prior to all Electrical Work (see definition)</td>
<td>Electrical Safety Risk Control Plan</td>
</tr>
<tr>
<td>Radiation Sources</td>
<td>Ionising Radiation Sources &amp; High-power Non-Ionising Radiation Emitters</td>
<td>Radiation Risk Control Plan</td>
</tr>
</tbody>
</table>

One-off Tasks
- A task not covered by a Risk Management Plan
- All high-risk construction tasks

Table 4: Mandatory Risk Assessments that must be completed prior to task commencement

6.3.4 RISK CONTROL PLANS (CHEMICAL, GAS, ELECTRICAL, RADIATION)

BACKGROUND

- A Risk Control Plan is essentially an HSE risk assessment for an individual item, group of related items or a system, e.g. mobile crane, cleaning solvents, a 4WD. It details very exact requirements for managing the inherent risks.
- Risk Control Plans are mandatory under CSIRO Procedure for SIGNIFICANT and HIGH risk chemicals, gases, routine electrical work and radiation sources/emitters.

ACTION REQUIRED

- The IPT-specific HSE Risk Management Plan must identify those items that require a Risk Control Plan.
- The Risk Control Plan must be completed by a competent person prior to task commencement (see definition).
HOW TO USE

_**Plant Risk Control Plan – SIGNIFICANT & HIGH RISK EQUIPMENT**_

1. Document the need to operate, maintain, clean, store &/or dispose of an item of plant or equipment in the _HSE Risk Management Plan_.

2. Gather supporting documentation for the plant item, e.g. operators and maintenance manuals.

3. Determine what, if any, are the licensing requirements, e.g. registration with Comcare. Consult HSE staff for assistance if required.

4. Determine the training requirements to operated the item of plant legally and safely, especially if use of the item requires a _high risk work licence_, e.g. dogging, rigging, forklift etc.

5. Complete the _Plant Risk Control Plan_ tool.

6. Ensure all users read and acknowledge the Risk Control Plan.

7. Ensure all operators are _authorised_ (see definition) by the relevant manager to operate the item. See _Authorisation to Operate Plant_ form (Enclosure 04).

_**HAZSUB Risk Control Plan – SIGNIFICANT & HIGH RISK Chemicals**_

1. Document the need to work with, store &/or dispose of a chemical (including lead-acid batteries) in the _HSE Risk Management Plan_.

2. Gather supporting documentation for the chemical item, e.g. MSDS and additional manufacturer/supplier information sheets. Provide this information to the Site Manager, Supervisor or Coordinator.

3. Determine what; if any, are the governing legislative requirements, e.g. is the chemical a scheduled (controlled) substance or does the chemical have _medical surveillance_ requirements. Consult HSE staff for assistance.


5. Ensure all users read and acknowledge the Risk Control Plan.

**NOTE**: An MSDS must accompany all _hazardous substances_ and _dangerous goods_ being brought onto site any CSIRO site/facility.

_**Gas Risk Control Plan – SIGNIFICANT & HIGH RISK Gases**_

1. As above, except use the _Gas Risk Control Plan_ tool.
**Electrical Safety Risk Control Plan**

1. Document the need to conduct electrical work in the *HSE Risk Management Plan*

2. Ensure qualifications of electrical workers have been verified, refer to: [Verification of Electrical Licence & Qualifications form](#)

3. Complete [Electrical Safety Risk Control Plan](#) tool for each task / group of tasks that are routine

4. For each instance of electrical work:
   - Determine if any penetrative or excavation work will be undertaken
   - Determine if the electrical work is inside a hazardous or flammable atmosphere
   - Determine if a contractor will perform the work

5. If yes to any of the above, a *Permit to Work* must be completed (see below - *Permits to Work*)

**Radiation Risk Control Plan**

1. Document the need to procure and use radiation sources and high-powered emitters in the *HSE Risk Management Plan*

2. Procure the item in consultation with the *CSIRO Radiation Safety Manual*

3. Complete the [Radiation Risk Control Plan](#) tool for each task / group of tasks involving the radiation source or emitter
6.3.5 **ONE-OFF TASKS & HIGH RISK WORK**

**BACKGROUND**

- There are times when a CSIRO staff member or affiliate must perform a task that is not covered in their group’s *HSE Risk Management Plan*. A risk assessment of the task must still be performed.

- Two types of one-off risk assessments are available in CSIRO:
  - Job Safety & Environment Analysis (JSEA)
  - Safe Work Method Statement (SWMS)

- Certain tasks are deemed as *high-risk construction work* by OHS law (see definition). These tasks must be subject to a SWMS and not a JSEA. While similar, the SWMS assessment is more thorough than a JSEA, recording qualifications, inspections and training required to perform the task.

**NOTE:** To avoid confusion the ASKAP Project will only use **SWMS** and not JSEA for one-off tasks and *high-risk* work.

**ACTION REQUIRED**

- Prior to undertaking any task that poses risk to health, personal safety or the environment not already covered by a *HSE Risk Management Plan* a **SWMS** must be completed and signed by the person’s line manager (or Site Manager in their absence).

- If the task becomes routine then it should be added to the *HSE Risk Management Plan* and a *Safe Work Instruction* (SWI) developed.

**HOW TO USE**

- The **SWMS** is an intuitive assessment. The person performing the task fills out the form line-by-line, breaking down the whole job into 'process steps', assessing the HSE risk at each step.

- Each member performing &/or supervising the task must sign onto the **SWMS**.

- The **SWMS** should be reviewed:
  - prior to task commencement;
  - whenever any process step changes;
  - routinely at toolbox talks; &
  - a full review annually.

- The **SWMS** template is available at Enclosure 03 at the MRO in the Site Office and online.
6.3.6 SAFE WORK INSTRUCTIONS (SWI)

BACKGROUND

- After identifying the HSE risks of a task in the IPT’s HSE Risk Management Plan, and further controlled the risks in a Risk Control Plan the next step is to document how to actually perform the job safely.

- The Safe Work Instruction (SWI) is a step-by-step guide to the task and the HSE risks one can expect to encounter.

- The SWI is a ‘workplace’ or ‘team’ level instruction approved by the line manager.

ACTION REQUIRED

- Any task that is routinely performed by CSIRO staff or their affiliates should be documented in a SWI.

- CSIRO procedure requires an SWI be developed for the following tasks, if performed routinely:
  
  - Routine electrical work
  - Safe methods for performing manual handling with mechanical devices
  - Control and use of firearms
  - Exposure to hazardous substances
  - Operation of SIGNIFICANT and HIGH Risk plant & equipment (incl. vehicles)
  - Isolating energy sources (i.e. lock-out / tag-out)
  - Working Alone
  - Working at Heights

HOW TO USE

- The Corporate SWI template must be used. The SWI is ‘free-text’ permitting the author maximum flexibility. Only one specific requirement exists regarding SWI content:
  
  - Corporate procedure requires that all Working at Heights SWIs cover “the prevention of injuries or damage occurring as a result of falling objects.”

- The SWI should direct the reader through a step-by-step approach of how to perform the task safely.

- Completed SWI’s must be approved by the line manager, displayed in a prominent position and saved electronically on the HSE SharePoint website.
6.3.7 PERMITS-TO-WORK

BACKGROUND

- CSIRO HSE Procedure requires that in some situations a nominated person must physically approve task commencement. This measure is called a *permit to work*.

- Of note: the method of permitting work to commence is not mandated, i.e. locally developed controls such as a *Scaff-Tag™* card system (for permitting scaffold work) are possible.

ACTION REQUIRED

- A permit-to-work must be obtained **prior to** performing the following task/s:

<table>
<thead>
<tr>
<th>Task</th>
<th>Permit-to-Work Description</th>
<th>Form of Permit</th>
<th>Permit Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined Space Entry</td>
<td>Confined Space Entry Permit</td>
<td><em>Entrytag®</em> tag system (scan &amp; file copy)</td>
<td>Single Task (Max 24hrs)</td>
</tr>
<tr>
<td>Penetrating Works (see def.)</td>
<td>Penetrating/Excavation Works Permit</td>
<td>Paper form</td>
<td>Single task or Periodic</td>
</tr>
<tr>
<td>Excavation (see def.)</td>
<td>Penetrating/Excavation Works Permit</td>
<td>Paper form</td>
<td>Single task or Periodic</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Asbestos Permit to Work</td>
<td>Paper form</td>
<td>Single task or Periodic</td>
</tr>
<tr>
<td>Hot Work</td>
<td>Hot Work Permit</td>
<td>Paper form</td>
<td>Single task or Periodic</td>
</tr>
<tr>
<td>Working at Height – Mobile Tower</td>
<td>Working at Height Permit</td>
<td>Plastic tag system</td>
<td>Single task, Periodic or After relocation</td>
</tr>
</tbody>
</table>

Table 5: MRO/MSF Permit to Work System

- Permits can be obtained from the CSIRO MRO Site Office and Wittenoom Cottage Office

- **The Work Permit Officer is the MRO Site Manager.** An Assistant Work Permit Officer may be nominated at the Site Manager’s discretion.
6.4 FURTHER INFORMATION

- CSIRO Procedure: HSE Risk Management
- CSIRO HSE Guideline: HSE Risk Management
- CSIRO Procedure: Permit to Work
- CSIRO HSE Guideline: Permit to Work
- CSIRO Procedure: Plant Safety
- CSIRO Procedure: Hazardous Substances Safety
- CSIRO Procedure: Gas Safety
- CSIRO Procedure: Firearms Safety
- CSIRO Procedure: Electrical Safety
- CSIRO Procedure: Radiation Safety
- CSIRO Form: Safe Work Method Statement (SWMS)
- CSIRO Form: Safe Work Instruction (SWI)
7. ASKAP HSE HAZARDS & THEIR MANAGEMENT

7.1 PURPOSE

- To outline the majority of HSE hazards and controls in operation at the MRO to CSIRO staff and affiliates during the construction, commissioning and operation of the ASKAP telescope.

7.2 APPLICATION

- The instructions below are sourced from HSE legal requirements and CSIRO corporate procedure; applicable to all staff and affiliates for action.
7.3 WILDLIFE

7.3.1 SNAKES

**WARNING**

SNAKES HAVE BEEN SIGHTED AT THE BOOLARDY ACCOMMODATION FACILITY & MRO. STAFF SHOULD EXERCISE EXTREME CAUTION AT NIGHT.

- Most snake bites happen when people try to catch, corner or kill snakes. Look where you put your feet and your hands. Apply caution before lifting up any large objects from the ground where you cannot see underneath; snakes are least active during the cooler months of the year.

- Snakes don't like or seek human company, allow them an escape path.

- Amongst others, snakes of the Murchison include:

  ![King Brown or Mulga Snake](image1.png)
  ![Spotted/Butler’s Mulga](image2.png)
  ![Western Brown / Gwarder](image3.png)
  ![Desert Death Adder](image4.png)

  Source: Australian Venom Research Unit [http://www.avru.org]
7.3.2 INSECTS

- If visiting the site in warmer months of the year beware of the large numbers of flies. At the change of season, e.g. autumn to winter, there may be a large presence of sandflies.

- The Murchison Shire Council warns of the mosquito-borne disease called ‘Ross River Virus’.

- It is recommended you cover exposed skin and apply mosquito repellent when working in the twilight and evening hours.

7.3.3 SPIDERS

- Many Australian spiders are poisonous, and some bites can, at least in theory, be fatal.

- The Redback Spider is the most dangerous spider to be found at Boolardy and the MRO.
  - Bites are painful and the venom can stay in the body for months.
  - Asides from its distinctive markings, the Redback spider’s web is notable for being disorganised and irregular in appearance.

7.3.4 LIZARDS AND GOANNAS

- Goannas or monitor lizards are a common sight in the MRO, and they can be over two metres long!

- Goannas can rear up on their hind legs and will appear threatening. Sometimes they do it to scare off attackers and investigate anything they hear as suspicious.

- They are effectively blind yet are quick sprinters and will run up and over your upright body if you resemble the nearest tree and they feel threatened.

- Offer them a wide berth if sighted.
7.3.5 STANDARD PRECAUTIONS

- A number of MSF staff members hold snake-handling competence. If a snake is sighted, stop, back away slowly, secure the area of all personnel and advise a member of the MSF team.

- Before moving about the MRO or accommodation facility after dark ensure portable lighting (torch or lantern) is readily available.

- Conduct a thorough check of accommodation room before entering with luggage.

- Do not leave boots outside during evening hours.

- Management does not advise leaving the accommodation facility for exercise alone after dark.

- When lifting flat and bulky equipment or materials from the ground assume a snake is underneath and provide an escape path AWAY FROM YOU.

- As far as possible, materials and equipment should be not be left outdoors

7.3.6 ROUTINE PREVENTATIVE ACTIVITIES

- Grasses and other vegetation are kept well back from the accommodation areas and pathways

- Outdoor lighting is inspected and maintained

- Housekeeping inspection performed daily
7.4    EXPOSURE TO THE ELEMENTS – HEAT ILLNESS

7.4.1    BACKGROUND

- While it is common knowledge to apply suncare basics, e.g. sunscreen and wide-brim hat, the measurement of the ability to safely work in extreme temperatures is not so well known.

DEHYDRATION

- Recognition of dehydration and the onset of heat illness is the first step in management and prevention.

- When experiencing dry mouth, slight dizziness, loss of balance and general confusion it is important to seek shelter, break and replenish fluids.

HEAT EXHAUSTION & HEAT CRAMPS

- “Heat exhaustion is caused by excessive exposure to heat and the depletion of body fluids. Victims sweat profusely and may shiver and have goose bumps. Weakness, nausea, dizziness, headache, poor judgment, rapid pulse, and a normal or slightly elevated body temperature are present.

- Heat cramps occur in healthy individuals during or following strenuous physical activity. Muscles, oftentimes those in the calf, cramp and produce severe pain.

HEAT STROKE

- Heatstroke develops when the body is unable to dissipate excess heat under various combinations of high environmental temperature, high humidity, lack of wind, vigorous activity, heat retaining clothing, and dehydration.

- Early symptoms include excessive sweating, headache, nausea, dizziness, hyperventilation, and disturbance of consciousness.

- Consciousness may be lost or clouded and there may be hallucinations. There may be muscle twitching or convulsions and loss of control of the body sphincters.” (US Air Force, 2002)
7.4.2 INSTRUCTIONS

- Vehicles are to carry sufficient water (approx 10L/per person) to cope with an extended wait in the event of a vehicle breakdown or delay due to road conditions.

WORKING IN THE HEAT – THERMAL LIMITS

- There are a number of heat stress indices in use throughout the world, two of the more popular measurements include:
  - Thermal Work Limit (TWL) – used throughout the resources sector
  - Wet Bulb Globe Temperature (WBGT) – used by the military and in sports science

- An accurate measurement of the WBGT should be taken routinely by the Site Manager, HSE Officer or Team Leader and promulgated effectively.

- The following thermal restrictions MUST be observed:

<table>
<thead>
<tr>
<th>WBGT</th>
<th>RISK</th>
<th>RESTRICTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;26.6</td>
<td>LOW</td>
<td>NIL</td>
</tr>
<tr>
<td>26.7 to 29.3</td>
<td>MEDIUM</td>
<td>REGULAR BREAKS</td>
</tr>
<tr>
<td>29.4 to 31</td>
<td>HIGH</td>
<td>MORE FREQUENT BREAKS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAX 8HRS WORK</td>
</tr>
<tr>
<td>&gt;31</td>
<td>EXTREME</td>
<td>NO WORKING ALONE³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAX 6HRS WORK</td>
</tr>
</tbody>
</table>

Table 6: WBGT Risk Table (Limits Developed from: USAF Pamphlet 48-151 "Thermal Injury")

**NOTE:** Managers must be aware that many factors influence a person’s ability to work in the heat and tasks should be adjusted accordingly, factors to consider include:

- Age
- Sex
- Level of fitness
- Pre-existing illness, e.g. kidney disease or hypertension
- Acclimatisation

³ See definition in Glossary
STANDARD PPE

• When working outdoors, CSIRO staff and affiliates must wear:
  o long-sleeved shirts;
  o long-length trousers;
  o wide-brimmed hat with back ‘flap’;
  o safety glasses; &
  o sunscreen on any exposed skin

TASK/ACTIVITY PLANNING

• *Team Leaders* are responsible for planning the working day so to avoid or minimise outdoor ‘exposed’ tasks during the peak UV radiation times (typ. 10am-3pm).

• Wherever practicable *IPT Leaders* and *Managers* should schedule outdoor work to be performed in cooler months of the year.

7.4.3 FURTHER INFORMATION

• [Bureau of Meteorology - Thermal Stress](#)
• [US Air Force Pamphlet: Thermal Injury](#)
• [Sports Medicine Assoc (SA): Hot Weather Guidelines](#)
7.5  **FATIGUE MANAGEMENT**

7.5.1  **POLICY STATEMENT**

- All ASKAP Managers, affiliates and contractor coordinators shall adopt fatigue risk management procedures, practices and processes in order to effectively control fatigue-based hazards at CSIRO-controlled sites.

7.5.2  **BACKGROUND**

- Fatigue has been attributed as a major causal factor in some of the most horrific transport accidents of recent history and an underlying factor in many industrial HSE incidents.

- All ASKAP Managers and Contractor Coordinators have a duty of care under Commonwealth law to ensure staff, affiliates and contractors are not being required to operate under elevated fatigue levels.

7.5.3  **TASK & ROSTER PLANNING**

- ASKAP Managers and Contractor Coordinators must consider the following factors when planning project activities, particularly at the MRO:

<table>
<thead>
<tr>
<th>1. Working hours management</th>
<th>1.1. Daily, weekly, monthly limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2. Fly-in-fly out type arrangements</td>
</tr>
<tr>
<td></td>
<td>1.3. Nightwork</td>
</tr>
<tr>
<td></td>
<td>1.4. Breaks during work</td>
</tr>
<tr>
<td></td>
<td>1.5. Breaks between ‘on duty’ times, i.e. down time</td>
</tr>
<tr>
<td></td>
<td>1.6. ‘Seasonal’ work periods, i.e. periods of increased work tempo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Demands of the work tasks</th>
<th>2.1. Repetitive work (physical &amp;/or mental)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.2. Physically demanding work</td>
</tr>
<tr>
<td></td>
<td>2.3. High concentration and/or mentally demanding work</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Fatigue critical tasks where there are potentially increased risks, e.g. transporting passengers or heavy loads</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4. Extended exposure to hazards</th>
<th>4.1. Exposure to hazardous substances and atmospheric contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.2. Exposure to noise</td>
</tr>
<tr>
<td></td>
<td>4.3. Exposure to extreme temperatures</td>
</tr>
<tr>
<td></td>
<td>4.4. Exposure to vibration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Information and training</th>
<th>5.1. Provision of information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.2. Provision of training</td>
</tr>
<tr>
<td></td>
<td>5.3. Training on job skills</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. Supervision</th>
<th>6.1. Adequacy of supervision</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>7. Individual and lifestyle factors</th>
<th>7.1. Individual factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.1.1. Sleep (amount and quality)</td>
</tr>
<tr>
<td></td>
<td>7.1.2. Health</td>
</tr>
<tr>
<td></td>
<td>7.1.3. Fitness for work</td>
</tr>
<tr>
<td></td>
<td>7.2. Lifestyle factors</td>
</tr>
</tbody>
</table>
7.5.4 INDIVIDUAL LIMITS

- **Fortnightly Limit**: All CSIRO staff, affiliates and ASKAP contractors shall have a continuous rest period of at least 36 hours in any 14 consecutive days, i.e. maximum 12.5 working days per fortnight.

- **Daily Limits**: Time on-duty must not exceed 12 hours without authorisation by the Site Manager or Project Director.

- The *working day* shall be preceded at all times by a *rest period* of:
  
  o Eleven consecutive hours, where the rest period embraces the hours between 10pm and 6am local time or,
  
  o Twelve consecutive hours.

- *Rest period* should cover sufficient time at *suitable sleeping accommodation*.

- **Extensions**: The Site Manager or Project Director may authorise an extension of on-duty time of up to a total of 16 hours.

  **NOTE**: Those persons afforded such an extension beyond 12 hours must be given a *rest period* of 11 hours plus 2 hours for every 1 hour exceeding the 12 hour daily limit.

- Examples of extended on-duty time is shown below:

<table>
<thead>
<tr>
<th>On-duty</th>
<th>Hours over daily limit</th>
<th>Rest Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 hours</td>
<td>2 hours</td>
<td>11 + (2\times2) = 15 hours</td>
</tr>
<tr>
<td>16 hours</td>
<td>4 hours</td>
<td>11 + (4\times2) = 19 hours</td>
</tr>
</tbody>
</table>

7.5.5 HIGH-RISK & FATIGUE CRITICAL TASKS

- A person must not perform high-risk construction work or a fatigue critical task unless:
  
  o the person has had the required minimum rest period free of duty; and
  
  o the person has had the opportunity to take adequate sustenance; and
  
  o the person is free of any fatigue, illness, injury, medication or drug which could affect the safe exercise of his or her operations.

- Where an ASKAP staff member or affiliate performs *high-risk construction work*, e.g. crane operator or dogman, and/or *fatigue critical task(s)*, e.g. work at heights, this person **must not perform greater than 8 hours** of this type of work during any given 24 hours period.

- Extensions beyond this limit must be granted as per the process above.
7.5.6 FURTHER INFORMATION

- Commission for Occupational Safety and Health (WA); *Code of Practice: Working Hours; 2006*
# 7.6 VEHICLE FLEET MANAGEMENT

## 7.6.1 BACKGROUND

- Travelling to/from the MRO is arguably the highest risk activity ASKAP staff and affiliates undertake on a routine basis.

- It is most important that vehicles are maintained to a serviceable standard, driven only by trained staff and that any issues are promptly reported to the Fleet Coordinator &/or Site Manager.

## 7.6.2 RESPONSIBILITIES

| MRO/MSF Site Manager | • Remove from service any vehicle or trailer that is not roadworthy or otherwise unsafe to operate  
| | • Oversee the vehicle and trailer preventative maintenance program  
| | • Ensure all vehicles purchased for the MRO or MSF are, at minimum, ANCAP ‘4-Star’ safety rating  
| | • Sponsor the ASKAP 4WD Operators Manual  
| Team Leaders | • Ensure all drivers meet competency (licence and training) requirements  
| | • Ensure all drivers have completed a ‘Driver Approval Acknowledgment’ Form  
| | • Ensure all vehicle loads are properly restrained  
| | • Manage driver fatigue  
| | • Ensure call-back &/or SPOT position is reported on arrival at destination (non-metro trips)  
| Vehicle Fleet Coordinator (MSF Admin Officer) | • Maintenance scheduling  
| | • Issue keys, emergency kits and SPOT devices to authorised staff  
| | • Report vehicle hazards and problems to MRO/MSF Site Manager, as required  
| Drivers | • Operate vehicles in accordance with legislation, CSIRO procedure and the ASKAP 4WD Operators Manual SWI  
| | • Familiarise themselves with each vehicles’ particular handling characteristics and features  
| | • Complete the ‘Driver Approval Acknowledgment’ form  
| | • Utilise the Vehicle Logbook to keep track of mileage & vehicle maintenance issues  

7.6.3 COMPETENCY REQUIREMENTS

- All drivers must possess a valid licence for the class of vehicle being driven and complete a *Driver Approval Acknowledgment Form* prior to operating.

- All staff members driving to/from and within the MRO must demonstrate they have achieved a level of skill in operating a 4WD to meet VTAB competency unit RIIVEH305A. This can be done via:
  
  o successfully completing a Recognition of Prior Learning (RPL) assessment
    
    Process:
    
    - Request the RPL assessment from either: Barry Turner, Kylie Fraser or Brayden Briggs
    - Hand completed assessment to Gordon Xue
    - Independent 4WD specialists at Great Divide Tours will grade the assessment and advise of the outcome
    
  o attending the 4WD course at Braidwood with Great Divide Tours in NSW
  
  o attending the Occupational 2 day 4WD course run by Drive Safe Australia in WA

- Staff visiting the MRO for the *first time* MAY NOT drive by themselves.

7.6.4 VEHICLE REQUIREMENTS AT THE MRO

- All vehicles driven to/from or at the MRO must be equipped at minimum with:
  
  o UHF radio
  
  o Off-road tyres
  
  o 4WD transmission
  
  o 2x Spare wheels
  
  o First aid kit
  
  o Fire extinguisher
  
  o Tow rope and 2x Shackles
  
  o Flashing Light
  
  o Driving Lights (if driving after dark)
  
  o 10L of water per person
7.6.5 OPERATION

- All MSF/MRO vehicles are to be operated in accordance with the *ASKAP 4WD Operators Manual* (Enclosure 05).

- When used for regional travel, i.e. long distance journeys outside of Geraldton, **all other MSF vehicles** must be operated in accordance with the 4WD Operators Manual, i.e. carry an emergency kit, water, SPOT device/call-back procedure, etc.

- CSIRO staff members and affiliates are reminded that CSIRO vehicles and fittings, e.g. vehicle emergency kits, are Commonwealth property and handled as such.

- Lost or damaged vehicle parts or fittings must be reported to the HSE Officer &/or Site Manager at first available opportunity.

7.6.6 TRAILERS & LOAD RESTRAINT

- Trailers may only be towed by competent and authorised people off-road, where ‘off-road’ is defined as any unsealed road surface.
  
  - The MRO/MSF Site Manager will authorise individuals on a case-by-case basis using the *Authorisation to Operate Plant* (Enclosure 04) form to record the authorisation.

- Awkward and heavy loads must be handled in accordance with **CSIRO manual handling procedure**.

- *Team Leaders* are responsible for ensuring that heavy, awkward and fragile loads are properly restrained by competent staff members or affiliates.
  
  - Further advice on vehicle load restraint techniques is available from all MSF staff.

7.6.7 FURTHER INFORMATION

- Enclosure 04: Authorisation to Operate Plant Form

- Enclosure 05: ASKAP 4WD Operators Manual

- **CSIRO HSE Procedure: Vehicle Use Safety**

- **CSIRO HSE Guideline: Vehicle Use Safety**

- **CSIRO HSE Procedure: Ergonomics & Manual Handling**

- **CSIRO HSE Guideline: Ergonomics & Manual Handling**
7.7 PLANT & EQUIPMENT

7.7.1 BACKGROUND

- Broadly speaking, *plant* refers to any tool or instrument that is needed to perform a work task. The term most commonly refers to equipment used in the workplace that has the *potential to harm* somebody or the natural environment.

- Controls must be in place to protect the health and safety of people and the environment from the use, transport, cleaning, maintenance &/or storage of plant and equipment.

7.7.2 AFFILIATE USE OF CSIRO PLANT & EQUIPMENT

- Plant will not be, where practical, provided to affiliates for them to conduct work, e.g. ladders and power tools.

- Where circumstances provide no other alternative, CSIRO staff may issue plant to an affiliate on loan providing:
  - Plant is inspected by both parties prior to and after use
  - A licence/competency check is performed
  - The affiliate receives a safety brief on the operation of the item

7.7.3 MINIMUM REQUIREMENTS

- An *Authorisation to Operate Plant* (Enclosure 04) is required for all operators (staff and affiliates) of the following equipment:
  - 9" (and above) Angle Grinder
  - Powder (Explosive) Actuated Tool
  - Vehicle Trailer (of any kind)
  - Chainsaw
  - Telehandler
  - Any other equipment with a SIGNIFICANT or HIGH inherent safety risk
• Prior to operating any plant or equipment *Team Leaders* must ensure staff and affiliates in their team are:
  
  o Properly qualified and/or experienced;
  
  o Electrical equipment has undergone Electrical Integrity Testing (Test & Tag);

  **NOTE:** 6-monthly testing required on a construction site

  o PPE is available for the task; &
  
  o A SWMS is developed for *one-off* tasks OR a SWI has been developed for any tasks performed on a routine basis (see Sect 6: Risk Mgt)
  
  o Any relevant permits-to-work are obtained (see Sect 6: Risk Mgt)

7.7.4 GUARDING, LOCK-OUT & TAG-OUT OF ENERGY SOURCES

• As far as possible all sources of energy, e.g. electrical and material-under-pressure, must be guarded and/or fitted with an appropriate lock-out device.

• All sharp edges, pinch points and rotating parts must be guarded in accordance with the relevant Australian Standard.

• Where neither of these devices can be fitted the tag-out system must be established.

• An SWI will be developed for an ASKAP Antenna Maintenance Procedure. TBA.

• See [MRO-SWI-PLA001: Lock-out/Tag-out](#) for further information.

7.7.5 MOBILE PLANT – CRANE, EWP, FORKLIFT ETC

**BACKGROUND**

• Mobile plant will be used extensively throughout the lifecycle of the ASKAP telescope for construction, commissioning and maintenance tasks. Operation of most mobile plant requires a valid *high-risk work licence*.

• Mobile plant pose the following hazards:
  
  o Collision/Impact with vehicle or pedestrian
  
  o Loss of control/dropped load
  
  o Working at heights/fall hazard
  
  o Rollover
USE

- Only holders of the valid and relevant high-risk work licence/s may operate mobile plant.

- Where a licence is not required, e.g. telehandler with earthmoving attachment, the staff member must receive a Certificate of Competency from a reputable training organisation and a thorough safety brief from a duly experienced staff member or affiliate and complete the Authorisation to Operate Plant form (Enclosure 04).

- Wherever practicable the construction zone where lifting is being performed should be closed to pedestrian and vehicle access by bunting, etc.

- All operation of mobile plant must be in accordance with manufacturer supplied instructions.

STORAGE

- Mobile plant should be stored in accordance with manufacturer instructions and batteries isolated when practical.

MAINTENANCE

- Unless relevant qualifications are held, maintenance of mobile plant may only be performed to the operator level - as indicated in the manufacturer's instructions.

7.7.6 HAND & MACHINE TOOLS

USE

- Staff and affiliates should pre-plan what tools are required for each visit to the MRO and discuss tooling needs in the MRO Site Visit Application 'Resources' section.
  - Electrically powered tools MUST be tested and 'tagged' prior to arriving at the MRO or handed directly to an appropriately qualified person for test.

- Hand and machine tools must be used by competent staff in accordance with manufacturer's instructions and to applicable Australian Standards.

- PPE appropriate for the task must be worn by all staff and affiliates; Team Leaders arrange for instruction and supervision to be provided for the inexperienced.

- Guarding and other safety features must not be removed without MRO/MSF Site Manager prior approval.

STORAGE

- All hand and machine tools shall be stored so as to not pose a trip hazard and in a secure, orderly location.
MAINTENANCE

- Unsafe tools must be taken out of service with an ‘Out of Service’ tag and brought to the attention of the relevant owner. Where no clear owner exists the MRO Maintenance Officer should be notified.

7.7.7 POWDER ACTUATED (EXPLOSIVE) POWERED TOOLS

USE

- Explosive powered tools may only be operated by competent staff and affiliates.
  - DANGER safety signs must be placed 20 metres from the job-site.

- Only manufacturer-approved fasteners are to be used.

- Manufacturer recommended PPE must be worn.

- Users must complete the Authorisation to Operate Plant form (Enclosure 04).

- All users must complete the licensing course, available online at: http://www.ramset.com/ramtest/index.html

STORAGE

- Explosive powered tools must be stored in a lockable container.

- Charges must be stored separate from the tool in a ‘fireproof’ container, in a cool location and be clearly labelled with the relevant Dangerous Goods diamond.
  - A MSDS must be readily available with the charges.
  - Charges must be stored well away from any other HAZMAT.

MAINTENANCE

- Maintenance on the explosive powered tool/s may only be performed onsite up to the level specified in the OEM instructions. All other maintenance to be performed by the manufacturer.

7.7.8 HOT WORK – WELDING, BRAZING, SOLDERING ETC

USE

- As far as practicable, welding is to be conducted in conformance with AS/NZS 1674.2 (Safety in Welding and Allied Processes).

- Flash-back arrestors must be fitted according to WA OSH Legislation (Reg 3.98(1) of OSH Regulations 1996). Arrestors must meet and be fitted to AS 4603.

- Hot work equipment must be inspected prior to use and relevant PPE must be worn for the task.
- Inspect all leads, grounds, clamps, welding machines, hoses, gauges, torches and cylinders each day before use.

- Be sure all fittings, couplings and connections are tight.

- Avoid breathing fumes, use natural or forced ventilation systems and consider a respirator.

- No welding or burning is to be done on a closed vessel or tank, or on any vessel or tank which has not been certified decontaminated (cleaned), e.g. 44G drums!

- Each welder is responsible for containing sparks and slag and/or removing combustibles to prevent a fire.

- A 9kg Dry Chemical or CO₂ fire extinguisher must be within 10 metres of any welding, burning or open-flame work. A fire blanket should also be on-hand.

- Gas cylinders are not permitted inside the antenna pedestal. If necessary, protect them from damage. Procure cylinders with the protective shroud at the nozzle end.

- The use of welding equipment with disposable gas cylinders, e.g. MAPP cylinders, is strongly DISCOURAGED.
  - If used, the welding torch must be removed after task completion and **never** stored whilst fitted to the disposable gas cylinder.

**STORAGE**

- Flammable gas cylinders must be stored in a designated storage cage outdoors in line with AS 4332 (The Storage and Handling of Gases in Cylinders).

- Hot work equipment should be stored in a safe location with all valves turned off, lines purged and safety features fitted in accordance with OEM instructions.

**MAINTENANCE**

- Welding and allied process equipment must be inspected as per OEM instructions and tagged out of service when maintenance is due and being conducted.
GENERATOR & ELECTRICAL SAFETY USE

- Three major hazards surround portable generator use:

**Carbon Monoxide poisoning**

**DANGER**

Using a generator indoors CAN KILL YOU IN MINUTES.

Generator exhaust contains carbon monoxide. This is a poison you cannot see or smell.

NEVER use inside a home or garage, EVEN IF doors and windows are open.

Only use OUTSIDE and far away from windows, doors, and vents.

**Electrical hazards**

- Lockable cover to be closed with leads connected through bushed holes in the base.
- Max length of 10 amp (1.5 sq mm) extension lead is 35 metres.
- Switchboard fitted with isolating switch, over current protection and 30mA RCD's.
- Insulated or non conductive electrical lead stands.
- Bushed holes.
- Board to be solid and robust, securely fixed.
- Two extension leads can be joined together provided the total length does not exceed the maximum length described in Section 7.
- Portable outlet device must include over current protection and 30mA RCD.
- Portable electrical equipment and extension leads must be regularly inspected, tested and tagged and records kept.
- Maximum length of power tool lead is 5 metres.

**Note:** The use of a flexible extension lead, as illustrated in Figure 1 is allowed when using a portable outlet device provided the extension lead is plugged into a socket outlet that is RCD protected at the power source. If the socket outlet is not protected by an RCD a flexible extension lead cannot be used in this configuration and the portable outlet device (complying with the above requirements) must be plugged directly into the socket outlet.

Figure 1: Electrical equipment setup inside an Operational Construction Zone (Source: WorkCover NSW)
• Make sure the wattage rating for each lead exceeds the total wattage of all appliances connected to it.

• Check that the entire length of each lead is free of cuts or tears and that the plug has all three prongs. Protect the lead from getting pinched or crushed if it passes through a window or doorway or in a pedestrian or vehicle traffic zone.

• Extension leads must not be connected end-on-end to exceed the maximum lengths given in the table below:

<table>
<thead>
<tr>
<th>Current Rating (A)</th>
<th>Conductor Size$^4$(mm$^2$)</th>
<th>Max Length (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.0</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>1.5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>40</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 7: Maximum Electrical Extension Lead Length (Source: WorkCover NSW)

• NEVER try to power a circuit by plugging the generator into a wall outlet, a practice known as “backfeeding.” This is extremely dangerous and presents an electrocution risk to anybody working on the circuit. It also bypasses some of the built-in circuit protection devices (RCDs).

Fire hazard

• Store all fuel in an approved (to Australian Standards) container or fuel tank in a designated flammables cabinet.

• Any modifications to a generator OEM fuel supply system must be approved by a qualified mechanical engineer.

• Before refuelling a portable generator, turn it off and let it cool down. Fuel spilled on hot engine parts could ignite.

MAINTENANCE

• The Daily Pre-start Inspection must be performed by the person first starting the generator.

• Maintenance may only be undertaken on a generator to the level of competence of the individual, i.e. standard operator, diesel mechanic, electrician etc.

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$^4$ Conductor size should be printed on the side of every extension lead purchased in Australia
7.7.10  FURTHER INFORMATION

- Enclosure 04: Authorisation to Operate Plant Form
- MRO SWI: Lock-out/Tag-out
- CSIRO HSE Procedure: Plant Safety
- CSIRO HSE Guideline: Plant Safety
- Australian Standard AS4332 - The storage and handling of gases in cylinders
- Australian Standard AS4603 - Flashback arresters—Safety devices for use with fuel gases and oxygen or compressed air
- Dept of Commerce [WA] Guidance Note: Gas Welding Safety Flashback Arresters
- WorkCover NSW: Electrical Practice's for Construction Work
7.8 ELECTRICAL WORK

7.8.1 BACKGROUND

- With much confusion regarding what is electrical work and what is not, this instruction aims to give clear direction to ASKAP staff and affiliates on safe electrical work.

7.8.2 COMPETENCY REQUIREMENTS

- At the MRO, electrical workers must demonstrate to the MRO/MSF Site Manager that they hold a valid WA electrical workers licence before commencing any electrical work at the MRO.
- Electrical workers must only perform electrical work to the extent of their authorisation.
- All electrical workers (including contractors) must have had their qualifications verified using the Verification of Electrical Licence & Qualifications form prior to commencing electrical work.
- Electrical integrity testing (test and tag) shall only be performed by staff and affiliates who have undertaken the proper training in AS3760. See CSIRO Electrical Safety Guidelines (Appendix 6).
- Electrical installation work and electrical fitting work may only be undertaken by a person in possession of a valid Electrician Licence.
- A licence is not required for the following (except to the extent of final connection and testing of the equipment to an electrical installation):
  - work carried out on a communications or computer system, or a radio or television transmitter or receiver but does apply to an electricity supply circuit thereto having a nominal pressure exceeding 50 volts alternating current or 120 volts ripple free direct current
  - the mechanical assembly or winding of armatures, stators, rotors, field coils or other like equipment
  - the manufacture or assembly, at the place of manufacture, of equipment, or parts thereof, on a repetitive basis
  - to the underground installation of underground cables, cable ducts, conduits and cable support systems (excluding the final connection or testing of circuits)
  - to the affixing of a plug, electrical appliance plug or cord extension socket to a flexible cord used or intended to be used to connect an electrical appliance to a plug socket outlet through which electricity is
supplied or to be supplied at a nominal pressure not exceeding 1 000 volts alternating current or 1 500 volts direct current

- Additionally, a **professionally qualified electrical engineer** with experience relating to electrical installing work may conduct:
  - the **detailed inspection of an electrical installation**, including switchboards and equipment
  - the **measurement of electrical parameters** (such as voltage, current or energy) at any part of an electrical installation
  - the **commissioning of, or the finding of faults** in, an electrical installation (including any required disconnection or reconnection of electrical components and equipment)

### 7.8.3 STANDARD PRECAUTIONS

- An **Electrical Safety Risk Control Plan** must be developed for any repetitive or routine electrical work tasks (see Section 6: Risk Mgt)

**FOR INFORMATION:** this includes engineers performing inspection of electrical installations, switchboards etc or the commissioning or fault-finding in an electrical installation.

**NOTE:** Non-routine or one-off electrical work tasks must be documented on a Safe Work Method Statement (**SWMS**) prior to work commencing.

- Equipment used inside an **operational construction zone** must be tested and tagged every 6 months. RCDs are to be routinely tested as per AS3760.

- **Team Leaders** must ensure equipment from overseas is inspected by an electrician prior to being connected to the installation.

- Unserviceable, damaged or faulty equipment and outlets must be locked &/or tagged out of service in accordance with MRO SWI: **Lock-out/Tag-out**.

### 7.8.4 EQUIPMENT MANUFACTURED ‘IN-HOUSE’

- All equipment manufactured ‘in-house’ or by a contractor destined for the MRO with circuits exceeding either: 50V AC or 120V ripple-free DC, must be assessed as meeting **AS 3820 – Essential safety requirements for electrical equipment** prior to arriving at the MRO.

- Equipment manufactured ‘in-house’ fitted with a flexible cord should be tested and tagged in accordance with AS3760 prior to arriving at the MRO.
7.8.5 PENETRATING WORKS

- Any work involving penetrating walls, ceilings and floors/excavations where there is a heightened risk of electric shock or damage to services will require approval by the MRO Site Manager. A permit-to-work is required in this instance.

7.8.6 FURTHER INFORMATION

- [Electricity (Licensing) Regulations 1991 [WA]]
- CSIRO HSE Procedure: Electrical Safety
- CSIRO HSE Guideline: Electrical Safety
- CSIRO Electrical Safety Risk Control Plan
- CSIRO Verification of Electrical Licence and Qualifications Form
- AS 3760 – Inservice safety testing and inspection of electrical equipment

7.9 FIREARMS

- Presently, the only firearms used on Boolardy Station are by the Station Managers and their sub-contractors in support of pastoral activities.

- If required in the future, firearms may only be operated at the MRO by trained and qualified CSIRO staff and affiliates in strict accordance with the CSIRO Firearms Safety Procedure and Guidelines.

- The ASKAP Project Director is the approving authority for any application to bring a firearm on the MRO.

7.9.1 FURTHER INFORMATION

- CSIRO HSE Procedure: Firearms Safety
- CSIRO HSE Guidelines: Firearms Safety
7.10 HAZARDOUS ENVIRONMENTS

7.10.1 LIFTING OPERATIONS

BACKGROUND

- The use of mobile plant to conduct lifting operations on a construction site is classed as high-risk construction work.

- High-risk construction work is governed by specific clauses of legislation [OHS (Safety Standards) Regulations - Part 12, (Cw'th)] requiring a SWMS to be developed for the task or activity.

COMPETENCY

- Licencing and competency of plant operators is discussed in Section 7.6.5 (Mobile Plant) of this manual.

- A qualified dogman or rigger in two-way communication with the crane operator must be in control of every lifting operation involving mobile plant.

- Lifting equipment inspections may only be performed by a competent person.

GENERAL REQUIREMENTS

- SWMS: A SWMS must be developed prior to each lift/series of lifts. A template may be used where the task/s and risk of the task/s does not change.

- ACCESS: Wherever practicable the construction zone where lifting is being performed should be closed to pedestrian and vehicle access by bunting, etc.

- CLEAR OF PERSONNEL: The construction zone where lifting is being performed must be cleared of all personnel not involved in the lift.

- LIFT PLAN: The rigger/dogman must develop a lift plan in conjunction with the crane operator and brief the Team Leader and all other persons involved in the lift prior to any lifting operation.

- Lifting operations should not be conducted alone at the MRO or Boolardy Accommodation Facility.

- All rigging equipment must be inspected in accordance with the relevant Australian Standard on a quarterly basis. Evidence of inspection should then be placed on the inspected equipment.
7.10.2 WORKING AT HEIGHT

BACKGROUND

- This procedure outlines the mandatory requirements for preventing or minimising the risk of falls and injury where any work at an elevated position is proposed, and in particular, where work is proposed to be carried out at heights of two metres or more.

- Where a task is performed in connection with construction, fit-out or commissioning and a risk of >2m. fall exists the task is deemed high-risk construction work.

- High-risk construction work is governed by specific clauses of legislation [OHS (Safety Standards) Regulations - Part 12, (Cw'th)] requiring a SWMS to be developed for the task / group of tasks.

SAFETY BRIEF

- A safety brief must be conducted prior to each task performed at height. The Team Leader must be present at the brief. The safety brief must cover:
  
  o The risks of the task – brief from SWMS or SWI
    
    ▪ Must include: method of fall prevention
    
    ▪ Must include: method of enforcing drop zone
  
  o Task/activity duration
  
  o Equipment and chemicals required for the task and method of securing
  
  o Rescue plan

GENERAL PRECAUTIONS

- Team Leaders must ensure staff members and affiliates do not work alone while working at height.

- A SWMS must be developed prior to working at height, where risk of fall is >2 metres. A template may be used where the task/s and risk of the task/s does not change. The contents of the SWMS should be briefed at induction.
  
  o A SWI must be developed for routine tasks performed on/in the antenna structure where there is a risk of fall greater than 2 metres.

- A drop zone must be established by either barricading or bunting or an appropriately briefed person enforcing a no thoroughfare policy underneath the work at height location.

- Tools, chemicals and equipment must not be thrown up and down from an elevated position. A rope bag or similar shall be used.
• Tools and equipment must be attached by lanyard to the worker when operating above the antenna dish surface or whenever risk of fall onto personnel below exists.

• Lighting must be adequate to safely conduct the task/s

PERSONAL FALL PROTECTION EQUIPMENT (PFPE)

• PFPE is required when working at height and there is risk of fall of 2 metres or more from an unguarded edge and no passive fall prevention device (e.g. guardrail) exists.

• The selection and installation of anchorage points must be made by a competent person.

• The selection of PFPE for the task or activity must be made by a competent person with a working knowledge of AS1891.
  o Chinstraps must be fastened under the chin when working at 2 metres or more above ground level.

• PFPE must be protected at all times from hot work particles or sparks.

• PFPE must be inspected by the user before and after use in accordance with OEM instructions. When an item of PFPE is deemed unsafe it must be tagged out of service with an ‘Out of Service’ tag.

• PFPE must be routinely inspected by a competent person in accordance with AS1891.4. The result of this inspection must be recorded (see Section 10).
  o For CSIRO-owned PFPE this task will be coordinated by the HSE Officer.

WORK ON/IN THE ANTENNA STRUCTURE

• Prior to staff and affiliates accessing the antenna reflector surface or the Elevation Box they must receive an Antenna Work Induction.

• The Antenna Work Induction will cover:
  o ‘on the job’ training, including how to carry out a job or task in a safe manner and not be exposed to falls;
  o information on the hazards and risks from falls at that workplace;
  o information on the selection, fitting, use, care, maintenance and storage of personal protective clothing;
  o the selection of anchorage points for attaching PFPE; and
  o emergency rescue arrangements.

• This induction will be performed by a member of the ANT IPT, the MRO Site Manager or the HSE Officer.
LADDERS

- Extension or single ladders should be used as a means of access to or egress from a work area, **not** as a working platform.

- Ladders must be used in a 4:1 ratio (height to base) as per figure below.
  
  ![Ladder Diagram]

  - Ladders must be inspected before and after use.
  - Staff must use a fall arrest system if climbing a ladder greater than 3 metres above ground level.
  - Ladders must always be faced when traversing up and down.
  - Three points of contact must be observed when on a ladder.
  - No person may stand any higher than 900mm from the top of a ladder.
  - Damaged or faulty ladders must be tagged out of service in accordance with MRO SWI: Lock-out/Tag-out.

SCAFFOLDING & MOBILE TOWERS

- A **competent person** may erect a mobile tower or scaffolding up to a height of 4 metres.

  **NOTE:** The assembly of a mobile tower or scaffolding higher than 4 metres, may only be performed by a licensed scaffolder, i.e. holder of an **SB High-risk Work Licence**.

  **NOTE:** Initial inspection of a mobile tower or scaffold must be performed by a second competent person (to the person who erected it).

- Scaffolding and mobile towers passing inspection will have a **GREEN** plastic tag placed on the ladder.

- A reinspection must be conducted by a competent person after each significant move of the mobile tower, e.g. between two antennas

- Staff and affiliates must place a **RED** plastic tag at the entrance to the assembly if:
  
  - Safety or structural integrity is questionable
  
  - The structure has been modified

- Staff and affiliates working from mobile towers or scaffolding must read and acknowledge MRO SWI: Assembly, Work From & Disassembly of Mobile Towers.
EMERGENCY PROCEDURES

- A rescue plan must be briefed to the Team Leader and all other persons involved in the work at height prior to work commencing. The rescue plan must detail:
  
  - Possible emergencies
  - Primary descent procedure, e.g. EWP
  - Secondary (back-up) descent procedure
    - Must be different item/s of plant from primary, e.g. Emergency Descent Device
  - Location of nearest first aid (trauma) kit
    - Must be within 5min access
  - Method/s of communication with Site Manager, Site Coordinator &/or Team Leader

FURTHER INFORMATION

- CSIRO HSE Procedure: Working at Heights
- CSIRO HSE Guidelines: Working at Heights
- MRO SWI: Assembly, Work From & Disassembly of Mobile Towers
- MRO SWI: Lock-out/Tag-out
- OHS (Safety Standards) Regulations 1994: Part 12 – Falls from 2 metres or more
- WorkSafe WA Code of Practice: Prevention of Falls at Workplaces
- Australian Standard AS1891.4 – Industrial fall-arrest systems and devices: Selection, use and maintenance
7.10.3 WORKING AT NIGHT

- **Staff and affiliates may not work alone at night at the MRO.** There shall be a minimum of two personnel onsite at night with:
  - at least one person trained to the *Remote Area First Aid* level (see Section 12.3.5)
  - at least one person having two prior visits to the MRO

- Prior to working at night a call-back procedure must be agreed to with the *Team Leader*; the MRO Site Manager will notify MacDow of CSIRO’s intent to work at night.

- *Team Leaders* must ensure lighting is considered by the team and adequate for the task/activity at night.

- Staff and affiliates working at night should be aware of their own fatigue levels and not perform high-risk work if feeling tired. *Team Leaders* must manage staff and affiliate fatigue levels in accordance with Section 7.4 of this manual.

7.10.4 WORKING ALONE AT THE MRO

- **Working alone** is defined as:
  - Alone at the MRO; or
  - If other people are onsite: Working more than 400 metres from another person without access to a vehicle

- When a staff member or affiliate is required to work alone at the MRO, the *Team Leader* must ensure the staff member has a reliable radio on-hand at all times when alone.

- A call-back system should in place for the person to check-in **every hour**.

- The SPOT GPS Messenger device may also be used for this purpose.
7.11 MANUAL TASKS / ERGONOMICS

7.11.1 BACKGROUND

- Performing manual tasks can be hazardous, potentially leading to Musculoskeletal Disorders (MSD). Manual tasks at work accounted for over 41% of all compensation claims in Australia between July 1997 and June 2003.
- The back, shoulder and wrist are the most frequently injured parts of the body.

7.11.2 STANDARD PRECAUTIONS

- Where there is an increased risk of MSD, Team Leaders are required to plan the task/activity to minimise the risk.
- In most situations, risk can be reduced through consultation with experienced staff.

7.11.3 MANUAL TASK OPTIONS AT THE MRO

- Team lift
- Trolley
- Ute mounted crane (check SWL)
- Mobile crane/telehandler
- Rotating staff through the job
- Stretching before, during and after task commencement
- Working in the cooler parts of the day

7.11.4 FURTHER INFORMATION

- CSIRO HSE Procedure: Ergonomics & Manual Handling Safety
- CSIRO HSE Guidelines: Ergonomics & Manual Handling Safety
7.12 HAZARDOUS SUBSTANCES (INCL. GASES)

7.12.1 BACKGROUND

- A chemical is classified as an **Hazardous Substance (HAZSUB)** by the manufacturer or by SafeWork Australia\(^5\). It is a legal classification system, found online at:

  [hsis.ascc.gov.au](http://hsis.ascc.gov.au)

7.12.2 BRINGING A HAZSUB (INCLUDING A GAS) TO THE MRO

- The process for bringing a chemical to the MRO is as follows:
  
  o Procure chemical in accordance with Purchasing Instructions (Section 4)
  
  o Source the MSDS for the chemical (if not supplied with chemical follow this link)
    
    - Note the **storage** requirements – plan where you will store it at the MRO
    
    - Note the **handling** requirements – plan what PPE you will need
    
    - Note the **disposal** requirements – plan how the chemical will be disposed
  
  o Bring the MSDS to the MRO with the chemical and hand to HSE Officer or MRO Site Manager

TRANSPORTING HAZSUBS

- Transport must be in accordance with the MSDS

- A trayback utility vehicle is the preferred method of transporting compressed gases and other HAZSUBs. Transport and load restraint advice should be sought from MSF staff.

**NOTE:** Depending on the quantity and type of chemical or gas the *Australian Dangerous Goods Code* (ADG Code) may specify how the substance is to be transported, e.g. large quantities of compressed gases or flammable liquids.

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\(^5\) Criteria for applying classification of ‘hazardous substance’ includes: *Approved Criteria for Classifying Hazardous Substances* [NOHSC:1008(2004)] 3rd Edition and/or have National Exposure Standards declared under the NOHSC * Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment* [NOHSC:1003(1995)]
7.12.3 STANDARD PRECAUTIONS

- MSDS must be manufacturer original, within 5 years of issue (or reissue) and written in English. A translation is to be provided for any non-English MSDS.

- **Staff members and affiliates must read the MSDS prior to handling** any hazardous substance or dangerous good.

- Any substance with a **HIGH** or **SIGNIFICANT** inherent risk must be subject to a Hazardous Substance Risk Control Plan or Gas Risk Control Plan prior to use, e.g. sulphuric acid.

- When working with hazardous chemicals make sure the following is nearby (within 2min walk):
  - Eyewash station
  - Chemical Spill Kit

7.12.4 LABELLING

- If decanting a substance into a temporary use container, that container must be clearly labelled and disposed of at the sooner of, task completion or within 24hrs.

- For longer term storage of decanted substances see the HSE Officer for an approved label and container.

7.12.5 STORAGE REQUIREMENTS

- Chemicals stored in drums must be dispensed using a drum-top pump, dispensing station or other purpose-built decanting equipment. Dispensing should be performed at hip level.

- Staff and affiliates must observe the chemical incompatibilities chart and not store chemicals together that have the potential to violently react.

- Toxic or flammable cryogenic liquids must not be stored in laboratories, when they are used in a laboratory the container must not exceed 5L and must be kept in a ventilated extraction enclosure. Containers of non-toxic, non-flammable cryogenic liquids must not exceed 250L.

- Drums must be stored on bunded pallets or in an approved cabinet.

- The following limits must be observed regarding minor storage (outside of an AS1940 or AS3780 (corrosives) approved container):
7.12.6 STORAGE TIPS

- Control your inventory – only keep minimum amounts – don’t squirrel chemicals
- Label shelves and cupboards with the segregation scheme so that chemicals can be put away in the right place quickly
- Remove all cardboard and other packing from storage area
- Keep the outside of containers scrupulously clean and the area tidy
- Ensure the store area is lockable and kept locked
- Do not store liquids above solids in case of contamination in the event of a breakage
- Limit the size of containers on open shelves to ≤ 5 L/kg, otherwise use a storage cabinet
- Always store corrosives on spill trays – kitty litter trays are inexpensive and ideal
- Don’t overload shelves – sagging is a danger sign
- Never store flammable liquids in fridges/freezers unless they have been modified (i.e. spark proof)
- Do not store containers on the floor
- Inspect the area regularly and dispose of outdated chemicals including all portable LPG cylinders that are not in test (i.e. 10 years).
- Use secondary containment at all times

6 Check the MSDS or label for the Packing Group (PG)

<table>
<thead>
<tr>
<th>Chemical type or DG Class</th>
<th>Common name</th>
<th>Max. per 50m² (kg or L)</th>
<th>Max. container size (kg or L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DG Class 3 Combustible liquids (e.g. diesel)</td>
<td>Flammable Liquids</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>DG Classes 4.1, 4.2, 4.3, 5.1 or 5.2</td>
<td>Class 4 – Flammable solids Class 5 – Oxidisers</td>
<td>20 but less than 10 of any single sub-class</td>
<td></td>
</tr>
<tr>
<td>DG Class 6.1 Packing Group 1</td>
<td>Infectious Substances</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>DG Class 6.1 (Other)</td>
<td>Toxic Substances</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>DG Class 8</td>
<td>Corrosives</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>DG Class 9 and Aerosols</td>
<td>Miscellaneous</td>
<td>Liquids 50, Solids 100</td>
<td>Liquids 5, solids 20</td>
</tr>
<tr>
<td>Combined maximum</td>
<td></td>
<td>200</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 8: Maximum chemical minor storage quantities
7.12.7 HAZARDOUS SUBSTANCE REGISTER

- The MRO Hazardous Substance and Dangerous Goods Register (and Site Diagram) will be located at the BETA Site Office in the Emergency Information Cabinet.

- The Boolardy Accommodation Facility Hazardous Substance and Dangerous Goods Register (and Site Diagram) will be located in the Wittenoom Cottage Emergency Information Cabinet.

- MSDS Folders will be located on the side of each hazardous substance storage cabinet.

7.12.8 SPILL & FIRE PREVENTION

- Chemicals stored outside of an AS1940 (flammables) or AS3780 (corrosives) approved container must be stored on a spill tray or another temporary bund.

- All single-walled combustible liquid storage tanks must be bunded to contain 100% of the volume of the tank or 100% of the volume of the largest tank and 10% of the volume of the second largest tank in a two tank operation.

- A 9kg Dry Chemical Extinguisher and spill kit must be collocated with every combustible or flammable liquid storage area.

7.12.9 DISPOSAL

- Unwanted, out-of-spec and unknown substances must be safely decanted into the respective chemical waste disposal drums, located near the BETA Site Office.

- Aerosols are NOT to enter the general waste, they can be handed to the HSE Officer for disposal or taken directly to the Chemical Waste Storage Area at Antenna #29.

- Cogman Recycling at Narngulu will accept car and truck sized batteries free of charge.
  
  - Damaged or unserviceable batteries should be reported to the Maintenance Officer for disposal.
7.12.10 GASES

- Gas cylinders must not be stored indoors unless they are in use and reticulation from an outside location is not practicable.

- Compressed flammables gas cylinders must be stored in a designated storage cage outdoors in line with AS1940.
  
  o **EXCEPTION:** Oxygen-Acetylene systems may be stored on a purpose built trolley inside a shipping container.

- Compressed gases are not to be stored inside a vehicle and must be transported in accordance with the *Australian Dangerous Goods Code* (ADG Code).

7.12.11 FURTHER INFORMATION

- CSIRO HSE Procedure: [Hazardous Substances Safety](#)
- CSIRO HSE Guidelines: [Hazardous Substances Safety](#)
- [Australian Dangerous Goods Code, 7th Edition](#)
- Australian Standard 1940 – [The storage and handling of flammable and combustible liquids](#)
- Australian Standard 3780 – [The storage and handling of corrosive substances](#)
- [ChemGold III](#) – Online MSDS data centre
7.13 CONFINED SPACE

7.13.1 BACKGROUND

- The term *confined space* traditionally refers to a small enclosed space with low oxygen and high levels of atmospheric contaminants; however, the definition has broadened in recent times.

- Accordingly, CSIRO assists site *Managers* to classify a *confined space* using the following flowchart.

Reference: Australian/New Zealand (AS/NZS) 2865:2009 Confined Space
7.13.2 INSTRUCTIONS

- Confined space regulations apply to the following locations at the MRO and Boolardy Accommodation Facility:
  - Septic tank – Boolardy
  - Water tanks, above and below ground – Boolardy

- CSIRO Staff and affiliates may not enter a confined space unless properly trained and authorised by the MRO Site Manager.

- Contractors tasked to enter a confined space must be issued a Confined Space Permit signed by the Site Manager, Site Coordinator or HSE Officer prior to entry.

7.13.3 ANTENNA ELEVATION BOX ACCESS

- According to the flowchart above, the Elevation Box is not classed as a confined space. However, additional risk controls will be implemented prior to entry, refer to relevant SWI; below is a summary of HSE risk controls:
  - EWP and operator on standby the entire time
  - Use twin-tail lanyard to attach to anchor point inside El. Box and remain attached the entire time
  - Ensure the Emergency Decent Device backpack is brought into El. Box, should the EWP fail and there is no other means of retrieval
  - Complete the EntryTag® permit prior to entry.

7.13.4 FURTHER INFORMATION

- CSIRO Procedure: Confined Space
- CSIRO Guidelines: Confined Space
- OHS (Safety Standards) Regulations 1994: Part 7 – Confined spaces
7.14 WASTE

7.14.1 BACKGROUND

- CSIRO has an obligation to create as small an environmental footprint as possible at the MRO. Waste must be either brought back to Geraldton or placed in the designated waste receptacle at the MRO.

- Waste is increasingly being defined to include “externalities” like greenhouse gas emissions, leachate to water and soil, odour, wind-blown litter, vermin, noise, traffic and visual intrusion.

7.14.2 RESPONSIBILITIES

<table>
<thead>
<tr>
<th>MRO/MSF Site Manager</th>
<th>MRO &amp; Boolardy waste programs</th>
<th>Oversee the MRO &amp; Boolardy waste programs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initiate waste reduction, recycling and reuse schemes</td>
<td>Initiate waste reduction, recycling and reuse schemes</td>
</tr>
<tr>
<td></td>
<td>Ensure domestic waste receptacles are routinely emptied and cleaned</td>
<td>Ensure domestic waste receptacles are routinely emptied and cleaned</td>
</tr>
<tr>
<td></td>
<td>Ensure trade waste, HAZMAT and medical waste is properly disposed of or recycled</td>
<td>Ensure trade waste, HAZMAT and medical waste is properly disposed of or recycled</td>
</tr>
<tr>
<td>HSE Officer</td>
<td>Develop a ‘Waste Stream’ poster</td>
<td>Develop a ‘Waste Stream’ poster</td>
</tr>
<tr>
<td></td>
<td>Induct staff and affiliates on the waste disposal procedures</td>
<td>Induct staff and affiliates on the waste disposal procedures</td>
</tr>
<tr>
<td>Team Leaders</td>
<td>Plan and communicate waste management to staff</td>
<td>Plan and communicate waste management to staff</td>
</tr>
<tr>
<td></td>
<td>Insist on biodegradable packaging materials from suppliers wherever possible</td>
<td>Insist on biodegradable packaging materials from suppliers wherever possible</td>
</tr>
<tr>
<td></td>
<td>Ensure staff do not place hazardous waste into the domestic waste receptacles</td>
<td>Ensure staff do not place hazardous waste into the domestic waste receptacles</td>
</tr>
<tr>
<td>All staff and affiliates</td>
<td>Must not litter</td>
<td>Must not litter</td>
</tr>
<tr>
<td></td>
<td>Must not place hazardous waste in the general waste receptacles – seek advice from HSE Officer or Site Manager</td>
<td>Must not place hazardous waste in the general waste receptacles – seek advice from HSE Officer or Site Manager</td>
</tr>
<tr>
<td></td>
<td>Use the recycling facilities: Batteries, Aluminium Cans, Scrap Metal</td>
<td>Use the recycling facilities: Batteries, Aluminium Cans, Scrap Metal</td>
</tr>
<tr>
<td></td>
<td>Dispose of chemicals at the Chemical Waste Storage Area at Ant#29</td>
<td>Dispose of chemicals at the Chemical Waste Storage Area at Ant#29</td>
</tr>
</tbody>
</table>

7 Wastes with any of the following characteristics: Explosive, Flammable Liquids/Solids, Poisonous, Toxic, Ecotoxic, Infectious Substances (Source: Dept of Sustainability, Environment, Water, Populations & Communities, Jun 2010)
7.14.3 INSTRUCTIONS

HAZARDOUS SUBSTANCES

- Hazardous substances **must not enter the soil**, they may leach into the groundwater system.

- Unwanted, out of spec and unknown substances must be safely decanted into the respective (flammables & corrosives) chemical waste disposal drums, located at Ant#29 compound.

- **Gas bottles** must be returned to the place of hire or to a designated hazardous waste operator. Gas bottles must never be placed in the general waste receptacles or trailer unless certified as empty by an appropriate authority.

- **Batteries** of all sorts can be dropped off at the Chemical Waste Storage Area at Ant#29.

MEDICAL WASTE

- Medical waste and sharps must be placed in a clinical waste container, located at:
  - Wittenoom Cottage – First Aid Station
  - MRO Site Office

- If utilising a clinical waste container please advise the MRO Site Manager or HSE Officer so that it can be cleaned and returned.

BOOLARDY – DOMESTIC WASTE

- Aluminium cans should be crushed and placed in the designated recycle points.

- Food scraps should be scraped off the plate into the kitchen receptacle and taken to the compost bins.

MRO – SCRAP METAL

- Metal antenna packaging material will be taken to a central location and reused or recycled.

- All other scrap metal, including copper wire, must be placed in the scrap metal skip-bin located near the CSIRO MRO Site Office.

7.14.4 FURTHER INFORMATION

8. TRAINING

8.1 PURPOSE

- The CSIRO HSE Management Standard requires Managers to identify the skills and competencies required for staff to meet the HSE responsibilities of their role.

8.2 APPLICATION

- ASKAP Managers and affiliate Managers are to ensure staff are adequately trained and prepared to undertake all ASKAP-related tasks.

8.3 INSTRUCTIONS

8.3.1 TRAINING REQUIREMENT

- All persons undertaking work must be deemed competent or whilst under training be directly supervised, i.e. line of sight, by a competent person.

- IPT Managers must ensure that training requirements are identified in their IPT HSE Risk Management Plan.

- Some plant such as forklifts and require a specific licence to operate. Managers are to identify items of plant that require special licences to be obtained, and maintain a register of licence numbers and dates. Some examples include:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Competency Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slinging and controlling suspended and slung loads</td>
<td>Safe slinging course, dogman or rigger (task dependent)</td>
</tr>
<tr>
<td>EWP (&gt;11m)</td>
<td>EWP Licence</td>
</tr>
<tr>
<td>Scaffold Erection (&lt;4m)</td>
<td>Evidence of competency</td>
</tr>
<tr>
<td>Telehandler – Lifting</td>
<td>C6 Licence</td>
</tr>
</tbody>
</table>

8.3.2 HSE TRAINING

- All Managers are required to have a higher level of HSE knowledge commensurate with their position. CSIRO Managers should have completed HSE for Managers training. This course must be undertaken within one year of appointment as a manager with refresher training currently every 3 years.

  o The Executive Team has declared that HSE for Manager training must be an APA objective for all CSIRO Managers
• The CASS HSE Leader, supported by the ASKAP HSE Officer and WA HSE Team will conduct routine HSE training sessions at Marsfield, the MSF and the MRO on the contents of this manual and the wider CSIRO HSE expectation.

• All CSIRO staff members and collaborators employing contractor staff should complete the course in *Principles of Contractor HSE Management*. This course is run internally.

• All upcoming internal HSE courses will be promoted by the HSE Officer.

8.3.3 EVIDENCE OF TRAINING – RECORD MANAGEMENT

• *Managers* are to keep a copy of staff member’s training records on their personal file and oversee the provision of refresher training as required.
  
  o Staff will be required to show evidence of competency on relevant plant items to the HSE Officer before working at the MRO

• In planning an MRO site visit, *Team Leaders* should confirm, by sighting licences/tickets, the competency level and range of skills of the team.
  
  o Team Leaders are advised to contact the HSE Officer for advice on skills training courses available in WA.

• The HSE Officer is required to maintain the ASKAP Training Matrix and provide timely alerts to *Managers* when staff competencies require refresher training.

• The HSE Officer will maintain a training record *database*; *Managers* should ensure all licences, certificates and competencies relevant to ASKAP tasks are forwarded to the HSE Officer or uploaded directly into the *database*.

8.3.4 FURTHER INFORMATION

• [CSIRO HSE Management Standard](#)

• [ASKAP Training Matrix](#)

• [CASS HSE & Skills Training Database](#)
9. COMMUNICATION & CONSULTATION

9.1 PURPOSE

- It is well proven that the best solutions to safety problems has come from those who perform the task/s routinely, that is staff members.

- The CSIRO HSE Management Standard requires Senior Managers and Managers to engage regularly with staff on HSE matters on a regular basis to ensure their understanding and participation in HSE initiatives and activities.

9.2 APPLICATION

- This instruction applies to the ASKAP Senior Manager, IPT Leaders, IPT Managers and ASKAP Managers for action.

9.3 INSTRUCTIONS

- Guidance on communication and consultation to staff members is provided in the CSIRO Health and Safety Management Arrangements (HSMA) document.

9.3.1 GETTING HSE ON THE AGENDA - ASKAP MEETINGS

- In order to ‘engage regularly’ with staff and affiliates on HSE, IPT Leaders and IPT Managers should ensure “HSE” is listed as a standing agenda item at IPT meetings. Suggested topics for discussion include:
  
  - The IPT HSE Risk Management Plan – additions and updates
  - Upcoming courses and evaluation of courses
  - Developments/refinements to SWIs
  - Incidents
  - Continuous improvement – improvements from the ‘shop floor

- When possible a brief discussion of HSE developments should be made at ASKAP Team Meetings, especially where the HSE matter concerns the entire team.
9.3.2 GETTING HSE ON THE AGENDA – TOOLBOX TALKS

- A toolbox talk is much like an informal staff meeting but with a focus on safety alone. A toolbox talk is an opportunity for staff and affiliates to express HSE concerns, learn from other team members and the opportunity to learn new safe work procedures.

- Toolbox Talk will be run by the HSE Officer or Site Manager.

- All CSIRO staff members and affiliates must attend daily toolbox talk when at the MRO.
  - A record of attendance should be made (see Enclosure 06)
  - The Toolbox Talk is run at the MRO every Thursday during Morning Tea.

9.3.3 DESIGNATED WORK GROUPS (DWG)

- A DWG is a group of employees established collectively by the commonality of the work undertaken or geographical location. DWGs provide employees with representation through a health and safety representative, and the opportunity to consult with management about health and safety matters.

- ASKAP management has identified two DWGs:
  - MSF
  - MRO Transient Population

9.3.4 HEALTH & SAFETY REPRESENTATIVES (HSR)

- An HSR is a valued member of any workgroup. An HSR represents the interests of staff in the DWG and is an important person in terms of consultation and communication.

- The HSR has legislated power to issue a Provisional Improvement Notice (PIN) on their employer if they fail to meet the safety requirements of legislation.

- The HSE Officer will assist the Project Director in calling for nominations for the role of HSR.

- Health and Safety Representatives should refer to Comcare’s publication Health & Safety Representative Handbook (OHS 4).

9.3.5 HEALTH & SAFETY COMMITTEE (HSC)

- ASKAP is not required to establish an HSC under the CSIRO HSMAs but may do so in the future.
9.3.6 CHANGES TO ASKAP HSE PROCEDURES

- ASKAP staff members will be consulted when HSE procedures are created or varied.

- Staff members shall be given at minimum The method of

9.3.7 HSE DISPUTE RESOLUTION PROCESS

9.4 FURTHER INFORMATION

- CSIRO HSE Management Standard

- CSIRO Health and Safety Management Arrangements (Incorporates CSIRO’s HSE Dispute Resolution Process)

- Comcare: Health & Safety Representative Handbook (OHS 4)
10. HSE DOCUMENT & RECORDS CONTROL

10.1 PURPOSE

- The CSIRO HSE Management Standard requires HSE records to be accurate, legible, identifiable, confidential, secured, stored and maintained as per CSIRO Records Keeping Procedure.

- Internal and external documents and information necessary for HSE management will be readily accessible, current, relevant and controlled.

10.2 APPLICATION

- All ASKAP staff must maintain all HSE records in accordance with Commonwealth law and CSIRO procedure. Generally speaking, if a record relates to the safety of staff or the project (risk assessment) or environmental sustainment then the record must be kept.

10.3 INSTRUCTIONS

- OHS records relating to Commonwealth agency activities must be kept, destroyed or transferred in line with the Archives Act 1983 [Cw'th]. The administrative procedure governing these records is found at:

  National Archives - Administrative Functions Disposal Authority (AFDA)

### 10.4 WHAT TO KEEP? WHERE TO KEEP IT? HOW LONG FOR?

<table>
<thead>
<tr>
<th>WHAT TO KEEP?</th>
<th>EXAMPLE</th>
<th>WHERE TO KEEP IT?</th>
<th>HOW LONG FOR?</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSE Risk Assessments &amp; Action Plans</td>
<td>HSE Risk Management Plan</td>
<td>Initial – ASKAP HSE Sharepoint</td>
<td>75yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After 1 year – TRIM</td>
<td></td>
</tr>
<tr>
<td>Environmental Monitoring &amp; Health Surveillance data</td>
<td>Audiograms</td>
<td>Copy 1 – Personal File</td>
<td>75yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After 1 year – TRIM</td>
<td></td>
</tr>
<tr>
<td>Records of implementation of industry and CSIRO standards</td>
<td>&lt;this manual&gt;</td>
<td>Initial – ASKAP HSE Sharepoint</td>
<td>7yrs after standards are superceeded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After 1 year – TRIM</td>
<td></td>
</tr>
<tr>
<td>Records of HSE review and monitoring programs</td>
<td>Senior Manager review programs</td>
<td>Initial – ASKAP HSE Sharepoint</td>
<td>10yrs after action completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After 1 year – TRIM</td>
<td></td>
</tr>
<tr>
<td>Selection and resignation of HSR or first aid officer, building wardens and safety officers</td>
<td>First Aid Officer Lists</td>
<td>ASKAP HSE Sharepoint</td>
<td>1yr after term of office or resignation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RESEARCH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazards research</td>
<td>Properties of a HAZSUB</td>
<td>CASS HSE Common Drive</td>
<td>5yrs after action completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>REPORTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal and external HSE reports but not compensation or incident related</td>
<td>Periodic HSE status reports</td>
<td>CASS HSE Common Drive</td>
<td>7yrs after action completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PROCEDURES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copies of manuals, handbooks, directives etc</td>
<td>&lt;this manual&gt;</td>
<td>ASKAP HSE Sharepoint</td>
<td>When reference ceases</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MEETINGS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final version of minutes and supporting documents tabled at meetings held to support OHS function</td>
<td>IPT Meetings (when HSE is discussed)</td>
<td>Initial - ASKAP [Common/IPT] Sharepoint</td>
<td>5yrs after action completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>After 1 year - TRIM</td>
<td></td>
</tr>
</tbody>
</table>
## PLANNING

<table>
<thead>
<tr>
<th>Copies of all OHS plans</th>
<th>ASKAP HSE Plan 2011</th>
<th>Initial – ASKAP HSE Sharepoint After 1 year – TRIM</th>
<th>When reference ceases</th>
</tr>
</thead>
</table>

## INSPECTIONS

<table>
<thead>
<tr>
<th>Inspections following a major accident</th>
<th>TRIM</th>
<th>75yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comcare inspections</td>
<td>Initial – ASKAP HSE Sharepoint After 1 year – TRIM</td>
<td>10yrs</td>
</tr>
<tr>
<td>Routine HAZSUB inspections in the workplace</td>
<td>HAZMAT inspection report</td>
<td>Initial – ASKAP HSE Sharepoint After 1 year – TRIM</td>
</tr>
</tbody>
</table>

## IMPLEMENTATION

<table>
<thead>
<tr>
<th>Records of implementing first aid treatment to individuals</th>
<th>Record of First Aid Treatment</th>
<th>TRIM</th>
<th>5yrs</th>
</tr>
</thead>
</table>

## HEALTH PROMOTION

<table>
<thead>
<tr>
<th>Records of promoting safe work practices in the workplace</th>
<th>Notices, instructions, posters etc</th>
<th>Scanned &amp; TRIM</th>
<th>5yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSDS</td>
<td>MSDS</td>
<td>Onsite</td>
<td>Destroy when HAZMAT is disposed</td>
</tr>
</tbody>
</table>

## COMPLIANCE

<table>
<thead>
<tr>
<th>Compliance with OHS Regs</th>
<th>Plant maintenance records</th>
<th>&lt;Various&gt;</th>
<th>Destroy when compliance no longer req’d e.g. plant disposed of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined space access and identification records</td>
<td>Confined space permit</td>
<td>Scan &amp; TRIM</td>
<td>5yrs after space no longer accessed</td>
</tr>
<tr>
<td>All noticed issued under the OHS Act 1991</td>
<td>Improvement Notice</td>
<td>TRIM</td>
<td>5yrs after notice lapse</td>
</tr>
<tr>
<td>Hazardous Substances register</td>
<td>MRO HAZMAT Register</td>
<td>Initial – ASKAP HSE Sharepoint</td>
<td>75yrs after last entry</td>
</tr>
<tr>
<td>CATEGORY</td>
<td>Description</td>
<td>Storage Location</td>
<td>Retention Period</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>COMPENSATION</td>
<td>Records documenting claims for compensation submitted by members of the public managed by an external insurance provider</td>
<td>TRIM</td>
<td>7 yrs after finalisation of claim</td>
</tr>
<tr>
<td></td>
<td>Cases where a compensation claim has been submitted for personal injury, death, or loss or damage to personal property of the employee. Covers claims made under safety, rehabilitation and compensation legislation</td>
<td>TRIM</td>
<td>75 years after DOB of employee or 7 years after last action, whichever is longest. If date of birth is unknown assume the person was 15 at the time of the accident</td>
</tr>
<tr>
<td></td>
<td>Accident reports, witness statements, claims, determinations, correspondence, case notes, RTW plans</td>
<td>TRIM</td>
<td></td>
</tr>
<tr>
<td>CASE FILES</td>
<td>Records documenting medical examinations of employees which are undertaken for health surveillance as part of a case file</td>
<td>TRIM</td>
<td>Destroy in year 2040 or 75 yrs after DOB</td>
</tr>
<tr>
<td></td>
<td>Exposure to chemical – Doctor’s report</td>
<td>TRIM</td>
<td></td>
</tr>
<tr>
<td>AUDIT</td>
<td>Internal or external HSE audit reports &amp; preparatory documents</td>
<td>CASS HSE Audit report</td>
<td>CASS HSE common drive</td>
</tr>
<tr>
<td></td>
<td>Letters of appointment</td>
<td>CASS HSE common drive &amp; TRIM</td>
<td>5 yrs after delegation superceded</td>
</tr>
<tr>
<td>AUTHORISATION</td>
<td>Delegation of power to authorise administrative action relating to HSE</td>
<td>Letters of appointment</td>
<td>CASS HSE common drive &amp; TRIM</td>
</tr>
<tr>
<td>Authorisations for administering actions relating to HSE function</td>
<td>Appointment of investigation officer</td>
<td>CASS HSE common drive &amp; TRIM</td>
<td>5yrs after action completed</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Records relating to the receipt and provision of HSE advice</td>
<td>HSE email advice</td>
<td>CASS HSE Common drive</td>
<td>2yrs after action completed</td>
</tr>
<tr>
<td><strong>ADVICE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident/incident reports and supporting documentation of death, serious personal injury, dangerous occurrence and incapacity to Cw'th employees and the public</td>
<td>HSE Incident Report Form</td>
<td>eCopy – SAP Hardcopy – TRIM</td>
<td>30yrs after last action</td>
</tr>
<tr>
<td>All other accident/incident reports for Cw'th employees retained for CSIRO assessment purposes</td>
<td>HSE Incident Report Form</td>
<td>eCopy – SAP Hardcopy – TRIM</td>
<td>7yrs after last action</td>
</tr>
<tr>
<td>Accident/incident reports of personal injuries to members of the public aged under 18yrs, not resulting in claims for compensation</td>
<td>Witness statements, HSE Incident Report Form</td>
<td>eCopy – SAP Hardcopy – TRIM</td>
<td>When person reaches 25yrs of age or 7yrs after last action, later of</td>
</tr>
<tr>
<td>Accident/incident reports of personal injuries to members of the public aged over 18yrs, not resulting in claims for compensation</td>
<td>HSE Incident Report Form</td>
<td>eCopy – SAP Hardcopy – TRIM</td>
<td>7yrs after last action</td>
</tr>
</tbody>
</table>
10.5 FURTHER INFORMATION

- CSIRO HSE Management Standard
- CSIRO Records Keeping Procedure
11. HSE INCIDENT REPORTING

11.1 PURPOSE

- The CSIRO HSE Management Standard requires that incidents will be owned, managed and investigated by the appropriate Capability or Portfolio Manager. Where necessary, support will be sought from competent and experienced persons including HSE resources.

11.2 APPLICATION

- All ASKAP staff and affiliates must be aware of their legislated responsibilities of reporting HSE incidents in accordance with CSIRO policy while operating at a CSIRO-controlled site.

11.3 INSTRUCTIONS

- All safety breaches (hazards, near misses, first aid/medical injuries, dangerous occurrences and property damage) regardless of their severity or the concerned party need to be reported to the MRO/MSF Site Manager as soon as the scene is safe.
  
  o The MRO/MSF Site Manager will follow the CSIRO Internal Incident Reporting Process

- All safety hazards must be resolved as soon as possible and if a resolution is not possible immediately, a temporary measure must be put in place to contain the hazard until further assistance is sought from the appropriate person.

FOR INFORMATION: For sections of the MRO not under CSIRO-control, i.e. sections under the formal control of a contractor or collaborator, incident reporting will follow the sequence and timeframes as described in the MRO HSE Manual – Contractor.
11.4 INCIDENT & HAZARD REPORTING PROCEDURE

- **STEP 1: SECURE THE SCENE**
  o Person makes area SAFE and arranges for First Aid if required then notifies their *Team Leader*.
  o *Team Leader* notifies Site Manager/Coordinator who activates Emergency Management Plan, if required
  o MRO Site Manager may order complete site evacuation

- **STEP 2A (If, Serious Incident): NOTIFICATION**
  o *Team Leader* notifies MRO Site Manager by phone (who in-turn reports to CASS management as required)

- **STEP 2B (If, Vehicle Incident): IN ADDITION TO ABOVE**
  o Notify Police
  o Inform our insurer *Comcover* (1800 651 540)

- **STEP 4: HSE REPORT (<24hrs).** While still fresh, manager of individual/s completes HSE Incident Investigation
  - Gather eyewitness statements
  - [Hardcopy forms](#) at CSIRO BETA Site Office and Wittenoom Cottage office; or
  - Online into the SAP system

- **STEP 5: MRO/MSF Site Manager & HSE Officer endorses investigation and forwards to CASS BU HSE Leader**

11.4.1 INCIDENT INVESTIGATIONS

- HSE incident investigations are used to establish both the immediate and underlying causes, as well as to identify corrective and preventative actions to stop repeat occurrences.

- An investigation should begin as soon as possible after the incident is reported, and ideally within 24 hours of occurrence.

- The investigation should identify:
  o facts leading up to the incident
  o root cause/s of incident (including near miss) or injury/illness
  o actions to address all root causes of the incident
• The SAP HSE module should be used to document the completed investigation, and if not accessible, the same process can be completed using the paper-based form. See HSE Incident Investigation Form (Enclosure 07).

**FOR INFORMATION:** for regulatory reportable incidents, i.e. serious personal injury or hospitalisation, the regulator may ask for a copy of the investigation report. Typically legal advice is asked prior to release, this will be managed by the HSE Manager is necessary.

### 11.4.2 FURTHER INFORMATION

• CSIRO HSE Procedure: [Incident & Hazard Management](#)

• CSIRO HSE Guidelines: [Incident & Hazard Management](#)

• [MRO Emergency Management Plan](#)

• MRO Emergency Management Plan Enclosure 1: [Emergency Flip Chart](#)
12. **EMERGENCY & INJURY MANAGEMENT**

### 12.1 PURPOSE

- To provide an overview of the emergency management arrangements at the MRO.
- Injury management for staff who become ill or injured as a result of undertaking CSIRO activities will be conducted according to the legislative requirements as well as the requirements specified in CSIRO procedure.
- Outline CSIRO first aid arrangements generally and specifically at the MRO.

### 12.2 APPLICATION

- All staff and affiliates (including contractors) working at or visiting the MRO.

### 12.3 INSTRUCTIONS

#### 12.3.1 RANGE OF EMERGENCIES

- Some of the emergencies that may be encountered at or in the vicinity of the MRO or CSIRO Accommodation Facility include:

<table>
<thead>
<tr>
<th>MEDICAL</th>
<th>TRAVEL/VEHICLE RELATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal bite/sting</td>
<td>Missing Person/Missed Call-in</td>
</tr>
<tr>
<td>Burns (hot metal, chemical, sun/windburn etc)</td>
<td>Vehicle Breakdown</td>
</tr>
<tr>
<td>Cuts/abrasions</td>
<td>Vehicle Accident</td>
</tr>
<tr>
<td>Dehydration</td>
<td>(incl. mobile plant)</td>
</tr>
<tr>
<td>Electric Shock/Electrocution</td>
<td></td>
</tr>
<tr>
<td>Fall from Height / Dropped Object</td>
<td></td>
</tr>
<tr>
<td>Heat Illnesses</td>
<td></td>
</tr>
<tr>
<td>Hypo/hyperthermia</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SEVERE WEATHER</th>
<th>FIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storms &amp; Large-scale Flooding</td>
<td>Spot fires/smoke</td>
</tr>
<tr>
<td>Localised Flash Flooding</td>
<td>Building (internal) fires</td>
</tr>
<tr>
<td>Dust storm / ‘dust devils’</td>
<td>Bushfires</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SITE RELATED (BUILDINGS &amp; UTILITIES)</th>
<th>TRESPASSERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of power</td>
<td>Un-announced visitor</td>
</tr>
<tr>
<td>Major diesel spill</td>
<td></td>
</tr>
<tr>
<td>Sewerage incident</td>
<td></td>
</tr>
</tbody>
</table>
12.3.2 EMERGENCY PLANNING COMMITTEE (EPC)

- CSIRO procedure requires the establishment of an EPC (or representation on an EPC) on each CSIRO site. Letters of appointment are available [here](#).

- The MRO EPC will meet biannually (more frequently as required during construction and commissioning) to with the terms of reference as outlined in *CSIRO HSE Guidelines: Emergency Management*

- The purpose of the EPC is to:
  - Develop and review the Site Emergency Management Plan (SEMP) – at least annually
  - Establish and appoint people to the ECO
  - Facilitate communication with co-tenants to ensure coordinated approach to emergency planning and response
  - Identify all stakeholders in the local area and arrange joint emergency management planning as required
  - Arrange relevant training for ECO members
  - Conduct and review evacuation exercises to test various emergency scenarios and meet Australian Standards
  - Ensure that hazardous substance signage and manifests are current and available to emergency services personnel
  - Promote and publicise the SEMP and related procedures

- Representation on the MRO EPC is open to:
  - CASS and ICT Centre staff
  - Collaborators and other long-term visitors/co-tenants, e.g. MWA

- The MRO EPC consists of:
  - Theme Leader/Project Director (Chair)
  - MRO/MSF Site Manager
  - MRO Site Coordinator
  - HSE Officer (Secretary)
  - *Infrastructure Contractor* - Superintendent
  - *Infrastructure Contractor* – Management Rep (& Safety Rep)
  - *Collaborator* – Management Rep (& Safety Rep)
  - Boolardy Station Manager
12.3.3 SITE EMERGENCY MANAGEMENT PLAN (SEMP)

- The SEMP is a stand-alone document, stored on the CSIRO HSE Sharepoint Site.
- Hardcopies of the SEMP are available at/from:
  - Wittenoom Cottage Emergency Information Cabinet
  - BETA Site Office Emergency Information Cabinet
  - MSF Reception (Gemma Whiting)
  - ASKAP Project Director (Antony Schinckel)
  - ASKAP Project Manager (Alan Ng)
  - CASS BU HSE Leader (Kylie Fraser)
  - CASS Deputy BU Leader (Sarah Pearce)
12.3.4 EMERGENCY CONTROL ORGANISATION

- The person in-control of the worksite is responsible for the initial response to emergencies.
- The role of Emergency Coordinator will be filled in order of priority by:
  - MRO/MSF Site Manager
  - MRO Site Coordinator
  - HSE Officer & MRO/MSF Site Coordination Asst
  - Team Leader

**Emergency Coordinator**
CSIRO MRO Site Manager, Site Coordinator, HSE Officer or Team Leader

**Emergency Response Team Members**
- First Aid Responders
  (Remote First Aid or Senior First Aid trained)
- Fire Response Team
  (*holding place for future*)
- Maintenance Responder
  (for equipment & utilities issues)

**Emergency Services 000**
(RFDS, Police etc)

**Local Resources**
(nearby Station Owners etc)

**Base Contact**
(for travel related situations)

**Escalation as required**

**Communications Coordinator**
12.3.5 FIRST AID

FIRST AID OFFICERS

- CSIRO recognises that many staff members require first aid training as part of their duties, however are not appointed to an official position – they are called Approved First Aid Officers.

- Staff members officially appointed for a workplace are called Authorised First Aid Officers. Only Authorised First Aid Officers receive an allowance.

- For ASKAP, staff members who have received Remote Area First Aid Training are deemed to be Approved First Aid Officers.

- The Project Director (as Senior Manager) will appoint in writing a First Aid Coordinator for the MRO. Presently, the incumbent is the HSE Officer. Duties of this position are described in the CSIRO HSE Procedure: First Aid.

CSIRO FIRST AID PROCEDURE

- CSIRO procedure requires the provision of first aid services to be representative of the hazards and risks of the work undertaken, i.e. higher risk work requires a more substantial first aid arrangement.

- Authorised First Aid Officers and Approved First Aid Officers are indemnified by CSIRO for actions taken within their level of competence.

MRO REQUIREMENTS

- Unless under 100% escort, the minimum level of First Aid competence for all visitors to the MRO is Senior First Aid (basic 2-day course).

- Due to the transient nature of the CSIRO population onsite, the MRO does not have a permanent Authorised First Aid Officer.

- Team Leaders must ensure at least two members of their visiting team have undertaken Remote Area First Aid training. Where the team consists of just two people, at least one member must have undertaken Remote Area First Aid training.

- All instances of first aid kit use shall be recorded on the respective First Aid Kit/Station Manifest. This is best recorded at the ‘clean-up’ stage following the treatment of a casualty by a First Aid officer. If self-administering simply record use as you use it.

- All visitors to the MRO are requested to complete the Medical Disclosure Form (Enclosure 08) to voluntarily disclose any medical information the treating first aid officer may wish to know in an emergency situation. Records will be strictly kept ‘MEDICAL-in-CONFIDENCE’ and destroyed either as directed or after final MRO visit.
ADMINISTERING S4 MEDICATIONS (PAIN-RELIEF)

- Inside each MSF 4WD vehicle is a small ‘Field First Aid Kit’. This kit contains medications that are only available under a WA Schedule 4 (S4) Poisons Permit.
- An S4 medication is a controlled substance due to its addictive properties. The kit contains medications to assist in the relief of mild to medium pain.
- ASKAP’s S4 permit-holder must be contacted, wherever possible, prior to the administration of any S4 medications.
  - Contact details are enclosed within the Field First Aid Kit.

MRO FIRST AID KIT LOCATIONS

- First aid stations and first aid kit storage locations at the MRO:
  - Wittenoom Cottage – Boolardy Accommodation Facility [First Aid Station]
  - CSIRO Site Office [First Aid Station]
  - Antenna #29 Site Hut
  - All Vehicles

KIT MAINTENANCE

- The MRO First Aid Coordinator will maintain all first aid supplies and an up-to-date inventory at each first aid station and kit.

12.3.6 INJURY MANAGEMENT

- Work-related injuries will be managed in accordance with CSIRO Injury Management Procedure and Guidelines.
  - Requests for Early Intervention consideration should be made to a staff member’s immediate manager or to the IPT Manager. The manager should contact the HSE Officer or CASS BU HSE Leader for further advice.
  - All compensation claims should be made to the CASS BU HSE Leader directly.

12.3.7 FURTHER INFORMATION

- MRO Site Emergency Management Plan
- CSIRO HSE Procedure: Emergency Management
- CSIRO HSE Guideline: Emergency Management
- CSIRO HSE Procedure: First Aid
- CSIRO HSE Guideline: First Aid
13. CHANGE MANAGEMENT

13.1 PURPOSE

- TBA

13.2 APPLICATION

- TBA

13.3 INSTRUCTIONS

- TBA
APPENDIX A – CONSTRUCTION SITE RULES

- Zero Alcohol & Non-prescription Drugs onsite
- No pets
- Report all new HAZARDS and HSE INCIDENTS to HSE Officer or Site Manager ASAP
- White Card or 100% Escort
- Must sign onto a SWMS before job start
- Personally Sign-In and Sign-Out every day
- At least one UHF radio per work team – listening to Ch12
- Reverse park at the CSIRO Site Office compound
- Mandatory PPE Includes: Hardhat (chinstrap down when working aloft), High-Vis Clothing, Long Sleeves, Long pants, Safety Boots, Safety Glasses.
- Additional PPE must be worn according to the task - gloves, hearing protection, safety harness, lanyard, etc
- All vehicles MUST have a first aid kit & fire extinguisher within
- Team Leaders to monitor for and comply with fatigue, lighting and working alone instructions
- All HEIGHTS, LIFTING & ELECTRICAL EQUIPMENT must have current test tag
- Must have an MSDS onsite for every hazardous substance
- Follow all Manufacturer’s Instructions (general precaution)
- Smoking is not permitted inside any CSIRO building or vehicle.
APPENDIX B – BOOLARDY SAFETY & HYGIENE RULES

 Boolardy Station

• The Boolardy Accom Facility is co-located with Boolardy Homestead. When driving in the vicinity of Boolardy Accom Facility drivers are requested to reduce their speed for the safety of other visitors, Station residents and workers and to reduce dust.

• Boolardy Station is an operating pastoral business. Visitors to the MRO are to conduct their activities in manner that does not interfere with the normal operations of the Station’s activities. Station residents and staff are not available for traffic directions, inquiries etc.

• The Station Manager’s residence and adjacent farm building do not form part of the Boolardy Accommodation facility and are not available for access by visitors to the site. The Station Manager and his family are not CSIRO employees. All arrangements for visiting the MRO should be made through the CASS office in Geraldton.

• The Station cannot supply fuel, food, groceries or personal items. Neither the Station nor the accommodation facility carries supplies of alcohol or a licence to supply/sell liquor.

Clothing

• Visitors are advised to dress appropriately for the climate (summer temperatures regularly exceed 45°C in the shade). Long sleeved, lightweight shirts and long trousers are strongly recommended as is a wide brim hat. Contractors must supply own sunscreen.

Accommodation Facility

• The accommodation facility comprises a fully catered dining room (supplying hot or cold breakfast, packed lunch and hot evening meal) along with single and double bedroom en-suite rooms. Each room is supplied with linen, towels, pillows etc.

• Visitors are required to supply their own:
  
  I. Toiletries and personal items
  II. Torch
  III. Computer equipment (access to the internet is available via wireless LAN)
  IV. Wine, beer etc. (each room is fitted with a small fridge)

• Smoking is not permitted inside any CSIRO building or vehicle.

• Laundry facilities are available. Laundry powder is supplied. Please do not use alternative laundry products as they adversely affect the sewerage management system.
APPENDIX C – TASK FLOWCHART

ELECTRICAL

WORK AT HEIGHT

EXPLOSIVE TOOL

HAZARDOUS SUBSTANCE USE

LIFTING OPERATIONS

ONE-OFF TASKS

IF, PERFORMED BY CONTRACTOR:
1. CHECK JSA
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY CONTRACTOR:
1. CHECK JSA
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY CONTRACTOR:
1. CHECK JSA
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY CONTRACTOR:
1. CHECK JSA
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY CONTRACTOR:
1. CHECK JSA
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

IF, PERFORMED BY STAFF:
1. WRITE SWMS
2. ISSUE PERMIT-TO-WORK

ROUTINE TASKS

1. INSERT INTO IPT RISK MGT PLAN
2. WRITE SWMS
3. COMPLETE ELECTRICAL RISK CONTROL PLAN

1. INSERT INTO IPT RISK MGT PLAN
2. WRITE SWMS
3. DEVELOP SWI

1. INSERT INTO IPT RISK MGT PLAN
2. WRITE SWMS
3. DEVELOP SWI

1. INSERT INTO IPT RISK MGT PLAN
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3. DEVELOP SWI

1. INSERT INTO IPT RISK MGT PLAN
2. WRITE SWMS
3. DEVELOP SWI
REFERENCES & LINKS

[1] ATNF Visitors Website [www]
[2] MRO Site Visit Request Form [www]
[3] ASKAP HSE Sharepoint Website [CSIRO Intranet]

ENCLOSURES

[1] CSIRO & ASKAP HSE Policy Map (pdf)
[4] ASKAP Authorisation to Operate Plant Form (pdf)
[6] Record of Toolbox Talk Attendance (pdf)
[9] ASKAP Contacts List (pdf)
Employment labour market

Australian labour market

In the 12 months to June 2011, total employment rose and unemployment fell in the majority of Australian States and Territories, including Western Australia. In some regions, high demand and low unemployment rates have led to some tightness in the current labour market.

Australia’s total employment in July 2011 was 11,448,500, an increase of 1.7 percent since July 2010. Australia’s unemployment rate in July 2011 was 5.1 percent (a reduction of 0.2 percent from July 2010). This strength in the labour market is expected to continue over the medium term. The following tables summarise the major occupation groupings and qualification levels of the Australian labour force.

Table 1 – Number of employees by occupation group in Australia.

<table>
<thead>
<tr>
<th>Major occupation group</th>
<th>Average for year 2010</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Managers</td>
<td>1,477,100</td>
<td>13.2</td>
</tr>
<tr>
<td>2. Professional</td>
<td>2,410,500</td>
<td>21.5</td>
</tr>
<tr>
<td>3. Technicians and trades workers</td>
<td>1,657,800</td>
<td>14.8</td>
</tr>
<tr>
<td>4. Community and personal service workers</td>
<td>1,036,200</td>
<td>9.2</td>
</tr>
<tr>
<td>5. Clerical and administrative workers</td>
<td>1,649,300</td>
<td>14.7</td>
</tr>
<tr>
<td>6. Sales workers</td>
<td>1,085,900</td>
<td>9.7</td>
</tr>
<tr>
<td>7. Machinery operators and drivers</td>
<td>720,700</td>
<td>6.4</td>
</tr>
<tr>
<td>8. Labourers</td>
<td>1,177,100</td>
<td>10.5</td>
</tr>
<tr>
<td>Total</td>
<td>11,214,500</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Australian Bureau of Statistics Labour Force, Australia, Detailed Quarterly (cat.no. 6291.0.55.,003)
Categories are as per the broadest level of the Australian and New Zealand Standard Classification of Occupations.

Table 2 – Educational profile of the Australian population (15-64 years) – as at May 2010.

<table>
<thead>
<tr>
<th>Level of highest non-school qualification</th>
<th>Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postgraduate Degree</td>
<td>639,300</td>
</tr>
<tr>
<td>Graduate Diploma/Graduate Certificate</td>
<td>309,400</td>
</tr>
<tr>
<td>Bachelor Degree</td>
<td>2,388,100</td>
</tr>
<tr>
<td>Advanced Diploma/Diploma</td>
<td>1,345,800</td>
</tr>
<tr>
<td>Certificate III/IV</td>
<td>2,496,700</td>
</tr>
<tr>
<td>Certificate I/II</td>
<td>580,500</td>
</tr>
<tr>
<td>Certificate n.f.d.</td>
<td>129,100</td>
</tr>
<tr>
<td>Total with a non-school qualification</td>
<td>8,088,100</td>
</tr>
<tr>
<td>Total without a non-school qualification</td>
<td>6,423,800</td>
</tr>
<tr>
<td>Total</td>
<td>14,511,900</td>
</tr>
</tbody>
</table>

Source: Australian Bureau of Statistics Education and Work, Australia (cat. no. 6227.0).
Wage price movements for all Australia workers over the last decade have been relatively moderate and consistent with inflation (and the consumer price index), though the WPI for Western Australia has, at times, been higher than the national average.

The Wage Price Index (WPI) measures changes in total hourly rates of pay, excluding bonuses. The WPI for all sectors (public and private) in Western Australia increased by 4.1 percent in the year to 31 March 2011, with the private and public sectors increasing by 4.3 percent and 3.6 percent respectively. This compares to an Australian national average WPI increase of 3.9 percent, averaged across all sectors. The following chart plots the annual average change in WPI (a rolling average of four quarters) for Australia and Western Australia over the last decade.

**Western Australian labour market**

Western Australia is the fourth largest employing state, with around 1.2 million workers. The largest employing industries in Western Australia are construction (128 800), retail trade (120 700) and health care and social assistance (117 800). Mining with 82 400 employees is also a major employing industry. Employment grew by 15.7 percent (166 000) over the five years to November 2010, outstripping the national growth rate of 13.1 percent. Employment rose in 15 of the 19 main industries. The largest numbers of new jobs were created in mining (34 700), construction (30 700) and professional, scientific and technical services (21 300). Employment in regional Western Australia is driven mainly by construction (36 000), agriculture, forestry and fishing (33 900) and mining (31 800), with some construction activity taking place in the mining sector. The largest numbers of new jobs over the past year were in mining (7 500) and other services (5 700).

**New Zealand labour market**

**Table 3 – New Zealand employment trends & workforce resilience.**

<table>
<thead>
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<tbody>
<tr>
<td>Construction</td>
<td>-0.2%</td>
<td>156,281</td>
<td>-3.7%</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>Finance and insurance</td>
<td>5.2%</td>
<td>55,578</td>
<td>3.6%</td>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>Communication services</td>
<td>-3.9%</td>
<td>24,823</td>
<td>4.1%</td>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>Education</td>
<td>1.2%</td>
<td>165,839</td>
<td>-0.9%</td>
<td>medium</td>
<td>medium</td>
</tr>
</tbody>
</table>

*Source: Identifying the Resilience of the NZ Workforce in a Recession, Dept of Labour 2009.*
Attachment 23
Summary of applicable workplace legislation

Table 1 – Summary of applicable workplace relations legislation, instruments and organisations.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Type</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Australia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fair Work Act 2009</strong></td>
<td>Commonwealth</td>
<td>The Fair Work Act creates a safety net of minimum employment terms and conditions made up of two parts - National Employment Standards, and modern awards (see below). The Fair Work Act also allows for the making of enterprise agreements, which set out the conditions of employment between employees and their employer, at the business enterprise level. Part 2-4 of the Act establishes a framework for the negotiation and approval of enterprise agreements. It expressly allows for an employee to appoint a representative (including a union) to represent his or her interests in the negotiation of an enterprise agreement. For union members, their bargaining representative is taken to be their union (if the union is entitled to represent them) unless they appoint someone else or revoke the union’s status as their representative. The Fair Work Act operates on the basis that an employer and employee may choose to enter into common law contracts, provided those contracts do not contain terms that conflict with the National Employment Standards, any modern award or applicable enterprise agreement. The Fair Work Act does enable an employee and an employer to agree to vary the effect of a modern award or an enterprise agreement (under an 'individual flexibility arrangement') in order to meet the individual needs of the employee and employer, provided that the employee will be better off overall than if he or she had not entered into the individual flexibility arrangement. Individual flexibility arrangements must be genuinely agreed between the employee and employer; must be in writing and signed; and must be able to be terminated by either party by giving written notice of not more than 28 days. Under the Fair Work Act, it is lawful for an employer to dismiss an employee if it is a genuine redundancy or if the dismissal would not be considered harsh, unjust or unreasonable or (in the case of a business with fewer than 15 employees) if the dismissal is consistent with the Small Business Fair Dismissal Code.</td>
</tr>
<tr>
<td><strong>National Employment Standard</strong></td>
<td>Commonwealth</td>
<td>The National Employment Standards are a set of 10 minimum employment conditions which cover matters such as: maximum weekly hours of work (38 hours per week plus reasonable additional hours); the right to request flexible working arrangements (applying to some parents and carers of children); leave entitlements (including 4 weeks paid leave per year, up to 12 months parental leave, 10 days’ paid personal / carer’s leave), 2 days compassionate leave, community service leave and public holidays) and redundancy entitlements (including up to 4 weeks’ notice of termination and up to 16 weeks’ redundancy pay).</td>
</tr>
<tr>
<td><strong>Modern Awards</strong></td>
<td></td>
<td>Modern awards are industry or occupation-based enforceable minimum employment standards which apply in addition to the National Employment Standards covering matters including minimum wages and penalty rates, allowances and type of employment.</td>
</tr>
<tr>
<td><strong>Fair Work Australia and Fair Work Ombudsman</strong></td>
<td>Commonwealth</td>
<td>Statutory bodies created under the Fair Work Act to implement and monitor the national workplace relations system.</td>
</tr>
<tr>
<td><strong>State Awards</strong></td>
<td>State</td>
<td>Awards set out the minimum terms and conditions of employment for groups of workers employed in the same industry or occupation.</td>
</tr>
<tr>
<td><strong>Industrial Relations Act 1979</strong></td>
<td>WA State</td>
<td>In the Western Australian system, there are four kinds of employment relationship: (a) state awards applying to certain industries and occupations; (b) registered industrial agreements applying to specific businesses; (c) registered employer-employee agreements applying to individual employees; and (d) ‘common-law’ contracts of employment where no award or agreement applies.</td>
</tr>
</tbody>
</table>
The Minimum Conditions of Employment Act 1993

The Minimum Conditions of Employment Act 1993 provides a minimum standard of pay and conditions that underpins all of these employment arrangements. These minimum conditions cover topics including maximum weekly hours of work (38 hours plus reasonable additional hours), minimum rates of pay (currently, approximately $610 per week for full-time workers aged over 21) and leave entitlements.

Workplace Relations Act 1996

Commonwealth

Sets out a range of matters including in relation to freedom of association, right of entry and industrial action.

New Zealand

Employment Relations Act 2000

Specifies the responsibilities for employers and employees in New Zealand. It allows for collective or individual employment agreements, and the rights of unions to negotiate working conditions on behalf of employees. An employer can make an offer of employment subject to a trial period of up to 90 days, provided the trial is agreed in writing and negotiated in good faith as part of the employment agreement. Employees have the right to decide whether they want to join a union and, if so, which union.

Table 2 – Summary of applicable occupation health and safety legislation and organisations.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Type</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupational Safety and Health Act 1984</td>
<td>WA</td>
<td>Provides the legal framework to promote and secure the safety and health of people in the workplace in Western Australia.</td>
</tr>
<tr>
<td>Workers’ Compensation and Injury Management Act 1981</td>
<td>WA</td>
<td>Makes provision for the: compensation of workers who suffer an injury; compensation of certain dependants of workers who die as a result of an injury; and management of workers’ injuries in a manner that is directed at enabling injured workers to return to work as well as: specialised retraining programmes for certain injured workers; providing dispute resolution mechanisms for parties involved in workers’ compensation matters and promoting safety measures.</td>
</tr>
<tr>
<td>Workcover WA</td>
<td>WA</td>
<td>West Australian government agency responsible for overseeing workers’ compensation and injury management and is responsible for monitoring workplace compliance with the Workers’ Compensation and Injury Management Act 1981, as well as informing and educating workers, employers and others about workers’ compensation and injury management, and providing an independent dispute resolution system.</td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and Safety in Employment Act 1992</td>
<td></td>
<td>Imposes occupational health and safety obligations on employers, employees and others. Employers must provide a safe workplace (with proper training, supervision and equipment), identify, assess and manage hazards, and investigate health and safety incidents. Employees must take reasonable care to keep themselves safe and to avoid causing harm to others by the way they do their work. Employees may refuse work likely to cause them serious harm and employees have the right to participate in improving health and safety.</td>
</tr>
<tr>
<td>Accident Compensation Corporation</td>
<td></td>
<td>Employees who suffer an injury at work are entitled to compensation from a State funded insurance scheme administered by the Accident Compensation Corporation. This replaces the right of employees to sue at common law for compensatory damages. Employers are required to deduct an ‘Earner’s Levy’ from the pay of each employee, which is paid to Inland Revenue and contributes to funding the ACC scheme.</td>
</tr>
<tr>
<td>Legislation</td>
<td>Status</td>
<td>Comment</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Equal Opportunity Act 1984</em></td>
<td>WA</td>
<td>Prohibits discrimination on the grounds of sex, marital status, pregnancy or breast feeding, family responsibility or family status, race, religious or political conviction, impairment, age or gender history in the areas of work, accommodation, education, the provision of goods, facilities and services, access to places and vehicles, land and the membership of clubs. The Equal Opportunity Commission (WA) operates under the Act.</td>
</tr>
<tr>
<td><em>Sex Discrimination Act 1984</em></td>
<td>Commonwealth</td>
<td>Prohibits discrimination on the basis of sex, marital status, pregnancy or potential pregnancy and in relation to termination of employment, family responsibility.</td>
</tr>
<tr>
<td><em>The Racial Discrimination Act 1975</em></td>
<td>Commonwealth</td>
<td>Prohibits discrimination on the basis of race, colour, descent or national or ethnic origin and prohibits offensive behaviour based on racial hatred.</td>
</tr>
<tr>
<td><em>The Age Discrimination Act 2004</em></td>
<td>Commonwealth</td>
<td>Prohibits discrimination on the basis of age.</td>
</tr>
<tr>
<td><em>Superannuation Guarantee (Administration) Act 1992</em></td>
<td>Commonwealth</td>
<td>Employers are also required by law to make superannuation contributions (of at least 9 per cent of an employee's ordinary time earnings) on behalf of their employees. However, if the employee is a resident of a country which Australia has a 'bilateral social security agreement' with, then the person's employer may not be subject to the superannuation guarantee legislation. Australia currently has agreements with 18 countries.</td>
</tr>
<tr>
<td><em>Pay-Roll Tax Assessment Act 2002</em></td>
<td>WA</td>
<td>Pay-roll Tax is a general purpose tax assessed on the wages paid by an employer in Western Australia. Pay-roll tax is payable at a rate of 5.5 percent on pay-rolls greater than $750,000 per annum. Note: that certain organisations are exempt from pay-roll tax.</td>
</tr>
<tr>
<td><strong>New Zealand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Kiwisaver Scheme</em></td>
<td></td>
<td>All employees are automatically enrolled in the national Kiwisaver savings scheme, but have the right to opt out. Employers deduct Kiwisaver contributions from the pay of enrolled employees and pay this to Inland Revenue together with the compulsory employer contribution (which is 2% of employee gross salary or wages).</td>
</tr>
</tbody>
</table>
Overview of Operations and Maintenance Plan

The operations and maintenance plan developed by the ANZSCC for this response follows the requirements given in the Request for Information (RFI) and the operations and maintenance model described in the document ‘Initial Model for Maintenance and Operations Staffing for the SKA v1.8 11 February 2011’ by Peter Dewdney. We have taken the broad operating policies and facility operations requirements presented in the document ‘The SKA Science and Technical Operations Plan’ by K. Kellermann (WP2.001.010.010-PLA-001, 2010) to develop the operations and maintenance model used to estimate costs for the provision of basic infrastructure components, electrical power and data transport. The model also draws on CSIRO’s experience with building and operating radio astronomy facilities in Australia for over 50 years and borrows ideas from the operation of existing astronomy facilities around the world.

A description of the major components and the required cost estimates of this Operations and Maintenance model are presented in this report. As Kellermann notes in his report, it is important to keep in mind that the SKA will be more complex than any existing telescope being built today and the full Operations and Maintenance model for the SKA may well need to evolve to something very different from the guiding model that is described here. His report brings to the fore that the size and complexity of the SKA will mean that operating costs will be substantial.

The SKA observing schedule will likely be a mix of large-scale and time-intensive survey projects as well as shorter and individually targeted projects. It is proposed that observing time will be awarded to projects on the basis of scientific merit via a competitive proposal application process. The SKA user community will comprise a range of astronomers and students from all over the world with a variety of skills in working with data from radio wavelength array telescopes. Based on early experience with ALMA, it seems reasonable to assume that SKA will have more than 1000 individual users each year.

The construction phase for SKA is expected to continue for at least a 10-year period. Despite this extended construction phase, it will be important to begin astronomical observations as soon as there are sufficient infrastructure components in place to carry out early-science programs. The co-existence of construction and scientific operations will pose a challenge for operation and maintenance planning and there will be many valuable lessons learned from projects facing this challenge already such as ASKAP, ALMA, LOFAR, and MeerKAT.

We anticipate that expert operators will carry out all of the primary monitoring and control for SKA using state-of-the-art software and control system design. Signals collected from all of the SKA antennas will be transported along network optical fibres to a data processor for correlation. The raw output from the data processor will then be transported to a high-performance computing facility for data calibration and image processing. SKA scientific staff will verify the quality of the data products before they are stored in the SKA data archive for collection by the project investigator. The SKA monitoring and control system and the super-computing data system processing will be complex and will require a significant group of software and IT experts to develop and maintain both systems.

The SKA scientific staff (mostly astronomers) will be the driving force behind maximising the scientific output of the SKA and they will play a critical role in the SKA leadership. These staff will be the primary point of contact to the global SKA user community and will shape the ‘culture’ of the SKA observatory. They will work closely with the operators, software engineers, and maintenance staff as well as the education and public outreach staff.

Preventative maintenance will be a major component of the operations of the SKA core and remote stations. There will be a staff complement of engineers, technicians and skilled tradespeople required to routinely service the SKA antenna systems, power and data networks, buildings, roads and other supporting infrastructure.

There will be a team of administrative staff responsible for human resources, procurement, logistics, office management and ensuring health, safety and environmental sustainability for all of the SKA infrastructure sites. Also part of this team will be staff dedicated to the education and public outreach of the SKA project and new science results.

Staff working at the SKA core site will work on a rotating shift pattern following some variant of the ‘turno’ procedure in use at ALMA and the European Southern Observatory (ESO) in Chile (see inset, below). Staff working on rotating shifts is a commonly used model amongst large companies operating in remote locations throughout Australia and strikes a balance between working in a remote location and offering urban lifestyles for staff and their families. Working in shifts
also reduces the staff presence onsite, lowering site infrastructure requirements and minimising the human factors impacting radio frequency interference.

In this report we present our staffing plan for operating and maintaining the SKA and describe how these staff are accommodated. In doing so we have adopted the following science and facility operations platforms:

- All primary monitoring and control (observing) will be carried out by expert operators.
- Science quality data will be provided by the observatory for the majority of observing projects.
- The global SKA user community will use the data archive to access their data product.
- Scientific staff of the highest calibre will be recruited from around the world to maximise the science output of the SKA.
- Minimal staff presence on the SKA core site to reduce infrastructure costs and minimize radio frequency interference.
- The majority of staff working at the core site and the operations centre near the centre of the array will work on a rotating shift (a ‘turno’).

As noted in the ‘Initial Model for Maintenance and Operations Staffing for the SKA v1.8 11 February 2011’, by Peter Dewdney, the precise details of the work scheme adopted by maintenance staff will not affect the number of hours worked per year and hence has no impact on salary costs. It may be necessary to implement an alternative work scheme (for example, 10 hour days instead of 7.5 hours on an 8/6 shift system). An on-call roster system will also be in place for full 24/7 support coverage in case of emergencies and corrective maintenance.

Include in this report are references to the cost estimates for the operations and maintenance of each major infrastructure component as well as the operations plans and costs for operating the power and data transport networks for the first 30 years of full operations for both the compliant and motivated alternative configurations. Consideration has also been given to estimating the operating and maintenance costs of the preceding 10-year construction phase.

**Modus Operandi – The ‘turno’ – one possible scenario**

The observatories in Chile (VLT and ALMA) operate with an 8/6 shift system (or ‘turno’ as the locals call it). This consists of 8 days on duty followed by 6 days off duty. All staff start their shift on the same day of the week (nominally a week day). Shifts begin at midday and finish mid afternoon one week later. This ensures sufficient overlap with staff on both incoming and outgoing shifts.
Operations and maintenance staffing model

A breakdown of the staffing model for operating and maintaining the SKA is given Table 1. The staffing numbers have been taken directly from the Request for Information (RfI) and from the document ‘Initial Model for Maintenance and Operations Staffing for the SKA v1.8 11 February 2011’ by Peter Dewdney, noting that these numbers do not factor workforce productivity, and so may not reflect the real on-site situation at a particular location. Deviations from the RfI are:

For the compliant configuration of the Model SKA:
- The staff maintaining remote array-stations (greater than 180km from the core site) are based in Geraldton and Sydney (rather than near the centre of the array) using a more efficient service model
- Less frequent grading of roads is assumed, based on standard practice in the area
- Fewer staff to maintain the power network, consistent with the staffing models for other power networks in Australia of a similar scale
- Staff trained to maintain more than one antenna system to minimise travel time
- Fewer security staff are assumed, consistent with the local environment
- The primary monitoring and control (via operators) is carried out offsite in Perth
- Staff tracking the state of the system and the equipment needed to maintain it (configuration management and spares staff) are based in Geraldton
- No designated bus drivers.

For the Motivated Alternative:
- The same as those listed above for the Compliant Model.
- The numbers of maintenance staff are scaled down to reflect the reduction in the number of components, noting as for the compliant configuration that detailed modelling of maintenance requirements would need to consider workforce productivity.

The full breakdown structure for calculating the staff complement at the SKA Operations Centre Near the Centre of the Array for both the compliant and motivated alternative models is given at the end of this report.
Table 1 – Full staffing model for operating and maintaining the SKA.

<table>
<thead>
<tr>
<th>Staff numbers</th>
<th>Staff numbers</th>
<th>Staff numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compliant configuration</td>
<td>Motivated alternative configuration</td>
</tr>
<tr>
<td>Maintenance Group – Dishes &lt; 180 km</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>Maintenance Group – Dishes in remote stations</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Maintenance Group – AA systems</td>
<td>95</td>
<td>16</td>
</tr>
<tr>
<td>Maintenance Group – Data/Processor/Power Systems</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Maintenance Group – Roads/Buildings/Security</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance Group – Managers &amp; Schedulers</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Operations Group – Operators</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Operations Group – Onsite Managers</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Site Configuration Management Group – Config Management &amp; Spares Staff</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Near-Site Staff</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Total Site Staff Complement (Operations, Maintenance, Config. Mgt.)</td>
<td>179</td>
<td>75</td>
</tr>
<tr>
<td>Total Workforce Onsite</td>
<td>134</td>
<td>56</td>
</tr>
<tr>
<td>Astronomers and engineers including visitors</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Software development and maintenance</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Building maintenance, garden maintenance, security</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Super Computer and hardware support</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Software development and maintenance for supercomputer data processing</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Total Staff Complement</td>
<td>362</td>
<td>245</td>
</tr>
</tbody>
</table>

Provision of Basic Infrastructure Components

Accommodation of the operations and maintenance staffing model

The operations and maintenance staffing model incorporates the following three primary infrastructure sites:

- The central area containing three cores of receptors (SKA Core) and the Operations Centre near the Centre of the Array (SKA OCCA)
- The Observatory Support Office (SKA OSO)
- The Head Office Building (SKA HOB) and the Supercomputing Building (SKA SCB).

The role of the staff at each of these sites is detailed further below. While the remote stations are a significant part of the full SKA infrastructure they do not have permanently stationed staff on site.

SKA Core and SKA OCCA

The SKA Core will be located within the Murchison Radio-astronomy Observatory (MRO), with on-site staff utilising the MRO Control Building, owned and operated by CSIRO. There will be no continuous staff presence at the SKA Core. Instead there will be daily activities including preventative maintenance. Staff will spend a full day at the SKA Core, traveling in groups and driving designated 4WD vehicles. Staff will take with them a freshly packed lunch and water.
supply. Existing services at the MRO control building (bathrooms, kitchen, first aid room) can also be used. Staff working in the intermediate region (encompassing the spiral arms) will travel in crews of a minimum of two persons. Standard operating procedures for personnel working in remote areas of Australia will be followed.

Maintenance staff for the data processor and workshops together with managers and security staff will be based at the operations centre near the centre of the array (SKA OCCA), which will be located in the vicinity of the existing Boolardy Station homestead accommodation precinct, some 30 km from the MRO. The operations centre will consist of a data processor building, a power building and several other buildings containing workshops, offices and meeting rooms. This area will also include the permanent accommodation village. Managers from the Maintenance and Operations Groups based at the OCCA will keep track of all staff activities at the SKA Core and will be in frequent contact with the primary monitoring and control desk (located in Perth).

The breakdown of the total numbers of staff working at the SKA Core and SKA OCCA is given in Table 1. Accommodation for the majority of these staff has been allocated on the basis of an eight-day on, six-day off shift system with their home station being located in Geraldton. Each week, on the day of the shift change, charter buses (based in Geraldton) will transport staff via an all-weather road between Geraldton and the OCCA. When working on site these staff will be accommodated at the permanent accommodation village located at the Boolardy station homestead precinct, which is 700 m from the proposed operations centre and 30km from the central core area. The accommodation will be of a comparable standard to that provided for permanent accommodation camps on remote mining sites and oil and gas production sites. This accommodation solution will provide each person with a 13 m² single room and an ensuite bathroom. There will be a central mess area (canteen facility), wet mess facilities and recreation as well as self-contained power supply, water supply and waste water treatment facilities. A team of near-site staff will operate the accommodation village, covering services such as food preparation, laundry, cleaning, and office management.

We have also allowed for some of the maintenance staff (8 staff) to be located at the surrounding towns and communities to enable easy and economical access to the various work zones. Staff accommodated in the towns and communities will utilise existing residential accommodation and have a standard 5-day working week.

Table 2 – Numbers of staff based at the SKA OCCA.

<table>
<thead>
<tr>
<th>Infrastructure site</th>
<th>Compliant configuration - full staff complement</th>
<th>Motivated alternative - full staff complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based at the SKA OCCA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance group – Dishes &lt; 180 km</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>Maintenance group – AA systems</td>
<td>95</td>
<td>16</td>
</tr>
<tr>
<td>Maintenance group – Data/Processor/Power systems</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Maintenance group – Roads/Buildings/Security</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance group – Managers and schedulers</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Operations group – Onsite managers</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Near site staff</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Total staff complement (Operations and Maintenance)</td>
<td>179</td>
<td>72</td>
</tr>
<tr>
<td>Total workforce on site</td>
<td>134</td>
<td>56</td>
</tr>
</tbody>
</table>

The Observatory Support Office (SKA OSO)

The SKA observatory support office (SKA OSO) will be located in Geraldton, at the site of CSIRO’s planned MRO support facility. The building will accommodate office space for 30 people, a spares handling store as well as a small laboratory/workshop for LRU triage. Staff working here will provide logistical, administrative and maintenance support for the activities at the SKA Core and SKA OCCA. A full breakdown of the staff complement of the SKA OSO is given in Table 3. These staff will administer the purchasing, shipping and transportation of the supplies to the OCCA and provide local office/managerial support. The SKA OCCA will be the hub for all goods receiving and distribution for the continuous supply of spares to the SKA Core and OCCA as well as the remote stations. The configuration management and spares
staff will track the state of the system and the equipment needed to maintain it, including hardware, software, firmware, documentation and test fixtures. They will be responsible for ordering new spares, returning unserviceable components and communicating with the appropriate managers in the Maintenance Group at the OCCA.

It is expected that the OCCA staff will reside in or around Geraldton, allowing them to enjoy the community spirit, relaxed lifestyle and world-class facilities offered by one of Australia’s finest regional coastal cities. With the exception of the maintenance group servicing the remote array stations, all staff will work a standard 5-day working week. Occasional visits to the OCCA for 1–2 days to meet and work on site are expected.

The maintenance group responsible for the remote (>180 km) array stations will be based at the SKA OSO or in Sydney or New Zealand. The remote stations will be located across Australia and for the motivated alternative configuration there will be a station located in New Zealand.

Each remote array-station is assumed to take a team of two people of order a week to maintain. According to the maintenance regime provided, this would need to occur every 90 days. Access will depend on the site of the station and could, for example, be via commercial flights to nearby centres and then access by vehicle or air.

Table 3 – Staff complement for SKA OSO.

<table>
<thead>
<tr>
<th>Infrastructure site</th>
<th>Compliant configuration – full staff complement</th>
<th>Motivated alternative configuration – full staff complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKA OSO</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>Administrative staff</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Maintenance group – dishes in remote stations</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Site configuration management group – configuration management and spares staff</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Maintenance group – managers and schedulers (for dishes in remote stations)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Software development and maintenance</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total staff complement</td>
<td>36</td>
<td>33</td>
</tr>
</tbody>
</table>

The Head Office Building (SKA HOB) and the Super Computing Building (SKA SCB)

The Perth location of the HOB will gain significant leverage from the people and infrastructure represented by the Curtin University, University of Western Australia and CSIRO. The staff complement will be made up of the key scientific and administrative staff, and operators and software developers supporting the operations of the SKA.

The primary monitoring and control desk for all SKA observations will be located at the SKA HOB. Expert operators will work on day or night shifts to ensure 24 hr/7 days a week continuous observing operations. The operator staff will have sufficient skills to perform routine start-up/shutdown of the instruments, start the programmed observations, modify the observation schedule depending on environmental conditions, respond to alarms, report unexpected faults, contact support engineers in case of critical faults and continuously monitor the facility. The tele/video communications to the Operations Building at the SKA OCCA will facilitate communication between the operators and the staff coordinating all maintenance activity on the SKA Core site. The network connectivity will be maintained to the highest standard but in the unlikely event of loss of connectivity there will be a local monitoring control desk in the Operations Building at the OCCA and there will be local staff on hand trained to carry out basic observing procedures until connectivity is restored.

The power supply to the supercomputing facility is anticipated to be a secure supply consisting of at least two high voltage feeds from the local public electricity network. All of the assets up to the connection to the building would be the property of Western Power, the Government owned transmission and distribution utility, and would be operated and maintained by them to international standards. Typically, the reliability of such a connection would be a cumulative failure rate of less than 4 hours per annum on each connection. With two connections the correlated outage time each year would be very small – of order one outage per ten years of operation.
Table 4 – Staff complement for SKA HOB.

<table>
<thead>
<tr>
<th>Infrastructure site</th>
<th>Compliant configuration – full staff complement</th>
<th>Motivated alternative configuration – full staff complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKA HOB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative staff</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Astronomers and engineers including visitors</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Software development and maintenance</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Operations group – operators</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Total staff complement</td>
<td>110</td>
<td>110</td>
</tr>
</tbody>
</table>

The SKA SCB and its associated facilities will be housed within the already funded Pawsey Supercomputing Centre for SKA Science, which is currently under construction on CSIRO’s property in Bentley, Perth. Offices will be made available for the required software developers and computer support staff that will make up the SKA Computing Group. There will be software engineers, responsible for the maintenance and development of the SKA monitoring and control, data processing and data archiving software as well as IT support staff responsible for the maintenance, installation and configuration of the IT infrastructure of the SKA sites, including staff and system computers and networking equipment. Even though most of the software and IT support can be done remotely it is envisaged that the computing group will travel to the other SKA sites to carry out routine maintenance work.

All of the staff working at the SKA HOB and SCB will live in Perth and enjoy the vibrant and modern lifestyle that living in one of Australia’s principle capital cities has to offer. With the exception of the operators, all staff will work a normal 5-day working week with one or two software staff ‘on-call’ to ensure full 24/7 software and network support coverage.

Table 5 – Staff complement for SKA SCB.

<table>
<thead>
<tr>
<th>Infrastructure site</th>
<th>Compliant configuration – full staff complement</th>
<th>Motivated alternative configuration – full staff complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKA SCB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super computer and hardware support</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Software development and maintenance for supercomputer data processing</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Total staff complement</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

Staff transport and movement of staff and spares

The mode of transport for staff moving to and from the operations and maintenance infrastructure is described in the report on Basic Infrastructure. The measures in place to facilitate the movement of staff and spares within Australia and across Australia and New Zealand is described in the Basic Infrastructure report.

Cost estimates for the SKA operations phase

The operations and maintenance costs associated with infrastructure, power and data are considered in the separate reports of the response to the RfI. The total cost of operating and maintain the SKA is significantly dominated by the costs of powering the SKA site (SKA Core and OCCA) and the super computer in Perth (SKA SCB).

Major infrastructure components

The Basic Infrastructure report presents the cost estimate of each major infrastructure component assuming 30 years of operations and maintenance. The operational and maintenance cost estimates for these infrastructure components have
taken into account the operational (staff), maintenance and life cycle costs over a 30-year operating period. The total cost is dominated by the life cycle costs of the buildings, Aperture Array bunkers and roads.

In Tables 3 and 4 of the basic Infrastructure report, the calculation of the operation and maintenance costs for the item, Equipment and Buildings includes the following:

- Data and Operations Building including the operations control room and offices
- Power Building
- Canteen and maintenance facilities
- Storage facilities at the Remote Stations
- Operations Support Facility Building in Geraldton
- Permanent accommodation at the Boolardy Accommodation Village (excluding construction camps).

**Provision of electrical power**

The cost of powering the SKA site, all of the Remote Stations and the Super Computer Building in Perth has been presented in the Electrical Power report. The operations, maintenance and lifecycle costs for this power network has also been considered. The life cycle costs for the power network is dominated by the replacement of the diesel engines (full replacement every 10 yrs).

An overview of the operations for each of the power generation locations is given in the Electrical Power report. The operations plan for waste management, consumables and spares provision and staffing is also described in this report.

**Data transport**

The operations costs of maintaining and running the data networks are given in the Data Transport report.

**Further assumptions**

Operational costs – staff:

- Salaries of those staff maintaining the major infrastructure items listed. We have excluded operating costs associated with staff staying onsite at the OCCA (e.g. food services, transport between Geraldton and the OCCA, managerial staff component, cleaners and security).
- The assumed value of $100,000 per year for the salaries of the maintenance staff (including 30% for on costs) is consistent with the salaries drawn from the maintenance staff at the Australia Telescope Compact Array. Our costing adopts a fixed salary rate across the full 30 years of operations.

Maintenance costs:

- Provision of spares, tools and vehicles (including diesel fuel costs) required for the maintenance, routine testing and replacement of the major infrastructure items have been considered.

Life cycle costs:

- The cyclic costs associated with the upgrade and/or replacement of the major infrastructure items have been estimated based on the full CAPEX of the infrastructure asset. In arriving at estimates for capital and operating costs for both configurations, we have focussed in the reports on minimising capital costs. We have done so because the uncertainty, though large, in the capital component is still less than the very significant error on a 30-year operational lifetime model. This approach, we believe, is in keeping with producing as robust a cost estimate as possible, consistent with the SSG's requirements for a credible implementation model. Ideally, cost optimisation would be done over the whole of life costs and including the entire SKA system. That has not been possible for this response. When such an analysis is done, it may deliver a significantly different implementation. Replacement of items that is required towards the end of the 30-year lifecycle are included.
Cost estimates of SKA construction phase

A description of the staffing model during the 10-year SKA construction phase is given below. There is no detailed plan describing the ramp up of infrastructure, power usage and data transport usage during the 10-year construction phase. We have used a simple model to estimate the yearly cost of operations and maintenance during this SKA construction phase. The model yields a yearly cost of 40% of the average yearly cost of the full SKA operations and maintenance.

Table 6 – Staffing model during the 10-year SKA construction phase.

<table>
<thead>
<tr>
<th>Construction phase</th>
<th>Two years before operation</th>
<th>Full operations - Yr 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr -10</td>
<td>Yr -9</td>
<td>Yr -8</td>
</tr>
<tr>
<td>2016</td>
<td>2017</td>
<td>2018</td>
</tr>
<tr>
<td>Compliant model</td>
<td>Total staff</td>
<td>10</td>
</tr>
<tr>
<td>Motivated alternative model</td>
<td>Total staff</td>
<td>10</td>
</tr>
</tbody>
</table>
Break down structure of staff complement – spreadsheet calculations

Table 7 – Full staff breakdown for staff at the SKA OCCA for the compliant configuration.

<table>
<thead>
<tr>
<th>Maintenance Group</th>
<th>Number of Maintenance Items</th>
<th>Maintenance Interval (days)</th>
<th>Maintenance Team each visit (persons)</th>
<th>Maintenance Time (work-days / visit)</th>
<th>Annual Maintenance Time (work-days/month)</th>
<th>Full Staff Complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishes at &lt;10km</td>
<td>1795</td>
<td>90</td>
<td>2</td>
<td>0.25</td>
<td>303</td>
<td>16</td>
</tr>
<tr>
<td>Dishes 10-50km</td>
<td>331</td>
<td>90</td>
<td>2</td>
<td>0.5</td>
<td>112</td>
<td>6</td>
</tr>
<tr>
<td>Dishes 50-180 km</td>
<td>274</td>
<td>90</td>
<td>2</td>
<td>1</td>
<td>185</td>
<td>10</td>
</tr>
<tr>
<td>Dishes in remote stations</td>
<td>25</td>
<td>90</td>
<td>2</td>
<td>6.5</td>
<td>110</td>
<td>6</td>
</tr>
<tr>
<td>AA-low system &lt; 10 km</td>
<td>194</td>
<td>14</td>
<td>1</td>
<td>0.5</td>
<td>210</td>
<td>12</td>
</tr>
<tr>
<td>AA-low 10-50 km</td>
<td>33</td>
<td>14</td>
<td>1</td>
<td>1</td>
<td>72</td>
<td>4</td>
</tr>
<tr>
<td>AA-low 50-180 km</td>
<td>23</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>100</td>
<td>6</td>
</tr>
<tr>
<td>AA-mid systems &lt; 10km</td>
<td>196</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>851</td>
<td>45</td>
</tr>
<tr>
<td>AA-mid 10-50 km</td>
<td>28</td>
<td>7</td>
<td>1</td>
<td>1.5</td>
<td>182</td>
<td>10</td>
</tr>
<tr>
<td>AA-mid 50-180 km</td>
<td>26</td>
<td>7</td>
<td>2</td>
<td>1.5</td>
<td>339</td>
<td>18</td>
</tr>
<tr>
<td>Data Transport</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>0.5</td>
<td>92</td>
<td>6</td>
</tr>
<tr>
<td>Central Processor System</td>
<td>1</td>
<td>0.33</td>
<td>1</td>
<td>0.2</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Central Power System &amp; Power Room</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>1</td>
<td>184</td>
<td>10</td>
</tr>
<tr>
<td>Power Reticulation System</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>0.5</td>
<td>92</td>
<td>6</td>
</tr>
<tr>
<td>Maintenance of Control/Office &amp; Buildings</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>61</td>
<td>4</td>
</tr>
</tbody>
</table>

| Minor Road System on site (596 km) | 2323                        | 150                         | 1                                    | 0.22                                 | 104                                       | 6                     |
| Core Area and Misc roads           | 0                           | 0                           | 0                                    | 0                                    | 0                                         | 0                     |
| Site security and maintenance      | 0                           |                             |                                      |                                      |                                           | 3                     |

| Total Staff                        | 138                         |                             |                                      |                                      |                                           |                       |
| Managers & Schedulers (10%)        | 14                          |                             |                                      |                                      |                                           |                       |
| Managers & Schedulers (10%)        | 2                           |                             |                                      |                                      |                                           |                       |
| Total Maintenance Staff Complement | 185                         |                             |                                      |                                      |                                           |                       |

| Operations Group                   |                             |                             |                                      |                                      |                                           |                       |
| Operators                          | On-Duty                     | 3                           |                                      |                                      |                                           | 15                    |
| On-Site Managers                   |                             | 1                           |                                      |                                      |                                           | 2                     |
| Total Ops Staff                    |                             |                             |                                      |                                      |                                           | 17                    |

| Site Configuration Management Group |                             |                             |                                      |                                      |                                           |                       |
| Config, Mgt and Spares Staff       | On-Duty                     | 2                           |                                      |                                      |                                           | 3                     |

| Near-Site Staff                    |                             |                             |                                      |                                      |                                           |                       |
| On-site Accommodation Room Preperation | 134                  | 8                           | 1                                    | 0.2                                  | 102                                       | 5                     |
| Food Services                      | 134                         | 1                           | 1                                    | 0.05                                 | 204                                       | 11                    |
| Transportation Staff               | 0                           | 0                           | 0                                    | 0                                    | 0                                         | 0                     |
| Near-Site Security                 | 0                           | 0                           | 0                                    | 0                                    | 0                                         | 0                     |
| Managerial Office Staff            |                             |                             |                                      |                                      |                                           | 1                     |

| Days per year                      | 365                         |                             |                                      |                                      |                                           |                       |
| Months per year                    | 12                          |                             |                                      |                                      |                                           |                       |
| Hours per day                      | 24                          |                             |                                      |                                      |                                           |                       |
| Effective Working Days per year    | 228                         |                             |                                      |                                      |                                           |                       |
| Length of working day (hours)      | 7.5                         |                             |                                      |                                      |                                           |                       |
| Fractional additional units to account for near-site staff | 0.2 |                             |                                      |                                      |                                           |                       |
| Tax value in calculation of annual maintenance time | 1.085 |                             |                                      |                                      |                                           |                       |
Table 8 – Full staff breakdown for staff at the SKA OCCA for the motivated alternative model.

<table>
<thead>
<tr>
<th>Maintenance Group</th>
<th>Number of Items</th>
<th>Maintenance Interval (days)</th>
<th>Maintenance Team (each visit) (persons)</th>
<th>Maintenance Time (work-days / visit)</th>
<th>Annual Maintenance Time (work-days/month)</th>
<th>Full Staff Complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishes at &lt;10km</td>
<td>1628</td>
<td>90</td>
<td>2</td>
<td>0.25</td>
<td>275</td>
<td>14</td>
</tr>
<tr>
<td>Dishes 10-50km</td>
<td>375</td>
<td>90</td>
<td>2</td>
<td>0.5</td>
<td>127</td>
<td>7</td>
</tr>
<tr>
<td>Dishes 50-180 km</td>
<td>225</td>
<td>90</td>
<td>2</td>
<td>1</td>
<td>152</td>
<td>8</td>
</tr>
<tr>
<td>Dishes in remote stations</td>
<td>12</td>
<td>90</td>
<td>2</td>
<td>6.5</td>
<td>53</td>
<td>3</td>
</tr>
<tr>
<td>AA-low system &lt; 10 km</td>
<td>79</td>
<td>14</td>
<td>2</td>
<td>0.5</td>
<td>171</td>
<td>9</td>
</tr>
<tr>
<td>AA-low 10-50 km</td>
<td>13</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>56</td>
<td>3</td>
</tr>
<tr>
<td>AA-low 50-180 km</td>
<td>8</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td>AA-mid systems &lt; 10km</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AA-mid 10-50 km</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AA-mid 50-180 km</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Data Transport</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>0.5</td>
<td>92</td>
<td>3</td>
</tr>
<tr>
<td>Central Processor System</td>
<td>1</td>
<td>0.33</td>
<td>1</td>
<td>0.2</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Central Power System &amp; Power Room</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>1</td>
<td>184</td>
<td>6</td>
</tr>
<tr>
<td>Power Reticulation System</td>
<td>1</td>
<td>0.33</td>
<td>2</td>
<td>0.5</td>
<td>92</td>
<td>3</td>
</tr>
<tr>
<td>Maintenance of Control/Office &amp; Buildings</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>61</td>
<td>4</td>
</tr>
<tr>
<td>Minor Road System on site (596 km)</td>
<td>596</td>
<td>150</td>
<td>1</td>
<td>0.22</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>Core Area and misc roads</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Site security and maintenance</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Staff Complement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>70</strong></td>
<td></td>
</tr>
<tr>
<td>Managers &amp; Schedulers (10%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>5</strong></td>
<td></td>
</tr>
<tr>
<td>Managers &amp; Schedulers (10%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total Maintenance Staff Complement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>72</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Operations Group**

- Operators On-Duty 3
- On-Site Managers 1

**Total Ops Staff** 17

**Site Configuration Management Group**

- Config. Mgt and Spares Staff On-Duty 2

**Total Maintenance & Ops Site Staff Complement** 74

**Total People Onsite** 56

**Near-Site Staff**

<table>
<thead>
<tr>
<th>Service</th>
<th>Number of Items</th>
<th>Service Interval (days)</th>
<th>Service Team (persons)</th>
<th>Service Time (work-days)</th>
<th>Annual Maintenance Time (work-days/month)</th>
<th>Full Staff Complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-site Accommodation Room Preparation</td>
<td>56</td>
<td>8</td>
<td>1</td>
<td>0.2</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>Food Services</td>
<td>56</td>
<td>1</td>
<td>1</td>
<td>0.05</td>
<td>85</td>
<td>4</td>
</tr>
<tr>
<td>Transportation Staff</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Near-Site Security</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Managerial Office Staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Near-Site Staff Complement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

- Days per year 365
- Months per year 12
- Hours per day 24
- Effective Working Days per year 228
- Length of working day (hours) 7.5
- Fractional additional units to account for near-site staff 0.2
- Tau value in calculation of annual maintenance time 1.085
Rental and housing market data

Geraldton

Table 1 – Geraldton rental market statistics.

<table>
<thead>
<tr>
<th>Rental market statistics (June quarter 2011)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current vacancy rate</td>
<td>4%</td>
</tr>
<tr>
<td>12-month change in vacancy rate</td>
<td>-1.3%</td>
</tr>
<tr>
<td>Median weekly rental</td>
<td>$340</td>
</tr>
<tr>
<td>12-month change in median weekly rental</td>
<td>6.3%</td>
</tr>
</tbody>
</table>

Table 2 – Geraldton housing market statistics.

<table>
<thead>
<tr>
<th>Housing market statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Median sale price – houses</td>
<td>$358,000</td>
</tr>
<tr>
<td>12-month change in median sale price houses</td>
<td>-8.2%</td>
</tr>
</tbody>
</table>

Perth

Table 3 – Perth rental market statistics.

<table>
<thead>
<tr>
<th>Rental market statistics (June quarter 2011)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current vacancy rate</td>
<td>3.4%</td>
</tr>
<tr>
<td>12-month change in vacancy rate</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Median weekly rental</td>
<td>$380</td>
</tr>
<tr>
<td>12-month change in median weekly rental</td>
<td>+1.3%</td>
</tr>
</tbody>
</table>

Table 4 – Perth housing market statistics.

<table>
<thead>
<tr>
<th>Housing market statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Median sale price - houses</td>
<td>$470,000</td>
</tr>
<tr>
<td>12-month change in median sale price houses</td>
<td>-6%</td>
</tr>
<tr>
<td>Median sale price – multi-residential</td>
<td>$405,000</td>
</tr>
<tr>
<td>12-month change in median sale price multi-residential</td>
<td>-2.4%</td>
</tr>
</tbody>
</table>

## Primary and secondary schools

### Geraldton and surrounding areas

- Allendale Primary School
- Beachlands Primary School
- Bluff Point Primary School
- Geraldton Grammar School (Years K–12)
- Geraldton Primary School
- Geraldton Public Senior College (Years 11–12)
- Holland Street School (Special needs)
- John Willcock Public College (Years 8–10)
- Leaning Tree Primary School
- Mount Tarcoola Primary School
- Nagle Catholic College (Years 8–12)
- Rangeway Primary School
- St Francis Xavier Primary School
- St John's Primary School
- St Lawrence's Primary School
- Strathalbyn College (Years K–12)
- Waggrakine Primary School

### Perth – Schools offering the International Baccalaureate

- Presbyterian Ladies' College
- St Brigid’s College
- Scotch College
- The International School of Western Australia
- The Montessori School
- Treetops Montessori School

Further information is available at: [http://www.det.wa.edu.au/education/schoolinfo/schoolsList.htm](http://www.det.wa.edu.au/education/schoolinfo/schoolsList.htm).

A motivated alternative configuration for the SKA

This report is supplementary to the Implementation Plans and Costs – Motivated Alternative Justification. It highlights the reasoning, opportunities and considerations behind this financially achievable and scientifically motivated alternative to the SKA model presented in the Request for Information.

The high cost of infrastructure for the compliant SKA model is largely driven by the following:

- The presence of three 5 km diameter cores with receptors scattered throughout, which significantly increases the cabling costs for power and optical fibre
- The large number of small receptors resulting in extremely large numbers of connection components
- The very high cost of energy and maintenance for AA-mid, coupled with high infrastructure cost.
- The large staff presence at the Operations Centre near the Centre of the Array.

The ANZSCC’s proposed motivated alternative presented here is a result of targeting the high cost drivers that do not deliver commensurate science returns, and re-designing the configuration accordingly. It is not a fully optimised design; we believe this process should involve a system-integrated approach including much broader considerations than infrastructure alone. In arriving at estimates for capital and operating costs for both configurations, we have focussed in the reports on minimising capital costs. We have done so because the uncertainty, though large, in the capital component is still less than the very significant error on a 30-year operational lifetime model. This approach, we believe, is in keeping with producing as robust a cost estimate as possible, consistent with the SSG’s requirements for a credible implementation model.

Ideally, cost optimisation would be done over the whole of life costs and including the entire SKA system. That has not been possible for this response. When such an analysis is done, it may deliver a significantly different implementation. However, we have nominated this alternative as it demonstrates, within an AACE Class 4 capital cost estimate, that significant cost reductions can be achieved (in the infrastructure component) while still delivering transformational science.

The motivated alternative configuration concept would:

- Deliver on the vision of the SKA as a high sensitivity instrument, enabled by a superb radio-quiet environment across a large range of baselines extending over 5,000 km. The presence of an extensive research fibre-optic network already in Australia and New Zealand, together with a reduction in the number of remote array-stations from the compliant configuration, provides an affordable implementation path for long baselines.
- Entail capital costs much closer to the publicly stated SKA project budget that has formed the basis for building the level of international funding support achieved for SKA to date. Retaining collecting area along three spiral arms and using concentrated cores to minimise cabling costs significantly reduces infrastructure expense.
- Retain options for a progressive evolution of the architecture as component costs decrease with time.

Changes from the compliant configuration to the motivated alternative span the physical placement of receptors as well as electrical power, data transport, maintenance and operations and infrastructure. Significant changes are outlined in detail in this report.

Features of the motivated alternative configuration include:

- Retention of substantial collection area and configuration along a range of baselines exceeding 5,000 km, with earlier clustering of dishes into slightly larger array-stations to reduce costs of data and power distribution
- Deployment, at least initially, of two receptors systems; the model here adopting dishes and AA-low, with capability for future incorporation of AA-mid
- Cost-effective placement of remote array-stations along the research fibre-optic backbone across Australia and New Zealand to minimise both construction and operational expenses
- A reduction to three spiral arms.
Receptor configuration

Dish array

The dish array is configured as follows:

- An inner core of 0.42 km radius contains 653 dishes in a closely packed arrangement, designed to maximise the collecting area within the core and to facilitate data processing for pulsar experiments.
- Emanating from the inner core are three strings from 0.42–2.5 km radius from the centre, each containing eleven array stations. The inner core and three strings are shown in Figure 1 within the purple circle, which has a radius of 2.5 km. Each array station contains 25 dishes and is denoted by a ‘snowflake’ – which provides large savings in power and fibre infrastructure costs. The dish arrays on these three arms are closely packed (30 m pedestal-to-pedestal spacing). Three strings of dish arrays comprise a total of 33 x 25 = 825 dishes.
- From 2.5 - 140 km from the core, there are three intermediate spiral arms, as shown in Figure 3. On the spiral arm terminating to the South of the core there are 10 dish arrays, on the SW arm there are 11 dish arrays and on the West arm are nine dish arrays. 30 dish arrays = 750 dishes in the intermediate spiral arms.
- Beyond 140 km radius from the core are the remote array stations, each containing 25 dishes in a snowflake arrangement. The motivated alternative includes 12 array-stations of 25 dishes, each accessing existing research network fibre. These are shown by the red dots on Figure 4 and one additional station in New Zealand. The remote stations contain a total of 12 x 25 = 300 dishes.

AA-low array

The sparse aperture array (AA-low) motivated alternative configuration is as follows:

- 37 AA-low stations in a hexagonal array completely fill the inner core, to a radius of 0.6 km. Each AA-low station has a diameter of 180 m, as stipulated in the request for information. Figure 2 shows this central portion of the motivated alternative SKA AA-low configuration with the AA-low stations in the inner core shown as black circles.
- Emanating from the inner core are three strings of 11 AA-low stations, which are displayed on Figure 2 as red circles. The stations just outside the inner core from 0.6 to 2.5 km radius are regularly (and closely) spaced, in order to maximise the collecting area in the central region.
- Outside a radius of 2.5 km, the AA-low stations are arranged in three logarithmic spiral arms. These travel for some 35 km before joining up with the intermediate spiral arms from the dish array (see Figure 3).
- When the dish and AA-low intermediate arms join up, each station comprises an AA-low and dish array station co-located, to share infrastructure. From 2.5 km to 140 km, the arm terminating to the south of the core has 10 AA-low stations, the arm terminating to the south-west has 11 AA-low stations and the arm terminating to the west of the core has nine AA-low stations.
The circle has a radius 2.5 km from the centre of the array.

- Black dots represent individual dishes in the inner core
- Red dots show the strings of dish stations.
- Three strings of dish stations have replaced the randomised distribution of dishes stipulated in the Request for Information.
- This move has led to very large cost savings over the 5 km core design.

Figure 1 – Core region of the dish array for the motivated alternative SKA.

We note that:

- Two of the suggested three cores are present, with the AA-mid in this case left as a possible upgrade path
- The 3-arm design is a sub-set of the suggested 5-arm design, leading to a clear upgrade path for the design of the configuration.

Figure 2 – The inner core region of the motivated alternative SKA.
Features to note include:

- The dish array retains a very high collecting area within this region
- The dish and AA-low spiral arms share common infrastructure
- The three spiral arms shown here are a subset of the five arms suggested for the compliant configuration, leading to a possible upgrade path.

Figure 3 – The motivated alternative configuration within 180km radius of the Murchison Radio-astronomy Observatory.

Features include:

- Retention of collection area and configuration along a range of baselines to 5,000 km
- Cost-effective placement of remote array-stations along the research fibre optic backbone across Australia and New Zealand to minimise both construction and operational expenses
- An array-station on the south of the South Island of New Zealand (not shown in the figure).

This alternative design takes maximum advantage of the extensive high bandwidth research network in Australia managed by AARNet and the equivalent New Zealand network. Detailed information is provided in the Data Transport report of this response. Comparison with the compliant configuration is shown in Attachment 39.

Figure 4 – Features of the alternative configuration across Australia and New Zealand.
Science impact

The motivated alternative SKA presented in this document has not gone through a rigorous process of science optimisation. This is a task to be carried out by the international SKA project once the final science priorities, budget and technology options are decided. Here, we simply present a possible implementation that sits within the advertised budgetary framework of SKA.

The compliant configuration is based closely upon the ‘SPDO/AUS configuration for SKA2’ developed by the SKA Configurations Taskforce, slightly adjusted for recently modelled RFI-threshold exclusion masks. The motivated alternative configuration is an example of an SKA design that can be realised within the advertised budget of the international SKA project.

We have compared the sensitivity, survey speed and imaging performance of the compliant configuration and the motivated alternative configuration by calculating a range of quantitative measures that are commonly used in radio astronomy. Using these results, we have assigned a likely impact on the ability of the SKA to deliver the science experiments identified in the SKA Design Reference Mission, as a result of adopting the motivated alternative rather than the compliant model.

We defined four levels of impact, from No Impact to High Impact, as outlined in Figure 5 below. These are used in Table 1, which states the likely impact on science capability for each of the SKA Design Reference Missions. Details on the calculations of the performance metrics used in this table are given at the end of this report.

On the basis of our calculations, we estimate that thirteen out of the total fourteen SKA Design reference missions will be readily achievable with the motivated alternative configuration with no more than a 50 percent increase in observing time. Moreover, a good fraction of these experiments will be carried out as originally planned for the prescribed configuration with no significant impact (at most, a very minor increase in observing time).

Due to a reduction in the collecting area of AA-low in our motivated alternative, the Epoch of Reionisation (EoR) experiment is expected to require some careful optimisation. Looking at the SKA Design Reference Mission alone, the sensitivity of the motivated alternative AA-low array exceeds the 4,000 m²K⁻¹ lower-limit sensitivity requirement for the EoR imaging survey. However, we note that it is premature to specify the actual requirements of the EoR experiments before the EoR pathfinders (LOFAR and MWA) have provided any results. On balance, the experiment will likely require a modified survey strategy, focusing on larger-scale emission than the compliant configuration. We do not consider this to be a fatal blow for the EoR experiment, but acknowledge that further changes and optimisations could undoubtedly be made to the motivated alternative if this, or any other impact, were deemed unacceptable by the International SKA project.

![Figure 5 – Colour scheme for describing the impact on SKA science projects of implementing a motivated alternative SKA configuration.](image-url)
Table 1 – Assessment of the impact on the ability to fulfil the SKA Design Reference Mission, by changing the compliant configuration (CC) to the motivated alternative (MA).

<table>
<thead>
<tr>
<th>Design reference mission</th>
<th>Impact</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-biotic Molecules in/around Protoplanetary Disks</td>
<td>None</td>
<td>Max baseline has increased for MA, thus improving maximum resolution. MA sensitivity is better than conforming model. Dirty beam sidelobe rms is reduced compared to CC.</td>
</tr>
<tr>
<td>Probing Gravity, Dark Matter with Radio Pulsars</td>
<td>None</td>
<td>MA dish array meets DRM sensitivity requirements.</td>
</tr>
<tr>
<td>Pulsar Timing with the SKA</td>
<td>None</td>
<td>Sensitivity of MA is only 6% lower than CC. Neither meet the published DRM sensitivity requirement of $10^7$ m$^2$ K$^{-1}$.</td>
</tr>
<tr>
<td>The Transient Radio Sky</td>
<td>None</td>
<td>Higher filling factor in the inner core than CC, which will assist processing of high time-resolution data.</td>
</tr>
<tr>
<td>Pulsar Surveys with the SKA</td>
<td>None</td>
<td>Longer baselines available for astrometry to assist timing. Higher filling factor in the inner core will assist processing of high time-resolution data. 6% reduction in sensitivity.</td>
</tr>
<tr>
<td>Neutral Gas in Galaxies: HI Deep Field</td>
<td>None</td>
<td>Very minor impact on all measures. 2% reduction in sensitivity.</td>
</tr>
<tr>
<td>Resolving AGN/Star Formation in Galaxies</td>
<td>None</td>
<td>MA exceeds required survey speed for this project by a factor of 80,000. No impact on science.</td>
</tr>
<tr>
<td>Cosmic Magnetism Deep Field</td>
<td>Low</td>
<td>Requires dish array &lt; 20 km. Sensitivity and PSFrms largely unaffected. SS reduced by 12%.</td>
</tr>
<tr>
<td>Continuum Deep Field</td>
<td>Low</td>
<td>Requires dish array &lt; 500 km. Sensitivity, survey speed and PSFrms largely unaffected. SS reduced by 12%.</td>
</tr>
<tr>
<td>Wide Field Polarimetry</td>
<td>Low</td>
<td>Sensitivity largely unaffected. SS reduced by 12%, but MA dish array still meets SS requirement for this experiment.</td>
</tr>
<tr>
<td>Galaxy Evolution vs. Cosmic Time: HI Absorption</td>
<td>Low</td>
<td>Max baseline has increased, but total sensitivity slightly reduced Low impact to a redshift $z = 2$, but sensitivity reduction could lead to 6 x longer integration times if AA-low used at $z &gt; 2$.</td>
</tr>
<tr>
<td>HI Baryon Acoustic Oscillations</td>
<td>Low</td>
<td>Neither CC nor MA meets survey speed requirement (both fall short by 2 orders of magnitude). SS reduced by 12%.</td>
</tr>
<tr>
<td>Probing AGN environments via HI Absorption</td>
<td>Low</td>
<td>Max baseline has increased, but total sensitivity slightly reduced. Low impact to a redshift $z = 2$. Sensitivity reduction could lead to 6 x longer integration times if AA-low used at $z &gt; 2$.</td>
</tr>
<tr>
<td>EoR HI Imaging Tomography</td>
<td>Medium</td>
<td>Sensitivity, image fidelity of MA reduced compared to CC. Survey either takes 6 times longer, or survey strategy requires re-scoping (e.g. image the EoR on larger angular scales).</td>
</tr>
</tbody>
</table>

Cost implications

Electrical power

The bulk power delivered to the core, spiral arms and Operations Centre near the centre of the array will be 28.6 MW and there will be 1.9 MW fed by generators towards the ends of the spiral arms out to 180 km. The bulk power delivery, proposed to be via transmission line in this response, will be 30 km south of the core.

The electrical power solution for the motivated alternative configuration provides SKA with a number of benefits. A major cost-driver for the power provision for the SKA model proposed in the RFI is the cost of copper cabling throughout the large dense cores for all three receptor types. The motivated alternative has smaller dense cores and the clustering of receptors into array-stations occurs closer to the centre than in the SKA model. This makes a significant reduction to the power provision cost, as cabling lengths are substantially reduced. By only deploying two receptor types the power provision can be at 6.6kV throughout the intermediate zone, which greatly facilitates essential radio-quiet compliance. Australia’s secure environment and low crime statistics makes it feasible to deploy stand-alone power stations within the intermediate zone, further reducing cabling costs.
By placing the operational centre 30 km south of the core and in the same location as the bulk power delivery, using stand-alone power for the outer array-stations of the intermediate region and not deploying AA-mid, the resulting lower load allows for a lower voltage distribution system that is now low enough that RFI filtration can be added to ensure RFI compatibility. The smaller cores and clumping of antennas into array-stations drastically reduces the amount of copper cabling required and reduces the number of transformers needed to feed the antennas, thus reducing RFI risk as well.

In addition, the ability to reduce the voltage distribution system reduces RFI risk from the power distribution network and means that array stations won’t need to be isolated from the backbone power distribution network.

Table 2 – Primary differences between the electrical power solutions for the compliant configuration and the motivated alternative configuration.

<table>
<thead>
<tr>
<th>Compliant configuration</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk power delivery 50 km from the core</td>
<td>Bulk power delivery 30 km from the core</td>
<td>Longer 132 kV and shorter 33 kV reduces cost as 132 kV overhead conductors are cheaper. No RFI impact as we are still outside the buffer zone and the design will use higher rated equipment to ensure low emissions. Shorter 33 kV system makes underground shielded cable feasible and eliminates the need for higher RFI risk of overhead cable or conductors.</td>
<td>The 132 kV design will be to a higher rf-screening design for the last 20km. In addition to this a low corona loss design with corona rings and other fittings normally seen on higher voltage designs will be incorporated to ensure the potential for emissions is minimised.</td>
</tr>
<tr>
<td>65 MW total load of core, spiral arms and computing centre</td>
<td>28.6 MW total load of core, spiral arms and computing centre plus 1.9 MW fed by generators at ends of spiral arms</td>
<td>Lower load by removing AA-mid and lower cost cabling to inner and mid spiral arms by eliminating loads at the last 2 to 4 snowflakes by supplying these with stand alone generators. Lower load allows for a lower voltage distribution system that is low enough that RFI filtration can be added to ensure RFI compatibility. In the SKA model the cost is higher by the need to keep all HV equipment away from antennas.</td>
<td>The lower distribution voltage allows for a much lower likelihood of emissions and facilitates the retro-fitting of filters and RF damping filters if emissions become a problem for any reason.</td>
</tr>
<tr>
<td>Five spiral arms &amp; extended clusters</td>
<td>Three spiral arms &amp; more compact clusters</td>
<td>Reduces the quantity, cost and complexity of the distribution system significantly and removes the risk of having to use overhead conductor cable.</td>
<td>Significant cost reduction.</td>
</tr>
</tbody>
</table>

Data transport

The compliant configuration for Australia–New Zealand contains 25 remote stations stretching across the Australian continent. The motivated alternative configuration is a reduced-cost model with 11 remote stations in Australia that lie close to the existing AARNet research and education network and one remote station in the south of the south island of New Zealand.

The AARNet network is capable of handling the data transport requirements for the Motivated Alternative configuration and thus provides a low risk and affordable data transport solution. As the network spans the Australian continent from north to south and east to west across the sparsely populated interior, it is possible to identify radio-quiet sites for remote array-stations across a large range of suitable baselines.

The fibre optic topology from the receptors to the data processor for the motivated alternative is the same as the topology for the SKA model. AA-mid receptors have been removed and the data rates used for the SPF dishes, PAF Dishes and AA-low receptors are the same as per the Request for Information. The closer aggregation of dishes and AA-low receptors in the motivated alternative model has reduced the quantity, cost and complexity of the data transport system significantly.
Table 3 – Primary differences between the data transport solutions for the compliant configuration and the motivated alternative.

<table>
<thead>
<tr>
<th>Compliant configuration</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using all available network fibre</td>
<td>Using only AARNet academic research network fibre</td>
<td>Ensures that bandwidth will be provided at non-commercial research rates, and ensures that maintenance of the Optic-fibre links will be state-of-the-art</td>
<td>Low-risk affordable solution providing excellent baseline opportunities</td>
</tr>
<tr>
<td>AA-mid</td>
<td>No AA-mid</td>
<td>Dramatically reduces data transport load</td>
<td>Significant cost reduction</td>
</tr>
<tr>
<td>250 AA-low</td>
<td>100 AA-low</td>
<td>Dramatically reduces data transport load</td>
<td>Significant cost reduction</td>
</tr>
<tr>
<td>Five spiral arms &amp; extended clusters</td>
<td>Three spiral arms &amp; more compact clusters</td>
<td>Reduces the quantity, cost and complexity of the data transport system significantly</td>
<td>Significant cost reduction</td>
</tr>
</tbody>
</table>

Operations and maintenance

The operations and maintenance infrastructure staffing plan for the compliant configuration is based on the following infrastructure sites, as well as remote array-station sites:

1. The central area containing three cores (SKA Core) and the operations centre near the centre of the array (OCCA)
2. Observatory Support Office (SKA OSO) in Geraldton
3. SKA Head Office Building (SKA HOB) and Super Computer Building (SKA SCB) in Perth

In developing the Operations and Maintenance Staffing Plan (see Attachment 24) for the compliant configuration we have been guided by the spreadsheet given by Dewdney in the document “Initial Model for Maintenance and Operations Staffing for the SKA v1.8 11 February 2011”, with the following deviations:

- The staff maintaining remote array-stations (up to 3,000km away) are based in Geraldton and Sydney rather than at the site near the centre of the array and a more efficient service mode has been adopted whereby teams of two staff spend 8 days at a time servicing each remote station (25 dishes x 0.25 days work + 2 days of travel time)
- Less frequent grading of roads is assumed, based on standard practice in the area, and to avoid constant RFI from the graders
- Operators and some managers are based off-site, consistent with modern remote observatory practice
- The configuration management and spares staff are based in Geraldton.

For the Motivated Alternative we have used the same deviations as those listed above for the compliant configuration and then have scaled the number of maintenance staff to reflect the Motivated Alternative configuration. Through not deploying AA-mid and halving the number of remote stations the staff numbers are significantly reduced at the SKA OCCA. Details on the staffing plans for both the compliant configuration and the motivated alternative configuration are given in Attachment 24: Operations and Maintenance Infrastructure Staffing Plan.

Table 4 – Primary differences between the operations and maintenance plans for the compliant configuration and the motivated alternative configuration.

<table>
<thead>
<tr>
<th>Compliant configuration</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total workforce onsite 134</td>
<td>Total workforce onsite 56</td>
<td>Clustering the receptors into fewer, larger array-stations, increases maintenance efficiency. Removal of AA-mid and a reduction in dishes and remote stations reduces the maintenance load</td>
<td>Significant reduction in ongoing labour costs</td>
</tr>
<tr>
<td>May require multiple data transport providers</td>
<td>AARNet to support network</td>
<td>Having the remote network with a single provider owned by the academic community and whose objective is to serve its members</td>
<td>Highest standard of support and cost-effective</td>
</tr>
</tbody>
</table>
Basic infrastructure

The motivated alternative configuration provides SKA with more financially achievable infrastructure solutions while maintaining a very high level of scientific outcome. A major cost-driver associated with the basic infrastructure components of the compliant configuration is the high capex costs associated with roads, the size and scale of buildings as well as the associated staff required to operate and maintain these facilities.

Table 5 – Primary differences between the basic infrastructure plans for the compliant configuration and the motivated alternative.

<table>
<thead>
<tr>
<th>Compliant configuration</th>
<th>Motivated alternative</th>
<th>Strength of motivated alternative</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads to central area</td>
<td>Revised configuration requires lesser extent of road</td>
<td>Increased efficiency in layout results in reduction in length of road required and results in a reduced capex and opex costs</td>
<td>Cost-savings significant and key science still possible. Future options retained.</td>
</tr>
<tr>
<td>Size of operations centre and sundry buildings at the OCCA (5,800 m²)</td>
<td>Size of operations centre and sundry buildings at the OCCA (3400 m²)</td>
<td>Due to the revised configuration and data requirements the physical size of the operations building can be reduced resulting in a reduction in capital cost</td>
<td>Modular construction retains options for future expansion.</td>
</tr>
<tr>
<td>Peak construction accommodation requirements at the OCCA (330 persons)</td>
<td>Reduced peak construction accommodation requirements (160 persons)</td>
<td>Reduction in capital costs results in lower person hours required for construction and consequently a lower peak workforce</td>
<td></td>
</tr>
<tr>
<td>Permanent accommodation at the OCCA (130 accommodation units)</td>
<td>Reduced permanent accommodation at the OCCA (60 accommodation units)</td>
<td>Reduced operational requirements allows for a reduction in the number of permanent accommodation units required</td>
<td></td>
</tr>
<tr>
<td>250 AA-mid stations</td>
<td>AA-mid – removed</td>
<td>Cost savings in infrastructure, and power consumption and maintenance staff</td>
<td></td>
</tr>
<tr>
<td>250 AA-low stations</td>
<td>100 AA-low stations</td>
<td>The proposed number of AA-low is sufficient to achieve major science advances in this frequency range.</td>
<td>Options for future expandability retained</td>
</tr>
<tr>
<td>Remote station numbers (25 across Australia – a total of 600 antennas)</td>
<td>Number of remote dish array stations reduced but baseline extended to New Zealand. 11 in Australia &amp; 1 in New Zealand</td>
<td>Operational costs are reduced by deploying remote stations on the existing AARNet backbone in Australia, providing secure bandwidth back to the central site.</td>
<td>Excellent configurability still obtained due to extensive AARNet and KAREN networks</td>
</tr>
</tbody>
</table>
Impact on specific science goals

First, we consider the relative performance of the compliant model and motivated alternative for the science projects described in the SKA Design Reference Mission. For each of these experiments, we have taken the maximum baseline, frequency range and observing modes stated in the SKA Design Reference Mission and calculated figures-of-merit (FoM) describing the sensitivity, image quality and survey speed for the compliant model and the motivated alternative. Table 6 (below) lists these performance metrics for the selected use cases.

Table 6 – Sensitivity, imaging and survey speed figures-of-merit for the compliant configuration (CC) and motivated alternative (MA), for each project in the SKA Design Reference Mission. In this example we have assumed that dishes are equipped with wide band single pixel receivers. The observing frequency is 1.4 GHz for dishes and 260 MHz for AAs, unless specified. For continuum observations we assumed a fractional bandwidth of 1 and for spectral line observations we assumed 10,000 spectral channels.

<table>
<thead>
<tr>
<th>Array Max. Baseline</th>
<th>Experiment</th>
<th>Setup</th>
<th>No. of Dishes or AA stations</th>
<th>Sensitivity $A_{\text{eff}}/T_{\text{sys}}$ (m²K⁻¹)</th>
<th>Image Quality Median PSFrms</th>
<th>Survey Speed SSFoM (m⁴K⁻²deg⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishes 10km</td>
<td>Pulsar surveys &amp; timing, wide-field polarimetry</td>
<td>Cont, 10 min</td>
<td>1,649 1,553</td>
<td>4995 4704</td>
<td>0.0186 0.0090</td>
<td>3.4x10⁷ 3.0x10⁷</td>
</tr>
<tr>
<td></td>
<td>HI BAOs</td>
<td>SL, 6hr</td>
<td>1,649 1,553</td>
<td>4,995 4,704</td>
<td>0.0178 0.0090</td>
<td>3.4x10⁷ 3.0x10⁷</td>
</tr>
<tr>
<td>Dishes 20km</td>
<td>Magnetism Deep Field</td>
<td>Cont, 6hr</td>
<td>1,799 1,703</td>
<td>5,450 5,159</td>
<td>0.0056 0.0059</td>
<td>4.1 x10⁷ 3.6 x10⁷</td>
</tr>
<tr>
<td>Dishes 60km</td>
<td>HI Deep Field</td>
<td>SL, 6hr</td>
<td>2,015 1,978</td>
<td>6,104 5,992</td>
<td>0.0038 0.0040</td>
<td>5.1 x10⁷ 4.9 x10⁷</td>
</tr>
<tr>
<td>Dishes 180km</td>
<td>Molecules in Protoplanetary Disks</td>
<td>SL, 6hr, 10 GHz</td>
<td>2,246 2,253</td>
<td>6,804 6,825</td>
<td>0.0027 0.0024</td>
<td>6.3x10⁷ 6.4x10⁷</td>
</tr>
<tr>
<td>Dishes 500km</td>
<td>Continuum Deep Field</td>
<td>Cont, 6hr</td>
<td>2403 2,253</td>
<td>7,280 6,825</td>
<td>0.0022 0.0024</td>
<td>7.3x10⁷ 6.4x10⁷</td>
</tr>
<tr>
<td>Dishes 3,000km</td>
<td>Resolving AGN/Star formation in galaxies</td>
<td>Cont, 6hr</td>
<td>3,000 2,527</td>
<td>9,088 7,658</td>
<td>0.0017 0.0017</td>
<td>1.1x10⁸ 8.0x10⁷</td>
</tr>
<tr>
<td></td>
<td>AGN via HI abs</td>
<td>SL, 6hr</td>
<td>3,000 2,527</td>
<td>9,088 7,658</td>
<td>0.0017 0.0017</td>
<td>1.1x10⁸ 8.0x10⁷</td>
</tr>
<tr>
<td>Aperture Arrays 20km</td>
<td>Epoch of Reionisation,</td>
<td>SL, 6hr</td>
<td>192 79</td>
<td>1.2 x 10⁸ 4.9 x 10⁵</td>
<td>0.0011 0.0068</td>
<td>1.4 x 10⁸ 2.4 x 10⁸</td>
</tr>
<tr>
<td></td>
<td>Magnetism Deep Field</td>
<td>Cont, 6hr</td>
<td>192 79</td>
<td>1.2 x 10⁸ 4.9 x 10⁵</td>
<td>0.0005 0.0042</td>
<td>1.4 x 10⁸ 2.4 x 10⁸</td>
</tr>
<tr>
<td>Aperture Arrays 180km</td>
<td>Probing galaxies via HI absorption</td>
<td>SL 6hr</td>
<td>250 100</td>
<td>1.5 x 10⁸ 6.2 x 10⁷</td>
<td>0.0007 0.0043</td>
<td>2.4 x 10⁸ 3.8 x 10⁸</td>
</tr>
</tbody>
</table>

When considering the differences between the compliant configuration and the motivated alternative, it is instructive to note how the median sensitivity, PSFrms and survey speed impact different science observations. The sensitivity and survey speed requirements for each of these experiments are laid out in the Design Reference Mission, which makes the consideration of the impact on science observations of differences in these FoMs rather straightforward.

The re-design of the configuration to feature a smaller number of larger stations will necessarily reduce u-v coverage and increase sidelobe levels, especially for short observations. For long observations, the effect on imaging is much smaller, as it will be for many spectral line observations. Therefore the scientific impact is minimal compared to the major cost savings.

Table 7 lists the sensitivity and survey speed for the motivated alternative for this range of SKA use-cases, as a percentage of the FoM for the compliant configuration.
Table 7 – Comparison of sensitivity and survey speed for the compliant model and motivated alternative, for each of the SKA use cases from the current SKA Design Reference Mission. Percentages were calculated from 4 significant figures before rounding numbers.

<table>
<thead>
<tr>
<th>Array Max. Baseline</th>
<th>Experiment</th>
<th>Sensitivity</th>
<th>Survey Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MA performance vs. CC</td>
<td>MA performance vs. CC</td>
</tr>
<tr>
<td>Dishes 10km</td>
<td>Pulsar surveys &amp; timing, wide-field polarimetry</td>
<td>94%</td>
<td>88%</td>
</tr>
<tr>
<td></td>
<td>HI BAOs</td>
<td>94%</td>
<td>88%</td>
</tr>
<tr>
<td>Dishes 20km</td>
<td>Cosmic Magnetism Deep Field (z &lt; 2)</td>
<td>95%</td>
<td>88%</td>
</tr>
<tr>
<td>Dishes 60km</td>
<td>HI Deep Field</td>
<td>98%</td>
<td>96%</td>
</tr>
<tr>
<td>Dishes 180km</td>
<td>Molecules in Protoplanetary Disks</td>
<td>100%</td>
<td>102%</td>
</tr>
<tr>
<td>Dishes 500km</td>
<td>Continuum Deep Field</td>
<td>94%</td>
<td>88%</td>
</tr>
<tr>
<td>Dishes 3,000km</td>
<td>Resolving AGN/Star Formation in Galaxies</td>
<td>84%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>AGN via HI abs</td>
<td>84%</td>
<td>73%</td>
</tr>
<tr>
<td>AA-low 20km</td>
<td>Epoch of Reionisation</td>
<td>41%</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>Cosmic Magnetism Deep Field (z &gt; 2)</td>
<td>41%</td>
<td>17%</td>
</tr>
<tr>
<td>AA-low 180km</td>
<td>Probing galaxies via HI absorption</td>
<td>41%</td>
<td>16%</td>
</tr>
</tbody>
</table>

The sensitivity and survey speed performance of the dish array between the two models is quite similar. This is unsurprising, as the only major differences between the CC and MA dish arrays are the distribution of dishes in the central 5km core and the number of remote stations. It is interesting to note that the re-design of the dish array from the CC (5 arms) to the MA (3 arms) and the increase in the number of dishes in each array station has actually led to a slight increase in the sensitivity of the sub-array with a maximum baseline of 180km, thus benefitting any surveys requiring that maximum baseline.

The number of aperture arrays has reduced quite significantly, but their distribution remains very similar as a function of baseline. The MA aperture array is configured as a 3-arm spiral as a sub-set of the CC 5-arm spiral, thus leaving open the possibility for upgrades to the central ~10km region, where the EoR and Cosmic Magnetism Deep Field experiments would benefit from additional collecting area. This is a possible upgrade path, or perhaps the subject of a re-design, to incorporate more aperture arrays at the scientific expense of the many surveys requiring dish arrays. The details of such a re-design would require a detailed science-cost trade-off analysis, which is beyond the scope of this current submission.

The major impact of the change between the CC and the MA configuration is the requirement in some cases for longer integration times, for example, by a factor of 1.4 for studies of distant AGN and star forming galaxies and at worst, a factor of 5.9 for the EoR and HI absorption studies of galaxies. The requirement for longer integration times could be mitigated in some cases by altering survey strategy to match the new specifications – for example focusing on high quality imaging of larger-scale HI emission in the EoR experiment. However, it is premature to specify the actual requirements of the EoR experiments before the EoR pathfinders (LOFAR and MWA) have provided any results.

**Array performance as a function of baseline**

The following Figures 7 to 9 show the imaging figure of merit ($PSFrms$) and the $u$-$v$ gap parameter (a measure of the gaps in the sampling of the $u$-$v$ plane) plotted as a function of baseline length, for each configuration.
Figure 6 – PSF rms as a function of baseline for the SKA Dish Array, showing the compliant model and motivated alternative (Continuum, 6hr).

Figure 7 – PSF rms as a function of baseline for the Low-Frequency Aperture Array, showing the compliant model and motivated alternative (Continuum, 6hr).
Figure 8 – $u$-$v$ gap as a function of baseline for the SKA Dish Array, showing the compliant model and motivated alternative (Continuum, 6hr).

Figure 9 – $u$-$v$ gap as a function of baseline for the SKA Low-frequency Aperture Array, showing the compliant model and motivated alternative (Continuum, 6hr).
The dirty beam sidelobe rms is very similar for both dish array models, differing slightly in the central 1 km due to the regular spacing of dishes in the MA’s central 0.42 km radius core. The increase in the maximum baseline length from 3,000 km for the compliant model to 5,000 km for the motivated alternative is also evident in Figure 6. The plot of \( u-v \) gap vs. baseline for the dish array in Figure 8 reveals the close similarities between the characteristics of the central \( \sim 10 \) km of the CC and the MA dish array. It also shows the reduction in \( u-v \) coverage on scales between 10 and 1,000 km, due to the reduction in the number of remote dish array stations.

For the AA-low portion of SKA, the MA offers a reduced collecting area, but reassuringly, the \( PSF_{\text{rms}} \) remains only a fraction of 1% on all scales, ensuring high-quality imaging performance in all areas of science.

The effect of the configuration change from 5 to 3 arms will have a greater effect on the sidelobes for shorter observations, but for many of the experiments, an integration time of 6 hours is appropriate.

**Dish array: sensitivity and survey speed**

For the analysis presented in this document, we compared the survey speed figure-of-merit and the array sensitivity \( A_{\text{eff}}/T_{\text{sys}} \) of the two SKA models. These are standard figures-of-merit used by the international radio astronomy community and are calculated as follows.

The survey speed figure-of-merit is given by

\[
SS_{\text{FoM}} = FoV \left( \frac{A_{\text{eff}}}{T_{\text{sys}}} \right)^2 \text{deg}^2 \text{m}^4 K^{-2},
\]

where \( FoV \) is the receiver field-of-view in \( \text{deg}^2 \), \( T_{\text{sys}} \) is the system temperature in Kelvin and \( A_{\text{eff}} \) is the effective area of the array, given by

\[
A_{\text{eff}} = \eta_{\text{eff}} A_{\text{coll}}
\]

Here, \( A_{\text{coll}} \) is the total collecting area of the array in \( \text{m}^2 \) and \( \eta_{\text{eff}} \) is the aperture efficiency. The quantity \( A_{\text{eff}}/T_{\text{sys}} \) is the sensitivity FoM for a radio interferometer.

Using the SKA High-Level System Description (Dewdney et al. 2010) as a guide, we assumed an aperture efficiency of 0.6 and a system temperature of 35 K in our calculations.

**Sparse aperture array: sensitivity and survey speed**

For a low-frequency (sparse) aperture array, the effective area is:

\[
A_{\text{eff}} \sim N_e \frac{\lambda^2}{4}
\]

where \( \lambda \) is the wavelength in metres, and \( N_e \) is the total number of elements, which is estimated to be \( 2.8 \times 10^6 \) for the model SKA. We also assumed a system temperature of 60 K and a central observing frequency of 260 MHz (Dewdney et al. 2010).

For aperture arrays, the survey speed figure of merit is

\[
SS_{\text{FoM}} = \left( \frac{A_{\text{eff}}}{T_{\text{sys}}} \right)^2 \Omega
\]

where \( \Omega \) is the total field-of-view in square degrees.
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### SUMMARY - CONFIG A

10 September 2011

<table>
<thead>
<tr>
<th>Section</th>
<th>Ref</th>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Comments / Assumptions</th>
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<td><strong>INFRASTRUCURE COMPONENTS</strong></td>
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<td>Receptors to Data Processor</td>
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<td>67,209,900</td>
<td></td>
<td></td>
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<td>Data Processor to Super Computer</td>
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<td>Super Computer to the World</td>
<td>50,000,000</td>
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<td>Testing &amp; Commissioning</td>
<td>-</td>
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<td><strong>Total</strong></td>
<td>260,097,312</td>
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<td>INFRASTRUCTURE COMPONENTS</td>
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<td><strong>2.2 CREDIT FOR USE OF EXISTING INFRASTRUCTURE</strong></td>
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<td>Infra Structure Components</td>
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<td>Data Transport</td>
<td>-</td>
<td>30,000,000</td>
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<td></td>
<td></td>
<td>Sub-Total Australian Dollars (Excluding GST)</td>
<td>1,506,893,812</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| | | Risk Allowance required to achieve a 90% confidence level (confirmed via ‘Monte Carlo’ Simulation) | 7.5% | 113,017,036 | | |
| | | **Total** | 1,619,910,848 | | | |

| | | GST (excluded refer to Clause 2.2 where local taxes are to excluded) | excluded | excluded | | |

| | | TOTAL AUSTRALIAN DOLLARS (September 2011) | 1,619,910,848 | | | |

| | | **2.3 TOTAL EURO (based on $1.35A / 1euro - Clause 2.3)** | 1,199,933,961 | | | |

| | | Conversion to Based Date 1 January 2007 (refer clause 2.3) | | | | |

| | | **2.3 Cost in 2007 Euro’s (refer to Cost Estimate Methodology for Calculation)** | 90% | 1,079,940,565 | | |
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)
### INFRASTRUCTURE COMPONENTS - CONFIG A

10 September 2011

<table>
<thead>
<tr>
<th>Ref</th>
<th>Heading Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Value</th>
<th>Comments / Assumptions</th>
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</thead>
<tbody>
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<td>Roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Central Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor Roads (inside 5km cores)</td>
<td>km</td>
<td>180</td>
<td>25,000</td>
<td>4,500,000</td>
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<tr>
<td>4.1.1</td>
<td>Minor road (outside the 5km cores)</td>
<td>km</td>
<td>448</td>
<td>25,000</td>
<td>11,200,000</td>
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<td>Minor roads</td>
<td>km</td>
<td>1,370</td>
<td>25,000</td>
<td>34,250,000</td>
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<tr>
<td>4.1.3</td>
<td>Clear central area including raising ground level and provision of gravel surface (2 No. 1 km diameter)</td>
<td>Ha</td>
<td>943</td>
<td>2,500</td>
<td>2,357,500</td>
<td>Minimal work required due to advantageous site selection</td>
</tr>
<tr>
<td></td>
<td>Lead in Road to central facility</td>
<td>km</td>
<td>210</td>
<td>160,000</td>
<td>33,600,000</td>
<td>Allowance to for chip sealed single lane road with graded shoulders including upgrading as required</td>
</tr>
<tr>
<td></td>
<td>Bridge / water crossing</td>
<td>No.</td>
<td>1</td>
<td>10,000,000</td>
<td>10,000,000</td>
<td>Indication of cost from Murchinson Shire</td>
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<tr>
<td></td>
<td>Minor Water crossings</td>
<td>No.</td>
<td>6</td>
<td>50,000</td>
<td>300,000</td>
<td>Estimate number</td>
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<tr>
<td></td>
<td>Minor road to individual station outside 13km</td>
<td>km</td>
<td>325</td>
<td>25,000</td>
<td>8,125,000</td>
<td>assume average 500m to each station from primary access</td>
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<td>Remote Sites - Within Australia (25 No.)</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Access to remote site</td>
<td>km</td>
<td>199</td>
<td>25,000</td>
<td>4,975,000</td>
<td>Minor road</td>
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<tr>
<td></td>
<td>Access within each remote site</td>
<td>No.</td>
<td>25</td>
<td>20,000</td>
<td>500,000</td>
<td>Assumed</td>
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<td>2</td>
<td>Buildings</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment &amp; Office Buildings</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
### SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

#### INFRASTRUCTURE COMPONENTS - CONFIG A

10 September 2011

<table>
<thead>
<tr>
<th>Ref</th>
<th>Heading</th>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Value</th>
<th>Comments / Assumptions</th>
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</thead>
<tbody>
<tr>
<td>4.2.1</td>
<td>2A</td>
<td>SKA Operations Centre - near centre of Array - Located 30 km from core (SKA OCCA)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4.2</td>
<td></td>
<td>Data Centre &amp; Operations Building</td>
<td>m2</td>
<td>1,500</td>
<td>7,750</td>
<td>11,625,000</td>
<td>Provision of ‘white space’ - no active equipment or associated cooling &amp; power requirements</td>
</tr>
<tr>
<td>4.2.2</td>
<td></td>
<td>Fibre Collection &amp; Management Building (60%)</td>
<td>m2</td>
<td>500</td>
<td>6,000</td>
<td>3,000,000</td>
<td>Additional area included to allow for collection and staging area for fibre management</td>
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<tr>
<td>4.2.2</td>
<td></td>
<td>Operations Control Room</td>
<td>m2</td>
<td>100</td>
<td>7,750</td>
<td>775,000</td>
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<tr>
<td>4.2.3</td>
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<td>Power building</td>
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<td>2,500,000</td>
<td>assumed size</td>
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<tr>
<td>4.2.3</td>
<td></td>
<td>Office - control building</td>
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<td>300</td>
<td>5,000</td>
<td>1,500,000</td>
<td>Allowance for 20 staff x 15m2 per person</td>
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<tr>
<td>4.2.3</td>
<td></td>
<td>Meeting Rooms included above</td>
<td></td>
<td></td>
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<td>4.2.3</td>
<td></td>
<td>Canteen</td>
<td>m2</td>
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<td>4,000</td>
<td>520,000</td>
<td>130 people</td>
</tr>
<tr>
<td>4.2.3</td>
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<td>Canteen kitchen facility</td>
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<td>65</td>
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<td>1,300,000</td>
<td>assumed size to be confirmed</td>
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<td>4.2.3</td>
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<td>Maintenance Facility</td>
<td>m2</td>
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<td>1,500</td>
<td>1,125,000</td>
<td>assumed size</td>
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<td>4.2.3</td>
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<td>Sub-Total: Net Area</td>
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<td>4.2.3</td>
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<td>663</td>
<td>5,000</td>
<td>3,312,500</td>
<td>allowed 25% grossing factor</td>
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<td>Total Gross Building Area</td>
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<td>4.2.4</td>
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<td>RFI Shield to Data Centre &amp; Power Building</td>
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<td>2B</td>
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<td>Sundry Building (700M from Operation Centre)</td>
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<td>m2</td>
<td>300</td>
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<td>1,500,000</td>
<td>20 staff x 15m2 / person</td>
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<tr>
<td>4.2.4</td>
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<td>Meeting Rooms included above</td>
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<td></td>
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<td></td>
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<tr>
<td>4.2.4</td>
<td></td>
<td>Canteen</td>
<td>m2</td>
<td>130</td>
<td>4,000</td>
<td>520,000</td>
<td>130 people</td>
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<tr>
<td>4.2.4</td>
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<td>Canteen kitchen facility</td>
<td>m2</td>
<td>65</td>
<td>20,000</td>
<td>1,300,000</td>
<td>assumed size to be confirmed</td>
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<td>4.2.4</td>
<td></td>
<td>Maintenance Facility</td>
<td>m2</td>
<td>750</td>
<td>1,500</td>
<td>1,125,000</td>
<td>assumed size</td>
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<td>4.2.4</td>
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<td>Sub-Total: Net Area</td>
<td>m2</td>
<td>1,245</td>
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<td>4.2.4</td>
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<td>Travel &amp; Engineering</td>
<td>m2</td>
<td>311</td>
<td>5,000</td>
<td>1,556,250</td>
<td>assumed 25%</td>
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<td>4.2.4</td>
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<td>Total Gross Building Area</td>
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<td></td>
<td></td>
<td>RFI shielding</td>
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<td></td>
<td></td>
<td>Furniture Fitting &amp; Equipment</td>
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<td></td>
<td>Excluded - assumed this is active equipment</td>
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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)
### INFRASTRUCTURE COMPONENTS - CONFIG A
#### 10 September 2011

<table>
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<tr>
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<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Value</th>
<th>Comments / Assumptions</th>
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<tr>
<td>4.2.5</td>
<td>Accommodation for Construction Crews &amp; Operations &amp; Maintenance Staff</td>
<td>No.</td>
<td>330</td>
<td>120,000</td>
<td>39,600,000</td>
<td>Peak construction workforce anticipated to be 400 persons with 70 access the various works sites from adjacent towns (330 accommodation units required)</td>
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<td>4.2.5.1</td>
<td>Construction phase staff</td>
<td>No.</td>
<td>330</td>
<td>120,000</td>
<td>39,600,000</td>
<td>Peak construction workforce anticipated to be 400 persons with 70 access the various works sites from adjacent towns (330 accommodation units required)</td>
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<td></td>
<td>Fly camp to allow construction of Construction Camp</td>
<td>No.</td>
<td>30</td>
<td></td>
<td></td>
<td>Assumed they are able to use Boolardy Station Accommodation</td>
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<td>Credit for Permanently - Operation phase Operating Construction camp</td>
<td>No.</td>
<td>130</td>
<td>120,000</td>
<td>15,600,000</td>
<td>Based on an average of 145 persons for 5 years</td>
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<td></td>
<td>Water sanitation</td>
<td>Item</td>
<td>130</td>
<td>150,000</td>
<td>19,500,000</td>
<td>Modular style facilities with allowance for Wet mess, Recreation Facilities, Sports courts, etc.</td>
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<td>Sewerage treatment</td>
<td>Item</td>
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<td>Included above</td>
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<tr>
<td></td>
<td>Geraldton Support Office / facility Support facility in Geraldton to accommodate 10 Staff &amp; m2 small laboratory, workshop and stores</td>
<td>No.</td>
<td>800</td>
<td>4,000</td>
<td>3,200,000</td>
<td>Currently in construction award phase</td>
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<td>2D</td>
<td>Remove Station Storage Facilities Remote station storage sheds - Australia</td>
<td>No.</td>
<td>25</td>
<td>100,000</td>
<td>2,500,000</td>
<td>80m2 per site allowed &amp; includes water tank &amp; First Aid equipment</td>
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<tr>
<td>4.2.7.1</td>
<td>Head Office - Located in Perth</td>
<td>m2</td>
<td>1,650</td>
<td>4,000</td>
<td>6,600,000</td>
<td>(110 people x 15m2/person)</td>
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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)
### INFRASTRUCTURE COMPONENTS - CONFIG A

**10 September 2011**

<table>
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<tbody>
<tr>
<td>4.2.7</td>
<td>3 Computing centre</td>
<td>Computer, Data storage, Etc. (1500m2 of 'active Floor is required)</td>
<td>m2</td>
<td>1,500</td>
<td>6,000</td>
<td>9,000,000</td>
<td>'White space' shell no allowance for equipment or equipment cooling; power filtering or UPS</td>
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<td></td>
<td></td>
<td>Data storage</td>
<td>m2</td>
<td>included</td>
<td>included</td>
<td>500,000</td>
<td>White space shell' space no allowance for equipment or equipment cooling; power filtering or UPS</td>
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<td>Data interconnect</td>
<td>m2</td>
<td>100</td>
<td>5,000</td>
<td>500,000</td>
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<td></td>
<td></td>
<td>Heating, cooling, ventilation - Plant Area</td>
<td>m2</td>
<td>2,000</td>
<td>3,000</td>
<td>6,000,000</td>
<td>500m2 Briefed appears to be insufficient - Increased to 2000m2 based on current experience with Pawsey Centre</td>
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<td></td>
<td></td>
<td>Office related component</td>
<td>m2</td>
<td>1,050</td>
<td>4,000</td>
<td>4,200,000</td>
<td>Based on 70 People (based on 15m2/person)</td>
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<td>4.3</td>
<td>4 Airstrip</td>
<td>Item</td>
<td>1</td>
<td>150,000</td>
<td>150,000</td>
<td>assumed to RFDS standard - include &amp; show as credit</td>
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<tr>
<td>4.4</td>
<td>5 Dish Foundation</td>
<td>Dish foundations - utilising 4 rock anchors and 5.5 x 5.5 x 0.80 concrete foundation</td>
<td>No.</td>
<td>1800</td>
<td>72,000</td>
<td>129,600,000</td>
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<td>Dish Foundation based on 7.0 x 7.0 x 1.0 concrete foundation</td>
<td>No.</td>
<td>600</td>
<td>88,500</td>
<td>53,100,000</td>
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<td>4.4</td>
<td>5 Dish Foundation - Remote</td>
<td>Dish Foundation - Remote</td>
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<td>88,500</td>
<td>53,100,000</td>
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<td></td>
<td></td>
<td>AA- Low Stations</td>
<td>No.</td>
<td>250</td>
<td>100,000</td>
<td>25,000,000</td>
<td>180m dia. Cleared and graded area</td>
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<td></td>
<td>AA-Low RFI Shielded Bunker</td>
<td>No.</td>
<td>250</td>
<td>200,000</td>
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<td>AA - MID STATION</td>
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<td>250</td>
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<td>AA MID Bunker</td>
<td>No.</td>
<td>250</td>
<td>1,000,000</td>
<td>250,000,000</td>
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<td>Security to Foundation sites</td>
<td>Dishes</td>
<td>No.</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>No security deemed required</td>
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<td></td>
<td></td>
<td>Dishes - remote</td>
<td>No.</td>
<td>600</td>
<td>-</td>
<td>-</td>
<td>No Security deemed required</td>
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<td></td>
<td>AA-LOW</td>
<td>No.</td>
<td>250</td>
<td>1,500</td>
<td>375,000</td>
<td>stock fence to perimeter ad 60m diameter</td>
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<td></td>
<td>AA- MID</td>
<td>No.</td>
<td>205</td>
<td>3,500</td>
<td>717,500</td>
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<td></td>
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<td>TOTAL</td>
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<td><strong>$ 809,388,750</strong></td>
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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### INFRASTRUCTURE COMPONENTS - CONFIG A

**10 September 2011**

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<th>Comments / Assumptions</th>
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<tr>
<td></td>
<td><strong>CREDIT FOR EXISTING INFRASTRUCTURE</strong></td>
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<td>4.1.2</td>
<td>Minor road (outside the 5km cores)</td>
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<td>134</td>
<td>25,000</td>
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<tr>
<td>4.1.2</td>
<td>Credit for Re-use of Existing ASKAP Facility Control Room (for the housing of equip to service 37 AA-low RFI shielded bunker functionality - by adding in a modular RFI shielded room into the existing RFI shielding building)</td>
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<td>1</td>
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<td>4.2.4</td>
<td>Credit for using existing Boolardy Station Commercial Kitchen &amp; facilities</td>
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<td>50</td>
<td>15,000</td>
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<td>Permanent Accommodation Credits</td>
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<td>Mullewa</td>
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<td></td>
<td>Mt Augustus</td>
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<td>-</td>
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<td></td>
<td>Pia Wajarri Community</td>
<td>No.</td>
<td>-</td>
<td>4</td>
<td>150,000</td>
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<td></td>
<td>Geraldton</td>
<td>No.</td>
<td>-</td>
<td>6</td>
<td>150,000</td>
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<td></td>
<td>Head Office - Credit for Utilising Motorola Building</td>
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<td>-</td>
<td>1,650</td>
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<td>Use of Pawsey High Performance Computing Centre (500m2 of active area &amp; 600m2 of associated)</td>
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<td>-</td>
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<td>-</td>
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<td>Airstrip</td>
<td>Item</td>
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**TOTAL CREDIT**: -$ 29,810,000
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<th>Comments / Assumptions</th>
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<td><strong>Power Generation</strong></td>
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<td><strong>1.1 Central Area</strong></td>
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<td>Central Area - power station</td>
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<td>Power transmission over land 132 KV</td>
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<td>Power upgrade at Geraldton</td>
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<td><strong>1.2 Remote Clusters</strong></td>
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<td>Diesel Generating Set</td>
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<td><strong>1.3 Offsite computing Centre - Perth</strong></td>
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<td><strong>Power Distribution</strong></td>
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<td><strong>2.1 33kV SKA Site MSB</strong></td>
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<td>33kV SWBD CBs</td>
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<td><strong>Total</strong></td>
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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)
### PROVISION OF ELECTRICAL POWER - CONFIG A
#### 10 September 2011

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<tr>
<td>2.2</td>
<td>33kV Core Substation 'Power Hub'</td>
<td>33kV SWBD</td>
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<td>6.6kV SWBD #1</td>
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### SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

**PROVISION OF ELECTRICAL POWER - CONFIG A**

10 September 2011

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### PROVISION OF ELECTRICAL POWER - CONFIG A

**10 September 2011**

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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### DATA TRANSPORT - CONFIG A

10 September 2011

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<td>1,672,272</td>
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</tr>
<tr>
<td></td>
<td>Fiber Splicing - large node</td>
<td>No.</td>
<td>124,000</td>
<td>16.59</td>
<td>2,057,160</td>
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<tr>
<td></td>
<td>Fiber Splicing - very large node</td>
<td>No.</td>
<td>105,000</td>
<td>16.59</td>
<td>1,741,950</td>
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<tr>
<td></td>
<td>Fiber Termination - Small node</td>
<td>No.</td>
<td>254,880</td>
<td>16.25</td>
<td>4,141,800</td>
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<td>Fiber Termination - medium node</td>
<td>No.</td>
<td>21,504</td>
<td>16.25</td>
<td>349,440</td>
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<td>Fiber Termination - large node</td>
<td>No.</td>
<td>23,808</td>
<td>16.25</td>
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<td>Fiber Termination - very large node</td>
<td>No.</td>
<td>16,128</td>
<td>16.25</td>
<td>262,080</td>
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<td>Fiber termination data processor</td>
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<td>16.25</td>
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<td>Small splice pit</td>
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<td>2,665</td>
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<td>Medium splice pit</td>
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<td>Large splice pit</td>
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<td>62</td>
<td>3,000.00</td>
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<td>Very large splice pit</td>
<td>No.</td>
<td>21</td>
<td>10,000.00</td>
<td>210,000</td>
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</tr>
<tr>
<td></td>
<td>Trenching for direct bury (5x170km)</td>
<td>km</td>
<td>850</td>
<td>20,000.00</td>
<td>17,000,000</td>
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<td></td>
<td>Trenching fibre drawn in conduit (inner 10km circle)</td>
<td>km</td>
<td>744</td>
<td>70,000.00</td>
<td>52,080,000</td>
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<td><strong>Remote Stations</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Local fiber optical cable - 24 core</td>
<td>km</td>
<td>13^93</td>
<td>1,300.00</td>
<td>120,900</td>
<td></td>
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<td>Unit</td>
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<td>Station local fiber terminations</td>
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<td>26,400</td>
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<td>25</td>
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<td>Trenching fibre drawn in conduit</td>
<td>km</td>
<td>21</td>
<td>70,000.00</td>
<td>1,470,000</td>
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<td></td>
<td></td>
<td>Fiber Optic tails to existing 'AARnet' fiber core network</td>
<td>Item</td>
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<td>45,525,000.00</td>
<td>45,525,000</td>
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<tr>
<td></td>
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<td>Transponders Remote station (Aarnet)</td>
<td>item</td>
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<td>19,590,000.00</td>
<td>19,590,000</td>
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<td></td>
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<td>Active Components</td>
<td>Item</td>
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<td></td>
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<td>Correlator Equipment</td>
<td>Item</td>
<td>1</td>
<td>-</td>
<td>exclude</td>
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<tr>
<td>6.2</td>
<td>DATA</td>
<td>DATA PROCESSOR TO SUPER COMPUTER</td>
<td></td>
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<td>PROCESSOR</td>
<td>Correlator - Central Area</td>
<td>Item</td>
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<td>excl</td>
<td>check is fibre upgrade required</td>
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<td>TO SUPER</td>
<td>Correlator - remote stations</td>
<td>Item</td>
<td>1</td>
<td>excl</td>
<td>assumed part of existing local networks</td>
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<td>COMPUTER</td>
<td>Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre</td>
<td>Item</td>
<td>1</td>
<td>30,000,000.00</td>
<td>30,000,000</td>
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<td>6.3</td>
<td>Super</td>
<td>Super Computer to the World</td>
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<tr>
<td></td>
<td>Computer</td>
<td>to the World</td>
<td></td>
<td></td>
<td></td>
<td>50,000,000</td>
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<td></td>
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<td>Testing &amp; Commissioning</td>
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<td></td>
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<td>excluded - assumed to part of the active equipment</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>260,097,312</td>
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**CREDIT/COST FOR EXISTING INFRASTRUCTURE**

- Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre
  - Qty 1
  - Rate 30,000,000.00
  - Value 30,000,000

---

10 September 2011
<table>
<thead>
<tr>
<th>Section Ref</th>
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<tbody>
<tr>
<td>1</td>
<td>Operating expenditure</td>
</tr>
<tr>
<td>2</td>
<td>Maintenance costs</td>
</tr>
<tr>
<td>3</td>
<td>Land costs or land leasing costs (Item 3 (5))</td>
</tr>
<tr>
<td>4</td>
<td>Purchasing pastoral leases</td>
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<td>5</td>
<td>Antenna costs</td>
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<tr>
<td>6</td>
<td>GST</td>
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<td>7</td>
<td>Carbon Tax</td>
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<td>8</td>
<td>Legislative Changes</td>
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<tr>
<td>9</td>
<td>Active equipment</td>
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<tr>
<td>10</td>
<td>Upgrade of Fibre from MRO to Geraldton &amp; Geraldton to Perth</td>
</tr>
<tr>
<td>11</td>
<td>Correlator &amp; data termination</td>
</tr>
<tr>
<td>12</td>
<td>Vehicles for maintenance and operations</td>
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<tr>
<td>13</td>
<td>Active Components</td>
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<tr>
<td>14</td>
<td>Loose Furniture, Fittings and Equipment</td>
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<tr>
<td>15</td>
<td>Accommodation for City based staff (i.e. head office, computer centre staff etc.)</td>
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<tr>
<td>16</td>
<td>Hotel accommodation for visitors</td>
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<tr>
<td>17</td>
<td>Professional Fees</td>
</tr>
<tr>
<td>18</td>
<td>Design Contingency</td>
</tr>
<tr>
<td>19</td>
<td>Construction Contingency</td>
</tr>
<tr>
<td>20</td>
<td>Raised area to specified height for AA mid &amp; low foundations</td>
</tr>
<tr>
<td>21</td>
<td>Computer &amp; Data : Excludes racks, cooling to racks, fire suppression system to racks, power filtering, ups, power distribution to racks, etc.</td>
</tr>
<tr>
<td>22</td>
<td>Internal CSIRO &amp; Government Costs</td>
</tr>
<tr>
<td>23</td>
<td>Escalation to construction commencement</td>
</tr>
<tr>
<td>24</td>
<td>Escalation during construction</td>
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</table>
### INFRASTRUCTURE COMPONENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Comments / Assumptions</th>
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<tbody>
<tr>
<td>Roads</td>
<td></td>
<td>58,720,250</td>
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<tr>
<td>Buildings</td>
<td></td>
<td>68,228,750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computing centre</td>
<td></td>
<td>19,700,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airstrip</td>
<td></td>
<td>150,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dish Foundation</td>
<td></td>
<td>216,150,000</td>
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**Total for INFRASTRUCTURE COMPONENTS**: 362,949,000

### PROVISION OF POWER

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>Comments / Assumptions</th>
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<tbody>
<tr>
<td>Power Generation</td>
<td></td>
<td>202,375,000</td>
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<tr>
<td>Power Distribution</td>
<td></td>
<td>206,165,000</td>
<td></td>
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<tr>
<td>Testing &amp; Commissioning</td>
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<td>2,756,000</td>
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**Total for PROVISION OF POWER**: 411,296,000

### DATA TRANSPORT

<table>
<thead>
<tr>
<th>Description</th>
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<th>Qty</th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td>Receptors to Data Processor</td>
<td></td>
<td>57,959,071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Stations (12 in Australia &amp; 1 in New Zealand)</td>
<td></td>
<td>26,176,800</td>
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<td></td>
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<tr>
<td>Data Processor to Super Computer</td>
<td></td>
<td>30,000,000</td>
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<tr>
<td>Super Computer to the World</td>
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<td>50,000,000</td>
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**Total for DATA TRANSPORT**: 164,135,871

**SUB-TOTAL**: 938,380,871

#### 2.2 CREDIT FOR USE OF EXISTING INFRASTRUCTURE

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
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<tbody>
<tr>
<td>Infra Structure Components</td>
<td></td>
<td>- 28,550,000</td>
<td></td>
<td></td>
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<tr>
<td>Provision of power</td>
<td></td>
<td>- 160,000,000</td>
<td></td>
<td></td>
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<tr>
<td>Data Transport</td>
<td></td>
<td>- 30,000,000</td>
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</table>

**Sub-Total Australian Dollars (Excluding GST)**: 719,830,871

**Risk Allowance required to achieve a 90% confidence level (confirmed via 'Monte Carlo' Simulation)**: 7.5% 53,987,315

**Total for CREDIT FOR USE OF EXISTING INFRASTRUCTURE**: 773,818,186

#### 2.2 GST (excluded refer to Clause 2.2 where local taxes are to excluded)

**TOTAL AUSTRALIAN DOLLARS (September 2011)**: 773,818,186

#### 2.3 TOTAL EURO (based on $1.35A / 1euro - Clause 2.3)

**Conversion to Based Date 1 January 2007 (refer clause 2.3)**: 573,198,656

#### 2.3 (COST in 2007 EURO’s (Refer to Estimate Methodology for calculation)

**90%**: 515,878,791
<table>
<thead>
<tr>
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<th>Heading Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
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<tbody>
<tr>
<td>1</td>
<td>Roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Central Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roads to perimetre of the 1Km Cores</td>
<td>km</td>
<td>31</td>
<td>25,000</td>
<td>775,000</td>
<td>Minor road</td>
</tr>
<tr>
<td></td>
<td>Roads within 1Km Cores</td>
<td>km</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>assume not required</td>
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<tr>
<td>4.1.1</td>
<td>Minor road (outside the 1km cores)</td>
<td>km</td>
<td>420</td>
<td>25,000</td>
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<td>4.1.2</td>
<td>Minor road to receptor</td>
<td>km</td>
<td>-</td>
<td>25,000</td>
<td>-</td>
<td></td>
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<tr>
<td>4.1.3</td>
<td>Clear central area including raising ground level and provision of gravel surface (2 No. 1 km diameter)</td>
<td>Ha</td>
<td>157</td>
<td>2,500</td>
<td>392,750</td>
<td>Minimal work required due to advantageous site selection</td>
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<tr>
<td></td>
<td>Lead in Road to central facility</td>
<td>km</td>
<td>210</td>
<td>160,000</td>
<td>33,600,000</td>
<td>Allowance to for chip sealed single lane road with graded shoulders including upgrading as required</td>
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<td>Bridge / water crossing</td>
<td>No.</td>
<td>1</td>
<td>10,000,000</td>
<td>10,000,000</td>
<td>Indication of cost from Murchinson Shire</td>
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<td>Minor Water crossings</td>
<td>No.</td>
<td>6</td>
<td>50,000</td>
<td>300,000</td>
<td>Estimate number</td>
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<tr>
<td></td>
<td>Minor road to individual station outside 13km</td>
<td>km</td>
<td>17</td>
<td>25,000</td>
<td>412,500</td>
<td>assume average 500m to each station from primary access</td>
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<td>Remote Sites - Within Australia (11 No.)</td>
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<td></td>
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<tr>
<td></td>
<td>Access to remote site</td>
<td>km</td>
<td>90</td>
<td>25,000</td>
<td>2,250,000</td>
<td>Minor road</td>
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<td>Access within each remote site</td>
<td>No.</td>
<td>11</td>
<td>20,000</td>
<td>220,000</td>
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<td>Remote Site - NZ (1 No.)</td>
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<td>Access to remote site</td>
<td>km</td>
<td>10</td>
<td>25,000</td>
<td>250,000</td>
<td>Assumed distance - minor road</td>
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<td>Access within each remote site</td>
<td>No.</td>
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<td>20,000</td>
<td>20,000</td>
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## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### INFRASTRUCTURE COMPONENTS - CONFIG B

10 September 2011

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<tr>
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<td></td>
<td>Equipment &amp; Office Buildings</td>
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<tr>
<td>4.2.1</td>
<td>2A</td>
<td>SKA Operations Centre - near centre of Array - Located</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>30 km from core (SKA OCCA)</td>
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<tr>
<td>4.2.2</td>
<td>Data Centre &amp; Operations Building</td>
<td>m2</td>
<td>900</td>
<td>7,750</td>
<td>6,975,000</td>
<td>Provision of 'white space' - no active equipment or associated cooling &amp; power requirements</td>
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<td></td>
<td>Fibre Collection &amp; Management Building (60%)</td>
<td>m2</td>
<td>300</td>
<td>6,000</td>
<td>1,800,000</td>
<td>Additional area included to allow for collection and staging area for fibre management</td>
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<tr>
<td>4.2.2</td>
<td>Operations Control Room</td>
<td>m2</td>
<td>100</td>
<td>7,750</td>
<td>775,000</td>
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<tr>
<td>4.2.3</td>
<td>Power building</td>
<td>m2</td>
<td>250</td>
<td>10,000</td>
<td>2,500,000</td>
<td>assumed size</td>
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<tr>
<td>4.2.4</td>
<td>Office - control building</td>
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<td></td>
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<tr>
<td></td>
<td>Sub-Total: Net Area m2</td>
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<td>1,650</td>
<td>5,000</td>
<td>500,000</td>
<td>Allowance for 5 staff + 2 meeting rooms</td>
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<tr>
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<td>Travel &amp; Engineering</td>
<td>m2</td>
<td>413</td>
<td>5,000</td>
<td>2,062,500</td>
<td>allowed 25% grossing factor</td>
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<td>Total Gross Building Area m2</td>
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<td>2,063</td>
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<td>RFI Shield to Data Centre &amp; Power Building</td>
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<td>1,150</td>
<td>3,500</td>
<td>4,025,000</td>
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<td>2B</td>
<td>Sundry Building (700M from Operation Centre)</td>
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<td>4.2.4</td>
<td>Office space</td>
<td>m2</td>
<td>225</td>
<td>5,000</td>
<td>1,125,000</td>
<td>15 staff x 15m2 / person</td>
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<td>4.2.4</td>
<td>Meeting Rooms</td>
<td>m2</td>
<td>90</td>
<td>4,000</td>
<td>360,000</td>
<td>70 people</td>
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<td>Canteen</td>
<td>m2</td>
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<td>Canteen kitchen facility</td>
<td>m2</td>
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<td>900,000</td>
<td>assumed size</td>
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<td>Sub-Total: Net Area m2</td>
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<td>1,206,250</td>
<td>assumed 25%</td>
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<td>Travel &amp; Engineering</td>
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<td></td>
<td>RFI shielding</td>
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<td>not required</td>
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<td>Furniture Fitting &amp; Equipment</td>
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<td>Excluded - assumed this is active equipment</td>
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3
<table>
<thead>
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<th>Ref</th>
<th>Heading Description</th>
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<tr>
<td>4.2.5</td>
<td>2C Accommodation for Construction Crews &amp; Operations &amp; Maintenance Staff</td>
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<td>4.2.5.1</td>
<td>Construction phase staff</td>
<td>No.</td>
<td>160</td>
<td>120,000</td>
<td>19,200,000</td>
<td>Peak construction workforce anticipated to be 200 persons with 40 access the various works sites from adjacent towns (160 accommodation units required)</td>
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<td>Fly camp to allow construction of Construction Camp</td>
<td>No.</td>
<td>30</td>
<td></td>
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<td>Assumed they are able to use Boolardy Station Accommodation</td>
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<td></td>
<td>Credit for Permanently - Operation phase</td>
<td>No.</td>
<td>60</td>
<td>120,000</td>
<td>7,200,000</td>
<td>Based on an average of 145 persons for 5 years</td>
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<td>Operating Construction camp</td>
<td>Man Weeks</td>
<td>40,000</td>
<td>325</td>
<td>13,000,000</td>
<td>Modular style facilities with allowance for Wet mess, Recreation Facilities, Sports courts, etc.</td>
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<td>Sewerage treatment</td>
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<td>Geraldton Support Facility</td>
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<td>Remove Station Storage Facilities</td>
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<td>Remote station storage sheds - Australia</td>
<td>No.</td>
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<td>80m² per site allowed &amp; includes water tank &amp; First Aid equipment</td>
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<td>Remote station storage sheds - New Zealand</td>
<td>No.</td>
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<td>100,000</td>
<td>100,000</td>
<td>80m² per site allowed &amp; includes water tank &amp; First Aid equipment</td>
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<td>4.2.7.1</td>
<td>2E Head Office - Located in Perth</td>
<td>m2</td>
<td>1,650</td>
<td>4,000</td>
<td>6,600,000</td>
<td>110 people (110 people x 15m²/person)</td>
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<td>4.2.7</td>
<td>Computing centre</td>
<td>Computer, Data storage, Etc. (1500m2 of ‘active Floor is required)</td>
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<td>Heating, cooling, ventilation - Plant Area</td>
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<td>Dish Foundation</td>
<td>No. 1600 72,000 115,200,000 Assumed all central foundations and 40% of outlying foundations</td>
<td>No. 1600</td>
<td>72,000</td>
<td>115,200,000</td>
<td>Assumed all central foundations and 40% of outlying foundations</td>
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<td>Dish Foundations - Remote</td>
<td>No. 300 88,500 26,550,000</td>
<td>No. 300</td>
<td>88,500</td>
<td>26,550,000</td>
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<tr>
<td></td>
<td>AA- Low Stations</td>
<td>No. 100 100,000 10,000,000</td>
<td>No. 100</td>
<td>100,000</td>
<td>10,000,000</td>
<td>180m dia. Cleared and graded area</td>
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<td></td>
<td>AA-Low RFI shielded Bunker</td>
<td>No. 100 200,000 20,000,000</td>
<td>No. 100</td>
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<td>20,000,000</td>
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<tr>
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<td>Security to Foundation sites</td>
<td>Dishes No. 2100 -</td>
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<td>Dishes - remote No. 300 -</td>
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<td></td>
<td>AA-LOW No. 100 1,500 150,000 stock fence to perimeter ad 60m diameter</td>
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**TOTAL** $362,949,000
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### INFRASTRUCTURE COMPONENTS - CONFIG B

**10 September 2011**

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<th>Value</th>
<th>Comments / Assumptions</th>
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<tr>
<td></td>
<td><strong>CREDIT FOR EXISTING INFRASTRUCTURE</strong></td>
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<tr>
<td>4.1.2</td>
<td>Minor road (outside the 1km cores)</td>
<td>km</td>
<td>-</td>
<td>126</td>
<td>25,000</td>
<td>3,150,000 assumes 30% credit for existing minor roads</td>
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<td>4.1.2</td>
<td>Credit for Re-use of Existing ASKAP Facility Control Room Item (for housing of equipment to service 37 AA-low RFI shielded functionality - by adding in a modular RFI shielded room into the existing RFI shielded building)</td>
<td>Item</td>
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<td>1</td>
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<td>6,000,000</td>
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<td>4.2.4</td>
<td>Credit for using existing Boolardy Station Commercial Kitchen &amp; facilities</td>
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<td>15,000</td>
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<td></td>
<td>Permanent Accommodation Credits</td>
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<td></td>
<td>Boolardy</td>
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<td>30</td>
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<td>Meekatharra</td>
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<td>Mullewa</td>
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<td>Pia Wajarri Community</td>
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<td>-</td>
<td>4</td>
<td>150,000</td>
<td>600,000</td>
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<td></td>
<td>Support Facility in Geraldton to accommodate 10 Staff &amp; small laboratory / workshop and stores</td>
<td>m2</td>
<td>-</td>
<td>800</td>
<td>4000</td>
<td>3,200,000</td>
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<tr>
<td>4.3 4</td>
<td>Airstrip</td>
<td>Item</td>
<td>-</td>
<td>1</td>
<td>150,000</td>
<td>Existing ASKAP Airstrip</td>
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<tr>
<td></td>
<td>Head Office - Credit for Utilising Motorola Building</td>
<td>m2</td>
<td>-</td>
<td>1,650</td>
<td>4,000</td>
<td>6,600,000 Lease costs to be accounted for with operating costs</td>
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<tr>
<td></td>
<td>Use of Pawsey High Performance Computing Centre (500m2 of active area &amp; 600m2 of associated)</td>
<td>Item</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3,300,000 500m2 of active floor &amp; 600m2 of plant area</td>
</tr>
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</table>

**TOTAL CREDIT**                                                                 $ 28,550,000
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)
### PROVISION OF ELECTRICAL POWER - CONFIG B
### 10 September 2011

<table>
<thead>
<tr>
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<th>Value</th>
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<td><strong>1</strong></td>
<td>Power Generation</td>
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<td>Central Area</td>
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<td>Central Area - power station</td>
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<td>Power transmission over land 132 KV</td>
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<td>437.5</td>
<td>240,000</td>
<td>105,000,000</td>
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<td>Horizon Power Headwork's</td>
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<td>Power upgrade at Geraldton</td>
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<td>Remote Clusters</td>
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<td>Diesel Generating Set</td>
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<td>Shielded generator building</td>
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<td>12,000,000</td>
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<td>Power Distribution</td>
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<td>33kV Site MSB</td>
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<tr>
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<td>50,000</td>
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<tr>
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<tr>
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### SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

**PROVISION OF ELECTRICAL POWER - CONFIG B**

10 September 2011

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<td>Installation</td>
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<td>4,000,000</td>
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<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

| 2.3 | 33kV UG Cabling | Supply to Power Hub’s | |
|     | 33kV UG Cabling (240sqmm AL) 2 cables in parallel | km | 140 | 200,000 | 28,000,000 | |
|     | Trenching | km | 70 | 30,000 | 2,100,000 | |
|     | Total |     |     |       |       | |
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### PROVISION OF ELECTRICAL POWER - CONFIG B

10 September 2011

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<th>Comments / Assumptions</th>
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<tr>
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<td>Cost of Outer Spiral Arms</td>
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<td>Accommodation Buildings</td>
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<td>Testing &amp; Commissioning</td>
<td>m/week</td>
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<td>5,000</td>
<td>530,000</td>
<td>Assume 10 men x 16 weeks + 4 weeks x 13 remotes</td>
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<td>Sundry Materials/ equipment / vehicles</td>
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**Total Value: 411,296,000**
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### PROVISION OF ELECTRICAL POWER - CONFIG B

10 September 2011

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<th>Unit</th>
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<td>CREDIT FOR EXISTING INFRASTRUCTURE</td>
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<td>Grid Transmission line from Geraldton &amp; terminal sub-stations</td>
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### Receptors to Data Processor

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<td>331</td>
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<td>Fiber optical cable + splicing - 36 core</td>
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<td>13,896</td>
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- Fiber Splicing - dish & AA-low snowflakes
  - No. 36,300 | 16.59 | 602,217

- Fiber Termination - dish & AA-low Snowflakes
  - No. 36,300 | 16.25 | 589,875

Fibre Termination - data processor
  - No. 36,300 | 16.25 | 589,875

- Splice pits Dish & AA-Low snowflakes
  - No. 189 | 3,000 | 567,000

- Trenching for direct bury (5x170km)
  - km 321 | 20,000 | 6,420,000

- Trenching fibre drawn in conduit (inner 10km circle)
  - km 223 | 70,000 | 15,610,000
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6.2 **Data Processor to Super Computer**
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<td>excl</td>
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<td>Dark Fibre Link From ASKAP</td>
<td>Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre</td>
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| Testing & Commissioning | m/week | 600 | - | Assume 20 men x 30 weeks |
| Direct employees        | m/week | 300 | 5,000 | 1,500,000 | Staff |
| Consultants             | m/week | 300 | 10,000 | 3,000,000 | Consultants |
| Remote LAHFA            | m/week | 800 | 3,500 | 2,800,000 |
| Sundry Materials/ equipment / vehicles | m/week | 800 | 2,000 | 1,600,000 |

- 8,900,000 Assume Testing & Commissioning is part of the 'active' phase of the project.  

**Total:** 164,135,871

**CREDIT/COST FOR EXISTING INFRASTRUCTURE**

| Dark Fibre Link From ASKAP Control Building to Pawsey Computing Centre | Item | 1 | 30,000,000 | 30,000,000 |
## SKA CAPEX FEASIBILITY ESTIMATE (AACE Class 4 Level)

### EXCLUSIONS

**10 September 2011**

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<td>Land costs or land leasing costs (Item 3 (5))</td>
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<td>Purchasing pastoral leases</td>
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<td>5</td>
<td>Antenna costs</td>
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<td>GST</td>
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<td>Carbon Tax</td>
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<td>10</td>
<td>Upgrade of Fibre from MRO to Geraldton &amp; Geraldton to Perth</td>
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<td>11</td>
<td>Correlator &amp; data termination</td>
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<td>12</td>
<td>Vehicles for maintenance and operations</td>
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<td>13</td>
<td>Active Components</td>
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<td>14</td>
<td>Loose Furniture, Fittings and Equipment</td>
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<td>15</td>
<td>Accommodation for City based staff (i.e. head office, computer centre staff etc.)</td>
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<tr>
<td>16</td>
<td>Hotel accommodation for visitors</td>
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<tr>
<td>17</td>
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<tr>
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<td>Construction Contingency</td>
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<tr>
<td>20</td>
<td>Raised area to AA mid &amp; low foundations</td>
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<td>Computer &amp; Data: Excludes racks, cooling to racks, fire suppression system to racks, power filtering, ups, power distribution to racks, etc.</td>
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<td>All AA MID</td>
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Note: The values are in AUS$.
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### Operational Cost

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<th>Roads</th>
<th>Maintenance costs</th>
<th>Vehicle replacement</th>
<th>Building Finishes</th>
<th>Diesel (fuel and maintenance costs)</th>
<th>Diesel (fuel and maintenance costs)</th>
<th>Data Transport</th>
<th>Roads</th>
<th>Maintenance costs</th>
<th>Vehicle replacement</th>
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### Life Cycle Costs

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<th>Maintenance costs</th>
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### Whole of Life Cost Model

**Motivated Alternative (AUD)**

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<tr>
<td>Elect for the grid connected remote stations</td>
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<tr>
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</table>
Capital cost estimate methodology

The capital cost estimate has been prepared by Rider Levett Bucknall in Perth, Western Australia. Rider Levett Bucknall is a global construction practise whose services include cost management and quantity surveying. Rider Levett Bucknall has 2,500 people in over 100 offices across Australia, New Zealand, Asia, Europe, Middle East, Africa and the Americas.

Specialist advice and costing information has also been provided by Aurecon on the power provision and power distribution systems. Aurecon provides world-class engineering, management and specialist technical services to government and private sector clients. With more than 6,500 staff and over 80 offices worldwide, Aurecon has a presence in Australia, New Zealand, Africa, Southeast Asia, China, and the Middle East.

In addition specialist advice and costing information has also been provided by AARNet and Cisco on the provision of optic-fibre architecture, materials and labour costs. AARNet operates Australia's Academic and Research Network (AARNet). It is a not-for-profit company limited by shares. The shareholders are 38 Australian Universities and the CSIRO. AARNet provides high-capacity leading-edge Internet services for the tertiary education and research sector communities and their research partners. AARNet serves over one million end users who access the network through local area networks at member institutions.

CSIRO, the Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency and one of the largest and most diverse research agencies in the world with more than 50 sites throughout Australia and overseas. CSIRO has managed radio astronomy national facilities for the research community for over 50 years and has extensive experience in operations and technical development of radio astronomy systems. CSIRO is currently managing the design and construction of the CSIRO Australian SKA Pathfinder radio telescope on the Murchison Radio-astronomy Observatory.

CSIRO has provided scientific and technical advice to the companies working on the costings presented, and has been responsible for interpreting the Model SKA and the Request for Information requirements. CSIRO has developed, based upon a robust science case, the Motivated Alternative Configuration presented and costed in this response.

The cost estimate outlined by the ANZSCC is the total dollar amount minus any discounts (‘costs to the project’). The cost estimates for infrastructure components, power provision, and data connectivity include plant, workforce and equipment to construct, supply and/or deliver in a fit-for purpose state. These costs and unit rates (for the constructed elements) do not include indirect costs and contingencies or local taxes.

Infrastructure costs

Infrastructure costs have been based on costs and rates applicable in Australia as at September 2011 and specifically in the various regions where construction will be carried out.

The CSIRO Australian Square Kilometre Array Pathfinder (ASKAP), which is currently under construction, is a project of a similar construction type and methodology to that envisaged for the SKA. This project has been specifically used to bench mark the construction types and associated costs for:

- Roads
- Operation Centre buildings
- Sundry buildings
- Accommodation buildings
- Foundations.

Capital allowances for the upgrade of the main lead in road and associate bridge have been based on input from the Local Council and roadwork sub-contractors in the region.

Rates for the manufacture, supply and installation of modular buildings have been based on ASKAP and also the many camps and mining operations where these types of buildings are extensively utilised throughout Western Australia. The rates used for construction phase accommodation and the permanent phase accommodation make allowance for all associated water supply and sewerage disposal required.
Rates and prices for the workshops, offices and sundry buildings have been based on the ASKAP buildings, the CSIRO office and maintenance facility in Geraldton (tendered in July 2011) and other projects that Rider Levett Bucknall have been involved with throughout Western Australia.

Rates and prices for the operations centre and super computing building have been based on the pricing received for ASKAP and also from Rider Levett Bucknall’s involvement as part of the team currently preparing tender documents and Budgets for the Pawsey Centre (Super Computing Building in Perth).

For purposes of the benchmarking relevant costs ASKAP has been deemed as the most appropriate basis to determine infrastructure rates and costs applicable to the SKA.

**Power**

The cost of a transmission line depends upon many factors and it is uncommon for two transmission lines to be identical. However, Aurecon has been recently involved in confidential projects where the cost of transmission line construction is intimately known by our engineers and this is the source of much of the data used to build the per kilometre estimate.

Aurecon has drawn on the extensive experience of its Energy team in design and costing of electrical infrastructure in remote Western Australia to produce the design and costings of the power generation and distribution system presented in this response.

The power usage estimates are based on current 2011 electricity prices and pricing methodology from Synergy, Western Australia’s government-owned retailer. Large uncertainties are unavoidable in any estimation of future energy costs. One additional uncertainty is in the return on capital that would be required for the transmission line and substation assets. Fifteen percent has been assumed for this determination.

For the purposes of deriving an operational cost, and while recognising all the uncertainties with energy prices and infrastructure costs, it has been assumed that the energy prices increase in line with the Consumer Price Index. Note that no impacts from climate change, including government policy on carbon pricing, has been included.

**Data transmission**

The data transport network and related capital and operational costs have been developed based on knowledge gained from Australia’s 20-year experience in deploying and operating national and international data transport networks to meet the needs of the research community. In particular, AARNet, Cisco and CSIRO have drawn on the recent knowledge gained from the roll-out of optical fibre networks designed to support the requirement of radio astronomy infrastructure (including ASKAP) at the MRO and its national connectivity to the Long Baseline array in Eastern Australia and the Warkworth facility in New Zealand.

**Credits**

Credits for infrastructure components have been identified separately, as per the Request for Information. This is done in the individual reports and summarised below.

**General**

The capital cost estimate has been produced to an AACE Class 4 Estimate. This includes a 7.5% risk allowance to bring estimates to this level.

The capital cost estimate is based on costs and rates commercially available in the Australian market and includes provision for plant, labour and equipment. The estimates are based on the standards and legal requirements within Australia which are of an ‘international standard’ and are well tested, well understood and are of a level appropriate for the SKA.

The labour rates used make allowance for all necessary leave, compulsory pension contributions and industry and trade allowances (as requested in clause 2.2 of the Request for Information). We confirm our approach also conforms to
clause 2.2 of the Request for Information, which requires the bid to exclude indirect costs and contingencies or local taxes, import duties or tariffs.

The capital cost estimate also includes replacement costs for items with less than a 30-year lifetime.

The following specific items of existing or funded infrastructure in Australia are included as part of the SKA infrastructure. For those items that were initially included in the capital cost evaluation, the subsequent discount applied to the capital cost estimate (based on a fractional of use by the SKA) is indicated. Items not included in the original capital cost estimate and thus for which no discount has been applied to the final capital cost, are listed alongside their full capital cost. We do not attempt to cost the national research optical fibre network.

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<th>Value (€ 2007)</th>
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<td>Geraldton-Perth optical fibre (AARNet)</td>
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<td>MRO power station for SKA Phase 1 (component thereof)</td>
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<td>Head-office building in Perth (UWA)</td>
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<td>Part of supercomputer building in Perth (IVEC) (component thereof)</td>
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<td>National Research Optical Fibre network (AARNet/ReANZ)</td>
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Further, specific costing assumptions have been stated at the appropriate points in the reports.

Exclusions

The following have been excluded from the capital cost estimate:

- Active equipment
- Computer equipment, racks etc. inclusive of all additional cooling and power reticulation requirements
- Operating expenditure
- Maintenance costs
- Land costs or land leasing costs. To be discussed during site negotiations.
- Antenna costs
- Goods and Services Tax (local tax)
- Carbon Tax
- Legislative changes
- Correlator and data termination
- Loose furniture, fittings and equipment
- Accommodation for staff based in cities and towns
- Hotel accommodation for visitors
- Professional fees (consultants, engineers, etc)
- Design contingency
- Construction contingency
- Raised area to AA mid and low foundations (assumed grading is adequate on high flat core site)
- Internal government costs
- Major roads around the site (minor roads are more appropriate in the remote Western Australian environment).
Currency and base date

The basis of the cost estimate has costs and rates applicable to Australia, and in particular the appropriate region of Western Australia, using a cost base as at September 2011.

From this cost base (and in accordance with Clause 2.3 of the Request for Information) we have taken the current Australian value construction costs and converted this to Euros at the stated rate of A$1.35/Euro.

The Request for Information also requires that the cost base be converted to a cost base of 1 January 2007. To do this the have used the Australian Consumer Price Index as an appropriate and identifiable source of data. The Consumer Price Index is a calculation and publication by the Australian Bureau of Statistics (ABS) in Publication No. 6401.0. Specifically we have used the ‘weighted average of eight capital cities’ and the following specific published index in our calculation:

- CPI Index December 2006          155.5
- Calculated Index in January 2007 (one third of the increase to the March 2007 Index) = 155.53
- CPI Index June 2011              178.3
- Assumed CPI increase from June 2011 to September 2011 based on the percentage movement in the previous 3 months (178.3/176.7 = 0.9%) giving a theoretical September 2011 index of 179.9
- Assumed September 2011 ABS Index: 179.9
- CPI Cost Base Reduction to 1 January 2007 = 155.53/179.9 = 86.45%.

We note that historically the construction costs trend to shadow the CPI movement. In times of high construction activity the construction escalation will exceed the CPI ‘trend line’ and in times of sustained low construction activity will fall below the ‘trend line’.

It is noted that in January 2007 construction activity in Australia and in particular Western Australia was at a high level. Based on the ‘strict’ application of the CPI changes, costs in January 2007 would be 86.45% of current costs. Our calculation takes a more conservative position, by also looking at the supply and demand impacts on the construction industry over this time, and have adjusted this to be only 90% of current costs.

Please refer to Attachment 31 for an extract from ABS Publication 6401.0 Consumer Price Index, Australia, June 2011 for further information.

Confidence level

Uncertainty in the cost estimate was accounted by assigning a range of possible costs for each element, typically -15% to +30%. A mathematical methodology, known as ‘Monte Carlo Simulation’ was then implemented to determine the probability distribution of costs across the whole project. This enabled the calculation of the most probable cost, and a cost with an assigned confidence level.

For example, a ‘70% confidence level’ means that there is a 70% probability that the actual cost will be less than or equal to the estimated cost. A 90% confidence level provides a high level of confidence that the actual cost will be less than or equal to the estimate.

Please refer overleaf for a detailed breakdown of our confidence level.
Cost elements

Rays

Central Area
Major Roads
Minor road (outside the 5km cores)
Minor roads
Clear central area including raising ground level and provision of gravel surface
Lead in Road to central facility
Bridge / water crossing
Minor Water crossings

Minor road to individual station outside 13km

Remote Sites - Within Australia (25 No.)
Access to remote site
Access within each remote site

Buildings

Equipment & Office Buildings

SKA Operations Centre - near centre of Array - Located 30 km from core (SKA
Data Centre & Operations Building
Fibre Collection & Management Building (60%)
Operations Control Room
Power building
Office - control building

Travel & Engineering

RFI Shield to Data Centre & Power Building

Sundry Building (700M from Operation Centre)
Office space
Meeting Rooms
Canteen
Canteen kitchen facility
Maintenance Facility

Travel & Engineering

RFI shielding
Furniture Fitting & Equipment

Accommodation for Construction Crews & Operations & Maintenance Staff

Construction phase staff
Fly camp to allow construction of Construction Camp
Credit for Permanently - Operation phase
Operating Construction camp
Operations Phase
Water sanitation
Sewerage treatment

Geraldton Support Office / facility
Support facility in Geraldton to accommodate 10 Staff & small laboratory, workshops, etc
Remove Station Storage Facilities
Remote station storage sheds - Australia

Head Office - Located in Perth

Computing centre
Computer, Data storage, Etc. (1500m2 of 'active Floor is required)
Data storage
Data interconnect
Heating, cooling, ventilation - Plant Area
Office related component

Airstrip

Dish Foundation
Dish foundations - utilising 4 rock anchors and 5.5 x 5.5 x 0.80 concrete foundation
Dish Foundation based on 7.0 x 7.0 x 1.0 concrete foundation
Dish Foundation - Remote
AA- Low Stations
AA-Low RFI Shielded Bunker
AA - MID STATION
AA MID Bunker

Security to Foundation sites
Dishes
Dishes - remote
AA-LOW
AA- MID

CREDIT FOR EXISTING INFRASTRUCTURE
Minor road (outside the 5km cores)
Credit for Re-use of Existing ASKAP Facility Control Room (for the housing of equip to service 37 AA-low RFI shielded bunker functionality - by adding in a modular RFI shielded room into the existing RFI shielding building
Credit for using existing Boolardy Station Commercial Kitchen & facilities
Geraldton Support Facility Office

Permanent Accommodation Credits
Boolardy
Meekatharra
Mullewa
Mt Augustus
Pia Wajarri Community
Geraldton

Head Office - Credit for Utilising Motorola Building
Use of Pawsey High Performance Computing Centre (500m2 of active area & 600m2 of associated)
Airstrip

Power Generation
Central Area
Central Area - power station
Power transmission over land 132 KV
Horizon Power Headwork's
Power upgrade at Geraldton
**Outer Spiral Standalone Power Supply (Diesel Gen)**
- Diesel Generating Set
- Shielded generator building
  - 415/6.6 250kVA kiosk
  - 6.6/415 250kVA kiosk
  - 6.6kV UG cable
  - 6.6kV Trenching
- Installation
- LV reticulation

**Outer Spiral Networked Power Supply**
- 33kV UG cabling (240sqmm AL)
- 33kV Trenching
- 33/6.6 250kVA kiosk
- 6.6/415 250kVA kiosk
- 6.6kV UG cable
- 6.6kV Trenching
- Installation
- LV reticulation

**Outer Spiral 33kV Ring Main**
- 33kV UG cabling (240sqmm AL) 30km dia UG ring main
- 33kV Trenching
- 33/33kV 10MVA Auto transformer voltage regulator
- 33kV 3 circuit RMU
- Trip & Close Batt & Charger
- 50kVA Aux Tx
- Auxiliary SWBD
- L&P
- Comms/SCADA
- Building
- Installation

**Dish Central Core**
- 6.6kV/415 1MVA kiosks
- 415V distribution
- Installation

**AA Low Central Core**
- 6.6kV/415 250kVA kiosks @250k each
- 415V distribution
- Installation

**AA Mid Central Core**
- 6.6kV/415 250kVA kiosks @250k each
- 415V distribution
- Installation

**Remote Clusters**
- LV reticulation

**Additional service trenching**

**Sundry Buildings:**
- Accommodation Buildings

**Testing & Commissioning**
Direct employees
Consultants
Remote LAHFA
Sundry Materials/ equipment / vehicles

CREDIT FOR EXISTING INFRASTRUCTURE
Grid Transmission line from Geraldton
Credit for power to Computing Centre - (costs will be converted to tarrif)

DATA TRANSPORT
Receptors to Data Processor
Out To 180KM
Fiber Optic cable - 12 core
Fiber Optic cable - 24 core
Fiber Optic cable - 36 core
Fiber Optic cable - 48 core
Fiber Optic cable - 72 core
Fiber Optic cable - 192 core
Fiber Splicing - small node
Fiber Splicing - medium node
Fiber Splicing - large node
Fiber Splicing - very large node
Fiber Termination - Small node
Fiber Termination - medium node
Fiber Termination - large node
Fiber Termination - very large node
Fiber termination data processor
Small splice pit
Medium splice pit
Large splice pit
Very large splice pit
Trenching for direct bury (5x170km)
Trenching fibre drawn in conduit (inner 10km circle)
Remote Stations
Local fiber optical cable - 24 core
Station local fiber terminations
Station local small splice pit
Trenching fibre drawn in conduit
Fiber Optic tails to existing 'AARnet' fiber core network
Transponders Remote station (Aarnet)
Active Components
Correlator Equipment
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**Total**

Use of @RISK statistics for key outputs (run simulation for these to be valid):
- Probability of meeting value of $1519578026
- Total budget required for 70.0% confidence
- Contingency (risk dollars) required for 70.0% confidence
- Total budget required for 90.0% confidence
- Contingency (risk dollars) required for 90.0% confidence
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<td>Allowance for chip sealed single lane road with graded shoulders</td>
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<td>Indication of cost from Murchinson Shire</td>
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<td>Provision of 'white space' - no active equipment or associated areas included above</td>
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<td>Additional area included to allow for collection and staging area for minor road</td>
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<td>Allowed 25% grossing factor</td>
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<td>Excluded - assumed this is active equipment</td>
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<td>Assumed they are able to use Boolardy Station Accommodation</td>
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Peak construction workforce anticipated to be 400 persons with 70% included above. Based on an average of 145 persons for 5 years. Recreation facilities included above. 20 staff x 15m² per person. Assumed size to be confirmed.
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<td>80m² per site allowed &amp; includes water tank &amp; First Aid equipment</td>
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<td>8,580,000</td>
<td>(110 people x 15m²/person)</td>
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<td>11,700,000</td>
<td>'White space' shell no allowance for equipment or equipment cooling</td>
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<td>500m² Briefed appears to be insufficient - Increased to 2000m²</td>
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<td>Based on 70 People (based on 15m²/person)</td>
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<td>Lease costs to be accounted for with operating costs</td>
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**KEY FIGURES**

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**KEY POINTS**

**THE ALL GROUPS CPI**

- rose 0.9% in the June quarter 2011, compared with a rise of 1.6% in the March quarter 2011.
- rose 3.6% through the year to the June quarter 2011, compared with a rise of 3.3% through the year to the March quarter 2011.

**OVERVIEW OF CPI MOVEMENTS**

- The most significant price rises this quarter were for fruit (+26.9%), automotive fuel (+4.0%), hospital and medical services (+3.4%), furniture (+6.0%), deposit and loan facilities (+2.1%) and rents (+1.1%).
- The most significant offsetting price falls were for vegetables (−10.3%), audio, visual and computing equipment (−6.3%), electricity (−1.5%), domestic holiday travel and accommodation (−1.5%), milk (−4.6%) and toiletries and personal care products (−2.3%).

**INQUIRIES**

For further information about these and related statistics, contact the National Information and Referral Service on 1300 135 070.
NOTES

FORTHCOMING ISSUES

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CHANGES IN THIS ISSUE

This issue incorporates a number of amendments to historical series in the international comparisons Tables 11 and 12 where errors had been made in the process of re-referencing all series to a common index base. The index numbers and movements included in these tables are derived from internationally comparable indexes and re-referenced to a base of 1989-90 = 100.0. Please see paragraphs 16 – 18 in the explanatory notes for more information on these tables.

INTRODUCTION OF THE 16TH SERIES CPI – SEPTEMBER QUARTER 2011 ISSUE

The 16th series CPI will be introduced from the September quarter 2011. This will include a new commodity classification and expenditure weights from the 2009–10 Household Expenditure survey. See page 3 – ‘Changes to the CPI from September Quarter 2011’ for more details on these and other changes.

IMPACT OF THE FLOODS AND CYCLONE YASI

Extensive flooding began in late December 2010 in Queensland, and intensified in both Queensland and other states in January 2011. In early February 2011, Severe Tropical Cyclone Yasi crossed the north Queensland coast. Gale force winds, flooding rain and storm surges caused significant damage to areas in the storm’s path.

On a quarter to quarter basis the prices of items can be impacted by a number of factors including exchange rates, supply constraints, specialising and seasonal patterns. The impact of events like the Queensland floods and Cyclone Yasi cannot be readily quantified. ABS price index compilation methodologies and quality assurance processes have ensured that any impact of the floods and cyclone on consumer prices is reflected in the data included in this publication.

ROUNDING

Any discrepancies between totals and sums of components in this publication are due to rounding.

INQUIRIES

For further information about these and related statistics, contact the National Information and Referral Service on 1300 135 070.

ABBREVIATIONS

ABS Australian Bureau of Statistics
CPI Consumer Price Index
n.e.c. not elsewhere classified

Brian Pink
Australian Statistician
The September quarter 2011 issue of the Consumer Price Index (CPI) will incorporate the main outcomes from the recent major review of the CPI to ensure that it continues to be a comprehensive and reliable measure of price inflation for Australia. This was a comprehensive review examining CPI concepts, methodologies and data sources. More detailed information can be found in the *Information Paper: Outcome of the 16th Series Australian Consumer Price Index Review, Australia, December 2010* (cat. no. 6469.0).

The new series will be the 16th series since the CPI was first compiled in 1960. The 16th series CPI will be introduced for the September quarter 2011. It will be linked to the 15th series CPI at the June quarter 2011, and will be published on 26 October 2011.

The main changes that will be incorporated in the September quarter publication are:

- new household expenditure weights derived from the 2009–10 Household Expenditure Survey (HES) and other data sources;
- the indirectly measured component of the deposit and loan facilities index (i.e. Financial Intermediation Services Indirectly Measured (FISIM)) will be removed from the headline CPI;
- the deposit and loan facilities index will comprise direct fees and charges only and will be renamed "Deposit and loan facilities (direct charges)";
- the CPI commodity classification (CPICC) used to categorise the goods and services in the CPI will be updated to ensure it reflects contemporary wording and groupings. To enable greater international comparability, the classification will be aligned with the United Nations Classification of Individual Consumption according to Purpose (COICOP) where possible. There will be considerable re-naming and some re-ordering of the items in the classification. The coverage of household expenditure will remain largely the same as the 15th series CPI. A detailed list of changes, including tables showing correspondences between the 15th and 16th series commodity classifications can be found in the *Appendix* on page 36 and publication *Consumer Price Index Commodity Classification, Australia, 16th Series, 2011* (cat. no. 6401.0.55.004).
- an additional number of analytical measures of inflation will be produced:
  - All Groups CPI (seasonally adjusted), weighted average of eight capital cities;
  - Expenditure class level price indexes (seasonally adjusted), weighted average of eight capital cities;
  - All Groups CPI including FISIM; and
  - All Groups CPI excluding food and energy.
- revised analytical trimmed mean and weighted median measures of inflation using standard ABS seasonal adjustment techniques.

The ABS will discontinue the *Average Retail Prices of Selected Items, Eight Capital Cities* (cat. no. 6403.0.55.001) publication. The 16th series review determined that the Average Retail Prices data neither performs the function of showing price change over time (temporal measure) nor a detailed price level comparison between capital cities (spatial measure) in an unbiased, robust manner. The June quarter 2011 release will be the final issue.
The ABS will release a series of publications in the coming months to provide users with detailed information associated with the 16th series CPI. Key dates are:

17 August 2011
- Seasonal Adjustment of Consumer Price Indexes (cat. no. 6401.0.55.003). This publication will outline the new seasonally adjusted measures of inflation.

6 September 2011
- Household Expenditure Survey, Australia: Summary of Results, 2009–10 (cat. no. 6530.0) will publish household expenditure, income and net worth of households for reference period 2009–10.

22 September 2011
- Information Paper: Introduction of the 16th Series Australian Consumer Price Index (cat. no. 6470.0) will include the new CPI commodity classification, weighting pattern, publication format and the new structure of the time series spreadsheets that will be published from the September quarter 2011 CPI.
- Consumer Price Index 16th Series Weighting Pattern (cat. no. 6471.0) will be a data cube which will include the CPI weighting pattern, points contributions and capital city weighting information.
- Analytical Living Cost Indexes and Pensioner and Beneficiary Living Cost Index: 16th Series Weighting Patterns (cat. no. 6465.0) will be a data cube which will include the analytical living cost indexes weighting patterns.

26 October 2011
- Consumer Price Index, Australia (cat. no. 6401.0) will be the 16th series CPI introduced in respect of the September quarter 2011.
- A Guide to the Consumer Price Index: 16th Series (cat. no. 6440.0) will include a guide to interpreting and using the CPI for general users.
- Consumer Price Index: Concordance with Household Expenditure Classification, Australia (cat. no. 6446.0.55.001) will contain the correspondence between the new CPI commodity classification and the Household Expenditure Survey Classification.
- Consumer Price Index: Historical Weighting Patterns (cat. no. 6431.0) will include the weighting patterns of the CPI from 1960 to 2011.

7 December 2011
- Consumer Price Index: Concepts, Sources and Methods, 2011 (cat. no. 6461.0) will contain an update to the methodology, classifications and description of collection and processing procedures including quality adjustment techniques.

For more information regarding the changes to the CPI from the September quarter 2011, please contact the Consumer Price Index Section, on (02) 6252 6654.
The main contributors to the increase in the transportation group in the June quarter 2011 were automotive fuel (+4.0%) and urban transport fares (+1.1%). Motor vehicle repair and servicing (–0.9%) and motor vehicles (–0.2%) recorded the largest offsetting falls.

The following graph shows the pattern of the average daily prices for unleaded petrol for the eight capital cities over the last fifteen months.

The food group recorded an increase in the June quarter 2011. The most significant contributors were fruit (+26.9%) and restaurant meals (+1.3%). The rise in fruit prices was mainly attributable to an increase of approximately 138% in the price of bananas in the June quarter 2011 due to shortages created by Cyclone Yasi in February 2011. Banana prices increased 377% over the six months to the June quarter 2011. Vegetables (–10.3%) provided the most significant offset, due to favourable growing conditions.

Over the twelve months to the June quarter 2011, fifteen out of the twenty six food categories rose, contributing to a 6.1% price rise across the food group. Increases were mainly driven by price rises in fruit (+66.6%), and vegetables (+9.7%). Milk (–10.8%) recorded the most significant offsetting price movement due to extensive price discounting across some retail outlets.
The health group recorded an increase in the June quarter 2011 with all capital cities registering a rise. The main contributor was hospital and medical services (+3.4%), which rose mainly as a result of the increases in private health fund premiums effective from 1 April 2011. The only offset was pharmaceuticals (–0.8%), mainly due to a greater

The household contents and services group rose in the June quarter 2011, with increases in furniture (+6.0%) and towels and linen (+7.5%). These increases were largely due to the cessation of specials offered in the March quarter 2011.

Over the twelve months to the June quarter 2011, the household contents and services group rose 0.1%. This increase was predominantly due to rises in other household services (+4.4%), child care (+7.5%), hairdressing and personal care services (+3.0%) and furniture (+1.0%), partially offset by falls in toiletries and personal care products (–2.4%), other household supplies (–1.8%) and major household appliances (–3.5%).

The main contributor to the increase in the financial and insurance services group in the June quarter 2011 was deposit and loan facilities (+2.1%), which include both direct fees and prices derived from interest rate margins. The price of services charged by financial institutions varies across the range of products covered in the CPI. In the June quarter 2011 there was an increase in prices derived from interest rate margins partially offset by falls in direct fees. For more details on calculating prices of financial services, please see the appendix in the June quarter 2008 publication.

Insurance services recorded an increase of 1.6% in the June quarter 2011, driven mainly by higher premiums for house insurance and household contents insurance.

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Insurance services recorded an increase of 1.6% in the June quarter 2011, driven mainly by higher premiums for house insurance and household contents insurance.

Over the twelve months to the June quarter 2011, the financial and insurance services group recorded an increase of 4.2%. This was due to increases in deposit and loan facilities (+5.5%), insurance services (+5.3%) and other financial services (+2.1%).

The household contents and services group rose in the June quarter 2011, with increases in furniture (+6.0%) and towels and linen (+7.5%). These increases were largely due to the cessation of specials offered in the March quarter 2011.

Over the twelve months to the June quarter 2011, the household contents and services group rose 0.1%. This increase was predominantly due to rises in other household services (+4.4%), child care (+7.5%), hairdressing and personal care services (+3.0%) and furniture (+1.0%), partially offset by falls in toiletries and personal care products (–2.4%), other household supplies (–1.8%) and major household appliances (–3.5%).

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The alcohol and tobacco group recorded an increase in the June quarter 2011. The main contributor to the rise was tobacco (+1.4%) partially due to the flow-on effects of the federal excise tax increase from 1 February 2011.

ALCOHOL AND TOBACCO  (+0.7%)

The fall in the recreation group in the June quarter 2011 was mainly due to decreases in audio, visual and computing equipment (–6.3%), domestic holiday travel and accommodation (–1.5%) and overseas holiday travel and accommodation (–1.2%). The most significant offset was recorded in pets, pet food and supplies (+4.0%).

RECREATION  (–0.6%)

The clothing and footwear group recorded an increase in the June quarter 2011. The main contributors to the movement were accessories (+8.8%) and men’s outerwear (+1.7%). The increase in accessories was mainly due to a rise in the price of jewellery. These increases were partially offset by a decrease in women’s footwear (–2.3%).

CLOTHING AND FOOTWEAR  (+2.5%)

The housing group recorded an increase in the June quarter 2011. The main contributor to the increase was rents (+1.1%) which recorded rises in both private and government rents. Government rents charged to pensioners and other welfare recipients are set as a proportion of income. Previous income increases to pensions in May 2009 were quarantined from the calculation of rental charges and have now been passed on to households in some states. The only offsetting price fall was in electricity (–1.5%) due to the seasonal switch to off-peak pricing in Melbourne and Adelaide.

HOUSING  (+0.4%)

The clothing and footwear group recorded an increase in the June quarter 2011. The main contributors to the movement were accessories (+8.8%) and men’s outerwear (+1.7%). The increase in accessories was mainly due to a rise in the price of jewellery. These increases were partially offset by a decrease in women’s footwear (–2.3%).

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The alcohol and tobacco group recorded an increase in the June quarter 2011. The main contributor to the rise was tobacco (+1.4%) partially due to the flow-on effects of the federal excise tax increase from 1 February 2011.

ALCOHOL AND TOBACCO  (+0.7%)
The tradables component (see table 8) of the All groups CPI rose 1.3% in the June quarter 2011. Prices for the goods and services in this component are largely determined on the world market. The tradables component represents approximately 40% of the weight of the CPI. The most significant contributors to the 1.4% rise in the tradable goods component were for fruit, automotive fuel, furniture, accessories, tobacco, towels and linen, glassware, tableware and household utensils and pets, pet foods and supplies. The most significant offsetting falls were for vegetables, audio, visual and computing equipment, toiletries and personal care products, food n.e.c. and other household supplies. The decrease in the tradable services component of 1.3% was driven by overseas holiday travel and accommodation.

Over the twelve months to the June quarter 2011, the tradables and non–tradables component both rose 3.6%. This compares to both components rising 3.3% through the year to the March quarter 2011. The main increases in tradables were for fruit, automotive fuel, tobacco, vegetables, accessories and lamb and mutton. The main decreases in tradables were for audio, visual and computing equipment, motor vehicles, sport and recreational equipment. The main contributors to non–tradables were rises for rents, electricity, deposit and loan facilities, house purchase, hospital and medical services and water and sewerage. The largest offsetting movements were for milk and motor vehicle repair.

The non–tradables component of the All groups CPI rose 0.6% in the June quarter 2011. Prices for the goods and services in this component are largely determined by domestic price pressures. The non–tradables component represents approximately 60% of the CPI. The non–tradable goods component rose 0.1% mainly due to house purchase and take away and fast foods. The most significant offsetting movements were for electricity and milk. The non–tradable services component rose 0.9%, due to increases for hospital and medical services, deposit and loan facilities, rents, insurance services, other financial services and restaurant meals.

Over the twelve months to the June quarter 2011, the alcohol and tobacco group rose 5.6%. This was driven by increases in tobacco (+12.0%) which was mainly due to the flow–on effect of the 25% increase in federal excise on tobacco implemented on 30 April 2010.

The communication group recorded a rise in the June quarter 2011 due to rises in both postal (+2.1%) and telecommunication (+0.4%).

In the twelve months to the June quarter 2011, the communication group recorded a rise of 0.4%.

The education group recorded no movement in the June quarter 2011.

Over the twelve months to the June quarter 2011, the education group rose 5.9%.
At the All groups level, the CPI rose in all capital cities in the June quarter 2011. The highest positive movement was recorded in Perth (+1.3%) followed by Canberra (+1.1%). The remaining six cities increased between 0.7% and 1.0%.

The food group was the largest positive contributor in Perth (+2.9%), Canberra (+2.2%), Melbourne (+1.5%) and Adelaide (+1.4%), driven by increases in fruit prices. The most significant positive contributor for Hobart and Brisbane was the transportation group, with the recreation group and the housing group the main contributors for Darwin and Sydney respectively.

At the eight capital cities level, the transportation group was the second largest positive contributor to the quarterly movement showing increases in all cities. The most significant contributor was the increase in automotive fuel in all capital cities, most notably in Darwin (+7.5%) and Hobart (+5.8%).

The recreation group was the largest negative contributor to the quarterly movement at the eight capital cities level. The largest decreases for the recreation group were recorded in Melbourne (–1.4%), Sydney (–0.5%) and Brisbane (–0.4%). Darwin (+2.8%) was the only city to record an increase in the recreation group in the June quarter 2011. Most of the cities recorded decreases for domestic holiday travel and accommodation ranging from 0.3% in Canberra to 3.7% in Melbourne. Another significant fall was recorded for audio, visual and computing equipment (–6.3%) with drops in all cities ranging from 2.2% in Perth to 8.7% in Melbourne.

Over the twelve months to the June quarter 2011, the All groups CPI rose in all capital cities. The largest positive movement was recorded in Adelaide (+3.9%) due to relatively higher increases in the clothing and footwear group. Perth (+3.0%) recorded the smallest positive movement mainly due to a relatively smaller rise in the housing group.
## Capital Cities Comparison continued

### CPI, All groups index numbers and percentage changes

<table>
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<tr>
<th>INDEX NUMBER(a)</th>
<th>PERCENTAGE CHANGE</th>
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<td>Perth</td>
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<td>Canberra</td>
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<tr>
<td>Weighted average of eight capital cities</td>
<td>178.3</td>
</tr>
</tbody>
</table>

(a) Base of each index: 1989–90 = 100.0.

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### Capital Cities Comparison

- **Canberra**: 1.1 (178.7)
- **Darwin**: 1.0 (175.4)
- **Hobart**: 1.3 (178.4)
- **Melbourne**: 1.0 (175.6)
- **Perth**: 1.0 (178.4)
- **Adelaide**: 0.9 (181.8)
- **Brisbane**: 1.0 (184.1)
- **Sydney**: 1.3 (177.6)

- **Weighted average**: 0.9 (178.3)

**Note**: CPI, Consumer Price Index, as at Jun 2011.
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<td>Group, sub–group and expenditure class, percentage change from previous quarter by capital city</td>
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<td>2010–11</td>
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2007
| June    | 157.4  | 155.6     | 160.2    | 160.3    | 158.0 | 157.4  | 154.7  | 158.0    |
| September | 158.1 | 156.9     | 161.7    | 161.5    | 158.9 | 157.9  | 156.6  | 159.2    |
| December | 159.5  | 158.5     | 163.4    | 163.1    | 160.2 | 159.2  | 157.1  | 160.8    |

2008
| March   | 161.7  | 160.6     | 165.6    | 165.5    | 162.5 | 161.3  | 158.5  | 163.0    |
| June    | 164.1  | 162.5     | 168.4    | 167.6    | 165.1 | 162.9  | 160.8  | 165.0    |
| September | 165.9 | 164.4     | 170.8    | 169.8    | 166.7 | 164.7  | 163.6  | 167.5    |
| December | 165.5  | 163.5     | 170.4    | 169.3    | 166.2 | 164.4  | 162.9  | 166.8    |

2009
| March   | 165.6  | 163.9     | 170.8    | 169.3    | 166.0 | 164.8  | 163.0  | 167.4    |
| June    | 166.3  | 164.4     | 171.8    | 170.3    | 167.4 | 165.7  | 164.8  | 168.4    |
| September | 168.1 | 165.4     | 174.1    | 172.1    | 168.7 | 167.7  | 168.0  | 169.9    |
| December | 169.1  | 166.4     | 174.7    | 172.7    | 169.7 | 168.7  | 167.8  | 170.6    |

2010
| March   | 170.5  | 168.5     | 176.0    | 173.7    | 171.6 | 170.0  | 168.7  | 171.7    |
| June    | 171.1  | 169.5     | 177.3    | 175.0    | 173.2 | 170.7  | 170.1  | 172.3    |
| September | 172.5 | 170.5     | 179.1    | 176.6    | 174.0 | 172.4  | 171.9  | 173.4    |
| December | 173.1  | 171.5     | 180.0    | 177.1    | 174.1 | 172.6  | 171.8  | 174.2    |

2011
| March   | 175.9  | 174.4     | 182.3    | 180.0    | 176.1 | 174.9  | 173.7  | 176.8    |
| June    | 177.6  | 175.6     | 184.1    | 181.8    | 178.4 | 176.5  | 175.4  | 178.7    |

(a) Base of each index: 1989–90 = 100.0.
## ALL GROUPS, Percentage changes

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<tr>
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<th>Sydney</th>
<th>Melbourne</th>
<th>Brisbane</th>
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<th>Perth</th>
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### PERCENTAGE CHANGE (from previous financial year)

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### PERCENTAGE CHANGE (from corresponding quarter of previous year)

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### PERCENTAGE CHANGE (from previous quarter)

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### PERCENTAGE CHANGE (from corresponding year of previous year)

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**Weighted average of eight capital cities**

- Canberra
- Darwin
- Sydney
- Adelaide
- Brisbane
- Melbourne
- Perth
- Hobart
<table>
<thead>
<tr>
<th>Period</th>
<th>Food</th>
<th>Alcohol and tobacco</th>
<th>Clothing and footwear</th>
<th>Housing</th>
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(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.
### CPI GROUPS, Weighted average of eight capital cities—Index numbers

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(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.

(b) Base: June quarter 2005 = 100.0.
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| **PERCENTAGE CHANGE (from corresponding quarter of previous year)** |
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| | September | –0.9 | 0.8 | 1.6 | 4.1 | 3.2 | 1.9 |
| | December | 5.6 | 0.4 | 1.0 | 4.1 | 4.9 | 3.0 |
| 2008 | March | 6.8 | 0.1 | 1.4 | 4.3 | 6.8 | 4.2 |
| | June | 6.9 | 0.0 | 1.7 | 4.2 | 9.9 | 4.5 |
| | September | 8.7 | 0.2 | 1.6 | 4.7 | 9.5 | 5.0 |
| | December | –1.2 | 0.5 | 1.3 | 4.8 | 7.0 | 3.7 |
| 2009 | March | –4.6 | 1.0 | 0.5 | 5.0 | –1.4 | 2.5 |
| | June | –5.9 | 1.2 | 0.7 | 5.1 | –6.6 | 1.5 |
| | September | –5.1 | 1.0 | 0.1 | 5.6 | –7.2 | 1.3 |
| | December | 1.2 | 0.6 | 1.1 | 5.6 | –6.3 | 2.1 |
| 2010 | March | 4.1 | 0.2 | 1.2 | 5.7 | 2.0 | 2.9 |
| | June | 3.2 | –0.2 | –0.6 | 5.7 | 3.9 | 3.1 |
| | September | 0.6 | –0.4 | –0.7 | 5.8 | 3.4 | 2.8 |
| | December | 1.7 | –0.4 | –1.9 | 5.7 | 2.2 | 2.7 |
| 2011 | March | 3.0 | –0.2 | –1.5 | 5.9 | 2.8 | 3.3 |
| | June | 3.5 | 0.4 | –0.3 | 5.9 | 4.2 | 3.6 |

| **PERCENTAGE CHANGE (from previous quarter)** |
| 2007 | June | 3.0 | 0.2 | –0.4 | 0.1 | 0.9 | 1.2 |
| | September | –0.7 | 0.0 | 1.4 | –1.0 | 2.0 | 0.7 |
| | December | 2.4 | 0.0 | 0.8 | 0.0 | 2.1 | 0.9 |
| 2008 | March | 1.9 | –0.1 | –0.3 | 5.2 | 1.7 | 1.3 |
| | June | 3.1 | 0.1 | –0.2 | 0.0 | 3.8 | 1.5 |
| | September | 1.0 | 0.2 | 1.3 | –0.5 | 1.7 | 1.2 |
| | December | –6.9 | 0.4 | 0.5 | 0.0 | –0.3 | –0.3 |
| 2009 | March | –1.5 | 0.4 | –1.1 | 5.4 | –6.3 | 0.1 |
| | June | 1.6 | 0.3 | –0.1 | 0.1 | –1.7 | 0.5 |
| | September | 1.9 | 0.0 | 0.7 | 0.0 | 0.9 | 1.0 |
| | December | –0.8 | 0.0 | 1.5 | 0.1 | 0.7 | 0.5 |
| 2010 | March | 1.3 | –0.1 | –1.0 | 5.6 | 2.0 | 0.9 |
| | June | 0.7 | –0.1 | –1.8 | 0.0 | 0.2 | 0.6 |
| | September | –0.6 | –0.3 | 0.7 | 0.1 | 0.5 | 0.7 |
| | December | 0.2 | 0.1 | 0.2 | 0.0 | –0.4 | 0.4 |
| 2011 | March | 2.7 | 0.1 | –0.6 | 5.7 | 2.6 | 1.6 |
| | June | 1.2 | 0.4 | –0.6 | 0.0 | 1.6 | 0.9 |
## CPI GROUPS, Index numbers(a)

### Quarters

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(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.
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**HEALTH**

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(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.  
(b) Base: June quarter 2005 = 100.0.
## CONTRIBUTION TO CHANGE IN ALL GROUPS INDEXES

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**NOTES**

- All groups index points.
## CONTRIBUTION TO CHANGE IN ALL GROUPS INDEXES (a)—Jun Qtr 2011

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(a) All groups index points.
## Food

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<td>Children's footwear</td>
<td>97.3</td>
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<tr>
<td>Accessories and clothing services</td>
<td>118.9</td>
<td>120.5</td>
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<td>Accessories</td>
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<td>101.9</td>
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<tr>
<td>Clothing and shoe repair</td>
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<td>209.9</td>
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</tbody>
</table>

(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.
(b) Base: June quarter 1998 = 100.0.
## Group, Sub-Group and Expenditure Class, Weighted Average of Eight Capital Cities

### Table: Index Numbers, Percentage Change, Contribution to Total CPI

<table>
<thead>
<tr>
<th>Group, sub-group and expenditure class</th>
<th>Jun Qtr 2010</th>
<th>Mar Qtr 2011</th>
<th>Jun Qtr 2011</th>
<th>Mar Qtr 2010 to Jun Qtr 2011</th>
<th>Jun Qtr 2011 to Jun Qtr 2010</th>
<th>Mar Qtr 2011 to Jun Qtr 2011</th>
<th>Change in Points Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Housing</strong></td>
<td></td>
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<td>Motor vehicle parts and accessories</td>
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<td>168.8</td>
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</tbody>
</table>

### Notes:
(a) Unless otherwise specified, base of each index: 1989-90 = 100.0.
(b) Base: June quarter 1998 = 100.0.
### Group, Sub-group and Expenditure Class, Weighted average of eight capital cities

#### Contribution to Total CPI (All Groups Index Points)

<table>
<thead>
<tr>
<th>Group, sub-group and expenditure class</th>
<th>Jun Qtr 2010</th>
<th>Mar Qtr 2011</th>
<th>Jun Qtr 2011</th>
<th>Mar Qtr 2010 to Jun Qtr 2011</th>
<th>Jun Qtr 2011</th>
<th>Mar Qtr 2011 to Jun Qtr 2011</th>
<th>Change in Points Contribution</th>
</tr>
</thead>
</table>

#### Recreation
- Audio, visual and computing
  - Jun Qtr 2010: 135.6
  - Mar Qtr 2011: 136.0
  - June quarter 2010: 135.2
  - June quarter 2011: 129.1
  - Change: -6.1
  - Percentage change: -4.5
  - Contribution: -0.10
- Audio, visual and computing equipment
  - Jun Qtr 2010: 39.9
  - Mar Qtr 2011: 39.7
  - June quarter 2010: 37.1
  - June quarter 2011: 36.3
  - Change: -0.8
  - Percentage change: -2.1
  - Contribution: -0.02
- Books, newspapers and magazines
  - Jun Qtr 2010: 224.5
  - Mar Qtr 2011: 227.5
  - June quarter 2010: 227.4
  - June quarter 2011: 221.2
  - Change: -6.2
  - Percentage change: -2.7
  - Contribution: 0.01
- Books(b)
  - Jun Qtr 2010: 131.6
  - Mar Qtr 2011: 133.1
  - June quarter 2010: 132.6
  - June quarter 2011: 133.0
  - Change: 0.4
  - Percentage change: 1.0
  - Contribution: 0.00
- Newspapers and magazines(b)
  - Jun Qtr 2010: 154.2
  - Mar Qtr 2011: 156.7
  - June quarter 2010: 157.1
  - June quarter 2011: 158.0
  - Change: 0.9
  - Percentage change: 0.6
  - Contribution: 0.01
- Sports and recreational equipment(b)
  - Jun Qtr 2010: 87.9
  - Mar Qtr 2011: 83.4
  - June quarter 2010: 82.0
  - June quarter 2011: 86.8
  - Change: 1.8
  - Percentage change: 2.3
  - Contribution: 0.03
- Sports participation(b)
  - Jun Qtr 2010: 176.2
  - Mar Qtr 2011: 182.5
  - June quarter 2010: 182.9
  - June quarter 2011: 183.0
  - Change: 0.8
  - Percentage change: 0.4
  - Contribution: 0.00
- Pets, pet foods and supplies
  - Jun Qtr 2010: 200.2
  - Mar Qtr 2011: 190.4
  - June quarter 2010: 198.1
  - June quarter 2011: 183.1
  - Change: -1.6
  - Percentage change: -0.8
  - Contribution: 0.00
- Other recreational activities(b)
  - Jun Qtr 2010: 174.5
  - Mar Qtr 2011: 179.0
  - June quarter 2010: 181.4
  - June quarter 2011: 181.1
  - Change: 0.7
  - Percentage change: 0.4
  - Contribution: 0.00
- Holiday travel and accommodation
  - Jun Qtr 2010: 144.9
  - Mar Qtr 2011: 148.4
  - June quarter 2010: 146.4
  - June quarter 2011: 152.2
  - Change: 6.8
  - Percentage change: 4.4
  - Contribution: 0.03
- Domestic holiday travel and accommodation
  - Jun Qtr 2010: 149.1
  - Mar Qtr 2011: 156.6
  - June quarter 2010: 154.3
  - June quarter 2011: 159.0
  - Change: 4.7
  - Percentage change: 3.1
  - Contribution: 0.00
- Overseas holiday travel and accommodation
  - Jun Qtr 2010: 139.1
  - Mar Qtr 2011: 138.2
  - June quarter 2010: 136.5
  - June quarter 2011: 136.2
  - Change: -0.3
  - Percentage change: -0.2
  - Contribution: 0.00

#### Education
- Preschool and primary education(c)
  - Jun Qtr 2010: 313.8
  - Mar Qtr 2011: 322.2
  - June quarter 2010: 322.2
  - June quarter 2011: 318.9
  - Change: -3.3
  - Percentage change: -1.0
  - Contribution: 0.00
- Secondary education(c)
  - Jun Qtr 2010: 175.8
  - Mar Qtr 2011: 186.6
  - June quarter 2010: 186.8
  - June quarter 2011: 189.4
  - Change: 2.6
  - Percentage change: 1.4
  - Contribution: 0.00
- Tertiary education(c)
  - Jun Qtr 2010: 191.9
  - Mar Qtr 2011: 205.0
  - June quarter 2010: 205.0
  - June quarter 2011: 208.9
  - Change: 3.9
  - Percentage change: 1.9
  - Contribution: 0.00

#### Financial and insurance services(d)
- Financial services(d)
  - Jun Qtr 2010: 110.7
  - Mar Qtr 2011: 113.6
  - June quarter 2010: 115.6
  - June quarter 2011: 115.9
  - Change: 0.3
  - Percentage change: 0.3
  - Contribution: 0.00
- Deposit and loan facilities(d)
  - Jun Qtr 2010: 107.0
  - Mar Qtr 2011: 109.6
  - June quarter 2010: 111.2
  - June quarter 2011: 110.7
  - Change: -0.9
  - Percentage change: -0.8
  - Contribution: 0.00
- Other financial services(d)
  - Jun Qtr 2010: 103.2
  - Mar Qtr 2011: 106.7
  - June quarter 2010: 108.9
  - June quarter 2011: 106.7
  - Change: -2.1
  - Percentage change: -1.9
  - Contribution: 0.00
- Insurance services
  - Jun Qtr 2010: 112.0
  - Mar Qtr 2011: 113.4
  - June quarter 2010: 114.4
  - June quarter 2011: 114.4
  - Change: 0.0
  - Percentage change: 0.0
  - Contribution: 0.00

#### All groups
- Jun Qtr 2010: 172.1
- Mar Qtr 2011: 176.7
- June quarter 2010: 178.3
- June quarter 2011: 178.3
- Change: 0.9
- Percentage change: 0.5
- Contribution: 0.16

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(a) Unless otherwise specified, base of each index: 1989–90 = 100.0.
(b) Base: June quarter 1998 = 100.0.
(c) Base: June quarter 2000 = 100.0.
(d) Base: June quarter 2005 = 100.0.
SPECIAL SERIES, Weighted average of eight capital cities (a)

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<th>PERCENTAGE CHANGE</th>
<th>CONTRIBUTION TO TOTAL CPI (ALL GROUPS INDEX POINTS)</th>
<th>CHANGE IN POINTS</th>
<th>CONTRIBUTION</th>
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<tbody>
<tr>
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<td>Jun Qtr 2010</td>
<td>Mar Qtr 2011</td>
<td>Jun Qtr 2011 to Jun Qtr 2011</td>
<td>Mar Qtr 2011</td>
<td>Jun Qtr 2011</td>
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<td>176.7</td>
<td>178.3</td>
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(a) Refer to paragraphs 11 and 12 of the Explanatory Notes for a description of these series.
(b) Unless otherwise specified, base of each index: 1989-90 = 100.0.
(c) Base: June quarter 1998 = 100.0.
## MARKET GOODS AND SERVICES EXCLUDING ‘VOLATILE ITEMS’

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<th>All groups excluding ‘volatile Items’</th>
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- September: 158.6, 161.5, 164.4, 149.9, 174.1, 157.2, 119.4, 141.7
- December: 160.1, 162.7, 166.0, 151.3, 176.7, 159.0, 119.8, 143.6

### 2008
- March: 162.2, 164.5, 168.0, 152.1, 178.6, 160.2, 120.8, 146.1
- June: 164.6, 166.6, 170.2, 153.9, 181.7, 162.4, 122.6, 148.1
- September: 166.5, 167.7, 172.0, 154.7, 184.9, 164.1, 123.4, 150.4
- December: 166.0, 166.6, 172.8, 155.3, 186.3, 165.0, 121.2, 151.3

### 2009
- March: 166.2, 167.9, 173.4, 156.7, 183.0, 164.7, 121.8, 151.1
- June: 167.0, 169.0, 174.4, 158.2, 182.9, 165.6, 122.6, 151.7
- September: 168.6, 169.7, 176.1, 159.0, 184.4, 166.6, 122.8, 153.9
- December: 169.5, 170.4, 177.0, 159.3, 186.5, 167.6, 122.9, 155.2

### 2010
- March: 171.0, 171.5, 178.4, 158.9, 187.9, 167.9, 123.1, 157.5
- June: 172.1, 172.6, 179.5, 160.7, 187.8, 168.9, 124.3, 158.0
- September: 173.3, 173.1, 181.3, 161.9, 189.1, 170.1, 124.5, 159.8
- December: 174.0, 173.8, 181.4, 161.7, 189.7, 170.2, 124.9, 160.5

### 2011
- March: 176.7, 176.4, 183.0, 161.6, 191.7, 170.9, 127.2, 162.7
- June: 178.3, 178.2, 184.0, 162.4, 193.1, 171.9, 128.8, 163.7

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- Unless otherwise specified, base of each index: 1989–90 = 100.0.
- Base: June quarter 1998 = 100.0.
- Refer to paragraphs 11–13 of the Explanatory Notes for a description of these series.
## PERCENTAGE CHANGE (from previous quarter)

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(a) Refer to paragraphs 11–13 of the Explanatory Notes for a description of these series.
# INTERNATIONAL COMPARISONS, All groups excluding Housing and Financial and insurance services—Index numbers (a)

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(a) Base of each index: 1989–90 = 100.0.
## INTERNATIONAL COMPARISONS, All groups excluding Housing and Financial and insurance services—Percentage changes

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<td>5.6</td>
<td>-0.1</td>
<td>2.6</td>
<td>1.0</td>
<td>1.2</td>
<td>1.6</td>
<td>2.1</td>
<td>2.1</td>
<td>3.0</td>
<td>1.8</td>
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</tr>
<tr>
<td>2008</td>
<td>3.5</td>
<td>3.0</td>
<td>4.9</td>
<td>8.9</td>
<td>1.2</td>
<td>3.8</td>
<td>6.1</td>
<td>4.9</td>
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</tr>
<tr>
<td>2009</td>
<td>2.1</td>
<td>2.7</td>
<td>-0.5</td>
<td>7.8</td>
<td>r-0.3</td>
<td>4.2</td>
<td>0.7</td>
<td>-0.1</td>
<td>0.7</td>
<td>-0.8</td>
<td>r0.5</td>
<td>3.0</td>
<td>2.1</td>
<td>2.7</td>
</tr>
<tr>
<td>2010</td>
<td>2.1</td>
<td>2.2</td>
<td>1.2</td>
<td>r2.6</td>
<td>-2.3</td>
<td>2.6</td>
<td>-0.4</td>
<td>-1.4</td>
<td>1.7</td>
<td>2.0</td>
<td>0.9</td>
<td>3.5</td>
<td>2.1</td>
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<tr>
<td>2011</td>
<td>2.9</td>
<td>4.7</td>
<td>4.0</td>
<td>7.2</td>
<td>0.1</td>
<td>4.6</td>
<td>4.7</td>
<td>1.5</td>
<td>2.7</td>
<td>2.8</td>
<td>1.7</td>
<td>6.1</td>
<td>2.9</td>
<td>4.7</td>
</tr>
</tbody>
</table>

**Note:** nya not yet available  r  revised

**Source:** ABS Consumer Price Index 6401.0 Jun Qtr 2011
There are 90 expenditure classes (that is, groupings of like items) in the 15th series CPI and each expenditure class has its own weight, or measure of relative importance. In calculating the index, price changes for the various expenditure classes are combined using these weights.

Changes in the weighting pattern have been made at approximately five-yearly intervals to take account of changes in household spending patterns. The CPI now comprises fifteen series of price indexes which have been linked to form a continuous series. The current and historical weighting patterns for the CPI for the weighted average of the eight capital cities is published in Consumer Price Index: Historical Weighting Patterns (1948 to 2005) (cat. no. 6431). The 15th series weighting pattern for the weighted average of eight capital cities and for each of the eight capital cities, as well as each city's percentage contribution to the weighted average, are also published in the
Various series are presented in tables 8, 9 and 10 in this publication which are helpful for analytical purposes. These series are compiled by taking subsets of the CPI basket. (A complete list of CPI groups, sub-groups and expenditure classes is contained in tables 6 and 7.

Some of the compiled series are self explanatory, such as 'All groups excluding Food'. Other series and their composition are described below:

- **All groups excluding Financial and insurance services**: Reflecting the changing composition of the CPI, from September quarter 1989 to June quarter 1998, comprises the All groups CPI excluding house insurance, house contents insurance, vehicle insurance and mortgage interest charges and consumer credit charges; from September quarter 1998 to June quarter 2000 comprises the All groups CPI excluding house insurance, house contents insurance and vehicle insurance; from September quarter 2000 to June quarter 2005 comprises the All groups CPI excluding insurance services; from September quarter 2005 comprises the All groups CPI excluding Financial and insurance services.

- **All groups excluding Housing and Financial and insurance services**: Reflecting the changing composition of the CPI, from September quarter 1989 to June quarter 1998, comprises the All groups CPI excluding Housing, house contents insurance, vehicle insurance and consumer credit charges; from September quarter 1998 to June quarter 2000 comprises the All groups CPI excluding Housing, house insurance, house contents insurance and vehicle insurance; from September quarter 2000 to June quarter 2005 comprises the All groups CPI excluding Housing and insurance services; from September quarter 2005 comprises the All groups CPI excluding Housing and Financial and insurance services.
In analysing price movements in Australia, an important consideration is Australia’s performance relative to other countries. However, a simple comparison of All groups (or headline) CPIs is often inappropriate because of the different measurement approaches used by countries for certain products, particularly housing and financial and insurance services. To provide a better basis for international comparisons, the 17th International Conference of Labour Statisticians adopted a resolution which called for countries to ‘if possible, compile and provide for dissemination to the international community an index that excludes housing and financial services’ in addition to the all-items index.

INTERNATIONAL COMPARISONS

The CPI uses a hierarchy of rounding procedures to ensure consistency between published index numbers and percentage changes. However, rounding differences can arise in the ‘points contributions’ published in tables 6, 7 and 8 because of the different levels of precision required in those data.

In analysing price movements in Australia, an important consideration is Australia’s performance relative to other countries. However, a simple comparison of All groups (or headline) CPIs is often inappropriate because of the different measurement approaches used by countries for certain products, particularly housing and financial and insurance services. To provide a better basis for international comparisons, the 17th International Conference of Labour Statisticians adopted a resolution which called for countries to ‘if possible, compile and provide for dissemination to the international community an index that excludes housing and financial services’ in addition to the all-items index.

13 Market goods and services excluding ‘volatile items’: in addition to the items excluded from the series ‘All groups excluding ‘volatile items’’, also excludes: Utilities, Property rates and charges, Child care, Health, Other motoring charges, Urban transport fares, Postal, and Education. A detailed description of the special and analytical series was published in Appendix 1 to the September quarter 2005 issue of Consumer Price Index, Australia (cat. no. 6401.0).

14 The ABS is grateful for the assistance of the Reserve Bank of Australia for specifying the items included in the ‘All groups excluding ‘volatile items’’ and ‘Market goods and services excluding ‘volatile items’’. The Reserve Bank of Australia does not accord any special policy status to these series.

15 The CPI uses a hierarchy of rounding procedures to ensure consistency between published index numbers and percentage changes. However, rounding differences can arise in the ‘points contributions’ published in tables 6, 7 and 8 because of the different levels of precision required in those data.

16 In analysing price movements in Australia, an important consideration is Australia’s performance relative to other countries. However, a simple comparison of All groups (or headline) CPIs is often inappropriate because of the different measurement approaches used by countries for certain products, particularly housing and financial and insurance services. To provide a better basis for international comparisons, the 17th International Conference of Labour Statisticians adopted a resolution which called for countries to ‘if possible, compile and provide for dissemination to the international community an index that excludes housing and financial services’ in addition to the all-items index.
17 Table 11 aims to present indexes for selected countries on a basis consistent with the above resolution and comparable to the Australian series 'All groups excluding Housing and Financial services' (see paragraph 12). However, other than Australia and New Zealand, the countries represented in this table are yet to develop indexes on this basis, so the indexes presented here are consistent with the series previously published for All groups excluding Housing. To facilitate comparisons all indexes in this table have been converted, where necessary, to a quarterly basis and re-referenced to a base of 1989-90 = 100.0. Index numbers and percentage changes are always published to one decimal place, and the percentage changes are calculated from the rounded index numbers. Index numbers for periods longer than a single quarter (e.g. for financial years) are calculated as the simple arithmetic average of the rounded quarterly index numbers.

18 In producing table 11, the ABS is grateful for the assistance of the relevant national statistical agencies which have either directly supplied indexes for all items excluding housing and financial services or data to enable their derivation.

19 Current publications and other products released by the ABS are listed on the ABS website <http://www.abs.gov.au>. The ABS also issues a daily Release Advice on the website which details products to be released in the week ahead.

20 Users may also wish to refer to the following publications and other data products that are available free of charge from the ABS website:

- A Guide to the Consumer Price Index, 15th Series (cat. no. 6440.0)
- Information Paper: Outcome of the 16th Series Australian Consumer Price Index Review, Australia (cat. no. 6469.0)
- Consumer Price Index Commodity Classification, Australia, 16th Series, 2011 (cat. no. 6401.0.55.004)
- Information Paper: Introduction of the 15th Series Australian Consumer Price Index 2005 (Reissue) (cat. no. 6462.0)
- Consumer Price Index: 15th Series Weighting Pattern (Reissue) (cat. no. 6430.0)
- Consumer Price Index: Historical Weighting Patterns (1948 to 2005) (cat. no. 6431.0)
- Australian Consumer Price Index: Concepts, Sources and Methods, 2009 (cat. no. 6461.0)
- Information Paper: Experimental Price Indexes for Financial Services (cat. no. 6413.0)
- Information Paper: The Introduction of Hedonic Price Indexes for Personal Computers (cat. no. 6458.0)
- Information Paper: Consumer Price Index with Reserve Bank of Australia Consumer Price Measures, Australia, 2007 (cat. no. 6401.0.55.002)
- Consumer Price Index: Concordance with Household Expenditure Classification, Australia (cat. no. 6446.0.55.001)
- Information Paper: Issues to be considered during the 16th Series Australian Consumer Price Index Review, December 2009 (cat. no. 6468.0)
- Average Retail Prices of Selected Items, Eight Capital Cities (cat. no. 6403.0.55.001)
- House Price Indexes: Eight Capital Cities (cat. no. 6416.0)
- Analytical Living Cost Indexes for Selected Australian Household Types (cat. no. 6463.0)
- Information Paper: Introduction of the Pensioner and Beneficiary Living Cost Index, Australia, 2009 (cat. no. 6466.0)
- Pensioner and Beneficiary Living Cost Index (cat. no. 6467.0)

21 As well as the statistics included in this publication, there is more detailed data for each capital city available on the ABS website. Inquiries should be made to the National Information and Referral Service on 1300 135 070.
<table>
<thead>
<tr>
<th>Group, sub-group and expenditure class</th>
<th>Correspondence with 15th series</th>
<th>Type of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 FOOD AND NON–ALCOHOLIC BEVERAGES</td>
<td>Previously Food</td>
<td>(a)</td>
</tr>
<tr>
<td>1.1 Bread and cereal products</td>
<td>Previously 1.2</td>
<td>(a)</td>
</tr>
<tr>
<td>1.1.1 Bread</td>
<td>Previously 1.2.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.1.2 Cakes and biscuits</td>
<td>Previously 1.2.2</td>
<td>(a)</td>
</tr>
<tr>
<td>1.1.3 Breakfast cereals</td>
<td>Previously 1.2.3</td>
<td>(a)</td>
</tr>
<tr>
<td>1.1.4 Other cereal products</td>
<td>Previously 1.2.4</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2 Meat and seafoods</td>
<td>Previously 1.3</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2.1 Beef and veal</td>
<td>Previously 1.3.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2.2 Pork</td>
<td>New, combination of 1.3.3 (Pork) and 1.3.5 (Bacon and ham)</td>
<td>(c)</td>
</tr>
<tr>
<td>1.2.3 Lamb and goat</td>
<td>Previously 1.3.2 (Lamb and mutton)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2.4 Poultry</td>
<td>Previously 1.3.4</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2.5 Other meats</td>
<td>Previously 1.3.6 (Other fresh and processed meat)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.2.6 Fish and other seafood</td>
<td>Previously 1.3.7</td>
<td>(a)</td>
</tr>
<tr>
<td>1.3 Dairy and related products</td>
<td>Previously 1.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.3.1 Milk</td>
<td>Previously 1.1.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.3.2 Cheese</td>
<td>Previously 1.1.2</td>
<td>(a)</td>
</tr>
<tr>
<td>1.3.3 Ice cream and other dairy products</td>
<td>Previously 1.1.3</td>
<td>(a)</td>
</tr>
<tr>
<td>1.4 Fruit and vegetables</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>1.4.1 Fruit</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>1.4.2 Vegetables</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>1.5 Food products n.e.c.</td>
<td>New, combination of part 1.7 (Other food) and 1.5.2 (Snacks and confectionery)</td>
<td>(c)</td>
</tr>
<tr>
<td>1.5.1 Eggs</td>
<td>Previously 1.7.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.5.2 Jams, honey and spreads</td>
<td>Previously 1.7.2 (Jams, honey and sandwich spreads)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.5.3 Food additives and condiments</td>
<td>Previously 1.7.4</td>
<td>(a)</td>
</tr>
<tr>
<td>1.5.4 Oils and fats</td>
<td>Previously 1.7.5 (Fats and oils)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.5.5 Snacks and confectionery</td>
<td>Previously 1.5.2</td>
<td>(a)</td>
</tr>
<tr>
<td>1.5.6 Other food products n.e.c.</td>
<td>Previously 1.7.6 (Food n.e.c.)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.6 Non–alcoholic beverages</td>
<td>New, combination of 1.7.3 (Tea, coffee and food drinks) and 1.5.1 (Soft drinks, waters and juices)</td>
<td>(c)</td>
</tr>
<tr>
<td>1.6.1 Coffee, tea and cocoa</td>
<td>Previously 1.7.3 (Tea, coffee and food drinks)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.6.2 Waters, soft drinks and juices</td>
<td>Previously 1.5.1 (Soft drinks, waters and juices)</td>
<td>(a)</td>
</tr>
<tr>
<td>1.7 Meals out and take away foods</td>
<td>Previously 1.6</td>
<td>(a)</td>
</tr>
<tr>
<td>1.7.1 Restaurant meals</td>
<td>Previously 1.6.1</td>
<td>(a)</td>
</tr>
<tr>
<td>1.7.2 Take away and fast foods</td>
<td>Previously 1.6.2</td>
<td>(a)</td>
</tr>
<tr>
<td>2 ALCOHOL AND TOBACCO</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>2.1 Alcoholic beverages</td>
<td>Previously Alcoholic drinks</td>
<td>(a)</td>
</tr>
<tr>
<td>2.1.1 Spirits</td>
<td>Previously 2.1.3</td>
<td>(a)</td>
</tr>
<tr>
<td>2.1.2 Wine</td>
<td>No change</td>
<td>(a)</td>
</tr>
<tr>
<td>2.1.3 Beer</td>
<td>Previously 2.1.1</td>
<td>(a)</td>
</tr>
<tr>
<td>2.2 Tobacco</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>2.2.1 Tobacco</td>
<td>No change</td>
<td></td>
</tr>
</tbody>
</table>

Note: (a) Series continuing, name change and/or move of series in the classification order.
(b) Series continuing, minor compositional change.
(c) New series, backcast with components from 15th series.
(d) New series, base of June quarter 2011 = 100.0 as no backcast data available.
<table>
<thead>
<tr>
<th>Group, sub-group and expenditure class</th>
<th>Correspondence with 15th series</th>
<th>Type of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 CLOTHING AND FOOTWEAR</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>3.1 Garments</td>
<td>New, combination of 3.1 (Men's clothing), 3.2 (Women's clothing) and 3.3 (Children's and infants' clothing)</td>
<td>(c)</td>
</tr>
<tr>
<td>3.1.1 Garments for men</td>
<td>New, combination of 3.1.1 (Men's outerwear) and 3.1.2 (Men's underwear, nightwear and socks)</td>
<td>(c)</td>
</tr>
<tr>
<td>3.1.2 Garments for women</td>
<td>New, combination of 3.2.1 (Women's outerwear) and 3.2.2 (Women's underwear, nightwear and hosiery)</td>
<td>(c)</td>
</tr>
<tr>
<td>3.1.3 Garments for infants and children</td>
<td>Previously 3.3 (Children's and infants' clothing)</td>
<td>(a)</td>
</tr>
<tr>
<td>3.2 Footwear</td>
<td>Previously 3.4</td>
<td>(a)</td>
</tr>
<tr>
<td>3.2.1 Footwear for men</td>
<td>Previously 3.4.1 (Men's footwear)</td>
<td>(a)</td>
</tr>
<tr>
<td>3.2.2 Footwear for women</td>
<td>Previously 3.4.2 (Women's footwear)</td>
<td>(a)</td>
</tr>
<tr>
<td>3.2.3 Footwear for infants and children</td>
<td>Previously 3.4.3 (Children's footwear)</td>
<td>(a)</td>
</tr>
<tr>
<td>3.3 Accessories and clothing services</td>
<td>Previously 3.5</td>
<td>(a)</td>
</tr>
<tr>
<td>3.3.1 Accessories</td>
<td>Previously 3.5.1</td>
<td>(a)</td>
</tr>
<tr>
<td>3.3.2 Cleaning, repair and hire of clothing and footwear</td>
<td>Previously 3.5.2 (Clothing services and shoe repair)</td>
<td>(a)</td>
</tr>
<tr>
<td>4 HOUSING</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>4.1 Rents</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>4.1.1 Rents</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>4.2 New dwelling purchase by owner-occupiers</td>
<td>New subgroup</td>
<td>(c)</td>
</tr>
<tr>
<td>4.2.1 New dwelling purchase by owner-occupiers</td>
<td>Previously 4.3.1 (House purchase)</td>
<td>(a)</td>
</tr>
<tr>
<td>4.3 Other housing</td>
<td>New, combination of 4.3.3 (House repairs and maintenance) and 4.3.2 (Property rates and charges)</td>
<td>(a)</td>
</tr>
<tr>
<td>4.3.1 Maintenance and repair of the dwelling</td>
<td>Previously 4.3.3 (House repairs and maintenance)</td>
<td>(a)</td>
</tr>
<tr>
<td>4.3.2 Property rates and charges</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>4.4 Utilities</td>
<td>Previously 4.2</td>
<td>(a)</td>
</tr>
<tr>
<td>4.4.1 Water and sewerage</td>
<td>Previously 4.2.3</td>
<td>(a)</td>
</tr>
<tr>
<td>4.4.2 Electricity</td>
<td>Previously 4.2.1</td>
<td>(a)</td>
</tr>
<tr>
<td>4.4.3 Gas and other household fuels</td>
<td>Previously 4.2.2</td>
<td>(a)</td>
</tr>
<tr>
<td>5 FURNISHINGS, HOUSEHOLD EQUIPMENT AND SERVICES</td>
<td>Previously Household contents and services</td>
<td>(a)</td>
</tr>
<tr>
<td>5.1 Furniture and furnishings</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>5.1.1 Furniture</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>5.2 New dwelling purchase by owner-occupiers</td>
<td>New, part 5.1.2 (Floor and window coverings)</td>
<td>(c)</td>
</tr>
<tr>
<td>5.2.1 Household textiles</td>
<td>New subgroup</td>
<td>(c)</td>
</tr>
<tr>
<td>5.3 Household appliances, utensils and tools</td>
<td>Previously 5.2</td>
<td>(a)</td>
</tr>
<tr>
<td>5.3.1 Major household appliances</td>
<td>Previously 5.2.1</td>
<td>(a)</td>
</tr>
<tr>
<td>5.3.2 Small electric household appliances</td>
<td>Previously 5.2.2</td>
<td>(a)</td>
</tr>
<tr>
<td>5.3.3 Glassware, tableware and household utensils</td>
<td>Previously 5.2.3</td>
<td>(a)</td>
</tr>
<tr>
<td>5.3.4 Tools and equipment for house and garden</td>
<td>Previously 5.2.4 (Tools)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.4 Non–durable household products</td>
<td>Previously 5.3 (Household supplies)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.4.1 Cleaning and maintenance products</td>
<td>Previously 5.3.1 (Household cleaning agents)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.4.2 Personal care products</td>
<td>Previously 5.3.2 (Toiletries and personal care products)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.4.3 Other non–durable household products</td>
<td>Previously 5.3.3 (Other household supplies)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.5 Domestic and household services</td>
<td>Previously 5.4 (Household services)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.5.1 Child care</td>
<td>Previously 5.4.1</td>
<td>(a)</td>
</tr>
<tr>
<td>5.5.2 Hairdressing and personal grooming services</td>
<td>Previously 5.4.2 (Hairdressing and personal care services)</td>
<td>(a)</td>
</tr>
<tr>
<td>5.5.3 Other household services</td>
<td>Previously 5.4.3</td>
<td>(a)</td>
</tr>
</tbody>
</table>

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<th>Group, sub-group and expenditure class</th>
<th>Correspondence with 15th series</th>
<th>Type of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 HEALTH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1 Medical products, appliances and equipment</td>
<td>New, combination of 6.2 (Pharmaceuticals) and part 6.1.2 (Optical services)</td>
<td>(c)</td>
</tr>
<tr>
<td>6.1.1 Pharmaceutical products</td>
<td>Part 6.2 (Pharmaceuticals)</td>
<td>(b)</td>
</tr>
<tr>
<td>6.1.2 Therapeutic appliances and equipment</td>
<td>New, combination of part 6.2 (Pharmaceuticals) and part 6.1.2 (Optical services)</td>
<td>(c)</td>
</tr>
<tr>
<td>6.2 Medical, dental and hospital services</td>
<td>Previously 6.1 (Health services)</td>
<td>(a)</td>
</tr>
<tr>
<td>6.2.1 Medical and hospital services</td>
<td>New, combination of 6.1.1 (Hospital and medical services) and part 6.1.2 (Optical services)</td>
<td>(c)</td>
</tr>
<tr>
<td>6.2.2 Dental services</td>
<td>Previously 6.1.3</td>
<td>(a)</td>
</tr>
<tr>
<td>7 TRANSPORT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 Private motoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.1 Motor vehicles</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>7.1.2 Spare parts and accessories for motor vehicles</td>
<td>Previously 7.1.4 (Motor vehicle parts and accessories)</td>
<td>(a)</td>
</tr>
<tr>
<td>7.1.3 Automotive fuel</td>
<td>Previously 7.1.2</td>
<td>(a)</td>
</tr>
<tr>
<td>7.1.4 Maintenance and repair of motor vehicles</td>
<td>Previously 7.1.3 (Motor vehicle repair and servicing)</td>
<td>(a)</td>
</tr>
<tr>
<td>7.1.5 Other services in respect of motor vehicles</td>
<td>Previously Other motoring charges</td>
<td>(a)</td>
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<td>7.2 Urban transport fares</td>
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<tr>
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<td>8 COMMUNICATION</td>
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<td>Previously Postal</td>
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<td>8.1.2 Telecommunication equipment and services</td>
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<tr>
<td>9 RECREATION AND CULTURE</td>
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<tr>
<td>9.3 Holiday travel and accommodation</td>
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<td>9.4.1 Equipment for sports, camping and open–air recreation</td>
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<td>9.4.2 Games, toys and hobbies</td>
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<td>9.4.4 Veterinary and other services for pets</td>
<td>Previously 9.3.5 (Pet services including veterinary)</td>
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<td>Previously 9.3.3</td>
<td>(a)</td>
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<td>9.4.6 Other recreational, sporting and cultural services</td>
<td>Previously 9.3.6 (Other recreational activities)</td>
<td>(a)</td>
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Note: (a) Series continuing, name change and/or move of series in the classification order.
(b) Series continuing, minor compositional change.
(c) New series, backcast with components from 15th series.
(d) New series, base of June quarter 2011 = 100.0 as no backcast data available.
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<td>10.1.2 Secondary education</td>
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</tr>
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<td>Previously 11.2 (Insurance services) (a)</td>
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Note: (a) Series continuing, name change and/or move of series in the classification order.
(b) Series continuing, minor compositional change.
(c) New series, backcast with components from 15th series.
(d) New series, base of June quarter 2011 = 100.0 as no backcast data available.
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Preliminary Design & Costings of Power Systems for SKA

CSIRO

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<table>
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<th>REVIEWED BY</th>
<th>APPROVED BY</th>
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<td>GW</td>
<td>RT</td>
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1 EXECUTIVE SUMMARY

Burns and Roe Worley Pty Ltd (BRW) has been engaged by CSIRO’s Australia Telescope National Facility (CSIRO) to provide a preliminary design and indicative costing of power systems for the proposed Square Kilometre Array (SKA) radio telescope. CSIRO is leading an Australian Consortium in the bid to build the telescope in Australia against rival bids for its location in one of three other countries.

1.1 Bid Timetable

The preliminary design and indicative costing is to be incorporated in the Australian Consortium’s bid that is to be submitted to the International SKA Project Director by 31 December 2005. It is anticipated that the successful bid consortium will be announced in September 2006. The timetable for the successful bid requires:

1. Initial infrastructure for the SKA radio telescope to be in place by 2012
2. SKA construction and operation over following eight years
3. SKA fully operational by 2020 with a full operational life of 30 years
4. Maintenance of the SKA Facility over a life of 50 to 80 years.

1.2 Design Principles

The preliminary design and indicative costing of the power system for the SKA radio telescope has been based on the power and energy needs defined by CSIRO. Two key challenges to be met are the need to provide power systems in sometimes hot, remote and rugged locations across some three thousand kilometres and to ensure the power systems do not cause electrical interference to the SKA radio telescope. Principles adopted in the preliminary design to help meet these challenges are:

- Reliability and relative simplicity
- Robust design with redundancy
- Long life with minimal maintenance
- Use of proven and readily available equipment
- Conservative costing.

1.3 Power System Elements

The preliminary design of the power system involves six main elements:

1. A 13 MW gas-genset power station with peaking capacity to 17 MW located to the immediate west of the central area and fuelled by natural gas piped via a lateral from the Dampier to Bunbury gas pipeline to the west. This provides power to 100 arrays.
2. A 22 kV 3 phase distribution system from the power station consisting of over 920 km of overhead lines and almost 160 km of underground cable. The two overhead lines supply
25 Outer arrays and 5 close-in Remote arrays while three underground cables supply the 65 Core and Central arrays and 5 close-in Outer arrays. A fourth 22 kV underground cable supplies the nearby Core Facilities Centre. Metal enclosed padmount transformers reduce the 22 kV voltage to 415 V for intra-array reticulation to the 45 antennas in each array.

3. A Remote Area Power Supply (RAPS) system for each of the 11 arrays not supplied from the power station or a local electricity network. Each RAPS system is a hybrid photovoltaic/battery/standby diesel system. It consists of a photovoltaic (PV) array of solar panels to generate electricity directly from sunlight; a battery system for daytime storage and overnight generation; regulators and inverters to charge the batteries and convert the electricity from DC to 240V AC; and a standby diesel genset for those periods of inadequate sunlight or contingencies.

4. Supply to 14 arrays (Remotes and Maximums) from the electricity network in the area of the array.

5. Low voltage underground reticulation within each of the arrays to provide power for each of the 45 antennas. The underground power cable is laid in the same trench as the fibre optic signalling and control cable to minimise trenching costs.

6. Earthing and lightning protection for each antenna within the array.

1.4 Radio Frequency Interference

To minimise radio frequency interference (RFI) from the power and distribution system:

- Underground 22 kV and 415 V cable is used as much as technically feasible and economically viable.
- The 22 kV overhead lines maintain a minimum distance of 4 km from any array. High quality insulators are used together with regular monitoring and maintenance to minimise the risk of gaps, the main cause of RFI from overhead lines.
- The final 4 km run-in from an overhead line to the array periphery is done with 22 kV underground cable.
- When the arrays are finally located, the balance between overhead line and underground cable can be finely adjusted to ensure the 4 km distance from an array to an overhead line is maintained.
- Metal-screened, totally enclosed padmount transformers are used on the periphery of arrays to transform the 22 kV to 415 V for underground reticulation to each antenna in the array.
- Electrical equipment, especially the high frequency inverters used in the RAPS systems, is installed in metal screened buildings and enclosures that form a Faraday cage.

1.5 Construction Program

The entire SKA system is to be fully operational by 2020. The construction program to achieve this involves basic infrastructure in place by 2012 followed by an eight-year program of array construction. To determine the indicative costings the following construction program assumptions have been made:
The gas pipeline is built by 2012 to provide natural gas to the power station from the start.

The power station is built in two stages with the first stage (eight gas gensets) operational by 2012 and the second stage (four gas gensets) approximately 4 years later.

The 22 kV distribution and 415 V array reticulation systems are built progressively from the central site outwards with 50% in service by 2012 and the remainder in nominal 10% stages over the following 5 years so that the entire system supplied by the power station is fully operational by 2017.

The power supply to the 14 arrays each fed from a local electricity network is installed to meet the needs of the arrays, most likely in the period 2017 to 2019 though this is not critical to the costings.

The 11 RAPS systems are installed in the last 2 years of the construction program (2018 and 2019). This has the added benefit of taking advantage of real price reductions that are occurring with the rapidly developing technologies utilised in these systems. For example, PV prices have historically fallen in real terms at an average rate of about 5% per year over the last 15 years or more. This is predicted to continue for the next decade or so, especially as lower-cost, second generation PV technologies are taken up.

### 1.6 Indicative Lifetime Unit Costings

Net present Value (NPV) analysis has been used with a real discount rate of 7% to determine the indicative costs of the power system over the 30 year full operational life of the SKA system. This enables various options with very different capital and operating costs to be compared on a like-for-like basis.

This is done by calculating the lifetime unit cost\(^1\) in cents per kWh for each element of the power supply system and summing each in a weighted manner to give the total weighted cost. The lifetime unit cost includes all capital and O&M costs. It facilitates like-for-like comparison between competing alternatives and ownership options. For example, the entire power supply facilities could be built, owned and operated by third parties. The owner of the SKA system would pay the lifetime unit cost\(^2\) in much the same manner as it would pay for electricity supplied from the national electricity network.

The initial undiscounted capital cost and lifetime unit cost for the three types of SKA power supply system is given in Table 1.1 overleaf. As can be seen from Table 1.1, the average weighted lifetime unit cost of power from the SKA is approximately 26 c/kWh. In essence, this can be compared to the price the SKA owner would pay an electricity retailer had all the arrays been powered from a central electricity network.

The indicative capital cost of the project shown in Table 1.1 is A$189 million in undiscounted dollars\(^3\). This should not be interpreted as funding that the SKA must obtain. For example, the

---

\(^1\) The lifetime unit cost is the notional electricity price that results in an NPV of zero at the required discount rate. It is the price that offsets the capital and operating costs over the life of the project at the project’s required rate of return.

\(^2\) Based on the required rate of return of the IPP.

\(^3\) As indicated above, the construction program is spread over 8 years from 2012 for the arrays and longer when the first stage of the power station and gas pipeline is included as this is to be ready by 2012. The undiscounted capital cost is the
capital cost includes that for the gas pipeline and power station. This has been costed on the basis of it being built, owned and operated by a third party.

<table>
<thead>
<tr>
<th>ID</th>
<th>Element</th>
<th>Number of Arrays Powered</th>
<th>Initial Capital Cost (Undiscounted) A$</th>
<th>Lifetime Unit Cost (Capital &amp; Operating) c/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central Power System:</td>
<td>100</td>
<td>• 58.0 million</td>
<td>• 22.1&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>• gas pipeline</td>
<td></td>
<td>• 25.5 million</td>
<td>• 3.4</td>
</tr>
<tr>
<td></td>
<td>• power station</td>
<td></td>
<td>• 48.4 million</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• HV/LV distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RAPS systems</td>
<td>11</td>
<td>47.9 million</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Local network supply</td>
<td>14</td>
<td>9.2 million&lt;sup&gt;6&lt;/sup&gt;</td>
<td>21&lt;sup&gt;7&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>125</td>
<td>189 million</td>
<td>26.4&lt;sup&gt;8&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Table 1.1: Indicative costs of power system elements for SKA

There is some potential to reduce the lifetime unit costs and the capital costs by using the SKA power facilities to provide gas and electricity to third parties. For example, the gas pipeline has almost 60% spare capacity<sup>9</sup>. This could be sold to any third parties along the route or the pipeline could be extended to Meekatharra approximately 90 km to the east. Similarly the 22 kV overhead lines could be extended to any nearby homesteads to supply electricity. The entire 22 kV network is essentially a mini-grid. These possibilities should be explored if the bid to host the SKA is successful.

---

4 Intra-array reticulation and earthing costs are included in the respective costings for HV/LV distribution, RAPS systems and network supplies.

5 Includes gas pipeline.

6 Costing of power supplies fed from the local electricity network will depend on the distance from the connection point and the retail price of electricity from the local electricity retailer.

7 Includes an assumed market energy price of 17 c/kWh.

8 Weighted average lifetime unit cost with weighting by number of arrays supplied.

9 This is because gas pipelines in Australia come in standard sizes. The gas required is marginally greater than that capable of delivery by a 100mm line so a 150mm line was used.
2 INTRODUCTION

Burns and Roe Worley Pty Ltd (BRW) has been engaged by CSIRO’s Australia Telescope National Facility (CSIRO) to provide a preliminary design and indicative costing of power systems for the proposed Square Kilometre Array (SKA) radio telescope. CSIRO is leading an Australian Consortium in the bid to build the telescope in Australia against rival bids for its location in one of three other countries.

The preliminary design involves the following six elements:

1. A 13 MW gas-fired power station with peaking capacity to 17 MW.
2. A 22 kV distribution system from the power station to 100 of the 125 arrays.
3. A Remote Area Power Supply (RAPS) for each of 11 arrays not supplied from the power station or a local electricity network.
4. Supply from a local electricity network for 14 arrays.
5. Low voltage underground reticulation within each of the arrays to provide power for the 45 antennas.
6. Earthing and lighting protection for each antenna within the array.

Wherever possible, standard-size power equipment typically used in Australia has been specified in the preliminary design.

The indicative costing is based on the preliminary designs and largely uses indicative industry average prices on a per unit basis. The costs include both capital and operating and maintenance (O&M) costs over the nominal 30 year operating life of the facilities unless otherwise stated. All cost are in real (2005) Australian dollars and all future costs are discounted at 7% real using net present value (NPV) techniques to calculate lifetime unit cost and discounted capital costs.
3 BACKGROUND

3.1 SKA Design
The SKA radio telescope facility is nominally an A$ two billion project with four international consortiums competing to host the facility. The Australian consortium is led by the CSIRO and envisages the facility will:

- consist of 125 radio telescope arrays located across approximately three thousand kilometres
- include 45 radio telescope antennas in each array with each antenna 15 metres in diameter and about 7 metres in height\(^\text{10}\)
- consist of a core and central system of arrays within a 2.5km radius located about 85 km west of Meekatharra in Western Australia
- have arrays located on logarithmic arms spiralling out from the core location
- have antennas and arrays connected by ultra high-speed fibre-optic cable data links to a central processing facility.

3.2 SKA Timetable
The timetable for the facility is broadly as follows:

5. Initial infrastructure for the SKA radio telescope to be in place by 2012
6. SKA construction and operation over following eight years
7. SKA fully operational by 2020 with a full operational life of 30 years
8. Maintenance of the SKA Facility over a life of 50 to 80 years.

3.3 SKA Documentation
The main documents provided by CSIRO are:

1. “Request for Proposals for Siting the SKA”; International SKA Project Office; 1 September 2004
2. Diagrams and maps including:
   b. Australia – Config 9 SKA Antenna Stations Town/Places – WA dated 22 June 2005

\(^{10}\) This is known as the Large Number of Small Antennas (LNSA). An alternative that is to be costed consists of a Small Number of Large Antenna (SNLA) in which each array consists of one very large antenna with power requirements similar to that of a 45-antenna array. The main difference in the power systems of the two is that the SNLA should not require a power reticulation system within the array. For the purposes of this study, the power required for both array types is assumed to be the same. Thus the SNLA is anticipated to be lower in cost by approximately A$50,000 per array.
3.4 Array Definitions and Numbers

Each array contains 45 antennas each about 15 metre diameter and 7 metres high. Key site terms and number of arrays within each site type are given in Table 3.1 below.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Number of Arrays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Site</td>
<td>Area containing Core antenna arrays – nominally 1 km diameter</td>
<td>25</td>
</tr>
<tr>
<td>Central Site</td>
<td>Area containing Core and Central arrays – nominally 5 km diameter</td>
<td>40(^\text{11})</td>
</tr>
<tr>
<td>Remote Site</td>
<td>Area outside Central Site – stretches across some 3,000 km</td>
<td>30 (Outer)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23 (Remote)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 (Maximum)</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>125</td>
</tr>
</tbody>
</table>

Table 3.1: Array definitions and numbers

3.5 Electrical Data

The electrical data in Table 3.2 below has been compiled from the above documents and discussions with CSIRO.

<table>
<thead>
<tr>
<th></th>
<th>Average Power</th>
<th>Peak Power</th>
<th>Annual Energy (MWh)</th>
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<tbody>
<tr>
<td>Total for Stations on Central Site</td>
<td>8 MW</td>
<td>10 MW</td>
<td>70,000</td>
</tr>
<tr>
<td>Core Facilities Centre (Note 1)</td>
<td>1.2 MW</td>
<td>2 MW</td>
<td>10,000</td>
</tr>
<tr>
<td>Remote Station (each array location)</td>
<td>120 kW</td>
<td>150 kW</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Table 3.2: Power and energy requirements for SKA

\(^{11}\) Excludes 25 Core area arrays.
Notes:

1. The Core Facilities Centre is located near the core site and will include high power DSP electronics, some degree of data processing and basic amenities for fly-in/fly-out staff. The facility will enable some maintenance and module replacement etc.

2. The Main Facilities Centre will be located at Geraldton. It will house the majority of staff; grid super computing facilities; management and administration; and scientific, engineering and technical staff. Electronic module repair and upgrades will be conducted at this location. The facility will be connected to the town power supply and as a consequence, its power requirements are outside the scope of the Services.

3. A power supply availability for each array of 96% will be satisfactory. This is equivalent to approximately 15 days per year downtime in total.

4. The annual average energy requirements have been calculated by multiplying the average power requirement by 8,760 hours and rounding down. This is conservative as it assumes 100% availability compared with an acceptable availability of 96%.

5. Each antenna requires approximately 2 kW for motor drive (two axis tracking) and electronics giving a total of 90 kW for the 45 antennas in each array. An additional 30 kW per array is assumed for common facilities including an air-conditioned control hut.

As the preliminary design and its costing progressed, it was determined that the size of the power station could be expanded to supply as many arrays as technically feasible and economically viable.

3.6 Radio Frequency Interference (RFI)

CSIRO has advised that it is extremely important that each array station is sited in a location with minimum RFI to avoid interference with the extremely small radio signals being detected. One of the documents provided by CSIRO identifies a buffer distance of 4 km between an array and an overhead line. This distance has been determined mainly on the basis that any “gap” in the HV circuit will generate unacceptable levels of Radio Frequency Interference (RFI).

---

12 R Beresford, “SKA Remote Array Station Buffer Distance to Overhead HV Transmission Line”, 1 June 2005 (rev 16)
4 POWER SUPPLY SYSTEM OVERVIEW

This section provides an overview of the power supply system for the 125 arrays in terms of the elements and the methodology for estimation of their indicative costs.

4.1 Elements of Power System

The power supply system for the SKA arrays involves six main elements:

1. A 13 MW gas-genset power station with peaking capacity to 17 MW located to the immediate west of the central area. It is fuelled by natural gas piped via a lateral from the Dampier to Bunbury gas pipeline approximately 240 km to the west. This provides power to 100 arrays.

2. A 22 kV distribution system from the power station and consisting of some 920 km of overhead lines and 160 km of underground cable. The two overhead lines supply 25 Outer arrays and 5 close-in Remote arrays while three underground cables supply the 65 core and central arrays and 5 close-in Outer arrays. A fourth underground cable supplies the nearby Core Facilities Centre. Metal enclosed padmount transformers reduce the 22 kV voltage to 415 V for intra-array reticulation to the 45 antennas in each array.

3. A Remote Area Power Supply (RAPS) system for each of the 11 arrays not supplied from the power station or a local electricity network. Each RAPS is a hybrid photovoltaic/battery/diesel system. It consists of a photovoltaic (PV) array of solar panels to generate electricity directly from sunlight; a battery system for daytime storage and overnight generation; regulators and inverters to charge the batteries and convert the electricity from DC to 240V AC; and a standby diesel genset for those periods of inadequate solar insolation or contingencies.

4. Supply to 14 arrays (Remotes and Maximums) from the electricity network in the area of the array.

5. Low voltage underground reticulation within each of the arrays to provide power for the 45 antennas. The underground power cable is laid in the same trench as the fibre optic signalling and control cable to minimise trenching costs.

6. Earthing and lighting protection for each antenna within the array.

Each element is described in the following sections.

4.2 Array Specific Power System

The type of power supply for an array is determined by the array’s location. Those in or near the central area are powered by the gas-fired power station. Those near an existing electricity network are supplied from it while those near neither are powered by a remote area power supply. The number of arrays supplied by each type is given in Table 4.1 below.
Report:

Preliminary Design & Costings of Power Systems for SKA

SKA

<table>
<thead>
<tr>
<th>Number of arrays</th>
<th>Array ID</th>
<th>Power Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>COR 0-24; CEN 0-39, OUT 0-29, REM 0-4</td>
<td>Central Power Station</td>
</tr>
<tr>
<td>14</td>
<td>REM-5, 8, 10, 11, 15, 16, 22-26, MAX-0, 1, 2</td>
<td>Local Electricity Network</td>
</tr>
<tr>
<td>11</td>
<td>REM-6, 7, 9, 12-14, 17-21</td>
<td>RAPS</td>
</tr>
</tbody>
</table>

Table 4.1: Array power source specification.

4.3 RFI

The 4 km distance from an array to an overhead line has largely been maintained to the extent possible in the preliminary design. The final design will precisely locate the power station and each array enabling the optimisation of overhead lines and underground cable usage to achieve the required 4 km distance. In addition, high quality insulators are to be used and the overhead line regularly maintained and monitored periodically for any RFI emissions.

During the course of the preliminary design it was determined that the number of arrays that could be supplied from the central power station should rise from the specified 70 to 100\(^{13}\) as a result of voltage drop and cost considerations to meet the RFI requirement. This has increased the load on the power station which has been accommodated by increasing the number of gensets from 8 to 12 and increasing the size of the gas supply line.

It will be necessary to house all power supply electronics (eg inverters for remote area power supplies) in Faraday Cages to minimise RFI if they are located within close proximity of an antenna.

4.4 Costing Methodology

The design of the power system has been carried out sufficiently to enable its indicative costing based on indicative industry average prices on a per unit basis. The costs include both capital and operating and maintenance (O&M) costs over the nominal 30 year operating life of the facilities unless otherwise stated. All cost are in real (2005) Australian dollars and all future costs are discounted at 7% real using net present value (NPV) techniques.

Net present Value (NPV) analysis has been used as it enables various options with very different capital and operating cost profiles to be compared on a like-for-like basis. For example, RAPS systems could be powered from renewable energy sources or from fossil fuel sources. The former has a high initial capital cost followed by a very low operating cost over the life of the SKA system.

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\(^{13}\) The capacity of the power station as originally specified could only supply approximately 70 arrays. The use of 22 kV overhead lines increased the number of arrays that could be centrally powered by 30.
The latter has a relatively low initial capital cost followed by a high and volatile operating cost due to the cost of fuel.

The NPV analysis enables a lifetime unit cost to be estimated in cents/kWh. **The lifetime unit cost is the notional electricity price that results in an NPV of zero at the required discount rate.** It is the price that offsets the capital and operating costs over the life of the project at the project’s required rate of return. An NPV of zero means that the required rate has been achieved.

Use of this methodology acknowledges that there is no real difference between what is classified as a capital cost and what is classified as an O&M cost; it is only a matter of financing. Thus, for example, the major components (eg power station, distribution system, RAPS system) could be provided by Independent Power Producers (IPP) and the electricity sold to the SQA owners. This would be the case had it been possible to power all the arrays from the national electricity network and not just the 14 arrays identified as being sufficiently close to a network to take supply from it\(^\text{14}\).

Capital and O&M costs have been given in this report as well as the lifetime unit cost to enable a fuller understanding of the preliminary design and indicative costing.

\(^{14}\) It is likely that the SKA owners will pay an energy charge for the electricity consumed by these 14 arrays plus a network charge for the use of the infrastructure that delivers this electricity.
5  POWER STATION PRELIMINARY DESIGN

The gas-fired power station has been designed to deliver approximately 13 MW average power and 17 MW peak power up to 45°C ambient temperatures with an annual output of approximately 100 GWh.

5.1 Selection of Generating Plant Technology

The chart below (Figure 5.1) is a plot of the hourly data over 4.5 years and is a good representation of the temperature for the area. From this, it is reasonable to design the power station for a maximum of 45°C ambient temperature.

The alternative gas-fired technologies that can economically and practically supply a load of this size and location are gas reciprocating and gas turbines. Turbines of the size needed are much less efficient than gas reciprocating plant, which rules them out from an economical point of view. On a higher heating value basis gas engines range from 30% to 36% exported for use on site, while gas turbines will range between 23% to 30%. Gas turbines also derate much more and at lower temperatures than gas engines as the ambient air temperature rises. For these reasons gas reciprocating engines are the preferred power generating prime mover for this application.
5.2 Genset Type and Capacity

At this early stage the Cummins QSV91 gas reciprocating engine (genset) has been selected as the engine for the power station. It initially comprises 8 Cummins QSV 91 gensets and from year 4 onwards, an additional 4 units making a total of 12 units in all. There is one spare gas genset in the final configuration so that at any time a gas genset is out for service the power station can still supply the required peak demand of 17 MW.

Each unit has an expected availability of between 96 to 97% so with 11 sets running at all time, one gas genset will be out of service for 33% to 44% of the time, at which time the spare gas genset is needed. If a higher reliability is required, an additional diesel genset would be installed to provide for the small number of hours where two units may be out of service at the same time.

Table 5.1 and 5.2 below show the performance characteristics of the gensets in the first stage (8 gensets total) and the final stage (12 gensets total) when an additional 4 gensets are installed in the third year for operation in the fourth year of the construction period onwards.

<table>
<thead>
<tr>
<th>Cummins QSV91</th>
<th># units</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>%MCR</td>
<td>47.5deg C kWel</td>
<td>45deg C kWel</td>
<td>45DegC kWel</td>
</tr>
<tr>
<td>100%</td>
<td>8,273</td>
<td>11,571</td>
<td>13,224</td>
</tr>
<tr>
<td>95%</td>
<td>8,273</td>
<td>10,992</td>
<td>12,563</td>
</tr>
<tr>
<td>90%</td>
<td>8,273</td>
<td>10,414</td>
<td>11,902</td>
</tr>
<tr>
<td>85%</td>
<td>8,273</td>
<td>9,835</td>
<td>11,240</td>
</tr>
<tr>
<td>80%</td>
<td>8,273</td>
<td>9,257</td>
<td>10,579</td>
</tr>
<tr>
<td>75%</td>
<td>8,273</td>
<td>8,678</td>
<td>9,918</td>
</tr>
<tr>
<td>70%</td>
<td>8,100</td>
<td>8,100</td>
<td>9,257</td>
</tr>
<tr>
<td>65%</td>
<td>7,521</td>
<td>7,521</td>
<td>8,596</td>
</tr>
</tbody>
</table>

Table 5.1: Characteristics of 8 gensets in Stage 1

<table>
<thead>
<tr>
<th>Cummins QSV91</th>
<th># units</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>%MCR</td>
<td>47.5deg C kWel</td>
<td>45deg C kWel</td>
<td>45DegC kWel</td>
</tr>
<tr>
<td>100%</td>
<td>13,000</td>
<td>18,183</td>
<td>19,836</td>
</tr>
<tr>
<td>95%</td>
<td>13,000</td>
<td>17,274</td>
<td>18,844</td>
</tr>
<tr>
<td>90%</td>
<td>13,000</td>
<td>16,365</td>
<td>17,852</td>
</tr>
<tr>
<td>85%</td>
<td>13,000</td>
<td>15,456</td>
<td>16,861</td>
</tr>
<tr>
<td>80%</td>
<td>13,000</td>
<td>14,546</td>
<td>15,869</td>
</tr>
<tr>
<td>75%</td>
<td>13,000</td>
<td>13,637</td>
<td>14,877</td>
</tr>
<tr>
<td>70%</td>
<td>12,728</td>
<td>12,728</td>
<td>13,885</td>
</tr>
<tr>
<td>65%</td>
<td>11,819</td>
<td>11,819</td>
<td>12,893</td>
</tr>
</tbody>
</table>

Table 5.2: Characteristics with additional 4 gensets in Stage 2

---

This may change over the next five years before commitment needs to be made to power station’s final design.
Note that the gas gensets derate significantly above 45°C, which is typical for gas engines, while diesels do not. The 47.5°C has been included to show the affect of ambient air temperature, i.e. the change in air or combustion intake air temperature has on the gas reciprocating engine. From the 4.5 years temperature records, temperatures above 45°C are extremely rare and would only persist for a few hours.

From the table above the 17 MW can be supplied with 11 gas engines running at approximately 95% capacity. The power station cannot run at 100% loading as there must be some spare capacity on-line to allow for load following.

5.3 Fuel Efficiency

The annual average Higher Heating Value (HHV) heat rate of the power delivered to the SKA facility is expected to be 11,150 kJ/kWh. It should be noted that all gas is sold and purchased on HHV, while generating plant suppliers quote their heat rates in lower heating value (LHV).

The Cummins QSV91 is not the most efficient engine available, but given the isolated site, it is an appropriate choice, as it is more robust than higher efficiency machines. If the project proceeds, it may be worthwhile examining the nature of the load to determine if a higher efficiency machine will be suitable for the load and conditions. At this time the QSV91 provides both a reliable and economical solution.

5.4 Design Features and Assumptions

The site is assumed to be free of rock and not prone to flooding, as either of these would incur additional capital cost. It is assumed that the power station can gain access to good communications to Perth so that it can be remotely operated and condition monitoring data relayed to Perth for off-site performance and condition-based maintenance planning.

The plant will be manned 10 to 12 hours per day. However, the station is fully automatic and will despatch generation to meet demand. Should the site have any large block loading scenarios, some form of start permissive communication and control between the power station and the load will be needed to ensure that sufficient plant is brought on line prior to connecting the load.

The plant will be installed in a metal clad engine hall. At this time no additional allowance has been made to manage RFI.

5.5 Electrical

The gensets generate at 415 V with each genset having a 415V/22kV step-up transformer connected to a 22 kV indoor generator/feeder switchboard located in the engine hall. This modular genset-transformer configuration is lower in cost than the alternative of 11 kV gensets connected to an 11 kV switchboard supplying two 11/22 kV transformers connected to a 22 kV feeder switchboard. The switchboard will have a bus section circuit breaker so that a switchboard fault will not trip the entire station. A single line diagram of the power station is shown in 5.2.
Cost of Power

The analysis has been done over twenty years for power supplied “over the fence” by an independent power producer (IPP). The cost includes a risk premium of 5% for the IPP to carry the contractual commitment required for gas supply. The all-inclusive indicative cost of power supply of **22.09c/kWh** to the SKA facility is set out in the Table 5.3 below.

<table>
<thead>
<tr>
<th>Gas</th>
<th>$/kWh</th>
<th>$/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capex</td>
<td>$0.0968</td>
<td></td>
</tr>
<tr>
<td>Opex</td>
<td>$0.0262</td>
<td></td>
</tr>
<tr>
<td>Gas supply</td>
<td>$0.0418</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$0.1648</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power</th>
<th>$/kWh</th>
<th>$/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capex</td>
<td>$0.0416</td>
<td></td>
</tr>
<tr>
<td>Opex</td>
<td>$0.0145</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$0.0561</strong></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$0.2209</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.3: Breakdown of indicative electricity cost from the power station

There are a few points to note:
The above cost of 22.09 cents/kWh is at the ‘power station gate”. It does not include the cost of distribution to the 100 arrays (see Section 7).

The gas CAPEX component is disproportionally high as the gas demand requires a 150mm high pressure pipeline, which is substantially oversized for the demand. This has come about because the common pipeline diameter jumps from 100 to 150mm. 125mm is not manufactured in Australia. The 150mm pipeline is approximately A$18m more than the 100mm pipeline.

Of the 22.09c/kWh 17.6 c/kWh is fixed.

All prices are escalated at CPI

Debt to equity of 20% / 80% is assumed

Debt interest is 7.5%, for a 15 year term

Period of analysis is 20 years

### 5.7 Capital Costs

The capital cost of the power station and pipeline is set out below

<table>
<thead>
<tr>
<th></th>
<th>Initial installation</th>
<th>Stage 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Station</td>
<td>A$21,500,000</td>
<td>A$4,000,000</td>
<td>A$25,500,000</td>
</tr>
<tr>
<td>Gas pipeline</td>
<td>A$58,000,000</td>
<td></td>
<td>A$58,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>A$79,500,000</td>
<td>A$4,000,000</td>
<td>A$83,000,000</td>
</tr>
</tbody>
</table>

Table 5.4: Capital cost of power station and gas pipeline
6 GAS SUPPLY

The site is located approximately 240km east of the Dampier to Bunbury Natural Gas Pipeline (DBNGP). Pipeline costing has assumed that the project requires its own pipeline corridor, which will require flora, fauna, native title, and heritage issues to be addressed. No detailed assessment has been made of the cost to obtain this easement but an allowance for an average cost has been included. It may be possible to place the gas pipeline and fibre optic in the same easement. However, the shortest pipeline route is directly west from the SKA to the DBNGP, while the fibre optic service has to go to Geraldton.

6.1 Gas Supply and Indicative Cost

To supply 113GWh per year at a heat rate of 11,150kJ/kWh will require an annual gas demand of 1,260TJ per annum, or 3.45TJ/day. It is difficult to say at this time what the price of gas will be in 2008, particularly as the current world oil price increase has pushed up the price of Liquefied natural Gas (LNG) and is now putting price pressure on the local gas supply. From the market sentiment at this time a future price of A$2.80/GJ (As at Jan 2006) is reasonable and is used in this study.

Gas transport down the DBNGP is calculated on a part haul basis on the kilometre length utilised as a proportion of the full length of 1,400km. If the off take is located due west of Meekatharra and the gas is sourced from the North West Gas Shelf (NWGS), the length of DBNGP utilised is approximately 750km. The full haul rate is approximately A$1.10/GJ, so that the cost of DBNGP gas transport to the SKA off-take would be A$0.59/GJ (as at January 2006).

In summary the cost of gas to the SKA off-take on the DBNGP is A$2.80/GJ plus A$0.59 or A$3.39/GJ.

6.2 Gas Pipeline from DBNGP to SKA

At this time there is very little other activity in the surrounding areas along the pipeline route from DBNGP to SKA to share the cost of the gas pipeline. On this basis the pipeline is designed as a sole use line and the full cost is born by the SKA project. However, this should be re-visited closer to the project start as third party use would reduce the lifetime unit cost and the capital costs to the SKA owners.

The gas pipeline required to supply the originally specified power station capacity was a DN100 nominal outside diameter 4" class 600 high pressure gas pipeline with a maximum operating pressure 10.2 MPa. However, as shown in Table 6.1 below, the 100mm is unable to meet the demand of 3.45 TJ/day.

16 It may be financially attractive to extend the pipeline approximately 90 km to Meekatharra to the east and supply its power station. Alternatively, if the existing pipeline to Mt Magnet was extended north to Meekatharra, it could be possible to supply the SKA power station from this source. Neither alternative has been sized or costed as they are contingent on third party actions.
Table 6.1: Gas pipeline characteristics and reason for selection of 150 mm pipeline

<table>
<thead>
<tr>
<th>Pipeline Diameter</th>
<th>Inlet pressure</th>
<th>Flow (kSCM/d)</th>
<th>Flow (TJ/Day)</th>
<th>Delivery pressure (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm</td>
<td>6,000</td>
<td>77</td>
<td>3.0</td>
<td>800</td>
</tr>
<tr>
<td>150mm</td>
<td>6,000</td>
<td>223</td>
<td>8.7</td>
<td>800</td>
</tr>
</tbody>
</table>

The DBNGP pressure is taken as 6,000kPa, which is the worst case, as it usually well above 6,000kPa. Capital cost is of the order of A$58 million. Reducing this capital cost and the lifetime unit cost to the SKA owners by supplying third parties with gas should be investigated if the project proceeds.
The power station provides supply for 100 arrays through a HV distribution system of 22 kV overhead lines and 22 kV underground cables. It consists of some 920 km of 22 kV concrete pole overhead lines, 160 km of 22kV underground cable and 86 step-down transformers of capacities ranging from 150 kW to 750 kW. The indicative lifetime unit cost of this high voltage (HV) distribution system is 3.4 c/kWh derived from a capital cost of approximately A$48.3 million with an ongoing annual O&M cost of approximately A$300,000. The elements of the HV distribution system are described below.

7.1 General Outline

The HV distribution system consists of the following elements:

- two 22 kV concrete pole overhead lines providing power to 25 Outer arrays and 5 Remote arrays
- three 22 kV underground cables providing power to the 65 nearby arrays in the central area and the 5 close-in Outer arrays
- one 22kV underground cable providing power to the nearby Core Facilities Centre
- 86 22kV/415V totally enclosed padmount transformers ranging in capacity from 150 kW to 750 kW to provide 415/240 V reticulation to the 45 antennas within each array.

A 22 kV distribution system was chosen to provide sufficient reach to the Outer arrays and close-in REM arrays within acceptable voltage drop limits. The 22 kV underground cable system results in a quarter of the electrical losses of an 11 kV system for underground supply to the central area at little additional capital cost. 22 kV is also a common distribution voltage with switchgear and step-down transformers being readily available in Australia.

7.2 22 kV Overhead Line System

The two 22kV overhead lines have a total length of approximately 920 km and are used to supply 25 Outer arrays and 5 close-in REM arrays. The design is a standard rural medium line using concrete poles with 120 m spans. The conductor arrangement is shown diagrammatically in Figure 7.1.
The two 22 kV overhead lines exit the power station switchroom with Feeder 1 forming a rough semi-circle to the north of the central site and close-in outer arrays and Feeder 2 forming a semi-circle to the south of the central site and close-in outer arrays.

Three spur overhead lines radiate from Feeder 1 to supply outer arrays and close-in remote arrays to the north. Two spur overhead lines radiate from Feeder 2 to supply the remaining outer arrays and close-in remote arrays to the south. A total of 10 auto reclosers are provided and 6 gas insulated sectionalising switches are used to provide flexibility in operation.

The material and labour costs of the two overhead lines are estimated to be A$28,000 per km giving a total cost of approximately A$26 million plus A$84,000 for the six sectionalising switches and A$340,000 for the 10 reclosers supplied and installed.

### 7.3 22kV Underground Cable System

Three 22kV XLPE underground cables radiate out from the central power station to supply the 65 central area arrays and 5 close-in Outer arrays. A fourth underground cable supplies the Core Facilities Centre. In addition, 30 underground cables are used for the last 4 km from overhead lines to the periphery of the 30 arrays they supply. All underground cables are:

- 35 mm² XLPE rated at 12.7/22kV
- 3 core light duty screened unarmoured compacted aluminium conductor wire screened to AS/NZS1429.1

Approximately 37,000 metres is used to supply the arrays with some 20,400 metres buried in shared trenches with the optical fibre cable and 16,600 metres in separate trenches. Approximately 500 metres is used to supply the Core Facilities Centre in its own trench. More details are provided in Appendices 12.1 (costs) and 12.2 (voltage drops)

The single line diagram for the HV/LV cabling for the Core arrays and close-in Central arrays is provided in Appendix 12.2.

The cost of materials and labour for the underground cable is estimated at A$27 per metre in shared trenches and A$77 per metre in unshared trenches. The estimated lengths and costs for the 22 kV underground cable is summarised in Table 7.1 below.

<table>
<thead>
<tr>
<th>Supply for</th>
<th>Total Length Required</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core, central &amp; 5 Outer arrays</td>
<td>37 km</td>
<td>A$1.707 million</td>
</tr>
<tr>
<td>25 Outer &amp; 5 Remote arrays</td>
<td>120 km</td>
<td>A$1.190 million</td>
</tr>
<tr>
<td>Core Facilities Centre</td>
<td>500 metres</td>
<td>A$0.039 million</td>
</tr>
</tbody>
</table>

Table 7.1: 22 kV underground cable approximate quantities and indicative costs
7.4 Padmount Transformers

Totally metal-enclosed, 22 kV/ 415 V padmount transformers typical of those used by distribution authorities throughout Australia are used to transform the 22 kV to 415 V at each array. Three standard transformer sizes are used:

- 150 kVA for single arrays
- 500 kVA for supply to three arrays
- 750 kVA for supply to four arrays.

Arrays supplied by the transformers are summarised in Table 7.2 below.

<table>
<thead>
<tr>
<th>Arrays Supplied</th>
<th>Number of Padmount Transformers</th>
<th>Cost (Supply &amp; Install) A$ Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 Outer &amp; 5 Remote arrays</td>
<td>30 (all 150 kVA)</td>
<td>1.215</td>
</tr>
<tr>
<td>70 Core &amp; Central and 5 Outer arrays</td>
<td>53 (150, 500, 750 kVA)</td>
<td>2.635</td>
</tr>
<tr>
<td>Core Facilities Centre</td>
<td>3 (750 kVA)</td>
<td>0.185</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>86</strong></td>
<td><strong>4.035</strong></td>
</tr>
</tbody>
</table>

Table 7.2: Padmount transformer quantities and indicative costs

7.5 Indicative Costs

The costs given above are by electrical equipment type. Table 7.3 below gives the capital and O&M costs by function as well as the lifetime unit cost of the reticulation system for the 100 arrays over a nominal operating life of 30 years at a discount rate of 7% real. This lifetime unit cost should be added to that of the power station (approximately 22.1 c/kWh) to arrive at a total cost of 25.5 c/kWh. It may be possible to reduce this cost by supplying electricity to third parties such as farmers in the area.

<table>
<thead>
<tr>
<th>Function</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV/LV Central Array Area transformation &amp; reticulation</td>
<td>A$ 9.1 million</td>
</tr>
<tr>
<td>Outer Array transformation &amp; reticulation</td>
<td>A$ 38.6 million</td>
</tr>
<tr>
<td>Core Facilities Centre transformation &amp; reticulation</td>
<td>A$ 0.27 million</td>
</tr>
<tr>
<td><strong>Capital cost TOTAL</strong></td>
<td>A$48 million</td>
</tr>
<tr>
<td>Annual O&amp;M cost</td>
<td>A$ 0.3 million</td>
</tr>
<tr>
<td><strong>Lifetime unit cost TOTAL</strong></td>
<td>3.4 c/kWh</td>
</tr>
</tbody>
</table>

Table 7.3: Indicative capital costs the three systems supplied from the power station
8 REMOTE AREA POWER SUPPLIES

Eleven arrays will each be powered by Remote Area Power Supply (RAPS) systems as they appear to be too distant from the central power station or a local electricity network. An analysis over the 30 year operating life of the arrays has indicated that a photovoltaic – battery – standby diesel hybrid combination is the most likely economic RAPS solution for implementation in the period 2018 to 2019.

It is possible that over the next decade other technological solutions may emerge due to the rapid technological changes that are occurring in the remote power field and related and supporting technologies. Similarly, continuing advances in the chosen solution may further their existing competitiveness. These matters are discussed further in this section.

8.1 General Outline

The RAPS system for each array is located immediately adjacent to it in an area of maximum solar insolation. Each system consist of:

- An array of photovoltaic (PV) panels with a nominal capacity of approximately 625 kW to convert sunlight into direct current (DC) electricity.
- A long-life battery system with sufficient capacity to store electricity from the PV system during the day and supply electricity to the array at night without full discharge.
- Regulators and single phase inverters to regulate the battery charging and convert its output to AC electricity.
- A standby 120 kW diesel genset and fuel storage facilities for those periods when there is insufficient solar insolation for the PV to fully charge the battery or for significant component failures.

All components capable of generating RFI are located in a metal building designed as a Faraday cage. All components have been conservatively specified to maximise their life and reliability. Each RAPS system is a single phase design using the same reticulation cabling as that used for mains powered arrays. This will supply the 2 kW power needs of each antenna within the array and 30 kW of general array demand.

8.2 PV System

8.2.1 Capacity

The PV system has a nominal capacity under standard test conditions of 625 kW. This capacity is required to meet the 120 kW average load on a “24 * 7” basis. The PV system has to supply sufficient energy during daylight hours to power the array and charge the batteries for overnight operation. This increases the capacity by a factor in excess of four when allowances are made for:

- battery conversion efficiency of approximately 90%
inverter efficiency of approximately 94%  
• average solar insolation of approximately 6 full sun hours on average over the year.

Additional capacity of 10% has been included for contingencies and variation in solar insolation.

8.2.2 Degradation
PV panels slowly reduce in output over their nominal 30 year life. This degradation is approximately 1% of their initial capacity annually. The preliminary design has accommodated this by adding an additional 10% of capacity every 10 years. This is conservative as improvements in PV design and the move to second generation PV technologies such as thin film is likely to result in lower degradation rates down to possibly 0.5% annually.

8.2.3 PV Type
Approximately 90% of annual PV manufacture is first generation crystalline or poly-crystalline silicon wafer technology. Over the coming decade this dominance is likely to be challenged by second generation technologies such as thin-film PV in its various forms and non-silicon PV systems. At this stage it is not necessary to specify the type of PV to be used as the technology is likely to change materially over the next decade or so. In addition, PV is a commodity that is sold on an A$/Watt basis with the sale price largely taking into account performance features.

8.2.4 PV Price
PV prices have exhibited a long term trend\textsuperscript{17} of real reductions in price amounting to approximately 5% annually on average. This is largely due to the experience curve which in general results in an approximate reduction of 20% for each doubling of cumulative production within an industry. This has been found to hold for a number of industries\textsuperscript{18} and results mainly from a combination of the learning curve, technology development and economies of scale. The experience curve has been applied to the price of PV going forward. This is largely in line with the PV industry’s roadmap which sees PV competitive with grid electricity in the second part of the next decade. Further details are given in the sub-section on costs and assumptions.

8.2.5 PV Mounting
In keeping with the principles of simplicity and reliability, the PV arrays are mounted on fixed support structures set at an angle to the sun determined by the latitude of the array’s location and facing north. This mounting configuration results in a reduction in output compared to single or dual axis solar tracking. However, the additional cost and complexity, particularly in remote areas, of tracking systems cannot be justified at this stage.

8.3 Battery System
The battery system stores the excess energy generated by the PV system during the day for use at night. A single phase design has been chosen to keep the battery voltage at approximately 340

\textsuperscript{17} The price reduction trend extends back at least15 years.

\textsuperscript{18} See for example Green M. A., “Green Energy Visions” in Appendix 4. There comes a point when the reduction rate drops and the cost reduction curve flattens out. In the case of PV, Green argues that the reduction rate will continue with increasing production of second generation PV technology which is currently an order of magnitude below that of first generation (wafer) technology.
V rather than close to 590 V that would be required for a three phase system\textsuperscript{19}. The battery has been sized to:

- provide 24 hour operation
- reduce the number of full charge/discharge cycles to increase the life
- accommodate the high ambient temperature which reduces the battery’s capacity.

A long-life battery capable of at least 2,000 full charge/discharge cycles is required. This could be a tubular plate lead acid or a more exotic battery. Battery technology is continuing to develop and as with PV, no particular battery type has been chosen at this early stage of the project. Over the next decade or more before the RAPS system needs to be deployed, there is likely to be significant developments and further cost reductions in battery technology. The final selection will largely be determined by cost, life and reliability. Thus only indicative industry costs and a life of 10 years have been assumed in this analysis.

8.4 Regulators/Inverters

Regulators control the charging/discharging of the battery system and inverters convert the DC output of the battery to 240 V AC electricity to meet the needs of the array. Four 50 kW inverters have been chosen to provide n-1 redundancy\textsuperscript{20}. A ducted air conditioner (about 2.5 kW capacity) is used to control the operating temperature of the inverters to improve their overall performance.

There is significant ongoing development in inverter technology. The advent of Insulated Gate Bipolar Transistors over the last 10 years is displacing the older thyristor technology and enabling a move to higher frequency switching/higher conversion efficiency and lower cost. Over the next decade or more this trend is likely to continue. Again, as with PV and batteries, it not appropriate to be technology specific but rather address function, performance and cost.

The indicative costing assumes a life of 15 years for regulators/inverters due to a combination of reduced serviceability\textsuperscript{21} and the increased functionality and performance of newer technologies.

8.5 Standby Diesel Genset

A standby diesel genset with a capacity of 120 kW has been provided as a back-up to the PV-Battery system in the event of:

- insufficient solar insolation for more than a day
- failure of two or more inverter systems despite the in-built redundancy

\textsuperscript{19} It is assumed that single phase power is sufficient for the array as each antenna only requires 2 kW to operate its tracking motor and electronics. A change to three phase would not have a material impact on the costings.

\textsuperscript{20} Loss of one inverter will still enable the system to operate normally when average power or peak power is required. In addition, the standby diesel is available should more than one inverter fail. This provides n-2 contingency.

\textsuperscript{21} Parts become increasingly harder to obtain with rapid technology development and service staff with experience in that generation of technology become harder to find.
8.6 Installation Program

With 125 arrays to be built and commissioned over 8 years it is assumed that the focus in the first five to six years will be on the 100 arrays supplied from the central power station. This would see all Core, Central, Outer and the first 5 Remote arrays operational. The remaining 25 arrays (all Remote or Maximum) would be built in the last three years of the construction program with the 11 arrays supplied by RAPS built in the last two years.

This staged program enables advantage to be taken of the technological advances being achieved in the areas of generation, storage and control technologies that will flow onto power supplies for remote areas not served by a main electricity network.

The program has two impacts on the costings:

- It provides in excess of 12 years for developments and resultant real cost reductions to occur.
- It enables the capital expenditure required for the RAPS systems to be deferred six to seven years from the array construction start in 2012. This significantly reduces the NPV at the project start.

8.7 Cost Assumptions

In summary, the main cost assumptions are:

- The above construction program which results in the 11 RAPS systems being installed and commissioned in the last two years of the program (2018 and 2019).
- The real price of PV, batteries and regulators/inverters falls due to the experience curve effect at rates of 5%, 2.5% and 2.5% respectively.
- 10% of the initial PV capacity is added every 10 years to accommodate gradual reduction in output (assumed 1% annually); the battery system is replaced every 10 years and the regulators/inverters are replaced every 15 years.
- No subsidies for PV systems compared to PV subsidies of up to 55% currently available in some Australian states through diesel offset programs and the like. This is on the basis that PV should be competitive in its own right given its price falling in real terms while the price of fossil fuel continues to rise in real terms.
- The real price of power station and distribution equipment will remain relatively constant in real terms over the next 15 years.
- The real price of diesel fuel will continue to rise in real terms from a 2005 delivered price of A$1.50 per litre in remote areas. A conservative annual rise of 2% (in real terms) is assumed. This results in a doubling of diesel fuel costs over 35 years; a slower rate rise than that which has occurred over the last 10 years.
There is no carbon tax or the equivalent on fossil fuel or network electricity.

Equipment, operating and maintenance costs on a "per unit" basis are given in Appendix 12.3.

8.8 Costs

Given the above assumptions, the lifetime unit cost\(^{22}\) of the RAPS systems for the 11 arrays is calculated as being $0.42 per kWh (ie 42 cents/kWh). The real capital costs discounted to the project’s construction start in 2012\(^{23}\), is approximately $29 million. For comparison, the undiscounted capital cost is $48 million which equates to a capital cost of about $4.4 million per array. The discounted O&M costs over the first 10 years of operation are $3 million and the undiscounted O&M costs are $7 million. These and other costs are given in Table 8.1 below.

<table>
<thead>
<tr>
<th></th>
<th>Discounted</th>
<th>Undiscounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>28.95</td>
<td>47.90</td>
</tr>
<tr>
<td>Replacement/upgrade</td>
<td>5.163</td>
<td>26.44</td>
</tr>
<tr>
<td></td>
<td>34.12</td>
<td>74.34</td>
</tr>
<tr>
<td>O&amp;M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial 10 years</td>
<td>3.02</td>
<td>7.00</td>
</tr>
<tr>
<td>Over 30 year life</td>
<td>5.19</td>
<td>21.17</td>
</tr>
</tbody>
</table>

Table 8.1: Discounted and undiscounted capital and O&M costs for the RAPS for the 11 arrays.

The components making up the RAPS system undiscounted cost for each array are given in Table 8.2 below for 2018:

<table>
<thead>
<tr>
<th>Component</th>
<th>ASM</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV capital cost</td>
<td>1.60</td>
<td>36</td>
</tr>
<tr>
<td>Battery capital cost</td>
<td>0.99</td>
<td>23</td>
</tr>
<tr>
<td>Regulator-inverter capital cost</td>
<td>0.36</td>
<td>8</td>
</tr>
<tr>
<td>Foundation &amp; steelwork costs</td>
<td>0.62</td>
<td>14</td>
</tr>
<tr>
<td>Standby diesel genset capital cost</td>
<td>0.15</td>
<td>4</td>
</tr>
<tr>
<td>Cabling materials and labour</td>
<td>0.05</td>
<td>1</td>
</tr>
<tr>
<td>Labour construction cost</td>
<td>0.62</td>
<td>14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4.41</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 8.2: Indicative undiscounted cost of components of a RAPS system in 2018

---

\(^{22}\) See Section 4 for the definition of lifetime unit cost.

\(^{23}\) Noting that the RAPS construction start is assumed to be 2018.
8.9 Sensitivity Analysis

A sensitivity analysis of PV-battery-standby diesel hybrid indicates that the key variables include the capital cost (especially the PV), the discount rate and the insolation level. The capital cost can manifest itself in a number of ways including the unit cost of the PV (A$/W), the degree of government subsidy (the analysis assumes none), the forecast reduction rate in PV unit costs and the level of contingency capacity assumed. Table 8.3 below provides a summary of the sensitivity analysis carried out.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Base Case Value</th>
<th>Test Value</th>
<th>Lifetime Unit Cost</th>
<th>Undiscounted Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Value (c/kWh)</td>
<td>% Change</td>
</tr>
<tr>
<td>Base case</td>
<td></td>
<td></td>
<td>42</td>
<td>47.9</td>
</tr>
<tr>
<td>Discount rate</td>
<td>7%</td>
<td>9%</td>
<td>47</td>
<td>+12%</td>
</tr>
<tr>
<td>Capacity contingency</td>
<td>10%</td>
<td>0%</td>
<td>39</td>
<td>-7%</td>
</tr>
<tr>
<td>PV subsidy</td>
<td>0%</td>
<td>50%</td>
<td>36</td>
<td>-12%</td>
</tr>
<tr>
<td>PV unit price in 2005</td>
<td>A$5/W</td>
<td>A$4/W</td>
<td>40</td>
<td>-5%</td>
</tr>
<tr>
<td>Ditto</td>
<td>A$6/W</td>
<td>44</td>
<td>+5%</td>
<td>51.4</td>
</tr>
<tr>
<td>PV annual price reduction</td>
<td>5%</td>
<td>3%</td>
<td>46</td>
<td>+10%</td>
</tr>
<tr>
<td>Solar insolation (full hours/day)</td>
<td>6</td>
<td>7</td>
<td>38</td>
<td>-10%</td>
</tr>
<tr>
<td>Ditto</td>
<td>5</td>
<td>47</td>
<td>+12%</td>
<td>54.7</td>
</tr>
<tr>
<td>Battery cost</td>
<td>-10%</td>
<td>41</td>
<td>-2%</td>
<td>46.8</td>
</tr>
<tr>
<td>Ditto</td>
<td>+10%</td>
<td>43</td>
<td>+2%</td>
<td>49.0</td>
</tr>
<tr>
<td>Battery annual price reduction</td>
<td>2.5%</td>
<td>0%</td>
<td>49</td>
<td>+17%</td>
</tr>
<tr>
<td>Reg/Inverter unit price (2005)</td>
<td>A$2.50/W</td>
<td>A$2.25/W</td>
<td>42</td>
<td>0%</td>
</tr>
<tr>
<td>Ditto</td>
<td>A$2.75/W</td>
<td>42</td>
<td>0%</td>
<td>48.9</td>
</tr>
<tr>
<td>Reg/Inv annual price reduction</td>
<td>2.5%</td>
<td>0%</td>
<td>44</td>
<td>+5%</td>
</tr>
<tr>
<td>Diesel fuel price annual rise</td>
<td>2%</td>
<td>0%</td>
<td>41</td>
<td>-2%</td>
</tr>
<tr>
<td>Ditto</td>
<td>3%</td>
<td>43</td>
<td>+2%</td>
<td></td>
</tr>
<tr>
<td>Standby diesel operating hours</td>
<td>336</td>
<td>672</td>
<td>45</td>
<td>+7%</td>
</tr>
</tbody>
</table>

Table 8.3: Sensitivity analysis of key variables in base case for PV-battery-standby diesel
The sensitivity analysis indicates in the worse case modelled, namely average annual solar insolation of 5 full hours a day, the lifetime unit cost will rise 12% to 47 c/kWh and the undiscounted capital cost will rise 14% to A$54.7 million. This increased capital cost would increase the overall undiscounted capital cost of the SKA power facilities from A$189 million to A$195.8 million, a rise of 3.6%.

8.10 Alternatives

There are a number of alternatives to the PV-battery-standby diesel analysed above. These include both fossil fuel and renewable technologies. Some of these are outlined below. It is possible that over the next decade or so, and before commitment has to be made to a RAPS technology package, one of these may prove to be more competitive.

8.10.1 Diesel Gensets

Diesel gensets were the technology of choice for RAPS systems for much of the 20th Century. They dominated the RAPS market except where access was long and/or difficult. They had a relatively low capital cost, maintenance was relatively simple, they were reliable and reasonably long lasting. In the days of low diesel fuel prices, they were also inexpensive to operate. Such is not the case today as illustrated in the analysis that follows. The key cost assumptions are indicated in sub-section 8.7 above.

Given these assumptions, the indicative lifetime unit cost\(^\text{24}\) of the diesel-fuelled RAPS systems for the 11 arrays over 30 years is A$0.75 per kWh (ie 75cents/kWh)\(^\text{25}\). This falls to 61 cents/kWh if the diesel price rise is relaxed to 1% p.a. and to 49 cents/kWh if it is assumed there will be no real increase in the price of diesel fuel over the 30-year operating life of the SKA. All of these costs are above the lifetime unit cost of 42 cents/kWh for the PV-battery-standby diesel hybrid.

The real capital costs discounted to the project's construction start in 2012\(^\text{26}\), is approximately A$2.7 million, less than 10% that of the PV-battery-standby-diesel solution. For comparison, the undiscounted capital cost is approximately A$4.5 million which equates to a capital cost of about A$405,000 per array. The discounted O&M costs over the first 10 years of operation are approximately A$39 million and the undiscounted O&M costs over the same period are A$91 million. These and other costs are given in Table 8.3 below.

\(^{24}\) See Section 4 for the definition of lifetime unit cost.

\(^{25}\) This falls to 68 c/kWh over the first 10 years.

\(^{26}\) Noting that the RAPS construction start is assumed to be 2018.
Given the above analysis and assumptions, diesel gensets are highly unlikely to be competitive with the alternatives that have emerged or are likely to emerge for RAPS systems.

### 8.10.2 PV-Diesel

The PV-diesel hybrid has been used in the past to displace some diesel fuel usage by using PV to generate during periods of solar insolation. This hybrid considerably reduces the initial capital by reducing the amount of PV capacity required and eliminating the need for batteries. The maximum amount of PV capacity required is equal to the average power demand (in this case, 120 kW) as any more is wasted as its output cannot be stored.

However, the high price of diesel fuel has made this option unattractive for the following reasons:

- The diesel genset provides over 75% of the energy assuming good solar insolation of 6 full sun hours a day on average.
- It has a significantly higher initial capital cost than the diesel RAPS system because of the higher cost of PV system.

The model used to cost the other alternatives indicates a lifetime unit cost of at least 75 c/kWh for the PV-diesel hybrid for the same underlying assumptions.

### 8.10.3 Gas Gensets

An alternative to diesel-fuelled RAPS system is gas, either as compressed natural gas (CNG) or as liquefied petroleum gas (LPG). Neither has been fully costed because of the lack of availability of either CNG or LPG in the quantities required in many remote areas of Australia. This may change over the next decade as diesel fuel prices continue to rise and accordingly this alternative should be re-evaluated then.

### 8.10.4 Others

There are a number of alternative technologies, either just being commercialised or in the latter stages of development, that are worthy of further consideration closer to the decision point for the RAPS systems. These include:

---

Table 8.3: Discounted and undiscounted capital and O&M costs for the diesel-fuelled RAPS systems

<table>
<thead>
<tr>
<th></th>
<th>Discounted</th>
<th>Undiscounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>2.69</td>
<td>4.46</td>
</tr>
<tr>
<td>Replacement/upgrade</td>
<td>0.821</td>
<td>5.50</td>
</tr>
<tr>
<td></td>
<td>3.51</td>
<td>9.96</td>
</tr>
<tr>
<td>O&amp;M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial 10 years</td>
<td>38.94</td>
<td>91.03</td>
</tr>
<tr>
<td>Over 30 year life</td>
<td>71.09</td>
<td>305.05</td>
</tr>
</tbody>
</table>
**Fuel Cells**: These are on the cusp of commercialisation for a number of applications. They provide an alternative to batteries in RAPS systems. In one scenario, the PV would be used to create hydrogen from water in a closed loop and the hydrogen then stored and used in the fuel cell to generate DC electricity when there is inadequate solar energy.

**Solar thermal**: This technology involves using solar insolation to heat water to create steam. It has a number of forms largely determined by the concentrator technology (e.g., flat-bed, parabolic trough or dish etc) and the engine (e.g., sterling) used to convert the steam to electricity. Storage technologies or other fuel sources are required overnight. At present, it is generally more expensive and complex than PV and not as reliable.

**PV concentrator**: This technology reduces the quantity of PV cells required by concentrating the solar insolation to effectively form many suns and so increase the output of the PV cells which are usually water cooled. Like solar thermal, it can take a number of forms depending largely on the collector technology. They largely involve a trade-off between the relatively high cost of PV cells and the lower cost concentrator technology. They are generally more complex due to the tracking technologies to remain focussed on the sun. Some of these are in the early stages of commercialisation.
9 ARRAYS CONNECTED TO THE ELECTRICITY NETWORK

A total of 14 arrays have been identified by CSIRO consultants as sufficiently close to local electricity networks to be economically powered from them. This section outlines the indicative cost of such connections and the lifetime unit cost of electricity from this source.

9.1 Arrays capable of Connection

The 14 arrays that may be connected to local electricity networks are given in Table 9.1 below together with the nominal distances for each connection.

<table>
<thead>
<tr>
<th>Array Station Designation</th>
<th>Nominal Distance to Grid km</th>
</tr>
</thead>
<tbody>
<tr>
<td>rem5</td>
<td>20</td>
</tr>
<tr>
<td>rem8</td>
<td>20</td>
</tr>
<tr>
<td>rem10</td>
<td>10</td>
</tr>
<tr>
<td>rem11</td>
<td>10</td>
</tr>
<tr>
<td>rem15</td>
<td>10</td>
</tr>
<tr>
<td>rem16</td>
<td>20</td>
</tr>
<tr>
<td>rem22</td>
<td>1</td>
</tr>
<tr>
<td>rem23</td>
<td>1</td>
</tr>
<tr>
<td>rem24</td>
<td>20</td>
</tr>
<tr>
<td>rem25</td>
<td>20</td>
</tr>
<tr>
<td>rem26</td>
<td>20</td>
</tr>
<tr>
<td>max0</td>
<td>1</td>
</tr>
<tr>
<td>max1</td>
<td>1</td>
</tr>
<tr>
<td>max2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 9.1: Arrays powered from local grid and distance to grid

9.2 Assumptions

In calculating the capital cost of connection and lifetime unit cost it is assumed that:

- All connection is at 22 kV as this is a common distribution voltage in Australia and there is little capital cost difference in connection at 11 kV.
- All arrays identified as being 1 km away in Table 9.1 are moved so that they are 4 km away to meet the RFI requirements. Such arrays are connected by 22 kV underground cable alone.
- All other arrays in Table 9.1 are connected by overhead 22 kV line with the last 4 km being by underground cable.
• The network electricity price is 17 c/kWh (2005) and this remains constant in real terms over the nominal 30 year operating life of the SKA. This is the price the local electricity retailer would charge the SKA owner.

• It is assumed that the SKA owner would pay the capital cost for the 22 kV connection. The indicative unit capital costs used for the HV/LV network connected to the gas-fired power station are used in this costing.

9.3 Component Costs

The installed component costs per array are given in Table 9.2 below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Indicative Unit Capital Cost (supply and install)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-off from local network (reclosers, protection, metering etc)</td>
<td>A$40,000</td>
</tr>
<tr>
<td>22 kV overhead line</td>
<td>A$28,000/km</td>
</tr>
<tr>
<td>22 kV underground cable</td>
<td>A$77,000/km</td>
</tr>
<tr>
<td>22kV/415V Padmount transformer</td>
<td>A$30,000</td>
</tr>
<tr>
<td>Intra-array 415 V cabling and switchboards</td>
<td>A$54,000</td>
</tr>
</tbody>
</table>

Table 9.2: Indicative capital cost of components

9.4 Indicative Costs

The modelling indicates an indicative lifetime unit cost of 21 c/kWh over the 30 year nominal operating life of the SKA. The indicative capital cost component amounts to 4 c/kWh, the remaining 17 c/kWh being the price of electricity from the local electricity network retailer.

The undiscounted capital cost of the connection to all 14 arrays is A$9.24 million, while the discounted cost in 2012 is A$5.57 million. The average undiscounted capital cost for those arrays connected by 22 kV overhead line and underground cable is A$0.787 million per array assuming an average 22 kV overhead line length of 12.7 km. For those connected by underground cable alone, the cost is A$0.432 million assuming a underground cable length of 4 km from the network to the array.

---

27 This price approximates the tariff for HV commercial customers in WA and the NT in 2005.
10 ARRAY POWER RETICULATION

Cabling to the 45 antennas within each array is the same for all 125 arrays. The underground cables are to be laid in the same trench as the fibre optic cable to reduce trenching costs. The cost of the reticulation is included with the power source for the array (ie power station, RAPS system or network connected). This section outlines the preliminary design of the intra-array reticulation.

10.1 Intra-Array Cabling

The intra-array cabling is shown in Figure 10.1 below.

Figure 1: Intra-array power cabling of the 45 antennas in each.

The designations refer to the voltage drop calculations included in Appendix 12.2. Maximum voltage drop is approximately 7% for A8, A10, and C7 to C10.

Cable X is the main incomer underground cable from the padmount transformer or RAPS system. It consists of four single cores of 300 mm² PVC underground cable rated at 0.6/1kV (3 phase and neutral). It is approximately 120 m in length for non-Core arrays. For Core arrays, it varies in length between 150 m and 550 m depending on the location of the padmount transformer and the number of arrays connected to it (see Section 7).
All other underground cables radiate out from the centre of the array in the same tranches as the fibre optic cable. The underground cable is four core and earth 16 mm$^2$ PVC cable rated at 0.6/1kV. Each array requires approximately 1,250 m of this underground cable. It can be used to connect 3 phase or single phase loads. All cabling lengths have an additional 10% contingency.

10.2 415V Distribution Boards

Two types of distribution boards are used for each array; one in the array hut at the centre and a second type for outdoor. The configuration of each is as follows:

- Indoor:
  - 4 element circuit CBs (120 A)
  - 3 hut CBs (25 A)
  - Earthing system

- Outdoor:
  - Up to 4 element circuit links
  - 2 motor CBs (15 A)

A Multiple Earthed Neutral (MEN) System is assumed.
11 EARTHING AND LIGHTNING PROTECTION

BRW has carried out a preliminary design of the earthing and lightning protection system. Full design will be site specific and require soil resistivity measurements.

11.1 Preliminary Design

The preliminary design has been carried out to Australian Standard AS/NZS 1768(Int.):2003 and involves:

• air terminal design to be incorporated into element design
• a down conductor shall be directly connected to an air terminal
• each element shall have 1 down conductor, each terminated on an earth termination.
• all down conductors shall be bonded together
• all practicable measures should be taken to achieve 5Ω or less for the whole interconnected Lightning Protection System (LPS) earth termination network
• the LPS shall be bonded to the MEN of the electricity supply system, building structural steelwork or reinforcing material and any metallic piping.

11.2 Arrangement and Components

The earthing and lightning protection preliminary design is shown in Figure 11.1 on the following page.
Figure 11.1: Earthing and lightning protection for each array

Earth Termination
- Earth Rod
  - 12 mm Diameter Cu
  - 98 Required

Down Conductor
- Earth Strip
  - 25mm x 3 mm Cu
  - 5 metres per Element
  - 20 metres for Hut
  - 490m required

Buried Bonding Conductor
- Stranded Conductor
  - 70mm² Cu
  - 1,200m required

Associated Connectors Required.
12 APPENDICES

- 12.1: HV/LV Distribution Costing
- 12.2: HV/LV Voltage Drop Calculations
- 12.3: Lifetime Unit Cost Models
- 12.4: Reference Papers
12.1 HV/LV Distribution Costing

- Core 7 Central Array Reticulation (includes OUT 0-4) (3pp)
- Outer Array Reticulation (includes REM 0-4) (2pp)
- Facilities Centre 22 kV Reticulation (1p)
# Core & Central Array Reticulation

## Material Quantities & Installation Including Labour Cost Assumptions

### 22kV & 415V Conductor

<table>
<thead>
<tr>
<th>Material &amp; Installation</th>
<th>22kV U/G Light</th>
<th>22kV U/G Light (S/T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share Trench LV 3C</td>
<td>$ 17 per metre</td>
<td>$ 77 per metre</td>
</tr>
<tr>
<td>Share Trench LV 1C</td>
<td>$ 27 per metre</td>
<td>$ 21 per metre</td>
</tr>
<tr>
<td>300 mm² PVC Cable 0.6/1kV</td>
<td>1,246 m Per Array</td>
<td>1,650,202</td>
</tr>
<tr>
<td>Single Core PVC V-90</td>
<td>95,942 m Sub Total</td>
<td>1,348,380</td>
</tr>
<tr>
<td>16 mm² PVC Cable 0.6/1kV</td>
<td>35 mm² XLPE Cable 12.7/22kV 3 Core Light Duty</td>
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</tr>
<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>20,396 m Shared Trench</td>
<td>42,316</td>
</tr>
<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>16,602 m Own Trench</td>
<td>1,278,354</td>
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<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>36,998 m Sub TOTAL</td>
<td>1,706,670</td>
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<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>34,050 m Phase Conductors</td>
<td></td>
</tr>
<tr>
<td>4,540 m - Sub Total</td>
<td>11,350 m Total Circuit Length</td>
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</tr>
<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>11,350 m Neutral Conductors</td>
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</tr>
<tr>
<td>4 Core plus Earth PVC V-75</td>
<td>4,540 10%</td>
<td></td>
</tr>
<tr>
<td><strong>Sub TOTAL</strong></td>
<td><strong>$ 9,124,752</strong></td>
<td><strong>$ 4,705,252</strong></td>
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## Labour Cost Assumptions

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost per Unit</th>
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<tbody>
<tr>
<td>Tx Installation</td>
<td>$7,200</td>
</tr>
<tr>
<td>Cable Termination</td>
<td>$1,100</td>
</tr>
</tbody>
</table>

### Type A - 150 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td></td>
</tr>
<tr>
<td>2 Function Switch</td>
<td></td>
</tr>
<tr>
<td>1 LV Circuit CB</td>
<td></td>
</tr>
<tr>
<td>Out-0</td>
<td></td>
</tr>
<tr>
<td>9 UNITS</td>
<td>$30,000</td>
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<tr>
<td>Transformer</td>
<td>$270,000</td>
</tr>
<tr>
<td>TX INSTALL</td>
<td>$64,800</td>
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<tr>
<td>TERMINATIONS</td>
<td>$29,700</td>
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<td>TOTAL</td>
<td>$364,500</td>
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</table>

### Type B - 150 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td></td>
</tr>
<tr>
<td>3 Function Switch</td>
<td></td>
</tr>
<tr>
<td>1 LV Circuit CB</td>
<td></td>
</tr>
<tr>
<td>Cent-1</td>
<td></td>
</tr>
<tr>
<td>Cent-17</td>
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<tr>
<td>25 UNITS</td>
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<tr>
<td>Transformer</td>
<td>$825,000</td>
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<td>TX INSTALL</td>
<td>$180,000</td>
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<td>TERMINATIONS</td>
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<td>TOTAL</td>
<td>$1,170,000</td>
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### Type C - 150 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

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<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>HV Fuses</td>
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</tr>
<tr>
<td>4 Function Switch</td>
<td></td>
</tr>
<tr>
<td>1 LV Circuit CB</td>
<td></td>
</tr>
<tr>
<td>Cent-0</td>
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</tr>
<tr>
<td>Cent-30</td>
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</tr>
<tr>
<td>11 UNITS</td>
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<tr>
<td>Transformer</td>
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<td>$79,200</td>
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<td>TERMINATIONS</td>
<td>$108,900</td>
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<td>TOTAL</td>
<td>$606,100</td>
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### Type D - 500 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

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<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>HV Fuses</td>
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</tr>
<tr>
<td>3 Function Switch</td>
<td></td>
</tr>
<tr>
<td>3 LV Circuit CB's</td>
<td></td>
</tr>
<tr>
<td>PAD1</td>
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</tr>
<tr>
<td>2 UNITS</td>
<td>$42,000</td>
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<tr>
<td>Transformer</td>
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<tr>
<td>TX INSTALL</td>
<td>$14,400</td>
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<td>TERMINATIONS</td>
<td>$13,200</td>
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<td>TOTAL</td>
<td>$111,600</td>
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</tbody>
</table>

### Type E - 500 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td></td>
</tr>
<tr>
<td>4 Function Switch</td>
<td></td>
</tr>
<tr>
<td>3 LV Circuit CB's</td>
<td></td>
</tr>
<tr>
<td>PAD2</td>
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</tr>
<tr>
<td>5 UNITS</td>
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<tr>
<td>Transformer</td>
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<tr>
<td>TX INSTALL</td>
<td>$36,000</td>
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<tr>
<td>TERMINATIONS</td>
<td>$49,500</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$320,500</td>
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</table>

### Type F - 500 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>HV Fuses</td>
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</tr>
<tr>
<td>3 Function Switch</td>
<td></td>
</tr>
<tr>
<td>4 LV Circuit CB's</td>
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<tr>
<td>PAD7</td>
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</tr>
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<td>1 UNITS</td>
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<tr>
<td>Transformer</td>
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</tr>
<tr>
<td>TX INSTALL</td>
<td>$7,200</td>
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<tr>
<td>TERMINATIONS</td>
<td>$6,600</td>
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<tr>
<td>TOTAL</td>
<td>$61,800</td>
</tr>
</tbody>
</table>

### Type T - 500 kVA Padmounted Transformer
22kV/433V Dyn11 ±2.5% & ±5.0% Taps

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td></td>
</tr>
<tr>
<td>3 Function Switch</td>
<td></td>
</tr>
<tr>
<td>4 LV Circuit CB's</td>
<td></td>
</tr>
<tr>
<td>PAD8</td>
<td></td>
</tr>
<tr>
<td>1 UNITS</td>
<td>$48,000</td>
</tr>
<tr>
<td>Transformer</td>
<td>$48,000</td>
</tr>
<tr>
<td>TX INSTALL</td>
<td>$7,200</td>
</tr>
<tr>
<td>TERMINATIONS</td>
<td>$6,600</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$61,800</td>
</tr>
<tr>
<td>Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>415V Distribution Boards</td>
<td></td>
</tr>
<tr>
<td>Type 1 per Array Hut (Indoor)</td>
<td></td>
</tr>
<tr>
<td>4 Element Circuit CB's - 120A</td>
<td></td>
</tr>
<tr>
<td>3 Hut Circuit CB's - 25A</td>
<td></td>
</tr>
<tr>
<td>Earthing System</td>
<td>70 Units</td>
</tr>
<tr>
<td>Lab &amp; Mat per Unit</td>
<td></td>
</tr>
<tr>
<td>Type 2 - per Array Element (Outdoor)</td>
<td></td>
</tr>
<tr>
<td>up to 4 Element Circuit Links</td>
<td></td>
</tr>
<tr>
<td>2 Motor CB's - 15A</td>
<td></td>
</tr>
<tr>
<td>Earthing System</td>
<td>3,220 Units</td>
</tr>
<tr>
<td>Lab &amp; Mat per Unit</td>
<td></td>
</tr>
<tr>
<td>OVERALL TOTAL</td>
<td></td>
</tr>
</tbody>
</table>
## Outer-Array Reticulation

**Material Quantities & Installation Including Labour Cost Assumptions**

### 22kV Conductor

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead 22kV Line</td>
<td>Designated Rural Medium on Concrete Poles (120m Spans)</td>
<td>$28 per m (Materials &amp; Labour)</td>
<td>$25,818,240</td>
</tr>
<tr>
<td>Gas Insulated Switches (for Sectionalising Purposes)</td>
<td>6 Units</td>
<td>$14,000 per Unit (Materials &amp; Labour)</td>
<td>$84,000</td>
</tr>
<tr>
<td>Reclosers</td>
<td>10 Units</td>
<td>$34,000 per Unit (Materials &amp; Labour)</td>
<td>$340,000</td>
</tr>
</tbody>
</table>

**Sub TOTAL** $35,482,440

### Underground 22kV Cable

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead 22kV Cable</td>
<td>30 Units</td>
<td>4,000 m per unit</td>
<td>$77 per m (Materials &amp; Labour)</td>
</tr>
</tbody>
</table>

**Sub TOTAL** $14,000

### 22kV/433V Padmounted Transformers

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclosers</td>
<td>10 Units</td>
<td>$34,000 per Unit (Materials &amp; Labour)</td>
<td>$340,000</td>
</tr>
</tbody>
</table>

**Sub TOTAL** $22kV/433V Padmounted Transformers $1,215,000

#### Labour Cost Assumptions

- **Tx Installation** $7,200 per Substation Complete (Pad, Earthing, Set Down, Connection & Test)
- **Cable Termination** $1,100 per Termination including materials

### TYPE A - 150 kVA Padmounted Transformer

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td>Out-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-8</td>
<td></td>
<td></td>
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<tr>
<td>Out-9</td>
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<td>Out-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-12</td>
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<td></td>
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<tr>
<td>Out-13</td>
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</tr>
<tr>
<td>Out-16</td>
<td>Rem-1</td>
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<td></td>
</tr>
<tr>
<td>Out-17</td>
<td>Rem-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-18</td>
<td>Rem-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-19</td>
<td>Rem-4</td>
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</tr>
</tbody>
</table>

**30 Units**

- **TRANSFORMER** $900,000
- **TX INSTALL** $216,000
- **TERMINATIONS** $99,000

**Sub TOTAL** $38,612,150
### 415V Conductor

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mm² PVC Cable 0.6/1kV Single Core PVC V-90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer Arrays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 m (=100m + 20m)</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m - Sub Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,800 m Phase Conductors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m Neutral Conductors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,440 10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m - Sub Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 mm² PVC Cable 0.6/1kV 4 Core plus Earth PVC V-75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,246 m Per Array</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125 10%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>41,118 m TOTAL</td>
<td></td>
<td></td>
<td>$ 707,230</td>
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<tr>
<td>300 mm² PVC Cable 0.6/1kV Single Core PVC V-90</td>
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<td></td>
</tr>
<tr>
<td>Outer Arrays</td>
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<tr>
<td>120 m (=100m + 20m)</td>
<td>30</td>
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<tr>
<td>3,600 m - Sub Total</td>
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</tr>
<tr>
<td>10,800 m Phase Conductors</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m Neutral Conductors</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,440 10%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m - Sub Total</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>16 mm² PVC Cable 0.6/1kV 4 Core plus Earth PVC V-75</td>
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</tbody>
</table>

### 415V Distribution Boards

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 per Array Hut (Indoor)</td>
<td>30 Units</td>
<td>$ 3,000</td>
<td>$ 90,000</td>
</tr>
<tr>
<td>4 Element Circuit CB's - 120A</td>
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</tr>
<tr>
<td>3 Hut Circuit CB's - 25A</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Earthing System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 2 - per Array Element (Outdoor)</td>
<td>1,380 Units</td>
<td>$ 500</td>
<td>$ 690,000</td>
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<tr>
<td>up to 4 Element Circuit Links</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2 Motor CB's - 15A</td>
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<td></td>
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</table>

### OUTER RETICULATION TOTAL

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>$ 1,134,910 Sub TOTAL</td>
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<tr>
<td>$ 780,000 Sub TOTAL</td>
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<tr>
<td>$ 3,600 Sub TOTAL</td>
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</tr>
<tr>
<td>300 mm² PVC Cable 0.6/1kV Single Core PVC V-90</td>
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<td></td>
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</tr>
<tr>
<td>Outer Arrays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 m (=100m + 20m)</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m - Sub Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,800 m Phase Conductors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m Neutral Conductors</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,440 10%</td>
<td></td>
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<tr>
<td>3,600 m - Sub Total</td>
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<tr>
<td>16 mm² PVC Cable 0.6/1kV 4 Core plus Earth PVC V-75</td>
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</tr>
<tr>
<td>1,246 m Per Array</td>
<td>30</td>
<td></td>
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<tr>
<td>125 10%</td>
<td></td>
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</tr>
<tr>
<td>41,118 m TOTAL</td>
<td></td>
<td></td>
<td>$ 707,230</td>
</tr>
<tr>
<td>300 mm² PVC Cable 0.6/1kV Single Core PVC V-90</td>
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<tr>
<td>Outer Arrays</td>
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</tr>
<tr>
<td>120 m (=100m + 20m)</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,600 m - Sub Total</td>
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<td></td>
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</tr>
<tr>
<td>10,800 m Phase Conductors</td>
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</tr>
<tr>
<td>3,600 m Neutral Conductors</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1,440 10%</td>
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<td></td>
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</tr>
<tr>
<td>3,600 m - Sub Total</td>
<td></td>
<td></td>
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<tr>
<td>16 mm² PVC Cable 0.6/1kV 4 Core plus Earth PVC V-75</td>
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<tr>
<td>1,246 m Per Array</td>
<td>30</td>
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</tr>
<tr>
<td>125 10%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>41,118 m TOTAL</td>
<td></td>
<td></td>
<td>$ 707,230</td>
</tr>
<tr>
<td>$ 1,134,910 Sub TOTAL</td>
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<td>$ 780,000 Sub TOTAL</td>
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<tr>
<td>$ 3,600 Sub TOTAL</td>
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<tr>
<td>$ 2,454,910 Sub TOTAL</td>
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### OUTER RETICULATION TOTAL

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<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate</th>
<th>Total</th>
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<tr>
<td>$ 1,544,485.98 per Array</td>
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</table>
Facilities Centre 22kV Reticulation

Material Quantities & Installation

Including Labour Cost Assumptions

Key Elements:
500 m of 22kV Underground Cable from 0.415/22kV Substation to Facilities Centre
3 x 750 KVA Padmount Substations at Facilities Centre
5 x 150 kVA 415V Circuits per Padmount Substation (15 Circuits Total) - 30 m

<table>
<thead>
<tr>
<th>22kV &amp; 415V Conductor</th>
<th>$ 91,960</th>
<th>Sub TOTAL</th>
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</table>

**Installation (Labour & Material) Cost Assumptions**

<table>
<thead>
<tr>
<th>Share Trench LV 1C</th>
<th>$ 27</th>
<th>per metre</th>
<th>22kV U/G Light</th>
<th>$ 77</th>
<th>per metre</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>300 mm$^2$ PVC Cable 0.6/1kV</th>
<th>Single Core PVC V-90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padmount Substation to Main Switchboard</td>
<td></td>
</tr>
<tr>
<td>30 m</td>
<td>15 3 Phase Circuits</td>
</tr>
<tr>
<td>450 m - Sub Total</td>
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<tr>
<td>1,350 m Phase Conductors</td>
<td>450 m Neutral Conductors</td>
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<tr>
<td>180 m 10%</td>
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<td>1,980 m Sub TOTAL</td>
<td>$ 53,460</td>
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</table>

<table>
<thead>
<tr>
<th>35 mm2 XLPE Cable 12.7/22kV 3 Core Light Duty</th>
<th>Screened Unarmoured Compacted Aluminium Conductor Wire Screened to AS/NZS1429.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 m Own Trench</td>
<td>$ 38,500</td>
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<tr>
<td>500 m Sub TOTAL</td>
<td>$ 38,500</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>22kV/433V Padmounted Transformers</th>
<th>$ 185,400</th>
<th>Sub TOTAL</th>
</tr>
</thead>
</table>

**Labour Cost Assumptions**

| Tx Installation | $ 7,200 | per Substation Complete (Pad, Earthing, Set Down, Connection & Test)) |
| Cable Termination | $ 1,100 | per Termination including materials |

<table>
<thead>
<tr>
<th>TYPE F - 750 kVA Padmounted Transformer</th>
<th>22kV/433V Dyn11 ±2.5% &amp; ±5.0% Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Fuses</td>
<td>PAD-A</td>
</tr>
<tr>
<td>3 Function Switch</td>
<td>PAD-B</td>
</tr>
<tr>
<td>4 LV Circuit CB's</td>
<td>PAD-C</td>
</tr>
<tr>
<td>3 UNITS</td>
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</tr>
<tr>
<td>$ 48,000</td>
<td>TRANSFORMER</td>
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<td></td>
<td>TX INSTALL</td>
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<td></td>
<td>TERMINATIONS</td>
</tr>
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<td></td>
<td>TOTAL</td>
</tr>
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**OVERALL TOTAL** | $ 277,360 |
12.2 HV/LV Voltage Drop Calculations

- Inter-Array Reticulation: 22 kV Underground Feeder Voltage Drop Calculations (2pp)
- Outer-Array Reticulation: 22 kV Overhead & Underground Feeder Voltage Drop Calculations (3pp)
- Intra-Array Reticulation: 415 V Voltage Drop Calculations (2pp)
- 22kV/415V Padmount Transformer Tapping Ranges (1p)
- Facilities Centre Reticulation: 22kV Underground Feeder Voltage Drop (1p)
Inter-Array Reticulation
22kV Underground Feeder Voltage Drop Calculations

XLPE Cable 12.7/22kV
3 Core Light Duty Screened Unarmoured
Compacted Aluminium Conductor Wire Screened to AS/NZS1429.1

<table>
<thead>
<tr>
<th>mm²</th>
<th>R (Ω/km)</th>
<th>X (Ω/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>1.1100</td>
<td>0.1360</td>
</tr>
<tr>
<td>50</td>
<td>0.8220</td>
<td>0.1300</td>
</tr>
<tr>
<td>70</td>
<td>0.5680</td>
<td>0.1200</td>
</tr>
</tbody>
</table>

Maximum HV Voltage Drop is -5% (Allows a +2.5% at Transformer LV Terminals @ 95% Tap)

**Bold Italic** Length indicates Chain Dig Installation $77,000 per km
Other Trenching is Shared with Fibre Optic Cable $21,000 per km

<table>
<thead>
<tr>
<th>Cos Φ</th>
<th>Sin Φ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0.6</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Feeder-A 14,333 m</th>
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</thead>
<tbody>
<tr>
<td>Section</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>PS - CENT-37</td>
</tr>
<tr>
<td>CENT-32</td>
</tr>
<tr>
<td>CENT-37 - CENT-32</td>
</tr>
<tr>
<td>CENT-32 - CENT-27</td>
</tr>
<tr>
<td>CENT-27 - CENT-22</td>
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<tr>
<td>CENT-22 - CENT-17</td>
</tr>
<tr>
<td>CENT-17 - CENT-12</td>
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<tr>
<td>CENT-12 - CENT-7</td>
</tr>
<tr>
<td>CENT-7 - CENT-2</td>
</tr>
<tr>
<td>CENT-2</td>
</tr>
<tr>
<td>CENT-16 - CENT-11</td>
</tr>
<tr>
<td>CENT-11 - CENT-6</td>
</tr>
<tr>
<td>CENT-6 - CENT-1</td>
</tr>
<tr>
<td>CENT-1 - PAD4</td>
</tr>
<tr>
<td>PAD4 - PAD3</td>
</tr>
<tr>
<td>PAD4 - PAD5</td>
</tr>
<tr>
<td>CENT-2 - CENT-21</td>
</tr>
<tr>
<td>CENT-26 - CENT-21</td>
</tr>
<tr>
<td>CENT-31 - CENT-36</td>
</tr>
<tr>
<td>CENT-31 - CENT-26</td>
</tr>
<tr>
<td>CENT-31 - CENT-21</td>
</tr>
<tr>
<td>CENT-31 - OUT-0</td>
</tr>
<tr>
<td>CENT-31 - OUT-0</td>
</tr>
<tr>
<td>CENT-2 - PAD1</td>
</tr>
<tr>
<td>PAD2 - PAD3</td>
</tr>
<tr>
<td>Section</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>PS - CENT-9</td>
</tr>
<tr>
<td>CENT-9 - CENT-4</td>
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<tr>
<td>CENT-4 - PAD6</td>
</tr>
<tr>
<td>PAD6 - PAD7</td>
</tr>
<tr>
<td>CENT-9 - CENT-14</td>
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<td>PAD5 - PAD6</td>
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<td>CENT-18 - CENT-13</td>
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<tr>
<td>CENT-13 - CENT-8</td>
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<tr>
<td>CENT-8 - CENT-3</td>
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<tr>
<td>CENT-3 - PAD8</td>
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<tr>
<td>PAD8 - PAD1</td>
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<td>CENT-28 - CENT-33</td>
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<tr>
<td>CENT-33 - CENT-38</td>
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<tr>
<td>CENT-33 - OUT-2</td>
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TOTAL  36,998 m
Outer-Array Reticulation
22kV Overhead & Underground Feeder Voltage Drop Calculations

22kV Overhead Line
Concrete Pole Construction with All Aluminium Conductor (Bare)
2.0m x 1.0m Delta Construction

<table>
<thead>
<tr>
<th>Code Name</th>
<th>Stranding</th>
<th>GMR (mm)</th>
<th>R (Ω/km)</th>
<th>X (Ω/km)</th>
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<tbody>
<tr>
<td>LEO</td>
<td>7/2.50</td>
<td>2.72</td>
<td>1.0200</td>
<td>0.3858</td>
</tr>
<tr>
<td>LIBRA</td>
<td>7/3.00</td>
<td>3.27</td>
<td>0.7060</td>
<td>0.3743</td>
</tr>
<tr>
<td>MARS</td>
<td>7/3.75</td>
<td>4.01</td>
<td>0.4520</td>
<td>0.3614</td>
</tr>
<tr>
<td>MERCURY</td>
<td>7/4.50</td>
<td>4.90</td>
<td>0.3140</td>
<td>0.3488</td>
</tr>
<tr>
<td>MOON</td>
<td>7/4.75</td>
<td>5.17</td>
<td>0.2820</td>
<td>0.3455</td>
</tr>
<tr>
<td>NEPTUNE</td>
<td>19/3.25</td>
<td>6.16</td>
<td>0.2230</td>
<td>0.3344</td>
</tr>
<tr>
<td>ORION</td>
<td>19/3.50</td>
<td>6.63</td>
<td>0.1930</td>
<td>0.3298</td>
</tr>
<tr>
<td>PLUTO</td>
<td>19/3.75</td>
<td>7.10</td>
<td>0.1680</td>
<td>0.3255</td>
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Maximum HV Voltage Drop is -5% (Allows a +2.5% at Transformer LV Terminals @ 95% Tap)
### Feeder 1

<table>
<thead>
<tr>
<th>Section</th>
<th>Length m</th>
<th>Arrays</th>
<th>Amps</th>
<th>Code</th>
<th>$R$ (Ω/km)</th>
<th>$X$ (Ω/km)</th>
<th>$VD$</th>
<th>Cum $VD$</th>
<th>Cum $VD$ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS - TO-A</td>
<td>3,000</td>
<td>15</td>
<td>59</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>133</td>
<td>133</td>
<td>0.60%</td>
</tr>
<tr>
<td>TO-A - TO-B</td>
<td>9,740</td>
<td>10</td>
<td>39</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>287</td>
<td>420</td>
<td>1.91%</td>
</tr>
<tr>
<td>TO-B - TO-C</td>
<td>8,340</td>
<td>5</td>
<td>20</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>123</td>
<td>543</td>
<td>2.47%</td>
</tr>
<tr>
<td>TO-A - OUT-6</td>
<td>3,000</td>
<td>5</td>
<td>20</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>44</td>
<td>177</td>
<td>0.80%</td>
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<tr>
<td>OUT-6 - OUT-11</td>
<td>6,000</td>
<td>4</td>
<td>16</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>71</td>
<td>246</td>
<td>1.13%</td>
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<td>OUT-11 - OUT-16</td>
<td>12,000</td>
<td>3</td>
<td>12</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>106</td>
<td>354</td>
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<tr>
<td>OUT-16 - OUT-21</td>
<td>18,000</td>
<td>2</td>
<td>8</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>106</td>
<td>460</td>
<td>2.09%</td>
</tr>
<tr>
<td>OUT-21 - OUT-26</td>
<td>46,000</td>
<td>1</td>
<td>4</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>136</td>
<td>596</td>
<td>2.71%</td>
</tr>
<tr>
<td>OUT-26 - REM-1</td>
<td>90,000</td>
<td>1</td>
<td>4</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>266</td>
<td>862</td>
<td>3.92%</td>
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<tr>
<td>TO-B - OUT-5</td>
<td>6,000</td>
<td>4</td>
<td>16</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>71</td>
<td>465</td>
<td>2.11%</td>
</tr>
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<td>TO-C - OUT-9</td>
<td>3,000</td>
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<td>20</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>44</td>
<td>465</td>
<td>2.11%</td>
</tr>
<tr>
<td>OUT-9 - OUT-14</td>
<td>6,000</td>
<td>4</td>
<td>16</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>71</td>
<td>658</td>
<td>2.99%</td>
</tr>
<tr>
<td>OUT-14 - OUT-19</td>
<td>12,000</td>
<td>3</td>
<td>12</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>106</td>
<td>765</td>
<td>3.48%</td>
</tr>
<tr>
<td>OUT-19 - OUT-24</td>
<td>18,000</td>
<td>2</td>
<td>8</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>106</td>
<td>871</td>
<td>3.96%</td>
</tr>
<tr>
<td>OUT-24 - OUT-29</td>
<td>46,000</td>
<td>1</td>
<td>4</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>136</td>
<td>1,007</td>
<td>4.58%</td>
</tr>
<tr>
<td>OUT-29 - REM-4</td>
<td>90,000</td>
<td>1</td>
<td>4</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>266</td>
<td>1,272</td>
<td>5.78%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>546,080 m</strong></td>
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</table>

### Feeder 2

<table>
<thead>
<tr>
<th>Section</th>
<th>Length m</th>
<th>Arrays</th>
<th>Amps</th>
<th>mm²</th>
<th>$R$ (Ω/km)</th>
<th>$X$ (Ω/km)</th>
<th>$VD$</th>
<th>Cum $VD$</th>
<th>Cum $VD$ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS - TO-E</td>
<td>7,340</td>
<td>10</td>
<td>39</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>217</td>
<td>217</td>
<td>0.98%</td>
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<tr>
<td>TO-E - TO-D</td>
<td>9,600</td>
<td>5</td>
<td>20</td>
<td>MOON</td>
<td>0.2820</td>
<td>0.3455</td>
<td>133</td>
<td>349</td>
<td>1.59%</td>
</tr>
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<td>OUT-22 - OUT-27</td>
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**TOTAL 922,080 m**
22kV Underground Cable

XLPE Cable 12.7/22kV
3 Core Light Duty Screened Unarmoured
Compacted Aluminium Conductor Wire Screened to AS/NZS1429.1

<table>
<thead>
<tr>
<th>mm²</th>
<th>$R$ (Ω/km)</th>
<th>$X$ (Ω/km)</th>
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<tr>
<td>35</td>
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<tr>
<td>70</td>
<td>0.5680</td>
<td>0.1200</td>
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**Bold Italic** Length indicates Chain Dig Installation  $ 77,000 per km

<table>
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<tr>
<th>Section</th>
<th>Length m</th>
<th>Arrays</th>
<th>Amps</th>
<th>Size</th>
<th>$R$ (Ω/km)</th>
<th>$X$ (Ω/km)</th>
<th>VD</th>
<th>Cum VD</th>
<th>Cum VD %</th>
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<td>Pole to Substation</td>
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**Maintenance**

1 Pole Inspection every 10 years @ $ 20.00 per pole
Assuming 150 m spans = 6,147 poles
Inspection Cost per 10 years = $ 122,944 per annum $ 12,294

Annual Aerial Line Inspection = $ 50,000

Fault & Emergency Work = $ 200,000 Assumnes 2 Full Time Staff $ 10,000 Materials

$ 272,294 per annum
Intra-Array Reticulation
415V Voltage Drop Calculations

PVC Cable 0.6/1kV
Single Core PVC V-90

<table>
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<tr>
<th>PVC Cable 0.6/1kV</th>
<th>Four Core plus Earth PVC V-75</th>
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<tr>
<td>3 Phase Voltage Drop</td>
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<tr>
<td>mm²</td>
<td>mV/A.m</td>
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<td>240</td>
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<tr>
<td>300</td>
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<td>400</td>
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</table>

X is the cable from the transformer to the Array Hut = 4 x Single Core (3 Phase + Neutral)

Other Sections are as per SKA Model 45 Element LNSD Array Station Diagram
Other Sections are 4 Core plus Earth PVC Insulated Laid Up Cable

As Transformer Terminal Voltage can be set above nominal voltage, allowable Voltage Drop taken as 7.5% (Assuming +2.5% at transformer terminals)
Therefore minimum LV is -5%

A Multiple Earthed Neutral (MEN) System is Assumed.

<table>
<thead>
<tr>
<th>2 kVA per Array</th>
<th>415 Volts</th>
</tr>
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<tbody>
<tr>
<td>Section</td>
<td>Extra (m) for X</td>
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</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Length (m)</th>
<th>Elements</th>
<th>kW</th>
<th>Amps</th>
<th>mm²</th>
<th>mV.A.m</th>
<th>VD</th>
<th>Cum VD</th>
<th>Cum VD %</th>
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<td>0.22</td>
<td>28.33</td>
<td>6.83%</td>
</tr>
<tr>
<td>D10</td>
<td>26</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>2.430</td>
<td>0.22</td>
<td>28.33</td>
<td>6.83%</td>
</tr>
<tr>
<td>D11</td>
<td>26</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>2.430</td>
<td>0.22</td>
<td>28.33</td>
<td>6.83%</td>
</tr>
</tbody>
</table>
22kV/433V Padmount Transformer Tapping Ranges

5% = Maximum HV Voltage Drop

<table>
<thead>
<tr>
<th>22 kV</th>
<th>2.5% Taps</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<tbody>
<tr>
<td>Range</td>
<td>105.00%</td>
<td>102.50%</td>
<td>100.00%</td>
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<td>95.0%</td>
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</tr>
<tr>
<td>HV</td>
<td>23100</td>
<td>22550</td>
<td>22000</td>
<td>21450</td>
<td>20900</td>
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<tr>
<td>Fixed LV</td>
<td>433</td>
<td>433</td>
<td>433</td>
<td>433</td>
<td>433</td>
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</tr>
<tr>
<td>Ratio</td>
<td>53.35</td>
<td>52.08</td>
<td>50.81</td>
<td>49.54</td>
<td>48.27</td>
<td></td>
</tr>
<tr>
<td>Fixed HV</td>
<td>20900</td>
<td>20900</td>
<td>20900</td>
<td>20900</td>
<td>20900</td>
<td></td>
</tr>
<tr>
<td>LV</td>
<td>392</td>
<td>401</td>
<td>411</td>
<td>422</td>
<td>433</td>
<td></td>
</tr>
<tr>
<td>% &gt;415</td>
<td>-5.6%</td>
<td>-3.3%</td>
<td>-0.9%</td>
<td>1.7%</td>
<td>4.3%</td>
<td></td>
</tr>
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</table>

Tap Position 4 and 5 (97.5% & 95.0%) will ensure a maximum of 5% LV voltage drop at the elements of each array.
Facilities Centre Reticulation  
**22kV Underground Feeder Voltage Drop Calculations**

**XLPE Cable 12.7/22kV**  
3 Core Light Duty Screened Unarmoured  
Compacted Aluminium Conductor Wire Screened to AS/NZS1429.1

<table>
<thead>
<tr>
<th>mm²</th>
<th>R (Ω/km)</th>
<th>X (Ω/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>1.1100</td>
<td>0.1360</td>
</tr>
<tr>
<td>50</td>
<td>0.8220</td>
<td>0.1300</td>
</tr>
<tr>
<td>70</td>
<td>0.5680</td>
<td>0.1200</td>
</tr>
</tbody>
</table>

Maximum HV Voltage Drop is -5% (Allows a +2.5% at Transformer LV Terminals @ 95% Tap)

**Bold Italic** Length indicates Chain Dig Installation $77,000 per km  
Other Trenching is Shared with Fibre Optic Cable $21,000 per km

<table>
<thead>
<tr>
<th>Feeder-A</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
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<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Sub - Fac Centre | 500 | 1 | 66 | 35 | 1.1100 | 0.1360 | 55 | 55 | 0.25% |
12.3 Lifetime Unit Cost Models

- PV-Battery-Standby Diesel (Assumptions & Calculations – 2 pp)
- Grid Supplied Power System (Assumptions & Calculations – 2 pp)
- HV Distribution & Intra-Array Reticulation (2 pp)
**Photovoltaic Systems**

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
<th>Symbol</th>
<th>Formula</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT LIFETIME COST ($/kWh)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.42</strong></td>
</tr>
</tbody>
</table>

**Project Assumptions:**
- **Average array power**: 120 kW AAP
- **Peak array power**: 150 kW PAP
- **Annual demand factor**: 100% ADF
- **Number of arrays**: 125 NA
- **RAPS fed arrays**: 11 GF
- **Capacity contingency allowance**: 10% PPA

**Financial Assumptions:**
- **Discount rate**: 7% DR
- **Economic life**: 30 Years EL
- **Renewable subsidy**: 0% RS

**PV Assumptions:**
- **Unit capital cost**: 5.00 $/W UPVC
- **Annual cost reduction**: 5% PVR
- **Average insolation level**: 6 kWh/kW AIL
- **Annual degradation**: 1% AD
- **Additional PV for degradn.**: 10% APV
- **PV life**: 30 Years PVL

**Battery Assumptions:**
- **Unit capital cost**: 580 $/kWh UBC
- **Annual cost reduction**: 2.5% BR
- **Conversion efficiency**: 90% BCE
- **Battery life**: 10 Years BL

**Balance of System:**
- **Regulator-inverter capital cost**: 2.50 $/W UIC
- **Annual reg-inv cost reduction**: 2.5% IR
- **Regulator-inverter conversion effic.**: 94% ICE
- **Regulator-inverter life**: 15 Years IL
- **Unit foundtn & steel work**: 1 $/W UFS
- **Unit construction labour**: 1 $/W UCL
- **Unit annual O&M costs**: 0.02 $M UOM

**Standby Generation:**
- **Diesel genset capacity**: 120 kW DGC
- **Diesel genset capital cost**: 0.15 $M DCC
- **Genset unit fuel consumption**: 0.29 litre/kWh GFC
- **Diesel fuel cost**: 1.50 $/litre DFC
- **Annual fuel price increase**: 2% FPI
- **Annual operating hours**: 336 hours AOH
- **Maintenance**: 0.01 $M DGM

---

This model calculates the lifetime unit cost of electricity of the PV-battery-standby diesel system in $/kWh. The lifetime unit cost is the notional price of electricity that gives a zero NPV at the required discount rate. It includes all capital & O&M costs over the life of the project. To operate the model, change a value in any tan coloured cell with border and then press "Control p".
### Calculations per Array:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Oct</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual energy demand</strong></td>
<td>1,051,200 kWh</td>
<td>AED</td>
<td>AAP<em>ADF</em>8,760</td>
<td>Daily energy demand is</td>
<td>2,880 kWh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual PV unit output</strong></td>
<td>2,190 kWh/kW</td>
<td>AUA</td>
<td>AIL*365</td>
<td>Daily energy output is</td>
<td>3,168 kWh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PV capacity</strong></td>
<td>624 kW</td>
<td>PC</td>
<td>AAP<em>ADF</em>(1+PPA)*(1+(24-AIL)/AIL)/BCE/ICE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual PV output</strong></td>
<td>1,366,809 kWh</td>
<td>AOU</td>
<td>AAP<em>AAP</em>AUO*AIL</td>
<td>Includes renewable subsidy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PV capital cost in 2005</strong></td>
<td>3.12 $M</td>
<td>PVC</td>
<td>UPVC<em>PC</em>(1-RS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PV capital cost in 2012</strong></td>
<td>2.18 $M</td>
<td>PVC11</td>
<td>PVC*(1-PV)*R</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Battery capacity</strong></td>
<td>2,376 kWh</td>
<td>BC</td>
<td>(24-AIL)<em>AAP</em>ADF*1+PPA</td>
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<tr>
<td><strong>Battery cost in 2005</strong></td>
<td>1.38 $M</td>
<td>BCC</td>
<td>UBC*BC</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Battery cost in 2012</strong></td>
<td>1.15 $M</td>
<td>BCC11</td>
<td>BCC*(1-BR)*R</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regulator-inverter cost in 2005</strong></td>
<td>0.50 $M</td>
<td>IC</td>
<td>UIC*PC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regulator-inverter cost in 2012</strong></td>
<td>0.42 $M</td>
<td>IC11</td>
<td>IC*(1-IR)*R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Foundtn &amp; steel costs</strong></td>
<td>0.62 $M</td>
<td>FSC</td>
<td>UFS*PC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Labour constrn. costs</strong></td>
<td>0.62 $M</td>
<td>LCC</td>
<td>UCL*PC</td>
<td></td>
<td></td>
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<tr>
<td><strong>Annual O&amp;M costs</strong></td>
<td>0.02 $M</td>
<td>OM</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intra-array cabling and labour</strong></td>
<td>0.05 $M</td>
<td>CML</td>
<td></td>
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<tr>
<td><strong>Diesel genset output</strong></td>
<td>40,320 kWh</td>
<td>DGO</td>
<td>DGC*AOH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Annual operating cost in 2005</strong></td>
<td>0.017 $M</td>
<td>DOC</td>
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</table>

### Present Value Analysis:

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<td><strong>Cost per array:</strong></td>
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<td></td>
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<tr>
<td></td>
<td>All values in $M</td>
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<tr>
<td>PV capital cost</td>
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<td>2.07</td>
<td>1.97</td>
<td>1.87</td>
<td>1.77</td>
<td>1.69</td>
<td>1.60</td>
<td>1.52</td>
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<tr>
<td>Additional PV for degradation</td>
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<td></td>
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<tr>
<td>Battery capital cost</td>
<td>1.15</td>
<td>1.13</td>
<td>1.10</td>
<td>1.07</td>
<td>1.04</td>
<td>1.02</td>
<td>0.99</td>
<td>0.97</td>
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<tr>
<td>Costs to replace battery after 10 years</td>
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<tr>
<td>Regulator-inverter capital cost</td>
<td>0.42</td>
<td>0.41</td>
<td>0.40</td>
<td>0.39</td>
<td>0.38</td>
<td>0.37</td>
<td>0.36</td>
<td>0.35</td>
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<tr>
<td>Costs to replace reg-inv after 15 years</td>
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<tr>
<td>Foundation &amp; steelwork costs</td>
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<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
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<tr>
<td>Standby diesel genset capital cost</td>
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<tr>
<td>Cabling materials and labour</td>
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<td>0.05</td>
<td>0.05</td>
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<td>Labour construction cost</td>
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<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
<td>0.62</td>
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<tr>
<td>TOTAL</td>
<td>5.21</td>
<td>5.06</td>
<td>4.92</td>
<td>4.78</td>
<td>4.65</td>
<td>4.53</td>
<td>4.41</td>
<td>4.29</td>
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**If capex over life required then 1 else 0**: 

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<thead>
<tr>
<th></th>
<th>Discounted</th>
<th>Undiscounted</th>
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<tbody>
<tr>
<td><strong>Capital:</strong></td>
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<tr>
<td>Initial</td>
<td>28.96</td>
<td>47.90</td>
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<td>Replacement/upgrade</td>
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<td>26.44</td>
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<td></td>
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<tr>
<td></td>
<td>34.12</td>
<td>74.34</td>
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<tr>
<td><strong>O&amp;M</strong></td>
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<tr>
<td>Initial 10 years</td>
<td>3.02</td>
<td>7.00</td>
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<tr>
<td>Over 30 year life</td>
<td>5.19</td>
<td>21.17</td>
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</tbody>
</table>

**NPV ($M)**: Real total power cost (Cap. + O&M) over the economic life of the system 

**UNIT LIFETIME COST ($/kWh)**: Real per unit cost of electricity over the economic life of the system
### C2741: CSIRO SKA RAPS Systems

#### Fossil Fuel Power System

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
<th>Symbol</th>
<th>Formula</th>
<th>Comment</th>
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</thead>
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<tr>
<td>120</td>
<td>kW</td>
<td>AAP</td>
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<td></td>
</tr>
<tr>
<td>150</td>
<td>kW</td>
<td>PAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td>%</td>
<td>ADF</td>
<td></td>
<td>% of time array requires average power demand</td>
</tr>
<tr>
<td>125</td>
<td>#</td>
<td>NA</td>
<td></td>
<td>All arrays requiring a RAPS system</td>
</tr>
<tr>
<td>11</td>
<td>#</td>
<td>GF</td>
<td></td>
<td>Assumes a proportion of remote arrays can be supplied from a local grid</td>
</tr>
<tr>
<td>5%</td>
<td>%</td>
<td>PPA</td>
<td></td>
<td>Energy consumed in peak</td>
</tr>
</tbody>
</table>

#### Project Assumptions:

- **Average array power**: 120 kW
- **Peak array power**: 150 kW
- **Annual demand factor**: 100%
- **Number of arrays**: 125
- **RAPS fed arrays**: 11
- **Peak energy allowance**: 5%

#### Financial Assumptions:

- **Discount rate**: 7.0%
- **Economic life**: 30 Years
- **Carbon tax or equivalent**: 0%

#### Genset Assumptions:

- **Genset size**: 85 kW
- **Number of gensets**: 3
- **Unit genset cost**: $50,000
- **Electrical 415V switchgear**: $45,000
- **Control system**: $50,000
- **Screened building**: $50,000
- **Installation**: $30,000
- **Engineering**: $20,000
- **Maintenance**: $30,000/year
- **Genset life**: 15 Years

#### Fuel Assumptions:

- **Fuel & oil storage & transfer**: $60,000
- **Fuel consumption**: 3.5 kWh/litre
- **Unit fuel price in 2005**: $1.50/litre
- **Real fuel price increase**: 2%

This model calculates the lifetime unit cost of electricity for the grid-supplied system of arrays in $/kWh. The lifetime unit cost is the notional price of electricity that gives a zero NPV at the required discount rate. It includes all capital & O&M costs over the life of the project. To operate the model, change a value in any tan coloured cell with border and then press "Control n".

All monetary values in real dollars Australian ($2005)

Modeled as % increase in fuel price

Sufficient for peak plus spare (maintenance) plus temperature derating

Includes cabling from gensets with three feeders

Monthly visits plus two days travelling, includes oil

Diesel fuel

59kl fuel storage tank and bund

Includes delivery to remote site in 32kl tankers
### Calculations per Array:

- **Annual energy generated**: 1,103,760 kWh
- **Genset cost**: $150,000
- **Total capital cost**: $405,000
- **Replacement cost at life end**: $250,000
- **Fuel usage**: 315,360 litre/yr
- **Fuel oil cost in 2005**: $473,040/yr
- **Unit fuel oil cost in 2005**: 0.43 $/kWh

### Present Value Analysis:

<table>
<thead>
<tr>
<th>Year number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>0.9346</td>
<td>0.8734</td>
<td>0.8163</td>
<td>0.7629</td>
<td>0.7130</td>
<td>0.6663</td>
<td>0.6227</td>
<td>0.5820</td>
<td>0.5439</td>
</tr>
<tr>
<td>Years since 2005</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
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<tr>
<td>Number of arrays</td>
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<td>Cumulative number of arrays</td>
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<td>6.0</td>
<td>11.0</td>
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</tr>
<tr>
<td>Capital cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>2.43</td>
<td>2.03</td>
<td>2.03</td>
</tr>
<tr>
<td>Annual fuel cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.67</td>
<td>6.87</td>
<td>7.00</td>
</tr>
<tr>
<td>Annual maintenance cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.18</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6.28</td>
<td>9.22</td>
<td>7.33</td>
</tr>
<tr>
<td>Notional revenue</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>5.00</td>
<td>9.16</td>
<td>9.16</td>
</tr>
<tr>
<td>NET</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>-1.28</td>
<td>-0.06</td>
<td>1.83</td>
</tr>
<tr>
<td>Discounted NET</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.80</td>
<td>-0.04</td>
<td>0.99</td>
</tr>
<tr>
<td>NPV ($M)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

| Energy output (MWh) | 000000 | 6,623 | 12,141 | 12,141 |
| UNIT LIFETIME COST ($/kWh) | 0.75 | Real per unit cost of electricity over the economic life of the system |

| Growth in fuel price | 1.72 | 1.76 | 1.79 | 1.83 | 1.87 | 1.90 | 1.94 | 1.98 | 2.02 |
| Discounted capital | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Discounted fuel cost | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Discounted O&M cost | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total discounted costs | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.91 | 5.37 | 3.99 |
## Grid Supplied Power System

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average array power</td>
<td>120 kW</td>
</tr>
<tr>
<td>Peak array power</td>
<td>150 kW</td>
</tr>
<tr>
<td>Annual demand factor</td>
<td>100%</td>
</tr>
<tr>
<td>Number of arrays</td>
<td>125 #</td>
</tr>
<tr>
<td>Grid fed arrays</td>
<td>14 #</td>
</tr>
<tr>
<td>Peak energy allowance</td>
<td>5%</td>
</tr>
<tr>
<td>Average energy usage</td>
<td>1,051,200 kWh/yr</td>
</tr>
</tbody>
</table>

## Project Assumptions:

<table>
<thead>
<tr>
<th>Array</th>
<th>Nom. dist. to grid</th>
<th>Distribution line</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>rem5</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>rem8</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>rem10</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>rem11</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>rem15</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>rem16</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>rem22</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>rem23</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>rem24</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>rem25</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>rem26</td>
<td>20</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>max0</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>max1</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>max2</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

## Financial Assumptions:

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>7.0%</td>
</tr>
<tr>
<td>Economic life</td>
<td>30 Years</td>
</tr>
<tr>
<td>Carbon tax or equivalent</td>
<td>0%</td>
</tr>
</tbody>
</table>

## Network Assumptions:

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity price</td>
<td>0.17 $/kWh</td>
</tr>
<tr>
<td>Distribution line cost</td>
<td>28,000 $/km</td>
</tr>
<tr>
<td>No. arrays fed by cable only</td>
<td>5 #</td>
</tr>
<tr>
<td>Recloser, protn. &amp; metering</td>
<td>40,000 $/km</td>
</tr>
<tr>
<td>22kV/415V Padmount cost</td>
<td>30,000 $</td>
</tr>
<tr>
<td>22kV cable length</td>
<td>4 km</td>
</tr>
<tr>
<td>22kV cable cost</td>
<td>77,000 $/km</td>
</tr>
<tr>
<td>Annual O&amp;M costs</td>
<td>0 $</td>
</tr>
<tr>
<td>Average 22kV line length</td>
<td>12.7 km</td>
</tr>
<tr>
<td>Real electricity price rise</td>
<td>0%</td>
</tr>
</tbody>
</table>

## Array Assumptions:

<table>
<thead>
<tr>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-array cabling &amp; labour</td>
<td>54,914 $/km</td>
</tr>
</tbody>
</table>

UNIT LIFETIME COST ($/kWh) **0.21**

This model calculates the lifetime unit cost of electricity for the grid-supplied system of arrays in $/kWh. The lifetime unit cost is the notional price of electricity that gives a zero NPV at the required discount rate. It includes all capital & O&M costs over the life of the project. To operate the model, change a value in any tan coloured cell with border and then press "Control n".
### Calculations:

- **Average line cost**: $354,667
- **Average cable cost**: $308,000
- **Capital cost per array with line**: $787,581
- **Capital cost per array w/o line**: $432,914
- **Electricity price in 2005**: $187,639

#### Yearly Data:

<table>
<thead>
<tr>
<th>Year number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>0.9346</td>
<td>0.8734</td>
<td>0.8163</td>
<td>0.7629</td>
<td>0.7130</td>
<td>0.6663</td>
<td>0.6227</td>
<td>0.5820</td>
<td>0.5439</td>
</tr>
<tr>
<td>Years since 2005</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Cumulative number of arrays</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>7.0</td>
<td>7.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Capital cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>4.63</td>
<td>4.63</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual electricity cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.31</td>
<td>2.63</td>
<td>2.63</td>
</tr>
<tr>
<td>Annual maintenance cost</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>5.94</td>
<td>7.25</td>
<td>2.63</td>
</tr>
</tbody>
</table>

#### Capital Costs:

<table>
<thead>
<tr>
<th></th>
<th>Discounted</th>
<th>Undiscounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital:</td>
<td>$M</td>
<td>$M</td>
</tr>
<tr>
<td>Initial</td>
<td>5.57</td>
<td>9.25</td>
</tr>
<tr>
<td>Replacement/upgrade</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>5.57</td>
<td>9.25</td>
</tr>
</tbody>
</table>

#### O&M Costs:

- **Initial 10 years**: $13.09 | $30.21
- **Over 30 year life**: $21.32 | $82.75

#### Revenue and Costs:

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notional revenue</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>NET</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Discounted NET</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>NPV ($M)</td>
<td>0.00</td>
<td><strong>Real total power cost (Cap. + O&amp;M) over the economic life of the system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy output (MWh)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7,726</td>
<td>15,453</td>
<td>15,453</td>
</tr>
</tbody>
</table>

#### Unit Lifetime Cost ($/kWh):

<table>
<thead>
<tr>
<th></th>
<th>Discounted</th>
<th>Undiscounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discounted capital</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Discounted fuel cost</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Discounted O&amp;M cost</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Total discounted costs</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**UNIT LIFETIME COST ($/kW)**: \( \$0.21 \) **Real per unit cost of electricity over the economic life of the system**
## HV Distribution & Intra-Array Reticulation

### Intra-Array 415 V Reticulation

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Length (m)</th>
<th>Cost/Unit ($)</th>
<th>Allowance (%)</th>
<th>Total Cost ($)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable (supply and instal):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300mm² PVC single core cable</td>
<td>1</td>
<td>120</td>
<td>27</td>
<td>10</td>
<td>3,564</td>
<td>Cable from RAPS into array centre</td>
</tr>
<tr>
<td>16 mm² PVC 4-core + earth cable</td>
<td>1</td>
<td>1,246</td>
<td>17</td>
<td>10</td>
<td>23,300</td>
<td>Share trenching</td>
</tr>
</tbody>
</table>

### Distribution Boards (S & I):

<table>
<thead>
<tr>
<th>Item</th>
<th>Rate</th>
<th></th>
<th>Middleware</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre hut</td>
<td>1</td>
<td>1</td>
<td>2,500</td>
<td>10%</td>
<td>2,750</td>
<td></td>
</tr>
<tr>
<td>Nodes within array</td>
<td>46</td>
<td>1</td>
<td>500</td>
<td>10%</td>
<td>25,300</td>
<td></td>
</tr>
</tbody>
</table>

**Total Cost:** 54,914

---

**UNIT LIFETIME COST (c/kWh):** 3.4

This model calculates the lifetime unit cost of electricity for the grid-supplied system of arrays in $/kWh. The lifetime unit cost is the notional price of electricity that gives a zero NPV at the required discount rate. It includes all capital & O&M costs over the life of the project. To operate the model, change a value in any tan coloured cell with border and then press "Control n".

---

### HV Distribution & LV Reticulation Costs

#### NPV Analysis:

<table>
<thead>
<tr>
<th>Discount rate (%)</th>
<th>Reticulation capital cost ($M)</th>
<th>Reticulation annual maint. cost ($M)</th>
<th>Energy demand per array (kWh/year)</th>
<th>Number of arrays (#)</th>
<th>Year number</th>
<th>Discount factor</th>
<th>Discounted net revenue ($M)</th>
<th>Real total reticulation cost (Cap. + O&amp;M) over the economic life of the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>48.3</td>
<td>0.3</td>
<td>1,103,760</td>
<td>100</td>
<td>1-10</td>
<td>0.9346</td>
<td>-21.08</td>
<td>24.45</td>
</tr>
</tbody>
</table>

---

**Real per unit cost of reticulation over the economic life of the system:** 3.4
<table>
<thead>
<tr>
<th>Weighted Average Lifetime Cost</th>
<th>Lifetime Unit Cost (c/kWh)</th>
<th>Lifetime Unit Cost (c/kWh)</th>
<th>Weighting (array number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Power Station</td>
<td>22.1</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>HV/LV distribution system</td>
<td>25.5</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>RAPS</td>
<td>41.7</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Local network powered</td>
<td>21.0</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Weighted Lifetime Unit Cost</td>
<td>26.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12.4 Reference Papers


SKA Remote Array Station Buffer Distance to Overhead HV Transmission Line
Ron Beresford 1st June 2005 (rev 16th June 2005).

The purpose of this report is to gain some understanding as to the appropriate spacing or corridor between HV overhead power transmission lines and an individual prospective SKA Array station location in rural Australia.

Figure 1. Problem Scenario

Australian Standard AS/NZS 2344:1997 “Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 to 1000MHz” is used to provide initial radio interference source levels. The Standard is developed primarily for the protection of broadcast radio reception and other communication services, including navigation and safety-of-life systems and further interpretation is required in context of a very high sensitivity radio astronomy receiving station.

The EMI source levels used are the upper limits given a compliant high voltage power line system in good working order. These limits are derived from close range measurements using a horizontal dipole antenna 2m above the ground and directly beneath the power line at a nominal test frequency of 60MHz. Radio disturbances may exceed these levels when faulty components (insulator breakdown or poor contacts) are introduced.

Although very difficult, if not impossible, to determine the true generated spectra for an electrical discharge in a high voltage “circuit” the main source of interference is likely to be from gap emission in the VHF spectrum above 100MHz rather than corona EHV (>100kV) radiation predominantly in the HF spectrum below 30MHz.

It should be noted that the whole powerline conductor is the radiating element and not the gap, although the gap is certainly the point of excitation.
Nominal Calculation.
Take a 66kV power line, AS2344 specifies the interference limit at 32 µV/m at a height of 2m above the ground at 60 MHz measured in a IF BW of 120KHz.

Converting to more familiar RA units

\[ E(dBuV/m) = 10\log(32) \]
\[ = 15dBuV/m \ldots \ldots \text{at height 2m} \]

\[ E(dBuV/m) = P(dBm/m^2) + 116 \]

\[ P(dBW/m^2) = E(dBuV/m) - 10\log(B) - 146 \]
\[ = -182dBW/m^2/Hz \]

Consulting Figure B1 AS2344 for Relative Field Strength at 100MHz subtract ~5dB.

\[ S_{2m,100MHz} = -187dBW/m^2/Hz \]

Using work of Pakala & Chartier “Radio Noise Measurements on Overhead Power Lines from 2.4 to 800kV.” Proc IEEE Summer Power Meeting, LA, 1970. Based on both theoretical and empirical studies it appears the flux varies as 1/r^2 to a distance of 300m and 1/r^4 beyond. Various assumptions are made including soil conductivity. Assume for this purpose that the emission gap or faulty insulator is h=15m above the ground and that this height is essentially the same as the power line conductor height (ie 13m above the AS2344 specified 2m standard dipole location).

\[ S_{300m,100MHz} = -187 - 20\log\left(\frac{300}{13}\right) \]
\[ = -214dBW/m^2/Hz \]

For the simplicity it can be assumed that there is a direct line of sight to the radio horizon (RH) and that all calculations apply within the radio horizon distance. There are no intermediate diffraction effects from uneven terrain and hills, although such effects can be utilized in determination of array station positioning in order to minimize or shield array stations from both power line radiation and broadcast transmissions (eg FM radio) born radio interference (RI).

The radio horizon at VHF given a powerline conductor at \( h_1 = 15m \) and an array station antenna at \( h_2 = 6m \) (say 12m diameter dishes) is approximately.

\[ RH = 4.1(\sqrt{h_1} + \sqrt{h_2}) \]
\[ = 26km \]
In order to gauge the magnitude of the potential power line RI, consider the limits as determined by ITU-R RA.769. This assumes 0dBi gain thru side lobes (from where RI will enter) and a nominal integration time of 2000secs, albeit in relatively narrow VLBI bandwidths of a few MHz, depending on observation frequency band. For continuum broadband observations below 611MHz the specified thresholds levels detrimental to astronomy are approximately -258dBW/m²/Hz, this flux would then be the allowable flux at the SKA array station site.

Hence

\[ S_{d,100MHz} = S_{300m,100MHz} - 40 \log \left( \frac{d_2}{300} \right) \]

ie

\[ -258 = -214 - 40 \log \left( \frac{d_2}{300} \right) \]

\[ d_2 = 3.8 \text{km} \]

**Conclusion.** Using broad assumption that an SKA remote array station operation will be similar to a VLBI antenna would indicate a lateral buffer distance of 4.1km between the 66KV power line and the SKA array station. At frequencies higher than 100MHz the power line RF emissions drop at roughly 20dB/decade, inferring that SKA array stations can move even closer to the power line conductor at higher frequencies, but this would contravene the SKA frequency specification. Reducing the line voltage will decrease the distance marginally, for example 11KV will reduce the emission limit to 12.3dBuV/m and hence the buffer distance down to 3.5km. Interestingly, AS2344 emission limits from gap discharge remain much the same for lines 66KV and above.

In any case it is most probable that for a properly serviced power line network, the RF emission levels will be 10dB lower than the AS2344 specified limits, this could be regarded as an inherent "built-in" EMC margin.

---

**Proposed HV Power Line to Array Station buffer distance be greater than 4km**

In the context of final array station placement the following factors should also be considered where placement may infringe on the 4km buffer boundary.

1. Fringe rate tracking
2. Duty cycle of RI source
3. Beam steering and nulling
4. Fresnel zone, diffractive effects & grazing angles
5. Other RI mitigation techniques.

Any of which can potentially reduce the RI effects and reduce the 4km boundary.
An alternative method of estimation:

Disregard the ITU-R RA.769 single dish VLBI specification and use first principles.

The SKA processing bandwidth will be very large (Let $v = 500$MHz). An Array Station will have a nominal collecting area (Let $A_c = 16700m^2$). Let $T_{sys} \sim 150k$. Let the integration period be 1 hour ie $\tau = 3600$ sec

$$S_{\text{min}} = \frac{2kT_{sys}}{A_c \sqrt{\tau v}}$$

$$= -307 dBW/m^2/Hz$$

Consulting Figure B1 AS2344 for Relative Field Strength at 350MHz subtract ~30dB.

$$S_{\text{2mid,350MHz}} = -212 dBW/m^2/Hz$$

and

$$S_{300m,350MHz} = -212 - 20\log \left( \frac{300}{13} \right)$$

$$= -239 dBW/m^2/Hz$$

Then the required buffer distance would be:

$$S_{\text{min}} = S_{300m,350MHz} - 40\log \left( \frac{d}{300} \right)$$

$$-307 = -239 - 40\log \left( \frac{d}{300} \right)$$

$$d \sim 15km$$

Additional SKA remote array station RI rejection will be obtained by fringe rate tracking resulting in loss of coherence to RI. As a first order approximation this could improve rejection by Log(N) dB, if N=150 off 12m dishes ~20dB. This would be highly dependent on antenna spacings and configuration.

Beam-nulling and side lobe steering could further improve rejection. This may add a further 20dB of rejection. The use of focal plane arrays or aperture arrays over broad bandwidths is not fully understood. Only rough assumptions can be made at present.
Insulator and component breakdown is notoriously unstable but it is likely to occur on the maximum and minimum AC half cycle peaks, thus for 50Hz there would be emissions at 10mS intervals. The duty cycle of the emission is likely much less than 100%. If the duty cycle were 10% this would be a 10dB improvement on initial calculations.

![Insulator Breakdown Diagram]

Figure 2. Insulator Breakdown

Array station placement could also be optimised for terrain shielding.

If one assumes the additive effect of the above mentioned components improving the RI rejection by a further 50dB (R=50dB), then:

$$S_{\text{min}} = S_{300m,350MHz} - 40\log\left(\frac{d}{300}\right) - R(\text{dB})$$

$$-307 = -239 - 40\log\left(\frac{d}{300}\right) - 50$$

$$d \sim 3\text{km}$$

This is commensurate with the ITU based calculation.

**Design Enhancement.**

The use of over specified HV transmission components will reduce the likelihood of gap emission. There will however be a small incremental cost associated. For example, for the final few kilometres of 66kV transmission line nearest the array station 4km buffer, 132kV components could be used instead of 66kV components.

Within the 4km buffer all power distribution should be underground.
REFERENCE TABLES & GRAPHS

TABLE B1
LIMITS OF INTERFERENCE FOR THE REFERENCE FREQUENCY OF 60 MHz

<table>
<thead>
<tr>
<th>System normal voltage* (KV)</th>
<th>Highest system voltage (KV)</th>
<th>Horizontal distance from the vertical projection of the nearest conductor (m)</th>
<th>Interference limit (dB/µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7.2</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>22</td>
<td>14</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>33</td>
<td>16</td>
<td>0</td>
<td>26</td>
</tr>
<tr>
<td>46</td>
<td>17.3</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>110</td>
<td>145</td>
<td>0</td>
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</tr>
<tr>
<td>120</td>
<td>145</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>130</td>
<td>162</td>
<td>20</td>
<td>51</td>
</tr>
<tr>
<td>506</td>
<td>525</td>
<td>20</td>
<td>52</td>
</tr>
<tr>
<td>750</td>
<td>763</td>
<td>20</td>
<td>52</td>
</tr>
</tbody>
</table>

* For lines of intermediate system normal voltage, the limit to be applied will be that pertaining to the next highest voltage level in this table.

AS/NZS 2344:1997

FIGURE B1: EXAMPLE OF RELATIVE INTERFERENCE FIELD STRENGTH AS A FUNCTION OF FREQUENCY

AS/NZS 2344:1997

ITU-R RA769

IEEE EHV conf 1970 Pakala & Chartier
GREEN ENERGY VISIONS:
PERSONAL VIEWS ON THE FUTURE OF PHOTOVOLTAICS

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ABSTRACT

This opening plenary presentation is to honour the award to the author of a Right Livelihood Award, also known as an “Alternative Nobel Prize”, in the Swedish Parliament in December, 2002. In this presentation, the author gives his views on the future of photovoltaics. He argues that current bulk wafer and ribbon approaches are too material intensive to allow the low costs required for photovoltaics to reach its full potential. A transition to thin-film technology is essential for this to occur.

The reasons as to why this transition has been so difficult to achieve are then explored. The author identifies a certain “lack of robustness” of the candidate thin-films as the key reason for their failure. He provides evidence that this is not a universal thin-film feature, but demonstrates that modules even more robust than standard bulk silicon are possible, given an appropriate materials selection. It is then argued that a sensible strategy for companies feeling the pressure on prices being applied by the large manufacturers is not to try to compete on volume, but exploit the lower manufacturing costs per unit volume possible with more recent, rugged thin-films.

1. INTRODUCTION

It was a great pleasure to receive the Right Livelihood Award in the Swedish Parliament on 10th December, 2002, the evening before the traditional Nobel Prizes were awarded. One reason was the citation, particularly the section containing the words:

“the key technological challenge and moral imperative of our age, the harnessing of solar energy”.

All of us working in the area can take pride in the fact that we are working on something important.

Another reason was that I was nominated by Dr. Hermann Scheer, Time magazine’s “hero of the green century”, who has done so much politically to give photovoltaics the opportunity to reach its full potential.

I am fortunate in my choice of parents in that it allows me effortlessly to convert a general presentation on “Green Energy Visions” to one on “Personal Views for the Future of Photovoltaics”. My vision for the future of photovoltaics is captured in Figure 1. I see photovoltaics as having the potential to be a major, if not the major, power source in the future, not only being able to generate electricity cost-competitively, without subsidies, compared to all other large scale options, but also able to provide a low-cost source of electricity for generating chemical fuels, such as hydrogen, for applications presently serviced by the liquid fossil fuels.

To me, the challenges in getting photovoltaic costs down to the very low levels required seemed to me only those associated with relatively modest technological progress, almost trivial by comparison with the challenges associated with other apparently highly regarded options such as nuclear fusion, particularly the environmentally benign aneutronic versions.

2. PROGRESS

How well have we been progressing towards being able to meet the low costs associated with such large-scale applications? Figure 2 shows a recently published “learning curve” showing a 77.2% progress ratio (~22.8% learning) over the past decades. I saw my first such curve in the early 1970s, showing a very similar progress ratio. If only I had believed in the predictive powers of this approach!

![Fig. 1: Rancho-Secco photovoltaic installation (California) with the ill-fated nuclear plant at the site in the background.](image)

![Fig. 2: Recent industrial learning curve for photovoltaics (after [1]).](image)
photovoltaics as in Figure 3. The industry only has to grow to about 100 times its present size to reach its full potential! At the enormous growth rates over the last 6 years, this will take only 14.6 years. This model provides the rationale behind the worldwide programs promoting the use of photovoltaics. These programs generate the “learning investments” allowing photovoltaics to bridge the gap.

But how valid is such extrapolation in the case of photovoltaics? We can gain some insight into this issue by comparing experience within some related industries. Figure 4 shows the photovoltaic experience compared with experience in related industries. In both these cases, after reaching an accumulated volume of sales similar to where photovoltaics is now, the learning rate switched from the same ~20% rate observed for photovoltaics to a much slower 5-10%, towards price saturation. In the case of wind [2], this slowdown is quite remarkable given the massive increase in machine size that has occurred over this period (however, there have been other benefits such as increased capacity factor, better aesthetics, quieter operation, reduced bird kills, etc.).

3. BULK SILICON LIMITATIONS

What are the prospects for photovoltaics? If the industry continues to meet the growth in demand by supplying cells based on bulk silicon, I think that photovoltaics is unlikely to meet the goals of the programs that are responsible for this growth.

Bulk-silicon modules have enormous strengths in terms of durability and the like, but some quite fundamental weaknesses. The basic material intensiveness of the technology provides a lower limit on likely future costs.

While costs below US$2/Wp seem feasible, very few would maintain that the bulk silicon technology could reach module costs below US$1/Wp. While this type of cost would be adequate for a range of niche applications, it will not allow photovoltaics to penetrate the important large-scale applications previously envisioned.

Another issue is that the material intensiveness results in an energy intensiveness that is also relatively high. Although the energy payback time of present modules is only about four years, much less than their operating life, it has been pointed out that there is still an energy issue over the period of high growth rates, required to reduce costs [3]. If the installed capacity is growing at 25%/year, all the energy produced by photovoltaics world-wide is only just supplying that required to support the growth. The equation becomes negative for longer payback times, or for higher growth rates. Are we justified in contributing negatively to the carbon balance over the present period if we are not targeting large-scale future applications?

If the industry continues to exploit the politically generated opportunities by concentrating on bulk silicon production, a likely future cost evolution is shown in Figure 5. Perhaps photovoltaics can maintain a 20% learning rate for a longer period than wind or gas turbines but, in the not too distant future, costs are destined to flatten out as they approach the US$1/Wp mark.

4. THIN-FILM TRANSITION

To reach the large-scale, large-impact applications, it seems that transition to a less material-intensive thin-film technology is essential. Why has such a transition been
so difficult?
Some insight is given by the CEO of one of the major PV companies, the one with possibly the widest range of thin-film experience, which dropped all its existing thin-film activities at the end of 2002;

“Amorphous silicon, even the microcrystalline variety ... has too low an efficiency (stabilised) to impact ... market”
“...people do not want to buy it (CdTe)”

This suggests that the efficiency/complexity trade-off for some thin-film candidates may be an issue, as well as the lack of market acceptance of toxic thin-film materials (regardless of the merits of the case).

Additional insight is gained for technologies involving multi-component compounds.

“development of ...methods for assuring manufacturing reproductibility of one key process parameter, the Cu/(In + Ga) ratio”
“...promising technology base upon which to construct the next generation equipment”

This hints at some of the manufacturability issues facing the more complex materials systems that have been the focus of some efforts, as well as the issue of the availability of suitable manufacturing equipment for sequences not strongly linked to other industries.

However, the real reason for the lack of an enthusiastic response to thin-films may lie elsewhere. I think the lack of evidence for a similar ruggedness as with the bulk silicon alternative holds the key. Comments by groups that have been involved in such comparisons are often guarded:

“a-Si modules...lack of complete understanding of the mechanisms and environmental influences that cause performance degradation”
“(proprietary) data from fielded CdTe and CIS modules suggest higher than expected degradation”
Sandia, May 2002 [6]

However, snippets of non-proprietary information available on the published record are not encouraging:

Long-term test, 3 a-Si arrays, (Kobern-Gordorf, 10/1988): Manuf A (5%/nameplate/8yr); B (10%/6yr); C (70%/10yr)
“unencapsulated CdTe and CIS cells degrade ... accelerated damp-heat, special encapsulation essential”
E-MRS Workshop on Stability and Yield, Thin-Film Chalcogenide Modules, June 2002
“(CdTe) efficiency slipped from 8% to 6% over a few weeks”

This raises the question as to whether all thin-films are in some way less rugged than the bulk silicon encumbent. The answer is a resounding “No!”.

At first sight, thin-films would seem to have some durability advantages in that there need be:
. no wafers to crack;
. no interconnect ribbons to fatigue;
. no solder joints to age;
. no EVA encapsulant in front of cell to degrade;
. no EVA/glass or EVA/cell delamination loss.

Given that these are some of main degradation modes of the acknowledged extremely reliable bulk silicon modules [6], it might be thought thin-film technologies could be even more reliable. It was therefore very exciting for me to recently see the first evidence for a thin-film technology demonstrating this potential.

Why this was especially exciting for me was that the results were obtained for a materials system that I had helped select on the basis of its likely durability, the thin-film (poly-)crystalline silicon on glass (CSG) technology developed by Pacific Solar [8,9].

Paul Basore of Pacific Solar has kindly provided me with some figures from his presentation at this conference [9]. Figure 6 shows the results of outdoor testing of CSG modules made on Pacific Solar’s pilot line, documenting not only their stability but the rapid improvement in module efficiency from 1999 to 2002!

![Figure 6: Outdoor performance of Pacific Solar's thin-film crystalline silicon on glass modules](image)

Outdoor testing is very appropriate, but also very slow. To get a more rapid turnaround on module reliability, Pacific Solar has implemented an accelerated test based on the IEC 61646 standard qualification tests for thin-film modules. Instead of the normal 200 thermal cycles, 10 humidity-freeze cycles and 1,000 hours of damp heat testing being applied to different modules as in the standard qualification test, they are applied sequentially to the same module. If this module survives one cycle of such tests (taking about 4 months), it is put through successive tests until performance drops to below 80% of its initial value.

![Figure 7: Accelerated test for thin-film CSG modules compared to those from a range of commercial modules](image)
Such testing is quite severe, as can be seen from the results in Figure 7 [9]. The commercial CIS modules shown, although likely to pass the standard qualification test, are not able to pass 1 cycle of the accelerated test. Standard crystalline silicon modules, from the large manufacturers and likely to survive over 20 years in the field, have difficulty in passing 2 cycles. Surprisingly, the number of cycles to failure for modules from the same manufacturer is quite reproducible, making the test almost a quantitative measure of robustness.

The Mark I CSG thin-film modules performed better than most of the commercial bulk silicon modules. Improvements to Mark II CSG modules pushed them even further ahead of the mainstream. The test procedure does not include UV testing where the CSG modules are almost “bullet-proof”. While a standard bulk silicon module degrades about 5% in output after 20 years equivalent exposure to UV radiation, it took 62 years equivalent of exposure for the thin-film module to degrade a comparable amount. Suitably chosen thin-films may be capable of a completely new level of durability compared to even the bulk silicon standard!


A desirable list of thin-film attributes might be:

- low cost (and energy content)
- materials, yields, efficiency, equipment
- market acceptance (non-toxic)
- stable and durable
- cost reduction potential

The quantities shown in bold is where past candidates may have fallen short, leading to recent bold pronouncements such as:

“No future for today’s thin-films”

These pronouncements overlook a new generation of emerging thin films. One, well represented by papers at this conference, is based on a tandem amorphous/microcrystalline silicon stack, as originally pioneered by the University of Neuchatel. This undoubtedly provides a better trade-off between the strengths and weaknesses of amorphous silicon technology. Unfortunately, for a good tandem, the best cell should be on the top, rather than on the bottom as in this case, giving rise to the same stability issues that have plagued other amorphous silicon approaches [11,12].

The other candidate is, of course, the thin-film (poly-) crystalline silicon on glass (CSG) technology [9] described in connection with improvements in thin-film cell stability. Although independently confirmed efficiencies similar to those so confirmed for stabilised amorphous/micro-crystalline tandem modules have been demonstrated, there may be more scope for improvement in this case given the inherently higher electronic grade of material used.

6. THIN-FILM LEARNING CURVES

One of the advantages of thin-films becomes apparent in Figure 8, where thin-film learning has been broken out separately from photovoltaics in general (by assuming 10% of production has been thin-film over recent years, and similar module prices [10]).

One feature becomes immediately clear: thin-films are cheaper for a given production volume. This translates to a greater potential for low costs in the long term. Also, smaller production volumes of thin-films are required for the same costs. “Bottom-up” studies, such as during the European Music-FM project [13,14] confirm this feature.

This has interesting practical consequences. While the learning curve experience suggests that a manufacturer producing in larger production volume has a cost advantage over smaller competitors using similar technology, a smaller competitor can become competitive by adopting a viable thin-film technology, one with the desirable attributes previously described.

7. CONCLUSIONS

Although the photovoltaics industry has been booming over recent years, it is unlikely it can meet the political expectations responsible for this boom, unless it can make a successful transition to a thin-film implementation.

Lack of robustness of thin-film candidates has been identified as a key reason why this transition has been difficult in the past. Recent experience shows that, with an appropriate choice of thin-film materials, the thin-film approach can eliminate many of the degradation modes associated with the acknowledged extremely reliable bulk silicon modules, and demonstrate better overall robustness than these.

Manufacturers presently face the dilemma of how to compete with the lower prices from large manufacturers such as Sharp, as might be expected from their greater economies of scale. One option is to take advantage of a viable thin-film technology to produce modules at competitive prices at much lower production volumes and required capital investment. Such manufacturers will also be in a much better position to realise the benefits from a technology able to reach the large-scale markets that bulk silicon technology will find difficult to access.
REFERENCES

Gas-fired power station option for SKA Phase 2

In the Australian 2005 ‘Proposal to site the SKA in Australia’ a solution for powering SKA with a gas-fired power station was presented. Updating this for the proposed SKA configuration shows that it is practical to construct a gas-fired power station near Murchison Settlement, 70 km west of the core and use a transmission line to bring the power to the computing facility and antenna distribution system. This would require the construction of an approximately 130 km gas pipeline lateral from the Dampier to Bunbury Natural Gas Pipeline to the power station.

Local power plant or transmission line supply comparison

Based on recent projects in remote parts of Australia, the construction of a transmission line and terminal yards from Geraldton to the project has been estimated to cost $150 m. In comparison, the cost of constructing a natural gas pipeline to the Murchison Settlement 70 km west of the central core and 30 km of transmission line to bring the 132 kV supply between the spiral arms to the computing center which would be located West of the cores would cost $39 m + 48 m.

Table 1 below shows that the capital cost of local natural gas fired power generation is higher than for a transmission line supply, but significantly cheaper on an annual operating cost basis. However, given that natural gas prices are currently changing rapidly it is unrealistic to expect the estimate of operating cost to have significance in nearly ten years time.

Table 1 – Indicative comparison of power options for the prescribed configuration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimated cost for local power generation1</th>
<th>Transmission line supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas pipeline</td>
<td>$39 m</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Power station</td>
<td>$110 m</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Transmission line</td>
<td>$48 m</td>
<td>$150 m</td>
</tr>
<tr>
<td>TOTAL CAPITAL COST</td>
<td>$197 m</td>
<td>$150 m</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$81 m pa2</td>
<td>$112.3 m pa</td>
</tr>
</tbody>
</table>

Compared to a grid-connect power supply option, use of a gas-fired power plant does not provide the project with access to a range of diversified renewable energy solutions or cheap base load coal fired power generation.

The actual power supply option and its configuration would need to be the result of a detailed study at a time closer to the need and should take into account a detailed knowledge of the load profile, reliability requirements, desire to have access to renewable energy options and the balance between capital cost and ongoing operating costs.

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1 These estimates are based on the complete cost of similar projects recently completed or under construction.
2 This is based on the power plant manufacturers recommended maintenance and associated costs plus natural gas fuel at a delivered cost of $9/GJ. The fuel cost was sourced from industry participants currently negotiating long term gas supply contracts of a similar size.
The Australian context for renewables development

The Australian Government and the State Government of Western Australia are putting in place the policy and regulatory framework for reducing the emissions intensity of power generation nationally while taking advantage of the energy resources found in each state. There are already significant renewables projects appearing in Western Australia in response to the current and future policy settings.

The Murchison area has a wealth of renewable and conventional energy options based on solar, wind, geothermal and gas. It is likely that the connection of the SKA project will be to the existing grid, which will enable different regions to deploy different technologies and provide a mix of generation options. Grid connection will provide the necessary continuity and stability of supply to the SKA project, while new technologies can be deployed and integrated as they are proven over time. There are already a number of options for both the central areas and supercomputing facilities as well as the remote sites to incorporate renewables at competitive cost. The uptake of the different technologies will be driven by opportunity and commercial market forces, policy and the regulatory environment.

Australia’s energy future

The Australian Government is progressing towards a future energy supply which is less dependent on fossil fuels and the consequent greenhouse gas emissions, while retaining affordability for Australian industry and households. To achieve this, significant changes in the energy supply mix will be required including the increased deployment of renewable energy technologies. This increase in renewables is being driven by a combination of renewable targets and federally and state funded programs which aim to stimulate the development and deployment of renewable technologies and ultimately accelerate their progression down the cost curve.

CSIRO has conducted a number of economic modelling studies to examine the possible trajectories for emissions reduction in Australia, consistent with the decreasing cost of new technologies as they follow the global learning curve of cost reduction. CSIRO’s modelling has contributed to widespread economic modelling by the Government’s climate adviser, Professor Ross Garnaut.

This figure shows that, under assumptions of an introduction of a price for carbon, that there is a general shift towards lower emissions technologies. Fossil fuels with carbon dioxide capture and storage and renewable technologies grow their share of the national electricity generation mix.

Figure 1 – Changing proportion of electricity generation for Australia – CSIRO scenario analysis.
Mechanisms for change in the Australian energy mix

To encourage the transitions towards technology change described in the scenarios of Figures 1 and 2, the Australian Government and State Governments has initiated a number of programs designed to close the gap in technology costs and to improve the market readiness of new technologies. The SKA project stands to benefit from this progression as renewable technologies are able to be reliably and commercially integrated into the SKA power system bringing the mutual benefits of lower operating costs and lower emissions. The following points provide an overview of some of the principal initiatives:

- MRET, the mandatory renewable energy target, which requires that 20 percent (45,000 GWh) of Australia’s electricity be produced from renewable energy by 2020.
- CPRS, the carbon pollution reduction scheme, which is expected to place a price on carbon to establish as price signal to drive investment in low carbon technologies (currently being prepared for legislation)
- CEFC, the Clean Energy Finance Corporation, a new $10 billion commercially oriented entity to drive innovation through commercial investments in clean energy through loans, loan guarantees and equity investments. The CEFC will leverage private sector financing for renewable energy and clean technology projects, investments critical to the transformation of the Australian economy. It will identify projects and remove barriers that would otherwise prevent the financing of large scale renewable energy projects. Investments will focus on renewable energy, energy efficiency and low emissions technologies and the transformation of existing manufacturing businesses to re-focus on meeting demand for inputs for these sectors. The CEFC will be run by an independent Board made up of experts in banking, investment management and clean energy and low emissions technologies.
- ARENA, the Australian Renewable Energy Agency, will be a new, independent statutory body created to coordinate around $3.2 billion in existing grant funding programs supporting research, development and demonstration of new renewable energy technologies. The establishment of ARENA as an independent statutory body presents a unique opportunity to adopt a holistic approach to financing the research, development, commercialisation and demonstration of renewable energy technologies.
- State Government initiatives designed to increase energy efficiency and encourage small to medium scale technology deployment, especially of photovoltaic systems via a feed in tariff.
The Western Australian context

Western Australia is a dynamic state with many new initiatives designed to broaden energy supply and develop the energy resources of the state. A number of these will directly or indirectly support the SKA over its long lifetime. Links to some of the more relevant reports, initiatives and organisations for the future provision of reliable, low emissions power to Western Australia are given below:

- A report was prepared in 2006 on the technology outlook for stationary energy for the Western Australia Greenhouse and Energy Taskforce. This report puts strong emphasis on ensuring the right research and development strategy is in place to support early demonstration of relevant technologies including geothermal, wave power, photovoltaics and more improved conversion of coal to energy. It also recognises the potential of solar thermal.

- The Western Australia Office of Climate Change has produced a range of factsheets that detail the expected impact of climate change on Western Australia and also seek to provide the Western Australian context for federal initiatives such as the MRET.
  [Link to factsheets](http://www.dec.wa.gov.au/content/view/5174/2187/)

- Western Australia's Office of Energy provides an overview of renewable technologies. In addition to general overviews of the attributes of the most relevant renewable technologies to Western Australia such as solar, wind, hydro and geothermal, comments on their current deployment and advantages and disadvantages in the Western Australian context are included.
  [Link to overview](http://www.energy.wa.gov.au/1/3671/64/renewable_energy_in_wa.pm)

- Following on from the 2006 Greenhouse and Energy Taskforce, the Western Australia Government is working with industry and the community to develop an ambitious and practical plan that aims to meet the energy needs of Western Australia over the next 20 years. Energy2031 has four strategic goals:
  1. Secure Energy
  2. Reliable Energy
  3. Competitive Energy
  4. Cleaner Energy

The plan is currently under review after a period of consultation. This plan will provide the primary roadmap for Western Australia’s future energy supply.
  [Link to plan](http://www.energy.wa.gov.au/0/3312/3312/strategic_energy_initiative.pm)

- Western Australia's regional power supplier is Horizon Power. Horizon Power operates the NWIS network, is a State Government owned power company with responsibility for regional areas. Horizon Power is the supplier of the MRO power plant.

- Western Australia's leading sustainable energy supplier is Verve Energy. Verve Energy has already developed a number of renewable energy projects using diesel—wind, wind farms, photovoltaic, biomass and is examining other sustainable options including wave energy. Verve Energy is currently installing a 10MW PV power plant at its Greenough River Solar Farm southeast of Geraldton. There will be scope for increasing renewable power generation to the SKA over its lifetime.

- Western Australia's SWIS grid operator is Western Power. Western Power purchases power generated by companies such as Verve Energy and Alinta for distribution in the Country North regional area adjacent to the SKA. Western Power’s sustainability policy will drive further options for renewable energy purchases over time.
Integration of renewable energy sources into the SKA power supply

The base case option for power delivery to the SKA facility is a conventional grid connection to Western Power’s network for the core antennae and infrastructure in combination with present generation stand alone diesel/PV hybrid off-grid power units to support the remote sites. The basic power requirements for the project are assumed to be as follows:

- For SKA Phase 1: 5 MW for the array (by 2016), 30 MW for supercomputer facility (by 2018)
- For SKA Phase 2: 65 MW for the central area out to 180 km, 25 remote sites of 96 kW each, a further 40 MW for a supercomputer facility. Timing is not specified but assumed to be progressive over approximately a decade from 2016.

It is well recognised that there is significant development work being undertaken around the world on improving the scale and despatchability of renewable energy systems. Increases in efficiency, development of short and medium term storage technologies and ongoing improvements in capital and operating cost intensities have the potential to position these technologies as true, reliable, cost competitive and low emissions power generation options in the near future. Through application of a distributed generation design approach this could also increase the anticipated reliability of the core grid based SKA power system.

Solar, geothermal and to a lesser extent wind technologies offer the most promise with respect to Australia’s future renewable energy supply. The staged and approximately decade long construction program associated with the SKA lends itself well to the flexibility required to monitor these technologies and their potential integration into the power supply design as they mature.

Diesel based generation has comparable emissions (0.75 kg CO2-e/kWh for a 100 kW generator set consuming 28 L/hr of diesel) to the available grid power (WA’s largest producer Verve Energy reports a GHG intensity of around 0.85 kg CO2-e/kWh). However, it is much more costly and requires a supporting fuel storage and distribution network for reliable fuel supply. If the delivered cost of fuel is assumed to be around $2/L, the cost of diesel generated electricity is approximately 0.56 c/kWh. The use of biodiesel has the ability to decrease the emissions footprint, but would be unlikely to reduce the high cost of generation. The inclusion of PV technologies to displace part of the diesel generation could reduce both the cost and emissions intensity of the remote site power generation.

Further reduction of the electricity costs and greenhouse gas (GHG) impact of the SKA project could be achieved through incorporation of additional PV capacity and electrical energy storage at the remote sites, together with larger scale generation and/or distributed generation solutions to supply the balance of the project’s electrical demand. This Annex will review and summarise the suite of renewable generation technologies available today in the context of the renewable energy resources available at or near the project site. Renewable energy technologies are developing rapidly at present, and it is expected that solar technologies will be competitive with grid supplied electricity in the timeframe of the SKA project. The technology trajectories that can deliver these outcomes will also be discussed to show that there is an available and competitive pathway for renewable energy to provide electricity for the SKA project and for WA and indeed Australia in general.

The renewables resource in the Murchison region

The proposed SKA site is remote and sparsely populated as is required to meet the science objectives of the system. Resource mapping summarised by Geoscience Australia indicates that there is an excellent solar resource available, as shown in Figure 3.

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This figure shows that there is an excellent solar resource available.

The project site is located inland and does not have good prospects for wind generation on site. However, the coastal region around Geraldton does have some of the best wind prospects in Australia, as shown in Figure 4. Geraldton already has a 90 MW farm, which is reported to boast a very high capacity factor of 47%4, which is indicative of excellent wind availability.

Any wind generation capacity installed to provide energy for the SKA project would require integration with the existing transmission grid, and would only be available to the project via a new transmission line. This integration with the existing grid network would also provide the necessary buffering of the output from the wind generation capacity, and the network provider would be responsible for providing whatever back-up generation is required to ensure reliable supply. Wind generation in good sites is capable of producing electricity at around 8c/kWh5.

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4 See Walkaway wind farm data at: [http://ramblingsdc.net/Australia/WindWA.html#Alinta_Wind_Farm](http://ramblingsdc.net/Australia/WindWA.html#Alinta_Wind_Farm)

This map shows Australia’s wind resources. The coastal region around Geraldton does have some of the best wind prospects in Australia.

Figure 4 – Australia’s wind resources (Geoscience Australia, 2010).

Geothermal energy is another renewable energy technology with great potential for development in Australia. While the country has limited resources, termed hot sedimentary aquifers (HSA), close to the surface, there are widespread resources of hot granite at a depth of 4-5 km. Figure 5 shows the rock temperature at a depth of 5 km from resource mapping presented by Geoscience Australia. Exploitation of these so called ‘hot rocks’ is more challenging than conventional exploitation of HSA in countries like Iceland and New Zealand, and only preliminary drilling and evaluation has as yet been carried out. Drilling is extremely costly as large casing holes are required, and can cost $15 million per hole. Some operational problems have also been encountered due to unexpected corrosivity of fluids from the hole. A number of companies including Geodynamics and Petratherm are actively developing pilot holes in South Australia. While extremely promising in the long term, the industry is still early on in development terms, lagging well behind wind and solar technologies.

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This map shows predicted rock temperature at a depth of 5 km. There are widespread resources of hot granite at a depth of 4–5 km.

Figure 5 – Predicted temperature at 5km depth based mostly on bottom-hole temperature measurements in more than 5000 petroleum and water boreholes (Geoscience Australia, 2010).

Current ‘state of the art’ in renewables

There are a number of possible renewable technologies that could be applied to the SKA. Their current state of development and their anticipated development path is detailed below. Figure 6 shows a generalised picture of how the cost of a new generation technology changes with time. Initial estimates of cost tend to be on the optimistic side during the development phase, and the first installations are often quite expensive in comparison. However, once the technology is deployed, efficiencies in manufacturing and engineering rapidly reduce the cost. Experience curves showing this process are shown in Figure 7 for PV and wind generation. PV costs are continuing to decrease with deployment, while wind is relatively mature and other factors such as supply and demand have tended to lead to a stabilisation or even a moderate increase in costs over recent years.
This figure shows a generalised picture of how the cost of a new generation technology changes with time.

**Figure 6 – Relative maturity of various renewable energy technologies (Source: CSIRO; OPV = organic photovoltaic, Geo HR = hot rock geothermal, CSP Brayt = Brayton (air) cycle; U/B = Ultrabattery, Geo HSA = hot sedimentary aquifer geothermal.)**

This figure shows experience curves for PV and wind generation cost reductions.

**Figure 7 – Learning curves for PV and wind (IPCC SRREN 2011, Summary for Policymakers, http://srren.ipcc-wg3.de/report/IPCC_SRREN_SPM).**
Solar PV

Photovoltaic cells convert sunlight direct into electricity through the interaction of light photons with semiconductors. PV technologies have been developing rapidly in recent years due to wide deployment, and this has reduced costs significantly. Indeed, it is now widely discussed that PV cells will be able to compete with the retail price of electricity in the next few years, as installed costs for systems have fallen to around $3 per peak watt. Conventional PV cells currently have a levelised cost of energy of around 20 c/kWh\(^8\), considerably cheaper than diesel.

The principal challenge for PV systems in the context of the SKA is security of supply. While clouds are likely to be a relatively minor problem at the project site, the diurnal cycle of production when the sun shines and a long period of non-production is unescapable. The conventional approach for off grid applications is to use batteries for small installations and diesel back-up for larger applications. Pumped hydro, where the electrical energy is stored in the potential energy of water for later generation with turbines, is a poor option in this context.

Battery storage has in the past been considered prohibitively expensive due to high up front costs and limited battery life. CSIRO has developed a more reliable battery called the Ultrabattery\(^9\) which is reported to last 10 to 15 years, which is 4–5 times longer than conventional lead acid batteries. This is expected to greatly improve the economic attractiveness of remote PV systems with battery back-up. While this is a relatively new technology and therefore difficult to assess on a cost per kWh basis, the possibility of adding inexpensive storage to PV systems may well make these systems cheaper and more reliable than diesel and diesel PV hybrid systems.

Concentrating systems are another potentially exciting area for photovoltaics. These systems can produce both thermal energy and electricity, but require cooling to remove the thermal load. Australian company Solar Systems (now owned by Silex) have Victorian government funding for a staged gate154MW project (currently 2MW) using a heliostat field and high efficiency PV cells\(^10\). The economics of these systems are based around the very high conversion efficiencies attainable by multi-junction cells (over 40%) and the relatively small area of PV cell required compared to conventional systems. If the thermal energy removed from the PV cell can be used as well, there is potential for combined heat and power, or power and cooling via an absorption chiller cycle.

Solar thermal

Concentrating solar thermal systems (usually referred to as CSP for concentrating solar power) use mirrors to concentrate the beam radiation from the sun (direct normal irradiance, or DNI) onto a receiver to convert solar radiation into thermal energy. This thermal energy is then converted to electricity using thermodynamic cycles, most commonly based on the generation of steam for steam turbines.

In contrast to PV systems, CSP plants are best suited to the multi-megawatt scale to exploit economies of scale and optimise the efficiency of the power conversion cycle\(^11\). A number of plants were constructed in Spain under favourable tariff legislation, although the unit size was limited to a maximum of 50 MW. More recent projects in the US have not had such restrictions and the steam turbine size has been increased to 132 MW at the Ivanpah plant (with a total capacity of 396 MW gross) under construction in southern California\(^12\). A number of plants have also been constructed with thermal storage to increase the despatchability of generation, and the Spanish plant Gemasolar recently demonstrated 24 hour electricity production\(^13\).

Western Australia has the best solar resource for CSP in Australia, and the project site appears to be in a particularly favourable area as shown in Figure 8. Note that DNI is less well mapped than total solar radiation as shown by the larger pixel size in the figure.

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\(^8\) The levelised cost of electricity is the amortised cost per kWh of electricity produced based on the initial capital cost, the cost of capital, the amount of electricity produced and the lifetime of the generating asset.

\(^9\) The Ultrabattery is marketed by ecoul; see: www.ecoul.com


\(^11\) For a list of CSP plants globally, see: http://en.wikipedia.org/wiki/List_of_solar_thermal_power_stations

\(^12\) See: http://www.brightsourceenergy.com/projects/ivanpah

\(^13\) See: http://www.torresolenergy.com/TORRESOL/gemasolar-plant/en
This map shows that Western Australia has the best solar resource for CSP in Australia, and the project site appears to be in a particularly favourable area.

CSP – Steam systems

CSP systems based on steam are a relatively mature technology, having been deployed since the 1980s in California. There are two basic collector technologies, parabolic troughs and power towers (see Figure 9). Parabolic trough plants use curved mirrors to concentrate the solar radiation on a linear receiver, where the solar energy is converted to thermal energy and collected in a heat transfer fluid. Most plants built so far use thermal oils which have an upper temperature of around 390°C, although direct steam generation and the use of molten salts is being assessed at pre-commercial scales to increase temperatures and the efficiency of conversion of thermal energy to electricity. While around 1 GW of parabolic trough plants have been deployed world wide, there are no plants operational in Australia currently, although the government has awarded funding under the Solar Flagships Program to construct a 250 MW plant at Chinchilla in South West Queensland. This project will use linear Fresnel technology, which is similar to parabolic troughs in that mirrors are used to concentrate energy on a linear receiver, in this case to generate steam directly for use in a steam turbine.

Solar Dawn project information can be found at: http://solardawn.com.au/
Figure 9 – CSP Technologies: parabolic trough (line focus) at Nevada Solar One, USA; and power tower (point focus) at Gemasolar, Spain. Credits: Jim Hinkley, Torresol.

Power towers use a field of individual mirror panels to focus solar radiation onto a tower mounted receiver. This ‘point focus’ system can achieve much higher concentration ratios and hence temperatures than linear focus systems. There are now three commercial power towers up to 20 MW operational in Spain, with a number of much larger projects (including the 392 MW Ivanpah project) under construction or planned. There are three operating research towers in Australia, two at CSIRO in Newcastle and one at Lake Cargelligo operated by Lloyd Energy, but no commercial projects. The cost of electricity from these technologies is currently estimated at around 22 c/kWh, although this is expected to decrease to around 15 c/kWh by 2017.15

Conventional CSP plants operate most efficiently with wet cooling, as the cycle efficiency is dependent on the temperature difference between the hot working fluid and the temperature at which heat is rejected (the ‘sink’ temperature). However, dry cooling can also be used, although this results in a minor reduction in efficiency. Research is currently underway into alternative technologies that don’t require water at all using air and other gases such as carbon dioxide as the working fluid. These are the CSP Brayton technologies shown in Figure 4. This work has the potential to significantly alter the deployment possibilities of CSP in arid areas such as those occupied by the SKA.

CSP has the potential to be a far more consistent and reliable generation technology than PV due to the fact that the solar energy is not directly converted to electricity, but is stored as thermal energy as an intermediate step. A CSP system has inherent thermal inertia which enables production to continue through brief periods of cloud shadowing the field, and this buffer can be extended though thermal energy storage to provide despatchable generation. Molten salts (for example, Hitec, a mixture of sodium and potassium nitrate with a melting point of 222°C and an upper temperature of around 565°C) have been used for some years now in solar plants in Spain, including the Gemasolar tower plant which has 14 hours of storage to enable round the clock operation in summer.

RENEWABLE ENERGY POTENTIAL:
A region with amongst the world’s greatest renewable energy potential

WIND: 98 wind turbines operational, 195 additional turbines approved, and applications for additional capacity creating a potential 750MW green power resource.

SOLAR: Mid West Energy Solar Thermal Project, Perenjori and Verve Energy Solar PV Farm, Greater Geraldton.

WAVE: Wave energy and desalination capacity being integrated into precincts.

GEOTHERMAL: Leases allocated and;

BIOMASS: Oil mallee plantations, biochar and bio-sequestration all being investigated in the region.

GROWTH: A potential tripling of population, and steep increase in demand for energy due to new industry is already putting pressure on existing infrastructure.

PARTNERSHIPS: Proactive local government already pursuing joint energy and climate projects with key government, infrastructure, technology, academic, research, NGO and consulting partners.

INTELLIGENCE: Timing is right for integration with National Broadband Network and Square Kilometre Array communications and computing capacity.

SKILLS: Growing the capacity and skills of regional Australia through to develop new green jobs – linked to tertiary sector TAFE programmes and infrastructure projects.

COMMUNITY-FOCUS: Strong interest from residents, schools and businesses through trials and pilot projects underway.

COMPETITIVE: Smart Grid will enable regional mining operations to reduce their emissions and costs and improve international competitiveness.

VALUE-ADD POTENTIAL: A city and region that could become a renewable energy-powered minerals processing hub.

INTEGRATION: Investigating bundling of utility services, for more efficient supply and recycling of water, energy and waste.

CLIMATE AND ENERGY RESILIENCE: This region and its future economic prosperity may be challenged by rising energy prices.

The Smart Grid will ensure it can support the population and industry required to drive Australia’s economy through the 21st Century.
A Vision for a Carbon Neutral Mid West Region

ELEMENT 1: A SMART GRID

The concept is based on the area encompassing Eneabba (east to Perenjori) and up to Kalbarri, e.g. the northern edge of the South West Integrated (electricity) System, and facilitating the following (within a $100 million budget). The concept will see the provision of the following:

- Smart meters in all households and business premises in that area;
- Smart switches on the entire power network;
- Mix of solar panel, micro-gas generators or micro-wind (all about 1KW capacity equivalent) on at least a quarter of all households; and
- Provide the opportunity for a higher level of larger scale renewables such as:
  - solar thermal (currently a proposal by Mid-West Energy for a 400MW station at Perenjori);
  - solar PV (currently a proposal for a 10 – 50MW plant in Geraldton which would be Australia’s largest);
  - wind (currently 80MW generated in the region and proposals have received Council Planning Approval for an additional 500MW to be generated);
  - wave (potential for a wave generation plant as part of the port precinct);
  - geothermal (various large scale exploration tenements have been granted by the WA Government); and
  - clean coal.
- Carbon sequestration (a 300MW proposal has received EPA and WA Ministerial approval for Aviva Corporation at Eneabba)
- Coal seam gasification (a proposal has been developed for a 164MW coal seam gas power station Eneabba Gas at Dongara).

A key outcome will be a contained and measurable energy grid from which to determine and set as a model for Smart Grid technology and also applying renewable energy developments and energy sources into the mix. Current trials and proposals for Smart Grid do have the capacity to be all detailed or provide comprehensive data to monitor effectiveness from a householder, business or network point of view. This proposal represents the only real unique opportunity in Australia to develop a true test bed which can measure outputs.

ELEMENT 2: MID WEST CLEAN ENERGY HUB

There is currently a significant clean energy hub evolving in the Walkaway area (28km outside of Geraldton). The location is serviced well by transmission infrastructure although there is a need for a substantial upgrade to ensure energy can be distributed to larger markets (e.g. the Perth metropolitan area) and the mining/resources projects. The area also has the substantial advantage that it is on the Dampier to Bunbury Gas Transmission Pipeline. This provides secure and substantial gas supply which underwrites the (Verve Energy) Mungarra gas turbine. Gas turbines are an essential element to mix with wind and solar as the “peaking” nature enables it to offset natural variations in supply of renewables.

ELEMENT 3: MID WEST TRANSMISSION INFRASTRUCTURE

A further critical element to achieving the major renewable projects listed above is the funding for the Mid West Energy Project which consists of three (3) separate (but connected/related) 330kv transmission lines which include:

1. Mid West Energy Stage 1: this is a fully funded WA Government project which is from Pinjar (Perth) to Eneabba. At which point it provides a connection to the privately funded 300kva line being constructed by Karara Resources (magnetite iron ore mine) some 180km to the east;

2. Mid West Energy Stage 2: which is from Moonyoonooka (Geraldton) – however the City strongly contends the project needs to be extended 35km to connect with the Oakajee deep water port and industry precinct. This project has been listed by the WA Government as a priority to infrastructure Australia. This project will unleash a wave of renewable and clean energy projects meaning WA’s energy mix surpasses the 20% RET and in fact will enable our region to achieve it desired state of being a Carbon Neutral Resources/Industry Region;

3. Mid West Energy Stage 3 – “the Iron Wire Project”: which is based on a line from Karara through to Jack Hills in the northern Mid West region. This line is in recognition of the major energy issues which confront the Mid West iron ore province. This province is made up mostly of magnetite iron ore (as opposed to haematite – iron ore as found in the Pilbara). Haematite is referred as a dig and ship ore – that is it can be simply dug out of the ground in a raw state and sent via ship to mills overseas (usually China, Korea or Japan). Magnetite on the other hand requires significant refining and treatment on site. However whilst magnetite needs more site on processing, it actually consumes a lot less energy in the whole life cycle of making steel. The only issue is the energy consumption (and therefore the associated carbon price) is in Australia as opposed to offshore – the impact however is that globally magnetite has a lesser carbon impact. In the Mid West it has been estimated that there is a demand of approximately 2,000MW (which can be compared to the total WA Grid base load demand of 2,100MW) in order to process the ore from the six major magnetite iron ore mines. Current policy would see much of this energy sourced from inefficient and more carbon intensive forms of energy. The proposal would see all the mines connected to the grid and being able to source secure (and cheaper) energy and also to access the major Mid West Clean Energy Hub in order to get a significant supply of low carbon energy which can help offset the impact of any potential carbon price, which is likely to be inevitable, given the lifespan of this resource is expected to be between 30 to 100 years; and

4. SKA Link: There is an opportunity to connect the International Square Kilometre Array project at Boolardy Station in the Murchison to the “Iron Wire Project”. This would facilitate base load, secure and green power to this internationally significant project.
**Electrical power diagrams**

**Overview of one option for proposed electricity supply and reticulation**

The following diagram highlights the primary power supply and reticulation scheme proposed for SKA Phase 2 and identifies the component ownership and operations/maintenance responsibilities.

![Figure 1 – High level block diagram of the SKA’s power supply reticulation.](image)

**Minimum requirements to be provided at Moonyoonooka main substation**

This high level schematic details the minimum requirements to be provided at the Western Power Moonyoonooka 330/132 kV terminal station. At the point of grid connection, Western Power state that this node has had only one short power interruption in the past five years. When the Moonyoonooka upgrade is complete it will be to a higher reliability standard and also provide additional redundancy.

![Figure 2 – High level schematic detailing the minimum requirements to be provided at the 330/132 kV main substation for SKA Phase 2.](image)
SKA power supply reticulation

Figure 3 – High level block diagram – SKA power supply reticulation.
Concept layout of 33kV supply from main substation to power hubs

This diagram shows the outer spiral arm 33 kV ring main and radiating 33 kV submains.

For the purpose of costing this configuration each of these ring main feeders has been sized for the maximum demand of the antenna loads planned. As the data available does not show reactive loads to size the installation we have made the assumption that each antenna will operate with a power factor of 0.9.

Figure 4 – High level concept layout of 33 kV supply from main substation to power hubs.

Typical power hub distribution scheme

This typical power hub distribution scheme (shown overleaf) illustrates the connections within 33/6.6 kV hub substation #1 and shows two typical ring main circuits being supplied from the hub. The ring main circuits can supply a number of remote substations (depending on the remote substation capacities) and are normally operated as spur feeders with an open point at or near the centre of the ring. Ring main units are never operated ‘fully closed up’ as this would tie the substation 6.6 kV busses together. A simple key interlocking scheme prevents inadvertent operation of the rings in the fully closed up state.
Two 415/240 V auxiliary power busses will be incorporated into the substation to supply the auxiliary power system including:

- General lighting and power
- Substation auxiliary power supply battery systems for circuit breaker control and monitoring
- Communications equipment
- Air conditioning (cooling) plant
- Potable and waste water treatment plants
- Security equipment and lighting.

Building/civil works will comprise of a substation building and outdoor transformer yard with chain mesh security fence and earth grid for the whole substation area. The substation building will comprise of:

- Two 33 kV switchrooms housing the 33 kV indoor vacuum type switchgear
- Two 6.6 kV switchrooms housing the 6.6 kV indoor vacuum type switchgear
- Auxiliary/battery room
- A shielded control/relay/communications room
- Breakout room with sink
- Toilet and locker room
- Store room
- Water collection
- Potable water treatment plant
- Waste water treatment plant
• Security fence / enclosure
• Road works.

At this point in the electrical reticulation there is a significant increase in fault tolerance and concurrent maintainability because of the introduction of 6.6kV ring main circuits to the load substations (6.6 kV – 415/20 V) and dual 33 kV feeder arrangements.

The use of dual feeders, split busses etc., arises from the need to reduce load capacities in the feeder circuits to within acceptable working capacities and avoid the need for very large cable sizes for the submains between the main substation and the 33/6.6 kV substations. By marginally increasing the capacities of the multiple 33 kV submains a degree of redundancy is introduced and can be utilised by switching the ring main feeders to transfer load substations between 33/6.6 kV substation busses. This system can also be used to cater for abnormal operating conditions such as maintenance and repairs.

It will also be possible to maximise antenna availability by powering down one of the antenna arrays (or part of) to allow the remaining arrays to continue operation during fault repair and maintenance operations.

These availability improvements are achieved at minimum cost as the need to duplicate feeders to satisfy capacity considerations has already been implemented and small increases in individual circuit current capacities can be achieved at virtually no additional cost to the SKA. As it is not practical to filter 33 kV circuits to remove induced high frequency signals from the cables, RFI performance will be assured by the use of solidly screened 33 kV underground cable to the transformers. The transformer oil tanks will be fully welded and will incorporate waveguide filters on oil cooler pipes and the connection to the conservator tank. All 6.6 kV outgoing circuits will be filtered with the use of double ∞-network RFI filters so that the large number of potential emission points at the 6.6kV and lower voltages can be treated as a passive electrical network that requires little or no further expense to eliminate RFI emissions generated by the power distribution equipment itself.

**Typical 6.6kV core distribution scheme**

![Figure 6 – Typical 6.6 kV core distribution scheme.](image)

![Figure 7 – Typical 6.6 kV core distribution scheme – motivated alternative.](image)
Clump distribution scheme

Figure 8 – Clump distribution scheme.
Data transport technical information

Rationale

The architecture proposed by the ANZSCC for the fibre infrastructure for the central area and spiral arms offers the SKA a number of benefits including:

- Uniformity across all receiver types
- Ease of initial deployment
- Ability to stage deployment in an incremental fashion
- Cost effectiveness both for the passive infrastructure itself and the active equipment it will support.

The following section outlines our rationale for a 10Gbps solution as well as further technical details on infrastructure architecture within 180km of the SKA core.

Table 1 – Reasons supporting selected architecture.

<table>
<thead>
<tr>
<th>Architectural elements</th>
<th>Feasibility</th>
<th>Suitability</th>
<th>Availability</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital transmission</td>
<td>Proven in a number of pathfinder telescopes</td>
<td>Industry standard, successfully implemented in a number of pathfinder telescopes including LOFAR, MWA and ALMA. Leverages low cost driven by ICT industry</td>
<td>Widely available, and at significantly reduced cost in future</td>
<td>Insensitive to temperature and delay</td>
</tr>
<tr>
<td>10Gbps transmission</td>
<td>Proven and widely available in digital systems today</td>
<td>Much cheaper per bit than 40Gbps and 100Gbps Allows for single fibre unidirectional transmission. Optics not requiring positive feedback capabilities such as QPSK signalling. Can be cost effectively transmitted on a single wavelength (allows WDM). The 10Gbps solution is technically well understood, supported by industry with multiple supply chains and readily available today. Currently higher speed 40 or 100Gbps based technologies require long haul transmission capabilities to support distances over 1 km. Even aggressively predicted cost estimates till at least 2020 for long haul transmission systems at 40Gbps or 100Gbps are higher than multiple 10Gbps services within the central area 180km radius Standards currently have not been ratified for 100Gbps long haul transmission systems</td>
<td>Huge market drives down cost in a very high volume element of SKA</td>
<td>Used extensively throughout the service provision telecommunications sector offering 99.999% uptime.</td>
</tr>
<tr>
<td>Dedicated transmission paths</td>
<td>Simple, well understood</td>
<td>Scales well (allows for future faster transmission)</td>
<td>Proven technology with well understood cost curves</td>
<td>No interference and minimal dependency on common infrastructure</td>
</tr>
</tbody>
</table>
DWDM passive multiplexing

40 channel multiplexors

- Minimises splicing overheads
- Scales from 1Gbps to 10Gbps delivery without additional requirements for active componentry to distances of ~60km.
- Supplied systems support a higher 40 channel configuration
- Allows future expansion to 80 channels with the introduction of a secondary passive interleaver device.
- In use today with well understood characteristics. More cost effective than 32 channel
- Totally passive device, widely used in the telecommunications industry in field deployed systems

<table>
<thead>
<tr>
<th>Signal amplification and dispersion compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplification required for 10 Gbps where distance is &gt; 60km</td>
</tr>
<tr>
<td>Most receivers will be within the 60km zone not requiring amplification</td>
</tr>
<tr>
<td>Placement will be in defined ‘pit’ locations</td>
</tr>
<tr>
<td>In use with well understood characteristics</td>
</tr>
<tr>
<td>Low maintenance environment hardened devices available</td>
</tr>
<tr>
<td>Dispersion compensation available as passive ‘doped fibre’ when required</td>
</tr>
</tbody>
</table>

Central area network infrastructure

Each dish and aperture array station is supplied with multiple dedicated single mode fibre (SMF) trunk connections from downstream splice pits. Dedicated fibre pairs are provided for monitor and control, SCADA and timing to all receivers.

Aggregation of data plane traffic is achieved via passive wave division multiplexors (WDM). Each multiplexor supports forty 10Gbps transmitters over a single fibre core.

All receiver digital interfaces are presented with no intermediate active switching or aggregation to the data processor patch field for interconnection to the de-multiplexors, timing, monitor and control and SCADA network backbones.

For dishes having only a single pixel feed (SPF) receiver the twelve cores of fibre supplied allows for an upgrade to a dual SPF+PAF receiver. If higher speed interfaces do become cost-effective then the fibre supplied to each receiver has ample capacity to support the specified data rates.

Table 2 – Receiver interface bandwidth and number of fibres required and supplied for data and control planes.

<table>
<thead>
<tr>
<th>Receiver type</th>
<th>Gbps</th>
<th>Qty</th>
<th>% of total</th>
<th>No. of 10 Gbps Tx</th>
<th>Number of fibres</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF dish</td>
<td>216</td>
<td>130</td>
<td>28.1</td>
<td>22</td>
<td>DWDM Mux 1</td>
</tr>
<tr>
<td>PAF+SPF dish</td>
<td>1858</td>
<td>2270</td>
<td>4217.7</td>
<td>186</td>
<td>PAF+SPF 5</td>
</tr>
<tr>
<td>AA-low</td>
<td>33440</td>
<td>250</td>
<td>8360.0</td>
<td>3344</td>
<td>AA-low 84</td>
</tr>
<tr>
<td>AA-mid</td>
<td>16800</td>
<td>250</td>
<td>4200.0</td>
<td>1680</td>
<td>AA-mid 42</td>
</tr>
<tr>
<td>Remote</td>
<td>216</td>
<td>25</td>
<td>5.4</td>
<td>22</td>
<td>Remote 1</td>
</tr>
</tbody>
</table>

Central area optical fibre splicing topology

Within the 13 km central core, splice pits are co-located at receiver locations and aggregate multiple common receiver types. 12 core protected sheath fibres are used from each dish; forty-eight core protected sheath fibres are used from each AA-mid station and ninety-six core protected sheath fibres are used from each AA-low station. Inbound protected sheath fibres are aggregated and spliced onto a 288 core protected sheath trunk fibre and delivered to the data processor. Twenty-four dishes or six AA-mids or three AA-lows are spliced and aggregated onto a common 288 Core protected sheath trunk fibre.
The 12, 48, 96 and 288 fibre cables have been chosen because these are the commonly used standards in Australia for long haul fibre optic deployments and are available at commercially attractive rates.

Beyond the 13 km central core, a clump of 11 dishes, one AA-low and one AA-mid is aggregated and spliced to a single 288 core protected sheath trunk fibre. There are 10 of these sites for each of the spiral arms spanning 180km from the core. The 288 core fibre trunk cable allows for the upgrade from SPF to PAF configurations at all clump sites.

The data processor location patch field integrates all of the central area fibre links and spiral arms with a cross-connect patch of 73,000 fibre circuits for receivers, monitor and control (M&C) and timing functions between the dishes and aperture array stations to the 40 channel de-multiplexors for receivers and onto the data processor.

Table 3 – Central area fibre splicing.

<table>
<thead>
<tr>
<th></th>
<th>Central Area &lt; 13km</th>
<th>Central Area &gt; 13km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core / receiver</td>
<td>Dishes</td>
<td>AA-mid</td>
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<td>No. of aggregated receivers</td>
<td>24</td>
<td>6</td>
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<tr>
<td>No. of splices per pit</td>
<td>288</td>
<td>288</td>
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<tr>
<td>288 core trunk splice pit output</td>
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<td>1</td>
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<tr>
<td>288 core trunk data processor input</td>
<td>103</td>
<td>34</td>
</tr>
<tr>
<td>No. of 288 core inputs to data processor</td>
<td>254</td>
<td></td>
</tr>
<tr>
<td>No. of terminations at data processor</td>
<td>73,152</td>
<td></td>
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</table>
Diagram of optical fibre splicing topology.
Remote station fibre-optic topology, aggregation and long haul transmission

The diagrams below show the configuration and aggregation of a typical remote station’s fibre optic infrastructure and its interconnection to a long haul DWDM transmission system via an intermediate station beam former and bridge.

Inputs from each of the 24 single pixel feed receivers are over 22 fibres (10Gbps each) with an additional fibre pair for Monitor & Control and fibre core for time distribution. A beamformer will aggregate the 24 x 22 x 10Gbps input’s to output 22 x 10Gbps industry standard interfaces for long haul transmission over 3 x 100Gbps wavelengths to the Data Processor. In addition two 40Gbps wavelengths will interconnect adjacent ‘East & West’ remote stations to provide redundancy for the Monitor and Control functions.

For monitor & control each remote station will have a dedicated 40 Gbps wavelength running 4 x 10Gbps services to each adjacent station in a ‘daisy-chain’. The topology will form a cascaded ring with both ends connected to the central M&C facility to provide a redundancy capability.
Motivated alternative configuration data topology

The alternate configuration topology differs primarily by adopting an aggregation methodology made up of the following seven building blocks as described below. This approach has also been selected to enable the power and network infrastructure costs to be optimized.

1) An Inner core network of 653 PAF Dishes is supplied with 3888 cores of fibre over 6 x 648 trunk fibre links. 5 Cores of Fibre is supplied to each Dish for interconnection with 40 channel DWDM Multiplexors. An additional 623 cores of fibre is allocated from the Data Centre for timing Monitor/Control and expansion functions to the inner core Dish site.

2) Out to a distance of 2.5km there are 3 Strings of 11 x 25 Dish PAF Stations. Each PAF Station is supplied with 132 cores of fibre over a 1 x 132 core trunk fibre link. 5 Cores of Fibre is supplied to each PAF Dish for interconnection with 40 channel DWDM Multiplexors. An additional 4 cores of fibre is allocated from the Data Centre for timing Monitor/Control and expansion functions to each PAF station. Each Stations 132 core trunk fibre is spliced to a higher capacity trunk along the path, aggregating to a 648 core trunk fibre for direct connection to the Data Centre. PAF Stations out to a radius of 35km are interconnected similarly.

3) An Inner core network of 37 AA-Low Stations is supplied with 3240 cores of fibre over 5 x 648 trunk fibre links. 84 Cores of Fibre is supplied to each Station for interconnection with 40 channel DWDM Multiplexors. An additional 132 cores of fibre is allocated from the Data Centre for timing Monitor/Control and expansion functions to the inner core AA-Low site.

4) There are 3 Strings of 11 AA-Low Stations each Station supplied with 96 cores of fibre over a 1 x 96 core trunk fibre link. 84 Cores of Fibre is supplied to each Station for interconnection with 40 channel DWDM Multiplexors. An additional 12 cores of fibre is allocated from the Data Centre for timing Monitor/Control and expansion functions to the AA-Low station. Each Stations 96 core trunk Fibre is spliced to a higher capacity trunk along the path, aggregating to a 648 core trunk fibre for direct connection to the Data Centre. AA-Low Stations out to a radius of 35km are interconnected similarly.

5) Stations outside of 35 km’s combine a 25 Dish PAF and AA-Low Station. Each combined station requires 213 cores for Data and Monitor & Control and is supplied with 216 cores of fibre over a 1 x 216 core trunk. Each Stations 216 core trunk fibre is spliced to a higher capacity trunk along the path, aggregating to a 648 core trunk fibre for direct connection to the Data Centre.

6) Two remote stations outside of the 140km radius are a combined SPF + AA-Low capability. Each combined station requires 113 cores for Data and Monitor & Control and is supplied with 120 cores of fibre over a 1 x 120 core trunk. Each Stations 120 core trunk fibre is spliced to a higher capacity trunk along the path, aggregating to a 648 core trunk fibre for direct connection to the Data Centre.

For the motivated alternative configuration, extensive modelling was undertaken to optimize the routing of the data and power transmission systems to minimize the infrastructure costs whilst maintaining the systems integrity and reliability. Detailed information on fibre splicing, fibre core count, route distances, trenching or direct bury methods and receiver locations has been produced and can be provided upon request in spreadsheet and Google Earth formats.
Cost breakdown and pricing methodology

Costs for the fibre optic network and installation have been estimated based upon the recent completion of the ASKAP Geraldton to MRO fibre optic link. The prices used include materials and labour as supplied and installed at the Murchison Radio Observatory. Individual prices, any caveats and details are described below.

### Compliant Configuration Cost Breakdown: Central Area

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Rate</th>
<th>See Note</th>
<th>Amount</th>
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<tbody>
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Sub Total: $6,767,700

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Sub Total: $37,009,712

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Sub Total: $69,080,000

180km Central Area Total: $112,857,412
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<td>Active Network &amp; Transponders Remote Station (AARNet backbone)</td>
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<td>to AARNet Backbone</td>
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<td>K</td>
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### Motivated Alternative Configuration Cost Breakdown: Central Area

<table>
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<th>Description</th>
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<th>Qty</th>
<th>Rate</th>
<th>See Note</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Fibre Optic Cable - 12 Core Dish Snowflakes</td>
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<td>Fibre Splicing Dish &amp; AA-Low Snowflakes</td>
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**180km Central Area Total** $57,933,761
### Motivated Alternative Configuration Cost Breakdown: Remote Network

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<th>Qty</th>
<th>Rate</th>
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<td>Remote Site 20 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$650,000.00</td>
<td>J</td>
<td>$650,000</td>
</tr>
<tr>
<td>Remote Site 21 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$660,000.00</td>
<td>J</td>
<td>$660,000</td>
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<tr>
<td>Remote Site 22 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$760,000.00</td>
<td>J</td>
<td>$760,000</td>
</tr>
<tr>
<td>Remote Site 23 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$760,000.00</td>
<td>J</td>
<td>$760,000</td>
</tr>
<tr>
<td>Remote Site 24 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$860,000.00</td>
<td>J</td>
<td>$860,000</td>
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<tr>
<td>Remote Site 25 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$860,000.00</td>
<td>J</td>
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<tr>
<td>Remote Site NZ2 Network Equipment</td>
<td>Each</td>
<td>1</td>
<td>$1,065,000.00</td>
<td>J</td>
<td>$1,065,000</td>
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<tr>
<td><strong>Active Network &amp; Transponders Sub Total</strong></td>
<td></td>
<td></td>
<td></td>
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<td><strong>$8,505,000</strong></td>
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<tr>
<td><strong>Remote N/W Total</strong></td>
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<td></td>
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<td><strong>$26,182,040</strong></td>
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<td><strong>Motivated Alternative Configuration Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>$84,115,801</strong></td>
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# Notes on Pricing Sources and Assumptions

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Price Source</th>
<th>Unit Cost</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>m</td>
<td>ASKAP Project Geraldton-MRO Installation</td>
<td>$1.80</td>
<td>SMF ULL 48 Core Direct Bury Fibre as installed for the ASKAP long haul route.</td>
</tr>
<tr>
<td>B</td>
<td>m</td>
<td>Current pricing from multiple suppliers</td>
<td>$1.00, $1.30, $1.50, $2.50, $6.00</td>
<td>SMF ULL Direct Bury Fibre. Projected pricing for supply on-site.</td>
</tr>
<tr>
<td>C</td>
<td>Each</td>
<td>ASKAP Project Geraldton-MRO Installation</td>
<td>$16.59</td>
<td>Includes on-site labour @ $10.00 each and equipment @ $6.59 Each and verification.</td>
</tr>
<tr>
<td>D</td>
<td>Each</td>
<td>ASKAP Project Geraldton-MRO Installation</td>
<td>$16.25</td>
<td>Includes on-site labour @ $10.00 each and equipment @ $6.25 Each and verification.</td>
</tr>
<tr>
<td>E</td>
<td>Each</td>
<td>ASKAP Project Geraldton-MRO Installation</td>
<td>$3,000, $10,000</td>
<td>Includes supply to site and installation. Pricing from small to large pits does not vary significantly. Pricing for very large was projected based upon weight and volume.</td>
</tr>
<tr>
<td>F</td>
<td>m</td>
<td>ASKAP Project Geraldton-MRO Installation</td>
<td>$20.00</td>
<td>Includes equipment and labour.</td>
</tr>
<tr>
<td>G</td>
<td>m</td>
<td>ASKAP Project MRO Dish Infrastructure installation</td>
<td>$70.00</td>
<td>Includes equipment, labour and installation.</td>
</tr>
<tr>
<td>H</td>
<td>m</td>
<td>Current pricing from multiple suppliers</td>
<td>$1.57, $3.21, $4.43, $6.32, $6.86, $13.90, $21.29</td>
<td>Includes additional splicing cost for long runs in the Motivated Alternative Configuration. The cost / m is the total cost of the run including all splicing on-route. Compliant configuration assumes no intermediate splicing points between dishes given their close location throughout the core of the network.</td>
</tr>
<tr>
<td>I</td>
<td>m</td>
<td>Current pricing from multiple suppliers</td>
<td>$2.00</td>
<td>Fibre is reticulated inside a conduit within each snowflake or remote station dish to a central pit or beam-former location. Cost of trenching between the dishes within the snowflake is included in the Power reticulation estimates.</td>
</tr>
<tr>
<td>J</td>
<td>n/a</td>
<td>ASKAP Project Geraldton-MRO installation pricing with estimates for Long Haul DWDM Transmission System</td>
<td>n/a</td>
<td>Cost to the nearest AARNet backbone</td>
</tr>
</tbody>
</table>
### Assumptions relating to remote sites to data processor costs

The following assumptions have been used in determining the estimates in Table 5:

- The two cost models provided are for an optimistic (connection to nearest telecommunications carrier) and a conservative (connection to the existing AARNet backbone) costing option.
- The cost estimate to the nearest fibre assumes the following:
  - The fibre-optic tail is built to the nearest point on an optical fibre link whether there is an existing connection point or not. A connection would be created if needed
  - A spare pair of fibres is available from the connection point to the nearest Communications Hut.
  - A DWDM network that connects to the Data Processor is available at the Communications Hut on the timeframe required with capacity to transport the necessary data services.
  - The only costs to be borne by the project are the fibre-optic tails, transponders and the incremental equipment to house and integrate them into the existing carrier’s network
  - There are no costs associated with accessing the carriers backbone or using the wavelengths.
- The cost estimate to the AARNet backbone assumes the following:
  - A fibre-optic tail is built to the nearest existing connection point on the backbone. If required new communications repeater huts are installed along the path
  - A spare pair of fibres is available from the connection point to the nearest communications hut
  - Close to the core, fibres are installed between remote sites and back towards the end of the nearest spiral arm
  - A DWDM network that connects to the data processor is available at the communications hut on the timeframe required with capacity to transport the necessary data services
  - The only costs to be borne by the project to connect to the AARNet DWDM backbone are the fibre-optic tails, huts, transponders and the incremental equipment to house and integrate them into the existing carrier’s network.
  - Over the next 12 years the AARNet fibre (shown as a dashed line in Figure 3) that is provided by the NBN and Nextgen Networks will be fully upgraded to DWDM, funded by its members and the Australian Government via a variety of mechanisms
  - Only incremental costs associated with accessing the AARNet backbone and using the wavelengths are borne by the project.
- In general the cost represents the incremental upgrades to the existing active and passive equipment to meet the remote data requirements leveraging the existing Australian fibre backbone network and installed DWDM transmission systems.
- The AARNet cost represents a safety-net and maximum price point for the solution. Ongoing negotiations with the NBN Co. and companies owning other existing infrastructure may be able to reduce this figure. NBN Co. was created on 9 August, 2009 and is a wholly-owned Australian Commonwealth Government owned company established to deliver Australia’s first national open access broadband network to all Australians.
- The cost of both active and passive components has been included in the estimates in the previous table, as they are likely to represent costs that the SKA project would incur to an external provider.
- Estimates of remote stations power & fiber reticulation (840m of trenching & 3720m of fibre & power cable) are based upon supply to 24 evenly separated antennas with 30m separations over a 180m station diameter footprint.
Assumptions relating to New Zealand remote station connectivity for motivated alternative

The overall link is built up from the following assumptions:

- A 179km tail will be built from the location of the remote station to the nearest dark fibre backbone near Invercargill.
- A 1500km dark fibre pair is provisioned from Invercargill to Auckland with access to repeater huts approximately every 100km.
- A 100Gbps per channel DWDM system is installed over the entire length (the cost of this has not been included because it has been assumed that this will be provided by the NZ R&E community).
- A number of 100Gbps transponders are installed to transmit the required capacity to Auckland to cross connect with the international capacity to Australia and then on to the Data Processor Site.
- The capital cost for the international link from New Zealand to Australia have not been included separately here because they are already included as part of the budget for international cable capacity.

Map illustrating current New Zealand research network fibre infrastructure.
### Sources

<table>
<thead>
<tr>
<th>Company/Consultant</th>
<th>Role</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO Systems Inc, Australia</td>
<td>Data transport network design and related cost estimates</td>
<td>Cisco Systems, Inc. designs, manufactures, and sells Internet protocol (IP)-based networking and other products related to the telecommunications and information technology industry worldwide. Cisco was founded in 1984 and is headquartered in San Jose, California, USA. Cisco is a founding member of the Australian SKA Industry Consortium (in 2006), and executed a Statement of Mutual Interest with the SKA Project Development Office in July, 2011.</td>
</tr>
<tr>
<td>AARNet Pty Ltd</td>
<td>Data transport network design and related cost estimates</td>
<td>AARNet Pty Ltd (APL) is the company that operates Australia's Academic and Research Network (AARNet). It is a not-for-profit company limited by shares. The shareholders are 38 Australian Universities and the CSIRO. AARNet provides high-capacity leading-edge Internet services for the tertiary education and research sector communities and their research partners. AARNet serves over one million end users who access the network through local area networks at member institutions.</td>
</tr>
<tr>
<td>Mr. Charles Smith</td>
<td>Data transport network design and related cost estimates</td>
<td>Charles Smith is a networking consulting engineer currently attached to the CSIRO Astronomy and Space Science Division. He is advising the Australian Telescope National Facility and the Square Kilometre Array Project Development Offices on networking technologies and researching architectures for the data and control planes for the ASKAP and SKA radio telescopes. Charles spent 8 years at Cisco Systems, where he was a principal architect and engineered research and education networks including the National Lambda Rail in the United States and TWAREN backbones in Taiwan. He is co-author of the Saratoga high speed transport protocol which is in draft status with the IETF and author of the reference “C” implementation Code.</td>
</tr>
<tr>
<td>FX Networks Limited</td>
<td>Cost estimates for New Zealand remote connectivity</td>
<td>FX Networks Ltd is based in Wellington, with offices in Auckland, Hamilton, Tauranga, Napier, Christchurch and Dunedin. The core business of FX Networks Limited is construction, ownership and operation of fibre optic network infrastructure. FX owns and operates over 3,500 km of fibre optic network throughout New Zealand linking 19 cities having recently completed the expansion of the core network from Christchurch to Dunedin.</td>
</tr>
<tr>
<td>Kordia Group Ltd</td>
<td>Cost estimates for New Zealand remote connectivity</td>
<td>Kordia is a boutique telco and media business which provides network and technology solutions that enable customers with specialised communications needs to succeed. Kordia owns an extensive telecommunications network in New Zealand and is the major provider of television and radio broadcast facilities. Kordia is a founding member of the NZSKAIC (New Zealand SKA Industry Consortium).</td>
</tr>
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</table>
## Glossary of terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AA</td>
<td>Aperture array</td>
</tr>
<tr>
<td>AARNet</td>
<td>Australian Academic Research Network</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACC</td>
<td>Accident Compensation Corporation</td>
</tr>
<tr>
<td>ACMA</td>
<td>Australian Communications and Media Authority</td>
</tr>
<tr>
<td>ADR</td>
<td>Alternative dispute resolution</td>
</tr>
<tr>
<td>AGN</td>
<td>Active galactic nucleus</td>
</tr>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ANZSCC</td>
<td>Australia–New Zealand SKA Coordination Committee</td>
</tr>
<tr>
<td>ASKAP</td>
<td>Australian Square Kilometre Array Pathfinder</td>
</tr>
<tr>
<td>BCA</td>
<td>Building Code of Australia</td>
</tr>
<tr>
<td>BOM</td>
<td>Australian Bureau of Meteorology</td>
</tr>
<tr>
<td>BSi</td>
<td>British Standards Institute</td>
</tr>
<tr>
<td>C</td>
<td>Celsius</td>
</tr>
<tr>
<td>Capex</td>
<td>Capital expenditure</td>
</tr>
<tr>
<td>cm</td>
<td>Centimetre</td>
</tr>
<tr>
<td>CC</td>
<td>Compliant configuration</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed-circuit television</td>
</tr>
<tr>
<td>CDMA</td>
<td>Code division multiple access</td>
</tr>
<tr>
<td>CER</td>
<td>Closer Economic Relationship</td>
</tr>
<tr>
<td>COAG</td>
<td>Council of Australian Governments</td>
</tr>
<tr>
<td>CORF</td>
<td>Committee on Radio Frequencies (USA)</td>
</tr>
<tr>
<td>COSPAR</td>
<td>Committee on Space Research</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer price index</td>
</tr>
<tr>
<td>CRAF</td>
<td>Committee on Radio Astronomy Frequencies (Europe)</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>CT</td>
<td>Continuous transmission</td>
</tr>
<tr>
<td>CUCRH</td>
<td>Combined University Centre for Rural Health</td>
</tr>
<tr>
<td>CVT</td>
<td>Continuously variable transmission</td>
</tr>
<tr>
<td>dB</td>
<td>Decibel</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DRUPS</td>
<td>Diesel rotary uninterruptable power supply</td>
</tr>
<tr>
<td>DWDM</td>
<td>Dense wavelength division multiplexing</td>
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<tr>
<td>DIT</td>
<td>Durack Institute of Technology</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>DRM</td>
<td>Digital rights management</td>
</tr>
<tr>
<td>EDFA</td>
<td>Erbium-doped fiber amplifier</td>
</tr>
<tr>
<td>EoR</td>
<td>Epoch of Reionization</td>
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<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>ERA</td>
<td>Economic Regulation Authority</td>
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<tr>
<td>ESE</td>
<td>East-south-east</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>eVLBI</td>
<td>Technique allowing real-time data transfer from remote radio telescopes to</td>
</tr>
<tr>
<td></td>
<td>the central processing facility via optical fibre cables</td>
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<tr>
<td>Fibre-optic</td>
<td>Data communications system</td>
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<tr>
<td>FM</td>
<td>Frequency modulation</td>
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<tr>
<td>G</td>
<td>Gigabyte</td>
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<tr>
<td>GA</td>
<td>Geoscience Australia</td>
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<tr>
<td>GERD</td>
<td>Gross domestic expenditure on research and development</td>
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<td>GIS</td>
<td>Geographic information system</td>
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<tr>
<td>GPD</td>
<td>Gross domestic product</td>
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<td>GPS</td>
<td>Gigabyte per second</td>
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<tr>
<td>GPS</td>
<td>Global positioning system</td>
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<tr>
<td>GHz</td>
<td>Gigahertz</td>
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<tr>
<td>GRAMS</td>
<td>Geraldton Regional Aboriginal Medical Service</td>
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<tr>
<td>GRH</td>
<td>Geraldton Regional Hospital</td>
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<td>GST</td>
<td>Goods and Services Tax</td>
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<td>GTE</td>
<td>Government Trading Enterprise</td>
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<td>GUC</td>
<td>Geraldton Universities Centre</td>
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<td>HI</td>
<td>Neutral Hydrogen</td>
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<tr>
<td>HDI</td>
<td>Human Development Index</td>
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<tr>
<td>HMI</td>
<td>Human machine interface</td>
</tr>
<tr>
<td>HSE</td>
<td>Health, safety and environmental sustainability</td>
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<tr>
<td>HV</td>
<td>High voltage</td>
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<tr>
<td>IAU</td>
<td>International Astronomical Union</td>
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<td>ICRAR</td>
<td>International Centre for Radio Astronomy Research</td>
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<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<tr>
<td>ILUA</td>
<td>Indigenous Land Use Agreement</td>
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<tr>
<td>ISO</td>
<td>International Standard Organisation</td>
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<td>ITU</td>
<td>International Telecommunication Union</td>
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<tr>
<td>IUCAF</td>
<td>Inter Union Commission on the Allocation of Frequencies</td>
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<tr>
<td>KAREN</td>
<td>Kiwi Advanced Research and Education Network</td>
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<tr>
<td>km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt</td>
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<td>Term</td>
<td>Definition</td>
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<td>--------</td>
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</tr>
<tr>
<td>kWh</td>
<td>Kilowatt hour(s)</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquid natural gas</td>
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<tr>
<td>LRU</td>
<td>Line replaceable unit</td>
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<tr>
<td>LV</td>
<td>Low voltage</td>
</tr>
<tr>
<td>MA</td>
<td>Motivated alternative</td>
</tr>
<tr>
<td>MED</td>
<td>Ministry of Economic Development (New Zealand)</td>
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<tr>
<td>MF</td>
<td>Management Framework</td>
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<tr>
<td>MHz</td>
<td>Megahertz</td>
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<tr>
<td>m</td>
<td>Million</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetres</td>
</tr>
<tr>
<td>m2</td>
<td>Metres squared</td>
</tr>
<tr>
<td>M&amp;C</td>
<td>Monitor and control</td>
</tr>
<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
</tr>
<tr>
<td>MRO</td>
<td>Murchison Radio-astronomy Observatory</td>
</tr>
<tr>
<td>MSC</td>
<td>Murchison Shire Council</td>
</tr>
<tr>
<td>MVA</td>
<td>Megavolt amperes</td>
</tr>
<tr>
<td>MWA</td>
<td>Murchison Widefield Array</td>
</tr>
<tr>
<td>MSB</td>
<td>Main switch board</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean time between failure</td>
</tr>
<tr>
<td>MW</td>
<td>Megawatt</td>
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<td>NADRAC</td>
<td>National Alternative Dispute Resolution Advisory Council</td>
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<td>NBN</td>
<td>National Broadband Network</td>
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<tr>
<td>N/C</td>
<td>Normally closed</td>
</tr>
<tr>
<td>NER</td>
<td>National Electricity Rules</td>
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<tr>
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<td>North-north-east</td>
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<tr>
<td>NTA</td>
<td>Commonwealth Native Title Act 1993</td>
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<tr>
<td>NZ</td>
<td>New Zealand</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OHS</td>
<td>Occupational health and safety</td>
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<td>Optical-fibre</td>
<td>Data cable</td>
</tr>
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<td>Okta</td>
<td>Eights</td>
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<tr>
<td>OPGW</td>
<td>Optical ground wire</td>
</tr>
<tr>
<td>Opex</td>
<td>Operating expenditure</td>
</tr>
<tr>
<td>PAF</td>
<td>Phased array feed</td>
</tr>
<tr>
<td>Pastoral lease</td>
<td>Crown land leased generally for the use of grazing stock</td>
</tr>
<tr>
<td>PC</td>
<td>Personal computer</td>
</tr>
<tr>
<td>Pi</td>
<td>Electrical force law</td>
</tr>
<tr>
<td>PPP</td>
<td>Purchasing power parity</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>RAFCAP</td>
<td>Radio Astronomy Frequency Committee in the Asia Pacific</td>
</tr>
<tr>
<td>RALI</td>
<td>Radiocommunications Assignment Licensing Instruction</td>
</tr>
<tr>
<td>REMP</td>
<td>Radio Emissions Management Plan</td>
</tr>
<tr>
<td>RMS</td>
<td>Root mean square</td>
</tr>
<tr>
<td>RMU</td>
<td>Ring main unit</td>
</tr>
<tr>
<td>ROADM</td>
<td>Reconfigurable optical add-drop multiplexors</td>
</tr>
<tr>
<td>RF</td>
<td>Radio frequency</td>
</tr>
<tr>
<td>RFI</td>
<td>Radio-frequency interference</td>
</tr>
<tr>
<td>RQZ</td>
<td>Radio-quiet zone</td>
</tr>
<tr>
<td>Rx</td>
<td>Receive</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory control and data acquisition system</td>
</tr>
<tr>
<td>SKA</td>
<td>Square Kilometre Array</td>
</tr>
<tr>
<td>SKA₁</td>
<td>SKA Phase 1</td>
</tr>
<tr>
<td>SKA₂</td>
<td>SKA Phase 2</td>
</tr>
<tr>
<td>SKA Core</td>
<td>SKA central area containing the three cores</td>
</tr>
<tr>
<td>SKA HOB</td>
<td>SKA Head Office</td>
</tr>
<tr>
<td>SKA OCCA</td>
<td>SKA Operations Centre near the Centre of the Array</td>
</tr>
<tr>
<td>SKA OSO</td>
<td>SKA Observatory Support Office</td>
</tr>
<tr>
<td>SKA SCB</td>
<td>SKA Super Computer Building</td>
</tr>
<tr>
<td>SMF</td>
<td>Single mode fibre</td>
</tr>
<tr>
<td>SPF</td>
<td>Single pixel feed</td>
</tr>
<tr>
<td>Stevenson screen</td>
<td>Level where air temperature is measured</td>
</tr>
<tr>
<td>SS</td>
<td>Survey speed</td>
</tr>
<tr>
<td>SSFoM</td>
<td>Survey speed figure of merit</td>
</tr>
<tr>
<td>SSG</td>
<td>SKA Siting Group</td>
</tr>
<tr>
<td>SWIS</td>
<td>Western Australian Interconnected System</td>
</tr>
<tr>
<td>TAFE</td>
<td>Technical and further education</td>
</tr>
<tr>
<td>TBPS</td>
<td>Terabytes per second</td>
</tr>
<tr>
<td>Temp</td>
<td>Temperature</td>
</tr>
<tr>
<td>Turno</td>
<td>Shift system</td>
</tr>
<tr>
<td>TTMRA</td>
<td>Trans-Tasman Mutual Recognition Arrangement</td>
</tr>
<tr>
<td>Tx</td>
<td>Transmit</td>
</tr>
<tr>
<td>UG</td>
<td>Underground</td>
</tr>
<tr>
<td>UHF</td>
<td>Ultra high frequency</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible power supply</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>URSI</td>
<td>International Union of Radio Science</td>
</tr>
<tr>
<td>UWA</td>
<td>University of Western Australia</td>
</tr>
<tr>
<td>V</td>
<td>Volts/Voltage</td>
</tr>
<tr>
<td>VHF</td>
<td>Very high frequency</td>
</tr>
<tr>
<td>VPN</td>
<td>Virtual private network</td>
</tr>
<tr>
<td>VT</td>
<td>Voltage transformer</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>Western Power</td>
<td>Western Power Corporation</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>WPI</td>
<td>Wage Price Index</td>
</tr>
<tr>
<td>WSW</td>
<td>West-south-west</td>
</tr>
</tbody>
</table>
Contributors

Principal contributors

This response to the SKA Siting Group Request for Information from the Candidate SKA Sites (dated 25 June 2011) has been prepared for and approved by the Australia–New Zealand SKA Coordination Committee (ANZSCC). The ANZSCC comprises senior representatives from the Australian Government, New Zealand Government, Government of Western Australia, CSIRO and ICRAR.

Government inputs into the response have been coordinated for the Australian Government by the Department of Innovation, Industry, Science and Research; the New Zealand Government by the Ministry of Economic Development and the Government of Western Australia by the Department of Commerce.

CSIRO, the Commonwealth Scientific and Industrial Research Organisation, has provided scientific and technical advice to the companies working on the costings presented, and has been responsible for interpreting the Model SKA and the Request for Information requirements. CSIRO has developed, based upon a robust science case, the Motivated Alternative Configuration presented and costed in this response.

In addition, CSIRO has project managed the development of the responses, and the production of the documents.

CSIRO is Australia's national science agency and one of the largest and most diverse research agencies in the world with more than 50 sites throughout Australia and overseas. CSIRO has managed radio astronomy national facilities for the research community for over 50 years and has extensive experience in operations and technical development of radio astronomy systems. CSIRO is currently managing the design and construction of the CSIRO Australian SKA Pathfinder radio telescope on the Murchison Radio-astronomy Observatory.

Specialist advice, costing and security information has been provided by Aurecon Australia Pty Ltd (Aurecon) under contract to CSIRO. Aurecon input has also been sought on the power provision and power distribution systems. Aurecon provides world-class engineering, management and specialist technical services to government and private sector clients. With more than 6,500 staff and over 80 offices worldwide, Aurecon has a presence in Australia, New Zealand, Africa, Southeast Asia, China, and the Middle East.

The capital cost estimate has been prepared by Rider Levett Bucknall in Perth, Western Australia. Rider Levett Bucknall is a global construction practise whose services include cost management and quantity surveying. Rider Levett Bucknall has 2,500 people in over 100 offices across Australia, New Zealand, Asia, Europe, Middle East, Africa and the Americas.

In addition, specialist advice and costing information has also been provided by AARNet and CISCO on the provision of fibre materials and labour costs.

Cisco Systems, Inc. designs, manufactures, and sells Internet protocol (IP)-based networking and other products related to the telecommunications and information technology industry worldwide. Cisco was founded in 1984 and is headquartered in San Jose, California, USA

Cisco is a founding member of the Australian SKA Industry Consortium (in 2006), and executed a Statement of Mutual Interest with the SKA Project Development Office in July, 2011.

AARNet Pty Ltd (APL) is the company that operates Australia's Academic and Research Network (AARNet). It is a not-for-profit company limited by shares. The shareholders are 38 Australian Universities and the CSIRO.

AARNet provides high-capacity leading-edge Internet services for the tertiary education and research sector communities and their research partners. AARNet serves over one million end users who access the network through local area networks at member institutions.
Additional information and support

A number of other organisations provided specialist advice, information or other support including:

- Auckland University of Technology
- Australasian SKA Industry Consortium
- Australian National University
- Curtin University of Technology
- Horizon Power
- International Centre for Radio Astronomy Research
- iVEC
- Synergy
- University of Western Australia
- University of Sydney – CAASTRO
- Victoria University of Wellington
- Western Power.

National, state and local government agencies

A number of local, state and national government agencies have been consulted and involved in producing this response. These include but are not limited to:

- Attorney General's Department (Commonwealth)
- Australian Bureau of Meteorology (Commonwealth)
- Australian Bureau of Statistics (Commonwealth)
- Australian Customs and Border Protection Service (Commonwealth)
- Australian Government Solicitor (Commonwealth)
- Australian Communications and Media Authority (Commonwealth)
- Australian Taxation Office (Commonwealth)
- City of Greater Geraldton (Local)
- Department of Broadband, Communications and the Digital Economy (Commonwealth)
- Department of Education, Employment and Workplace Relations (Commonwealth)
- Department of Finance and Deregulation (Commonwealth)
- Department of Foreign Affairs and Trade (Commonwealth)
- Department of Immigration and Citizenship (Commonwealth)
- Department of Infrastructure and Transport (Commonwealth)
- Department of Innovation, Industry, Science and Research (Commonwealth)
- Department of Main Roads (Western Australia)
- Department of Mines and Petroleum (Western Australia)
- Department of Prime Minister and Cabinet (Commonwealth)
- Department of Regional Development and Lands (Western Australia)
- Department of State Development (Western Australia)
- Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)
- Department of the Premier and Cabinet (Western Australia)
- Mid West Development Commission (Western Australia)
- Ministry of Foreign Affairs and Trade (New Zealand)
- Ministry of Science and Innovation (New Zealand)
- Murchison Shire Council (Local)
- New Zealand Trade and Enterprise
- Office of Native Title (Western Australia)
- State Solicitor's Office (Western Australia)
- The Treasury (Commonwealth).
Configurations

This map shows the compliant configuration determined in collaboration with the international SKA Program Development Office. All array-station locations are fully compliant with the exacting EMI and receiver threshold buffer zones determined by the international project. All array-stations further than 180 km from the core are sited in the vicinity of existing optical fibre cable.

Figure 1 – Compliant configuration for the Model SKA.

This map shows the motivated alternative configuration determined for Australia and New Zealand (see Attachment 27). All array-station locations are fully compliant with the exacting EMI and receiver threshold buffer zones determined by the international project. In Australia, array-stations have been sited along the AARNet research optical fibre network for cost-optimised data transport.

Figure 2 – Motivated alternative configuration for Australia and New Zealand.
Dear Dr Pankonin

Organisations comprising the Australasian SKA Industry Consortium (ASKAIC) wish to convey their strong support for Australia and New Zealand’s response to the request for information on the candidate sites for the Square Kilometre Array (SKA).

The scale and ambition of the SKA promises to provide many new technologies that will further our understanding of the universe and enrich the lives of people around the world. With its long and successful history in radio astronomy research, innovation and in the industry partnerships underpinning those outcomes, Australia and New Zealand offer an excellent environment in which to locate the SKA telescope.

Australia and New Zealand candidature to host the SKA site enjoys strong industry support through the active membership of the Australasian SKA Industry Consortium (ASKAIC). This has been a very successful mechanism to promote collaboration between industry, government and the research community. As a result, ASKAIC has been recognised as international best practice in bringing together the interests of the public and private sectors in the pursuit of a common goal. ASKAIC has forged strong and extensive networks around the world, and we warmly welcome the opportunity to work even more closely with the global community in achieving the full vision for the SKA.

We therefore strongly endorse Australia and New Zealand’s suitability to host the SKA, and to working further in collaboration with the international community to ensure that the SKA has the opportunity to fulfil its potential as one of the most iconic and important scientific endeavours of the 21st Century.

Yours Sincerely,

John Humphreys
Australasian SKA Industry Consortium

Note: ASKAIC was founded in 2005 with the primary goal to support the Australia and New Zealand bid for SKA