Australian Antarctic Treaty Inspections

December 2016

Amundsen-Scott South Pole Station (United States)

Antarctic Specially Managed Area No. 5 Amundsen-Scott South Pole Station

Report of Inspections under Article VII of the Antarctic Treaty and Article 14 of the Protocol on Environment Protection to the Antarctic Treaty

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1. Executive Summary

On 20 December 2016 a team of three Australian observers conducted inspections of Amundsen-Scott South Pole Station (United States) and Antarctic Specially Managed Area (ASMA) No. 5 Amundsen-Scott South Pole Station.

The inspection team found that Amundsen-Scott South Pole Station was operating at a very high standard and in compliance with the provisions and objectives of the Antarctic Treaty and its Protocol on Environmental Protection. In all aspects of station operations there was a strong focus on the delivery of an ambitious and important science program. A strong culture of safety and environmental protection was evident. Despite the remote location which poses significant logistical challenges, it was clear that the station has been built utilising sophisticated and effective infrastructure suited for the environment. It was also noted that the operating systems and management arrangements for the station are well placed to address the needs of those using the facilities.

The inspection team found that ASMA No. 5 Amundsen-Scott South Pole Station was operating effectively and achieving the management objectives for which it was designated. In particular, the ASMA appeared to be an appropriate means of managing potential interactions between the scientific and operational activities of the United States Antarctic Program and the significant level of private and commercial non-governmental activity in the vicinity of the station. The ASMA management arrangements are somewhat complex, although effectively applied by personnel on the ground as a result of comprehensive procedures and awareness programs. It was also noted that the United States and Norway as ASMA Parties were continuing to work with other stakeholders to enhance the clarity and effectiveness of the ASMA management arrangements and that, to this end, a review of the management plan was currently underway.

2. Context and purpose

2.1 Background

Article VII of the Antarctic Treaty (the Treaty) provides that each Consultative Party can designate observers to undertake inspections. Observers have complete freedom of access at any time to any and all areas in the Antarctic Treaty area. Parties are obliged to provide designated observers with free access to stations, installations and equipment for inspection at any time. This also applies to ships and aircraft at points of discharging or embarking cargoes or personnel in Antarctica. The provision for inspection is a key element of the Treaty and is designed to promote the objectives of the Treaty and ensure observance of its provisions.

Article 14 of the Protocol on Environmental Protection to the Antarctic Treaty (the Protocol) also provides for the conduct of inspections, consistent with Article VII of the Treaty, to promote protection of the Antarctic environment and ensure compliance with the Protocol. The Protocol requires that reports of inspections are sent to the Parties whose facilities are subject to inspection and that, after those Parties have been given the opportunity to comment, the report and any comments on it are circulated to the Committee on Environmental Protection, considered at the next Treaty meeting and then made publicly available.

Australia is strongly committed to the inspection provisions of the Treaty and the Protocol. The inspection program described in this report, conducted at the South Pole in December 2016, represents the ninth undertaken by Australia since the entry into force of the Treaty in 1961, and the fifth by Australia since the entry into force of the Protocol in 1998. Australia first conducted inspections in 1964 and the most recent prior inspections were in 2010 and 2011.

2.2 Inspection Itinerary

Australian observers were appointed to conduct inspections during the 2016/17 season. The inspection team comprised:

- Dr Nick Gales, Director, Australian Antarctic Division (Inspection team leader)
- Ms Katrina Cooper, Senior Legal Advisor, Department of Foreign Affairs and Trade and Australian Head of Delegation for the Antarctic Treaty Consultative Meeting
- Dr Jason Roberts, Glaciologist, Australian Antarctic Division

In accordance with Article VII of the Treaty, all Antarctic Treaty Consultative Parties were notified of the names of the observers in advance of the inspection. The activities of the inspection team in Antarctica were subject to an authorisation in accordance with sections 12E and 12F of Australia's *Antarctic Treaty (Environment Protection) Act 1980* which implements the obligations of the Protocol in Australia's domestic law.

The inspection team travelled from Hobart to Wilkins Aerodrome near Casey research station aboard Australia's Airbus A319 on 14 December 2016. On 19 December the team flew from the Casey skiway to the French/Italian Concordia Station aboard a ski-equipped Australian Antarctic Program Basler BT-67, where support had been arranged in accordance with existing cooperative logistics agreements between the Australian and French National Antarctic Programs. At Concordia the Basler was refuelled and the inspection team was given a brief tour of the station. The team then continued in the Basler to Amundsen-Scott South Pole Station, arriving late in the evening on 19 December and was accommodated at the station overnight.

Advance notice of Australia's intention to conduct an inspection had been provided to the United States through diplomatic channels and by direct communication with senior officials in the State Department and National Science Foundation Office of Polar Programs.

On 20 December 2016 the inspection team conducted an inspection of Amundsen-Scott South Pole Station (United States) and Antarctic Specially Managed Area No. 5 Amundsen-Scott South Pole Station, over a period of approximately 8 hours.

On completion of the inspection, the team flew in the Australian Basler to the skiway at Williams Field, McMurdo Station on 20 December. Two team members (Cooper and Gales) then flew on 22 December 2016 to Christchurch, New Zealand, aboard a United States Antarctic Program LC-130 Hercules, while the third team member (Roberts) returned to Casey Research Station aboard the Basler, departing McMurdo Station on 24 December 2016.

Australia's logistic arrangements, including inter-continental and intra-continental aviation capabilities, proved suitable to support an efficient inspection activity at the South Pole by senior officials, without requiring aviation support from other National Antarctic Programs to access South Pole.

In accordance with Article 14(4) of the Protocol, a copy of the inspection report was provided to the United States for comment. A copy of the inspection report was also provided to Norway, as a member of the management group for ASMA No. 5. Only two minor comments of a factual nature were received from the United States, and were addressed when preparing this final inspection report.

Australian Inspection Team with Basler BT-67 aircraft (photo: Katrina Cooper)

3. Amundsen-Scott South Pole Station

3.1 General information

Amundsen-Scott South Pole Station is the southernmost structure on Earth. It is located on 2742 m thick ice at the geographic South Pole (90°S, 0°E) at an elevation of 2835 m. The station is administered by the National Science Foundation Office of Polar Programs, which manages the United States Antarctic Program. The original station at the site was established in 1956 as part of the United States' commitment to the 1957-58 International Geophysical Year. The original station operated until 1975 after which it was replaced by a new station, based on a large geodesic dome. Since then the station has undergone several redevelopments and expansions, with the third and current version of the station completed in 2008.

The main station buildings are elevated to help avoid snow accumulation. The station buildings move with the flow of the Antarctic ice sheet at a rate of about 10 m per year. The station includes approximately 50 buildings, 4 underground vaults and 15 mobile temporary buildings. The station is operated year round with a maximum capacity of 168 people during summer (including 18 people in hypertat buildings) and a winter population of 45-50 people.

The station is serviced by a 4 kilometre compacted snow-skiway maintained during the austral summer, used predominantly by LC-130 Hercules aircraft, Twin Otter aircraft and BT-67 Basler aircraft. Three overland traverses in the austral summer from McMurdo Station deliver fuel and other supplies to the station.

Key research disciplines supported by the station include astrophysics and cosmology, metrology and climatology, aeronomy and space physics, geophysics and glaciology, and medical research. This scientific research includes many international collaboration projects, including the IceCube Neutrino Observatory.

Amundsen-Scott South Pole Station was last inspected in 2007 by Sweden, France and New Zealand.

Amundsen-Scott South Pole Station main station building (photo: Katrina Cooper)

3.2 Observations

On arrival at Amundsen-Scott South Pole Station, the station leader gave the inspection team a presentation on the operation and key science activities being conducted at the station, as well as a station induction. The inspection team drew on the inspection checklists adopted under Resolution 3(2010) as a general guide to the conduct of the overall inspection. At the conclusion of the inspection the Inspection team was given a completed Inspections Checklist along with other documents including a list of standard operating procedures. The inspection team regarded this information as useful and welcome. The following observations are, however, based on first hand observations made by the inspection team during the inspection. Access was provided to all areas of the station, and the inspection team was kindly provided a comprehensive tour by station personnel.

3.2.1 Construction and design

The challenges of building and maintaining permanent structures at the South Pole are considerable. Apart from the extreme temperatures, any structure must deal with issues of surface snow accumulation and constant and variable movement of the ice. The current Amundsen-Scott station is well engineered for its location. Having been completed in 2008, the main Elevated Station has now been fully operational for 8 years. It has an estimated design life of 25 years, although the team was advised that its operational life may well exceed this. It has weathered the extreme environment very well, with the external cladding still looking relatively new. There are some ongoing engineering challenges for the station, most notably the differential settling of the main elevated building. These issues are well understood and addressed through the robust engineering design and ongoing maintenance and management of the building.

The station incorporates numerous design features which enable it to be readily operated in compliance with the provisions of the Treaty and Protocol. It is abundantly clear that the station is focussed on, and is delivering, quality science. There is extensive use of an under-ice network of tunnels connected internally with the station which creates significant energy efficiencies, such as storage of frozen products in these locations. Systemised redundancy and back-up in critical areas such as power generation and water supply was evident. A strong culture of waste management is embedded in the station's operations as is minimisation and mitigation of fuel spillage.

Under-ice network (photo: Katrina Cooper)

The station is orientated to be orthogonal to the prevailing wind direction, and utilises that wind to minimise snow accumulation below the structure. The main building is built on a series of columns embedded into the firn and is designed to allow for the entire structure to be raised the equivalent to two stories (6 m) in the future. It has not been necessary to raise the building so far, but some minor height adjustments to individual parts of the building have been necessary to allow for different settling rates across the building.

Columns beneath the main Station buildings (photo: Katrina Cooper)

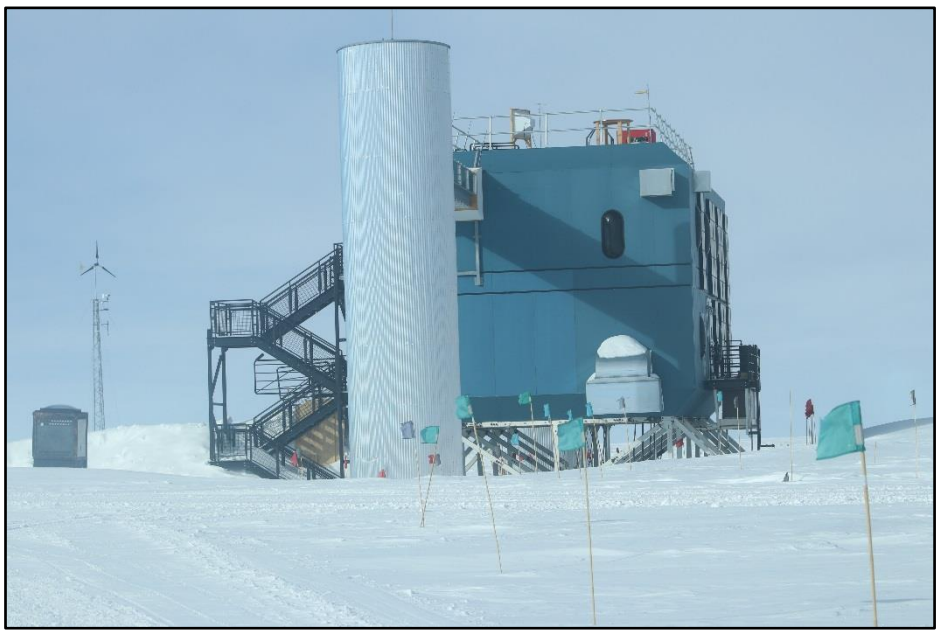
Other buildings away from the new elevated station structure are of a variety of ages and conditions. All buildings that are in use are of a high standard and an effective program of maintenance and upgrade of these buildings was evident. For example, the building used for the launching of meteorological balloons was being refurbished at the time of the inspection visit. The inspection team was particularly impressed by the management of buildings once their operational life is over. Decommissioning these buildings and returning the material to the United States for disposal is clearly a priority. Where practical, some materials are reused on station.

Overall the design, building materials and the structures themselves are of a very high standard.

3.2.2 Science activities

It is clear that science is the priority mission for South Pole station. World leading research in astronomy, astrophysics and related fields is supported through sophisticated infrastructure. The inspection team was given an overview of the scientific work being conducted at the station, and was provided access to scientific facilities associated with the main station area. The regular and sustained return of the principal investigators and their teams demonstrates the scientific desirability of working at South Pole. The zones within the ASMA are well designed to meet the needs of the science community, particularly the Quiet and Dark Zones.

Key, long term observational science is well supported at South Pole. Including, for example, an atmospheric sampling program has been run, as part of a pole-to-pole network of sites supported by the United States, with continuous research access to data since 1997. Such data series are key to understanding the atmospheric components of climate and climate change.



IceCube Neutrino Observatory (photo: Katrina Cooper)

It is evident that the science program at South Pole is well supported, with the major experiments having dedicated buildings and facilities to ensure their success and to limit any competition between different science projects for resources. In addition, a program of improvements to the science facilities is being undertaken, with one of the major telescopes part way through a major upgrade, while an extension to the IceCube

Neutrino Observatory is under consideration. Data volume management has the potential to be a significant issue, with large data volumes from modern scientific equipment and limited satellite communication access. This limitation appears to be well managed through normal station operations and the development of innovative solutions to ensure that the scientific output from the station is optimised.

3.2.3 International collaboration

While most scientists and science support personnel at the Station are from the United States, it is evident that virtually all of the research projects include many international collaborators. The inspection team was advised of collaborations with multiple other Antarctic Treaty Parties, including Australia, Chile, China, Russia, Italy, Germany, Sweden and Belgium. The strong level of international collaboration is well reflected in the authorship of scientific publications resulting from work conducted at South Pole.

3.2.4 Logistics

South Pole station is supported through a combination of aviation and over-ice assets. Both operate from McMurdo Station which is 1360km to the north.

LC-130 Hercules aircraft provide the most regular component of the supply chain with approximately 65-70 flights per season providing transport of passengers, cargo and fuel.

Up to three over-ice traverses from McMurdo Station provide about two thirds of the station's fuel supplies, plus some heavy cargo. Each traverse takes approximately 3 weeks to travel the 1360 km. The traverse equipment and operation continues to evolve and improve, particularly in relation to sledge design.

3.2.5 Operations and operational pressures

Given the remoteness of the station, logistical and operational pressures are ever-present. This is particularly the case for the supply chain (both to and from the Pole) of personnel, equipment and support materials necessary for the running of such a complex operation. At the time of the inspection, the station was under some operational pressures because delays to flights beyond the station's control meant that the flight schedule was behind by 20 flights. This was having an impact on operations and science but was being managed as well as possible.

While there are warehousing facilities both below the ice and through the main station building there are some evident pressures in managing the very high volumes of material needed to sustain the station. This is a common pressure at Antarctic stations and is being well managed at the South Pole through the use of external ice berms to allow for storage outside while protecting from snow accumulation. The relatively low snow fall and wind strengths mean this approach is highly effective. The network of berms appeared well organised and managed.

Storage facilities on Station (photo: Katrina Cooper)

3.2.6 Remediation and removal of old infrastructure

The inspection team was particularly struck by the considered program of the removal of unneeded buildings. The geodesic dome (commissioned in 1975 and replaced by the current elevated station in 2008) has been almost completely removed and a significant amount of its constituent material has been returned to the United States. Remaining material is well organised and stored in the network of berms constructed to minimise snowdrift. As the station is constructed and operated entirely on ice there are no issues with contaminated soil sites.

3.2.7 Waste management (storage, handling, repatriation)

There is strong evidence of recycling of waste embedded in the station culture. Systems for separation of waste are evident throughout the station with plentiful, well-marked bins provided for recyclables and landfill for return to the United States. There is also prominent and frequent signage reminding personnel on station of their obligations to separate waste. In the galley, kitchen waste is also separated from other forms of waste.

Waste sorting on Station (photo: Katrina Cooper)

Human waste and grey water is pumped into storage wells in the ice. Here the waste will freeze and, some tens of thousands of years later, will eventually be discharged into the Southern Ocean as the ice makes its way to the margin of the ice sheet. The storage wells are typically those that have been previously used for water collection. Personnel on station are reminded about the need to minimise grey water waste, with initiatives such encouraging short showers, which demonstrate a strong culture of environmental stewardship.

There is separate storage for hazardous waste in the mechanical workshop, all of which is destined to be returned to the United States for disposal.

3.2.8 Water production and usage

There is a sophisticated water production system and the inspection team visited the current operating well. These 'Rodriguez Wells' (Rodwells) operate by pumping warmed water down a drilled ice shaft, with the resulting melted ice pumped back to station for all water needs. The warmed water is a product of captured heat from the power generators which represents a very efficient and effective overall energy management system. The more typical use of boiler systems for heating water is rarely needed, but is available as a backup system.

3.2.9 Power production, management and usage

The power plant has been in operation for 25 years and the inspection team was advised about the systematic upgrades being undertaken to manage obsolescence and ensure continued longevity in power production. The inspection team was particularly impressed by the high level of heat recovery from the power plant that was evident, including heating the mechanisms to run the Rodriguez well. There are other innovative uses of power such as the glycol heated clothes dryers.

The main power house was very clean and gave every appearance of being effectively maintained.

3.2.10 Fuel handling practices and equipment

Approximately one third of the station's fuel is transported on LC-130 Hercules aircraft and the remaining two thirds is brought in by traverse. In total 1,378,000 litres of fuel is transported to the Station each season. There are extensive below-ice fuel storage facilities. Storage tanks have bunds and because they are protected from the weather, the bunds are not vulnerable to being filled by snow and ice.

The inspection team was advised that spills of fuel or other contaminants onto ice are managed immediately, with the contaminated ice being removed. The inspection team observed the high level of environmental awareness in relation to spills of fuel and other contaminants, and noted that spill kits were readily available in all places where fuel or other contaminants were stored.

Particular note was taken of aircraft refuelling procedures. The inspection team observed the infrastructure established for refuelling which was designed in a way which minimised the risk of spillage. There is ample evidence of good practice to deal with accidental spillage including the placement of absorbent mats on top of fuel drums.

Fuel spill mats used on drums (photo: Katrina Cooper)

3.2.11 Documentation for procedures for managing environmental risk

The inspection team was given a master list of all standard operating procedures for the station, including managing environmental risk. Given time constraints for the inspection activity these documents were not reviewed in detail, however it was observed through interactions with station personnel that these standard operating procedures were widely used and understood.

3.2.12 Awareness of station personnel of environmental requirements under the Protocol

On arrival at South Pole Station the inspection team viewed the standard induction video that all personnel are required to watch. The presentation was of a high quality and provided a general

overview of life at the station as well as obligations and procedures related to environmental management, including oil spills and waste management, and activities in the different zones of the ASMA.

While no station personnel were interviewed as a formal part of the inspection, the training video, along with a good deal of signage and other evidence (disposal bins, equipment to manage fuel spills, etc.) suggested a high level of training and awareness relating to environmental requirements under the Protocol.

3.2.13 Interactions with non-government activities

See below for comments on the station's interaction with tourist activities being conducted within the ASMA.

3.2.14 Health, safety and emergency response

It was clear that there is a positive safety culture at the station. There is a well-equipped medical facility with one doctor and one support technician. At the time of the inspection there was a second doctor visiting. Facilities for tele-medicine were evident, although the station is without satellite communications for many hours each day due to satellite limitations. These periods without communications are predictable and alternative options (while not as sophisticated) are available. While surgery can, and on occasions, has been performed at the station, the preferred procedure is to medivac patients to the McMurdo Station for medical treatment in the event of serious injury or illness.

Fire hydrants and muster points were observed throughout the station. Rescue equipment was observed in a number of locations. The inspection team was informed of the existence of specially trained emergency response teams – particularly for fire. While the induction video did not cover the various alarms, this may be covered in the more extensive briefing provided to station personnel.

Safety equipment evident on station (photo: Katrina Cooper)

3.2.15 Future plans for the station

Amundsen-Scott South Pole Station is well within its operational life and there are no current plans for major refurbishment or extensions. A continued program of maintenance and management of older buildings around the main station was evident.

4. Antarctic Specially Managed Area (ASMA) No. 5.

4.1. General information

Antarctic Specially Managed Area (ASMA) No. 5 Amundsen-Scott South Pole Station was proposed by the United States and adopted by the 30th Antarctic Treaty Consultative Meeting (2007) in order to manage human activities for the protection of scientific, environmental and historical values. The ASMA Management Plan (Measure 2 (2007) – Annex A) outlines the values to be protected, the aims and objectives, the management activities conducted within the ASMA, its period of designation, a description of the area (including the zones, supported by maps and photographs), a code of conduct for access and activities , and provisions for the exchange of information.

Norway joined the ASMA management group in 2015, and the United States and Norway are currently preparing a revision of the management plan for consideration by the Committee for Environmental Protection.

ASMA No. 5 covers an area of approximately 26,400 km^2 encompassing the station and long-term research and monitoring sites. It is divided into an Operational Zone (the site of the station and NGO activities), a Scientific Zone (isolation of sensitive scientific instruments), an Historic Zone (site of the Ceremonial South Pole, Amundsen's tent and other historic values) and a Hazardous Zone (site of the original 1957 station).

4.2. Observations

4.2.1. Awareness of station personnel of the requirements of the ASMA management plan

The immediate environs of the station are divided into sectors representing the various zones, including the Operational Zone, Scientific Zone, Historic Zone and Hazardous Zone. The Scientific Zone is further split into the quiet sector, dark sector, downwind sector, clean air sector and South Pole Remote Earth Science and Seismological Observatory (SPRESSO) quiet circle. The management arrangements are operationally complex but appear to be well understood and managed by station personnel. Although the absence of defining landscape features or boundary markers meant that the boundaries of the zones / sectors were not immediately apparent to the inspection team, the allowable travel routes are clearly marked and there appears to be a high degree of understanding among station staff about the various management areas and the requirements thereof.

ASMA maps available on display for station personnel (photo: Katrina Cooper)

4.2.2.Management of visitors and awareness of visitors of the ASMA management plan

The significance and history of the geographic South Pole is a drawcard for private and commercial non-government visits. However its remoteness and logistically challenging and costly access mitigates against the high levels of visitation experienced at coastal sites on the Antarctic Peninsula. An Information Paper submitted to the 39th ATCM (2016) by the Parties participating in the ASMA management group identified that from 2006/7 to 2015/16 tourism numbers have increased from approximately 189 per year to 216 per year, peaking at almost 500 in 2011/12 for the 100th anniversaries of the Amundsen and Scott expeditions. This relatively high number of visitors and visiting groups, combined with the frequency of turn-over creates the potential for conflict with the scientific and operational activities of the station. The ASMA management plan provides guidelines for non-government visitors, including prescriptions on overland approach routes, notification timeframes and camping within the ASMA which assists in managing potential conflicts.

The inspection team was advised that there are three main commercial operators providing trips to the South Pole. Commercial operators organise day trips and overnight visits to the Pole and also facilitate adventure tourism which includes skiing or cycling to or from the Pole. The programs include an increasingly popular program called 'last degree' where expeditioners ski from 89° S to the Pole (60 nm), a trip that takes 7-10 days. The overall number of tourists visiting in a season has doubled since the last inspection with an estimated 300-400 expected this year. Approximately 50 private flights were expected. The aircraft utilise the skiway managed by the United States and park at a specially designated site in the ASMA Operational Zone. At the time of the inspection 100 tourists had visited the Pole in the current season, however none were present at the time of the inspection activity.

The South Pole Area Management team acts as a point of contact / liaison for non-government (NGO) activities. The inspection team spoke with a representative of the management team, and gained an appreciation of how NSF interacts with non-government expeditions, including through the ASMA mechanism. It was evident that these interactions are well-managed and that in general the ASMA mechanism is effective at managing tourism activities while ensuring the scientific activities at the South Pole are not disturbed.

The inspection team also briefly visited the Antarctic Logistics and Expeditions (ALE) campsite, located within the designated NGO camping area approximately one kilometre from the station, and spoke to the site manager. At the time of the visit the ALE camp was the only NGO operator presence at South Pole, with other operators conducting fly-in-fly-out operations. The camp was in good order and it was apparent that there was a good relationship between the station and ALE. The site manager briefed the inspection team on ALE environmental practices in the ASMA and explained that, with the exception of grey water, all rubbish, including human waste, generated in the ASMA was returned to the United States via ALE's camp at Union Glacier. Grey water was disposed of with the assistance of the station. The inspection team was given details of ALE's environmental policies and noted that the site manager was clearly aware of and complying with the ASMA management plan. The inspection team noted the good relationship between the ALE camp and the station, including having clear processes for interactions between the two parties.

ALE Campsite (photo: Katrina Cooper)

4.2.3. Review of the ASMA management plan

The inspection team was informed of a thorough process of review that is guiding the development of a new ASMA management plan.

5. Acknowledgments

The inspection team extends its gratitude to:

- The United States Antarctic Program and personnel at Amundsen-Scott South Pole and McMurdo stations for respectively providing fuel, skiway support, overnight accommodation and friendly hosting during the inspection visit at South Pole, and access to the skiway at Williams Field, accommodation and visit at McMurdo, and flight to Christchurch (provided for under a Quid-Pro-Quo agreement between the Australian Antarctic Division and National Science Foundation).
- France/Italy and Concordia station personnel for fuel, skiway support and the warm hospitality in hosting the inspection team's brief transit.