Independent Environmental Audit of ANDRILL McMurdo Sound Portfolio Project

Phillip Tracey, Policy Advisor, Australian Antarctic Division

Rod Downie, Environmental Manager, British Antarctic Survey

Independent Environmental Audit of ANDRILL McMurdo Sound Portfolio Project

Executive Summary

i. *Introduction*

ANDRILL (ANtarctic geological DRILLing) is a collaborative scientific programme of geological stratigraphic drilling and core analysis conducted by Germany, Italy, New Zealand and the United States of America. The aim of the project is to determine Antarctica's role in global environmental change, by analysing sediment and bedrock cores retrieved from sea floor to 1000m or more below the sea floor. Drilling was undertaken at two sites - McMurdo Ice Shelf (MIS) in 2006/07 and Southern McMurdo Sound (SMS) in 2007/08 in the Ross Sea region of Antarctica.

A final Comprehensive Environmental Evaluation (CEE) for ANDRILL was submitted to the Committee for Environmental Protection in 2006. Antarctica New Zealand subsequently requested the Australian Antarctic Division and the British Antarctic Survey to undertake an independent environmental audit against the Final CEE. The audit included a visit to the operational SMS site and to the decommissioned MIS site in November 2007.

ii. Scientific Intent of ANDRILL

The principal scientific aim of these two drill sites is to determine ice sheet history and paleo-environmental changes in Antarctica over the last 14 million years, and to better understand the influence of Antarctica on global climate.

The audit team was confident of the globally important scientific value of ANDRILL. The audit team observed core samples being retrieved from the SMS site and processed at the Crary Laboratory, McMurdo Station for scientific analysis. No activities were observed that could be regarded as applied research to evaluate hydrocarbon resources in the Ross Sea.

iii. Environmental Risks and Mitigation Strategies

The potential break-out of fast ice and loss of the drilling rig, camp and associated facilities including bulk fuel storage tanks was considered by the auditors to be the most significant environmental risk. To mitigate this, project planning involved careful site selection, equipment design, early season commencement and a range of other precautions including buoyancy devices and routine snow clearance to minimise the load on the ice surface.

Possible impacts associated with the drilling operations included the release of high pressure gas or fluids, loss of drilling fluid, chemical spills from the hot water drill, loss of downhole logging tools, and the use of explosive sources for seismic investigations. These risks were well managed by the ANDRILL team, and consistent with the measures outlines in the CEE. This included the employment of highly experienced and qualified project managers, technicians and staff. High density drill mud was mixed on site in case fluids or gases under pressure were encountered, and pressure diversion equipment was incorporated into the drilling system. Drill fluid was recovered and re-circulated, and losses were minimised to the greatest extent practicable. Wildlife checks were undertaken when using explosives or an air gun, with measures in place to halt operations if mammals were noted within a 500m radius of the drilling operation.

Environmental risks and mitigation measures associated with the operation of the camp and drill site were also examined during the audit. Emergency planning for fire and medical evacuations were prepared and routinely tested. The management of wastes was well planned and executed, with most waste stored inside and taken back to Scott Base with returning vehicles, avoiding accumulation on site. Human waste was disposed of to ice pits. At SMS, grey water and brine was pumped directly to the sea through a hole drilled into the ice. At MIS, grey water was disposed of directly into a 'bulb' in the ice-shelf. The former MIS drilling site was also visited by the audit team and was noted to have been effectively cleaned up. Fuel storage and handling was generally well planned, and fuel consumption was approximately half that estimated in the CEE. All bulk fuel storage tanks were double-skinned, spill response equipment was sited at appropriate locations, and only one very minor spill of hydraulic fluid had occurred which was efficiently cleaned up. However, no operational procedures for refuelling or contingency plans for spills (a mitigation measure outlined in the CEE) had been prepared.

The CEE anticipated detailed, site-specific monitoring programmes. The audit team observed monitoring for fast ice stability, pressure control and wildlife presence. Some monitoring outlined in the CEE (including remote control video camera inspections of benthic communities around the drill hole and the reverse osmosis brine and grey water discharge outlet) was not undertaken for operational reasons.

iv. Conclusions and Recommendations

The audit team was convinced of the globally important scientific value of ANDRILL. There was no indication that ANDRILL was attempting to evaluate natural gas or hydrocarbon resources in the Ross Sea.

The auditors were satisfied that the ANDRILL programme was undertaken in compliance with the Protocol on Environmental Protection to the Antarctic Treaty, and largely in accordance with the Final CEE. Some discrepancies were noted between the CEE and actual operational practices, such as the lack of documented fuel handling and spill response procedures, and the lack of monitoring of benthic communities around the drill hole). The impacts of the activity were believed to be within the environmental limits established in the CEE.

The audit team commends in particular the professional approach of the ANDRILL project team. Their commitment to environmental protection in planning and undertaking the project, and their considerable experience in scientific drilling in Antarctica, is a major factor in minimising the impact of the activity.

The auditors recommend that:

- The Parties undertaking ANDRILL consider providing the CEP with a post activity report, sharing lessons learnt for future scientific drilling projects, and highlighting examples of best environmental practice.

- If future drilling programmes are undertaken, then mitigation strategies from environmental impact assessments are taken forward through a site Environmental Management Plan or checklist. Formal contingency plans should be prepared and implemented for any high risk scenarios identified.

31 January 2008

Independent Environmental Audit of ANDRILL McMurdo Sound Portfolio Project

1. INTRODUCTION

This report details an independent environmental audit of the ANDRILL – McMurdo Sound Portfolio project, carried out by representatives of the Australian Antarctic Division and the British Antarctic Survey, at the invitation of Antarctica New Zealand.

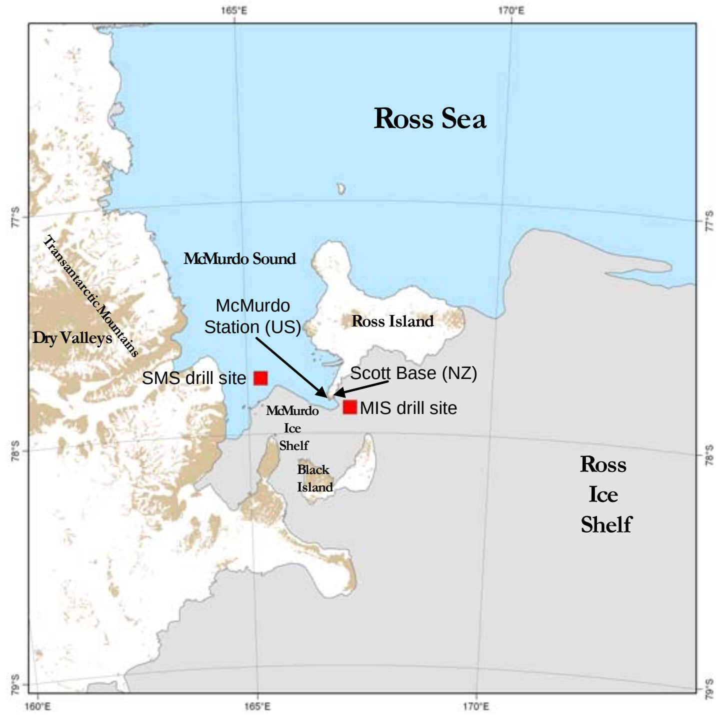
The audit was conducted against the Final Comprehensive Environmental Evaluation (CEE) for ANDRILL McMurdo Sound Portfolio (Huston *et al*, 2006).

1.1 Brief description of the ANDRILL – McMurdo Sound Portfolio project

The ANDRILL (ANtarctic geological DRILLing) project is a collaborative scientific programme of geological stratigraphic drilling and core analysis conducted by Germany, Italy, New Zealand and the United States of America. The aim of the project is to determine Antarctica's role in Cenozoic to recent global environmental change (a 65 million year time span). The project evaluated in the CEE includes drilling at two sites in the McMurdo Sound, Ross Sea region of Antarctica, geophysical (seismic) surveys associated with the specific drill sites, and logistic support. The sites were located on the McMurdo Ice Shelf (MIS) and on fast ice in southern McMurdo Sound (SMS) (Map 1). The project uses a drilling rig on ice-shelf and fast ice platforms to recover sediment and bedrock cores from the sea floor to 1000m or more below sea floor. A hot water drill was used to penetrate the ice (ice-shelf in the case of MIS, and fast ice for SMS).

The activity was undertaken over the 2006/07 and 2007/08 austral summers.

Figure 1. ANDRILL SMS drill site on fast ice



Map 1: Location of ANDRILL drill sites
(Base Map - Australian Antarctic Data Centre)

For the 2006/07 season at MIS, the infrastructure comprised the drill rig, site laboratory, office, dining and recreation area and emergency accommodation. Project staff lived at Scott Base (New Zealand) and commuted to the site. At the SMS site in 2007/08, an accommodation camp was established 300m from the drilling site.

1.2 Aim and objectives of independent audit

The final CEE stated that an independent audit of the ANDRILL project might be undertaken to verify the project's compliance with the environmental control and monitoring measures set out in the Final CEE, with Treaty regulations (including the scientific intent of the drilling project itself) and with other measures designed to safeguard the environment (Huston *et al* 2006). Consequently, Antarctica New Zealand requested that the Australian Antarctic Division and the British Antarctic Survey conduct an independent environmental audit between 31 October and 5 November 2007.

Dr Phillip Tracey (Policy Advisor, Australian Antarctic Division) and Mr Rod Downie (Environmental Manager, British Antarctic Survey) comprised the audit team. Site visits were facilitated by Ms Miranda Huston, Environmental Advisor, Antarctica New Zealand. Antarctica New Zealand provided logistic support including transport, field equipment, and accommodation for the period of the audit.

1.3 Scope and methodology of the audit

The audit covered activities documented in the final CEE for the ANDRILL project (Huston *et al* 2006). Site visits included the decommissioned 2006/07 drilling site on the McMurdo Ice Shelf, the 2007/08 drilling site on sea ice in southern McMurdo Sound (in operation at the time of visit), routes used to access these sites, equipment storage sites on land at Scott Base, and the processing of the core at Crary Laboratory facility at McMurdo Station (USA).

The audit was conducted using:

- observations during site visits from 2 November to 5 November 2007;
- a checklist developed by the audit team;
- interviews with key members of the ANDRILL project; and
- examination and verification of documented procedures and records.

2. SCIENTIFIC INTENT

Antarctic New Zealand requested the auditors to verify the project's compliance with the Antarctic Treaty, including the scientific intent of the project. The main scientific goals of ANDRILL are:

- to determine ice sheet history and paleo-environmental changes that Antarctica has experienced over the past 14 million years;
- to contribute towards the understanding of the influence of Antarctica on global climate;
- To calibrate numerical modelling of future climate change;
- To investigate the evolution of polar biota.

The Scientific Committee on Antarctic Research (SCAR), in its comments on the draft CEE, described ANDRILL as an important initiative for the geoscience community, and noted that it would provide 'a major focus for research into past climates and environmental change'.

The auditors met with members of the ANDRILL science team, and observed core samples being retrieved and processed for research. At the drill site this included cleaning, colour marking of analytical and archival sections, initial descriptions, analysis of fractures, and physical properties analysis (including density, porosity and magnetic susceptibility). In addition to drill site visits, the auditors were invited to attend the daily science meeting and 'core tour' at the Crary Laboratory on 13 November to see the further management of the retrieved cores. This included the splitting, imaging, scanning and initial characterisation of each individual length of core, and sample selection by the ANDRILL science teams for further analysis.

Figure 2. Cleaning and initial description of core at ANDRILL SMS site laboratory

Figure 3. Core tour and initial sample selection – Crary Laboratory, McMurdo Station

In commenting on the draft CEE for ANDRILL, one Party recommended that the CEE should underline that the data obtained by the ANDRILL project are not intended for evaluating hydrocarbon resources in the Ross Sea.

During the site visit to the SMS drilling rig and laboratory, and to the core processing facilities at the Crary Laboratory, all activities observed by the auditors were believed to be in support of the stated scientific goals. No activities were observed that could be regarded as 'applied research to estimate the area with regards to oil and gas reserves'.

The audit team was confident of the globally important scientific value of ANDRILL, and the contribution that it could make to climate investigations and environmental change.

Furthermore, the audit team was impressed by the extensive effort made by the ANDRILL project towards advancing the public understanding of Antarctic science, through web-based interactive projects for schools and media involvement in the project

3. ENVIRONMENTAL RISKS AND MITIGATION STRATEGIES

3.1 Potential loss of equipment associated with ice breakout

The CEE identified risks associated with the potential break-out of fast ice, including the possible loss of the drilling rig, camp and associated facilities including bulk fuel storage tanks. This was considered by the auditors to be the most significant potential environmental risk of the ANDRILL project. In addition, the weight of the drilling rig and equipment places a substantial load on the ice surface which could result in deformation of the ice, loss of ice stability and/or flooding of the ice surface.

In planning for ANDRILL, it was predicted that drilling operations at SMS could be safely conducted from fast ice with a thickness of 1.75m. In 2007/08, fast ice in southern McMurdo Sound was 6 years old, and the fast ice thickness at the commencement of drilling and during the visit of the audit team was 8.5m. It was considered that this provides a safe platform for drilling. The fast ice edge at the time of the audit visit was 8.5km from the SMS site.

ANDRILL project planning involved careful drill site selection, equipment design and a range of precautions aimed at reducing risks associated with sea ice stability or possible break out at the SMS site.

These precautions included the early-season commencement of drilling, whilst sea ice was at its most stable. Under-ice air bag flotation to offset the weight of the drilling equipment and facilities was planned for SMS. The auditors were advised that these were not deployed, because the very thick multi-year fast ice was strong enough for drilling operations, and because under-ice diving conditions were poor due to the presence of a 5-6 metre platelet ice layer. The auditors observed snow accumulation around the drilling and accommodation camps at SMS being cleared to reduce the load on the fast ice. The weight of the casing for the drill string through the water column (sea-riser) was offset by air-inflated buoyancy to reduce the load on the ice (and on the rig). This system was operating as planned at the time of the audit visit.

Project personnel provided the audit team with records of ice analyses and monitoring used to select the site and verify the ongoing stability of ice at SMS, including:

- analysis of satellite imagery for long term sea ice trends;
- analysis of ice breakouts in McMurdo Sound in the winter prior to drilling;
- ground truthing in early August of the drilling season to check ice thickness and surface condition;
- ongoing monitoring at the site and on access routes of ice thickness, ice temperature, ice deflection under the drill rig (via water level in the drill hole), horizontal movement, location of fast ice edge, and vertical movement due to tides and ocean swell.

Project staff also outlined the contingency plans in place for emergency evacuation to the nearest safe location. Scenario planning and contingency plans for both urgent evacuation, and evacuation with equipment (if conditions permitted) were described to the audit team.

3.2 Drilling operation

The CEE identified both unavoidable and potential environmental impacts associated with the coring operation. The audit team undertook a thorough examination of the drilling operation at the SMS site, and conducted comprehensive interviews with key project personnel, covering activity at both SMS and MIS drill sites.

3.2.1 Description of drill site and equipment

The drilling process involved making a hole through the ice-shelf or fast ice (using a hot water drill), and placing a casing ('sea-riser') through the water column and into the sea floor. A diamond coring bit, mounted on the end of hollow drill rod is deployed through the sea riser, and driven by the rotating drill rod to cut cores. Sections of core are removed from within the drill rod in a coring barrel. The rod progressively 'cases' the hole as coring proceeds and additional lengths of rod are added at the surface. Drill fluid is used to cool and lubricate the drill bit, return drill cuttings (rock and sediment waste) to the surface, and equalise the pressure inside the hole with the sub-surface pressures to prevent the hole collapsing inwards. The fluid is pumped down the drill rod, and circulates back to the surface during the drilling operation.

The ANDRILL rig is hydraulically powered from a separated diesel hydraulic power pack with hydraulic umbilical hoses feeding the winches, drill mast and rotary top head drive. The drill mast and platform are enclosed in a synthetic fabric shroud, designed to provide a warmer environment, and to enclose any hydraulic fluid spills from the hoses servicing the drill-head hydraulic power unit. A control box was mounted to the side of the drill platform, housing control, monitoring and logging equipment for the drill operation. The sides and underside of the drill rig were enclosed in synthetic fabric to direct and capture any fluid spills.

Figure 4. ANDRILL rig

Figure 5. Borehole – top of sea riser

The drill rig, rod ramp, and adjacent catwalk were mounted on covered sleds. Containers for generators, drill fluid production, drill mechanical equipment, and storage adjoined this covered area. Adjacent to the rig was a containerised power unit containing a hydraulic power pack for the drill. Containers housing the hot water drill and a dive hole were nearby.

Additional equipment included containerised site laboratory and office space, and dining/recreation areas. Fuel containers, storage containers and storage sleds were located some distance from the drill rig. Figure 6 shows the layout of the drill site.

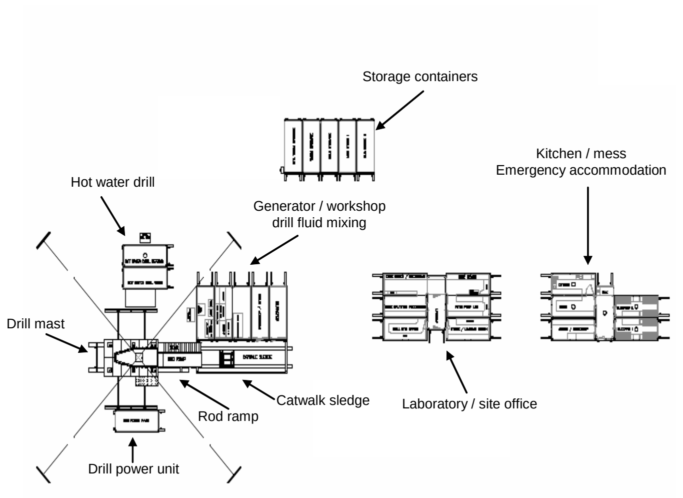


Figure 6. Layout of ANDRILL site
Adapted from Huston et al, 2006

3.2.2 Personnel and project management

A particularly important aspect of the management of environmental risks associated with drilling operations was the employment of highly experienced and qualified personnel, including project managers, drillers and scientific personnel. Many of the ANDRILL staff had considerable experience in Antarctic scientific drilling. In addition, safe working systems, procedures and drilling practices employed in the wider mineral research industry were being applied to ensure controlled and safe drilling. The employment of an experienced drill fluids engineer was considered by the audit team to contribute significantly to managing drilling risks.

3.2.3 Risks associated with gas and fluids under pressure

The CEE noted that high pressure gases or fluids can be encountered during drilling in deeper sediments. In addition, hydrocarbons, if present, could be released. The two ANDRILL sites were selected to avoid such hazards, based on the known geology of the area.

The CEE outlined measures for emergency pressure control, through application of high density drill fluid, and pressure diversion equipment. At SMS, the audit team was shown stocks of barite which could be added to drill fluid to provide additional density to control unexpected excess pressure in the drill hole. Project personnel explained that mixing fluid to a higher density as required is the most effective means of maintaining pressure control, due to the volumes of fluid involved, and the mixing and pumping process. Pressure control (diversion) equipment was also on site and being installed in preparation for the deeper portions of the hole. Contingency plans for encountering high gas pressure, based on standard drilling industry practices, were described to the audit team. The senior drillers on site had industry training in controlling gas blowouts.

Monitoring procedures for abnormal pressure, flammable gas, gas in drill fluid, and core checks were described to the audit team, and monitoring equipment for pressure and hydrocarbon hazards was observed in use. The audit team observed core checks being conducted.

Immediately prior to the visit of the audit team to the SMS drill site, coring was interrupted by an encounter with saline water under pressure in poorly consolidated sediments. The pressure in the borehole was quickly stabilised with drill fluid of higher density, as provided for in the CEE, and cement was applied to stabilise the area. Drilling recommenced while the audit team was on site. This incident demonstrated to the audit team the value of the planning and operational procedures and the role of drill fluid management in mitigating the environmental risks of the drilling operation. The audit team in particular noted the value of having a drill fluids engineer on site to analyse and respond to varying drilling conditions.

3.2.4 Drill fluids and cuttings

Drill fluids were mixed from seawater, potassium chloride, mica, and biodegradable viscosity agents (xanthan biopolymer and polyanionic cellulose polymers). Barite (barium sulfate) can be added to increase fluid density when required. Carbonate and organic fibre are used to reduce fluid loss to sediment, where required.

The ANDRILL project included a system of drill fluid mixing and circulation, housed in two containers in the drill site complex. A centrifugal separator to remove drill cuttings was incorporated in the system, enabling the re-use of drill fluid. A specialist drill fluids engineer was employed to manage the production and circulation of drill fluid to match drilling conditions.

The CEE noted that drill fluid can be lost to the water column and seafloor during the embedment of the sea riser and early coring. Subsequent drilling operations can involve loss of drill fluid to strata below the sea floor. The CEE also noted that drill cuttings would be disposed of into the water column (at SMS) or into bulbs within the ice shelf (at MIS).

During the SMS inspection, the auditors observed the drill fluid mixing and pumping equipment, including the centrifugal separator for the removal of cuttings. The auditors also observed the ice hole where cuttings were disposed of. Project personnel advised that drill fluid usage and loss to sub-sea strata was monitored and recorded by drillers and the drill fluids engineer. This information was also recorded in drilling logs and daily reports, both of which were observed by the auditors.

Project personnel advised that drill fluid loss to sediment at SMS was higher than anticipated, due to the nature of the sediments encountered. The expertise of the drill fluids engineer was regarded by project personnel as an important element in minimising fluid loss.

3.2.5 Downhole logging

The CEE details a number of procedures conducted in the borehole on completion of drilling, using specialised tools including two with low level radioactive sources. The CEE identified the risk of these tools becoming stuck in the borehole and lost. To reduce this risk, other tools including a calliper were used first, to ensure the hole was open. The project team advised that the radioactive source tool was not used at the MIS site as the borehole was not considered sufficiently stable. At SMS, downhole logging had not commenced when the auditors were on site, but was subsequently used in part of the hole that was stable.

3.2.6 Use of explosives for seismic investigations

ANDRILL used explosives and an airgun for seismic profiling, and for cutting the sea riser casing at the sea floor on completion of drilling. The CEE identified potential impacts associated with explosives use, including disturbance of marine mammals, and safety risks with explosives storage. The audit team observed the explosive sea riser cutting charges, stored in a container in their original UN approved transport packaging. These charges are contained within a housing that is inserted into the drill hole – the explosive material is not exposed at any point in the operation. Detonators were stored separately.

The CEE required checks for mammals within a 500 m radius of the drilling site before the use of explosives. Use of explosives would be delayed if seals or whales were observed. As anticipated in the CEE, seals and whales were not present at or near the MIS drill site. At the time of the audit team visit to the SMS drill site, seals were not present, the fast ice edge was at least 8.5km distant, and no cracks in the ice or access holes were seen or reported. ANDRILL personnel confirmed that procedures were in place for checking for marine mammals before seismic work or use of explosives.

3.2.7 Noise associated with drilling activity

The CEE predicted unavoidable noise from drilling operations. The audit team noted that noise levels were consistent with expectations for this type of operation, and no adverse impacts on fauna had been recorded.

3.2.8 Chemical spills

The use of a hot water drill (to make a hole through the ice shelf at MIS, through the fast ice at SMS, and for creating sewage pits) was identified in the CEE as a source of potential chemical spills. The hot water drill uses foodgrade propylene glycol (to minimise the effect of a potential spill) as antifreeze in the primary closed heating loop. The hot water drill, including fuel tanks and glycol circuits, was enclosed in a container. The drill is designed to heat sea water, which is circulated in a separate, corrosion resistant circuit from the propylene glycol. This arrangement was inspected by the auditors and in their view provides adequate protection from spills from this aspect of the operation. Project personnel reported no loss of propylene glycol or equipment associated with the hot water drill.

The audit team concluded that the environmental risks associated with the drilling operation were being well managed in accordance with the CEE.

3.3 Logistic support

Drilling at SMS was supported by an accommodation camp, located 300m from the drill site. During MIS operations, personnel lived at Scott Base, and travelled to the drill site each working day. Emergency accommodation was available at MIS to permit drilling to continue 24 hours a day in poor weather.

3.3.1 Accommodation camp

The audit team inspected the camp facilities at SMS. Figure 7 shows the camp layout. The audit team noted that the camp was well planned and managed to minimise environmental impacts. Camp support staff included a camp manager, a chef, and a domestic (also acting as a paramedic). Considerable effort had been made to provide a comfortable and safe living environment. The camp was constructed inside shipping containers on sleds, with two large tents providing living and eating spaces. These areas were linked together, and heated. Two separate toilets were located directly over pits in the ice. A large framed and soft-shell cold porch was in place, to provide a sheltered location for waste management, goods handling, cold storage, and maintenance of equipment.

Continuous drilling was conducted in two 12 hour shifts, which is standard operational practice in the drilling industry. Care had been taken to ensure that sleeping and meal arrangements were suitable for shift work, to reduce risks associated with fatigue. At the SMS accommodation camp, sleeping quarters were separated from other parts of the camp to avoid noise.

Records of the number of personnel on site were maintained and at no time exceeded the maximum of 48, as predicted in the CEE.

Fire safety arrangements were observed by the auditors. These included briefings and prominently displayed response procedures. A medical response plan was in place, and the auditors observed a medical response exercise during the site visit.

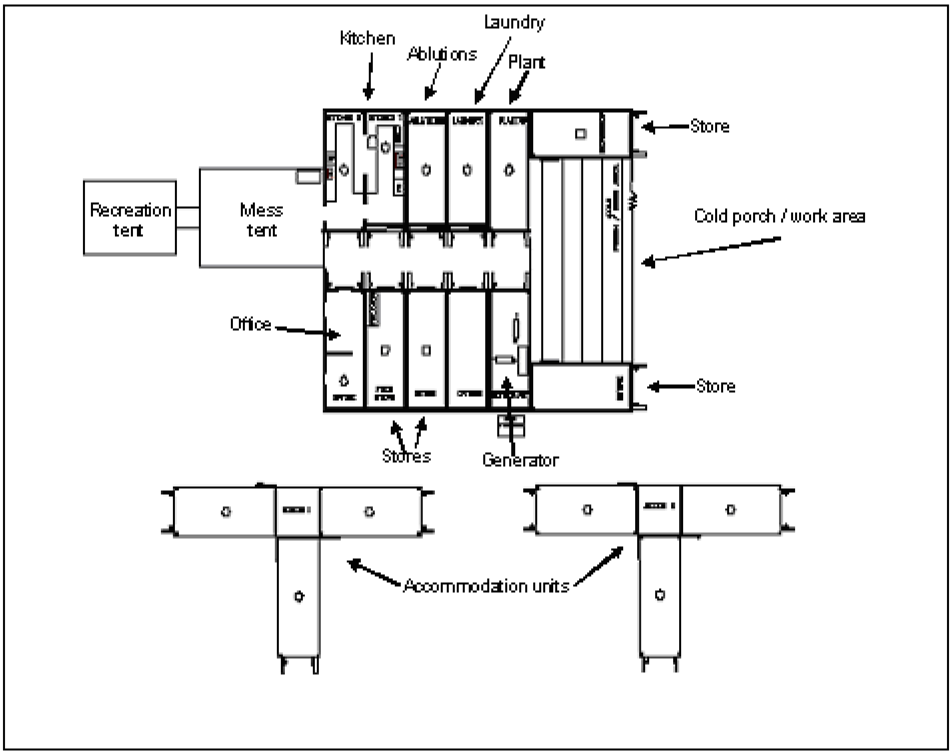


Figure 7. Accommodation camp layout
Adapted from Huston et al, 2006

Figure 8. ANDRILL accommodation camp

Overall, the auditors regarded camp operations as very well planned and managed. The measures outlined in the CEE to mitigate any predicted impacts were implemented as described in the CEE.

3.3.2 Storage

At the SMS drill site, equipment was stored outside on sledges, which were spaced apart to reduce snow build-up. This included camp construction equipment, drummed fuel in tarpaulin bunds, pallets of drill fluid constituents, and drilling equipment. Other items were stored in heated and ambient containers. In general materials including wastes were very well secured.

The auditors noted that plastic pallet wrap on some drill fluid constituent pallets had been cut to give access to the bags, and there was some risk of plastic becoming loose through wind action and being lost. Some partially emptied bags were also unsecured.

Between the two summer drilling seasons most ANDRILL equipment was stored on the McMurdo ice shelf. As such there was no impact on the terrestrial environment. Some ANDRILL cargo was stored at Scott Base for staging to the drill site. The auditors inspected this location, and noted that it has been heavily modified as a result of past activity. As such, the impacts associated with storage of ANDRILL equipment appeared to be negligible.

3.3.3 Transport

The ANDRILL project used oversnow vehicles and helicopters for day to day transport of personnel and equipment. Traverse support to transport heavy equipment including the drill rig, camp containers and bulk fuel to and from the drill sites was provided primarily by the United States Antarctic Program.

During the MIS drilling season, drilling teams were transported from Scott Base to the drill site by oversnow vehicle for each shift. Cores were transported to the Crary laboratory the same way. For the SMS site, helicopter flights were used to transport cores. Hagglund oversnow vehicles and skidoos were used for general transport and for personnel movements. Routes across fast ice and the McMurdo Ice Shelf, as well as local routes at the drill site were marked with flags. A small tracked loader was used around the drill site. A D6 bulldozer was on site and was used for refuelling operations, snow clearing, and moving heavy equipment. All surface transport was on snow and ice, except where using formed roads in the Scott Base and McMurdo Station areas.

Figure 9. Flagged route to ANDRILL SMS site

As far as could be ascertained, the impacts associated with transport use were consistent with the predictions of the CEE.

3.3.4 Fuel storage and handling

Bulk fuel was stored in two double skinned 15,000 litre sledge mounted fuel tanks. Two 2000 litre self bunded sledge mounted tanks were located at the drill site, and a third at the camp. A 1000 litre fuel tank and a 650 litre hydraulic oil tank supplied the drill rig powerpack, located inside a shipping container adjacent to the rig. Both were understood to be double skinned. The floor of the drill platform itself was lined with an impermeable sheet designed to catch spills. A 1000 litre diesel tank for a small heater was located outside the camp accommodation, fitted with an impermeable bund. This bund appeared to be well managed and little snow accumulation within the bund was witnessed. Drums of petrol/gasoline were stored on a raised sledge lined with a tarpaulin to collect fuel in the event of a spill.

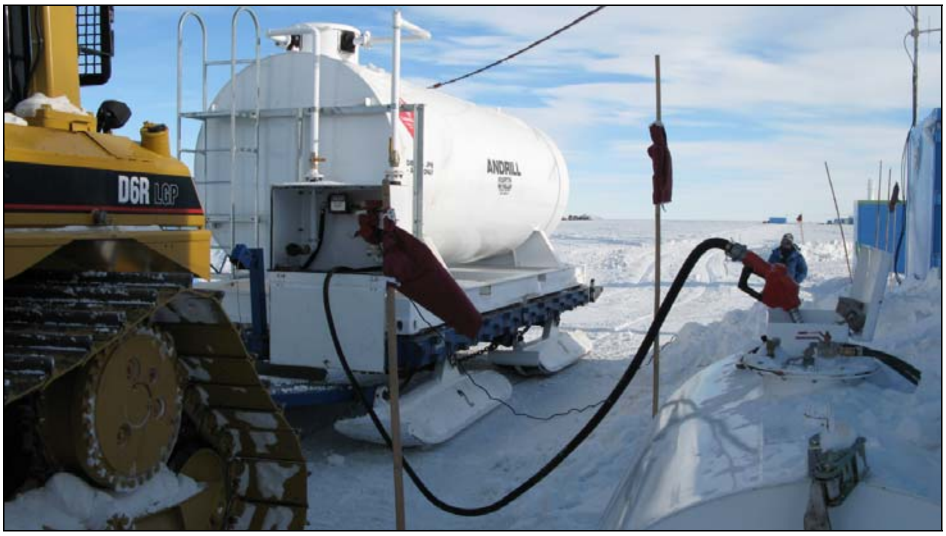


Figure 10. Refuelling from bulk to day tanks at ANDRILL SMS site

Oil spill absorbents were evident at all refuelling points, and overpack salvage drums were also available on site. A snow melter was available for melting out and recovering small quantities of contaminated snow, e.g. drips from refuelling vehicles and contaminated snow from drip trays.

Table 21 of the CEE summarised the environmental monitoring requirements of the CEE, and included the key parameters and environmental limits. This included a limit of 200 litres per spill and 300 litres total per season. No fuel spillage was reported from the MIS drilling season. As predicted in the CEE, hydraulic leaks were a greater risk. One spill of approximately 20 litres of hydraulic fluid from the drill rig during set-up was reported to the audit team. Most of the oil was captured and recovered within the drill rig shroud and impermeable ground sheet. Approximately 1 litre spilled out onto the sea ice, most of which was recovered. An incident report was completed and subsequently provided to the audit team.

The CEE stated that contingency plans would be prepared in line with COMNAP guidelines and that these would be kept at the drill site and camp for ease of reference (Section 6.5 of the CEE). During the audit, no documented fuel spill contingency plans were available on site or contained in the 2007 Project Management Plan (Operations Plan). Project staff regarded the Scott Base Contingency Plan as the operational fuel spill document, although this was not held on site.

Whilst recognising the experienced nature of the personnel on site, the team also noted the absence of documented fuel handling policy or procedures, which the CEE stated would be implemented. Transfer of fuel from bulk tanks to day tanks was observed during the site visit. This was carried out by a single operator, who remained inside the cab of the vehicle for part of the time during refuelling.

3.3.5 Fuel Consumption and emissions

The CEE predicted that 160 000 litres of fuel would be required for MIS and 210 000 litres of fuel for SMS.

Detailed records of fuel consumption were maintained by the ANDRILL Drill Site Manager. Actual fuel consumption during MIS was 86 627 (78 073 litres AN8 and 8 554 litres petrol / gasoline). Fuel consumption and the corresponding predicted emissions (Table 13 of the CEE) of MIS was therefore 54 % of that predicted in the CEE.

As at 4 November 2007, the total fuel consumption at SMS was 65 200 litres, and the Drill Site Manager was confident that actual fuel consumption, and corresponding emissions, would also be significantly less than that predicted in the Final CEE.

3.3.6 Disturbance to flora and fauna

Interaction with wildlife was identified as a potential area of impact in the CEE. Potential wildlife interactions could include noise disturbance from vehicles and aircraft, drilling, and camp operations, spills of fuel, oil, chemicals or underground fluids, use of explosives or air gun, and disposal of waste.

Project staff reported that the only fauna observed at MIS was a skua (*Catharacta mccormicki*) that briefly visited the site. At the SMS site at the time of the audit visit, three small groups of emperor penguins (*Aptenodytes forsteri*) had approached the camp, each group departing after some hours. No seals had been observed on the ice surface or in the dive hole close to the drill rig.

The planned deployment of a remotely operated underwater video camera, as described in section 6.4.3 of the CEE, had not taken place for operational reasons. As such, it had not been possible to monitor benthic community species and abundance, or damage to benthic communities, at the drill sites.

3.3.7 Waste management

The management and disposal of wastes generated at the drill site and accommodation camp was well planned and executed, and no littering or inappropriate waste disposal methods were observed.

Waste generated at ANDRILL was separated at source according to the waste management system in operation at Scott Base, and sent to the station with returning vehicles. Storage on site was short term and there was little accumulated waste. Waste oils and lubricants were stored inside an ISO container. General and recyclable waste was stored in an enclosed and covered porch at the main camp, thereby eliminating the risk of its dispersal into the environment.

Figure 11 ANZ Environmental Officer inspecting waste segregation at ANDRILL SMS site

Human waste was disposed of to ice pits made with the hot water drill. Three toilet pits were in operation at the time of the auditor's visit. The auditors were satisfied that this was the best practical method of sewage disposal for the sea ice camp. When the multi year sea ice breaks out, it is likely that there will be a short-term release of nutrients and organisms associated with human waste from the ice into the sea. Dispersal and dilution will occur rapidly.

Grey water and brine from the reverse osmosis plant was pumped directly to the sea though a hole bored into the ice. The audit team were able to confirm the use of biodegradable surfactants and other cleaning products in use at the ANDRILL site.

Section 6.4.2 of the CEE stated that the grey water outlet would be inspected by remote control video camera, and that periodic water samples from the vicinity of the grey water outlet beneath the ice would be taken, and nutrient analysis of the screened grey water conducted. Project staff advised that this monitoring was not conducted for operational reasons.

3.4 Site remediation

The audit team visited the MIS drilling site at 77 53"358'S, 167 05"640'E on 5 November 2007. Drilling activity at MIS was completed 12 January 2007, when the site was decommissioned. The outline of the camp, comprising small blocks of compacted snow or ice was all that was distinguishable. No evidence of the site is expected to be visible within one year. It was reported to the audit team that, as planned, the sea riser was cut with explosives close to the sea floor. Approximately 250 metres of casing was left below the sea floor, with 3 metres of pipe and concrete surrounds left in situ on the seabed. Project personnel also advised that the borehole collapsed with the withdrawal of the casing.

4. CONCLUSIONS

The audit team were convinced of the globally important scientific value of ANDRILL, and the contribution that it could make to investigations of climate and environmental change. There was no indication that ANDRILL was attempting to evaluate natural gas or hydrocarbon resources in the Ross Sea. The team also noted the exemplary education and outreach element to ANDRILL, and its significant contribution towards the public understanding of science.

The auditors were satisfied that the ANDRILL programme was undertaken in compliance with the Protocol on Environmental Protection to the Antarctic Treaty, and largely in accordance with the Final CEE. Some discrepancies were noted between the CEE and actual operational practices (for example the lack of documented fuel handling and spill response procedures, and the lack of monitoring of benthic communities around the immediate drill site). As far as could be ascertained, the impacts of the activity were well within the environmental limits set by the CEE.

The audit team commends in particular the professional approach of the ANDRILL project team. Their commitment to environmental protection in planning and operations phases of the project, and their considerable experience in scientific drilling in Antarctica, is a major factor in minimising the impact of the activity.

The auditors also commend Antarctica New Zealand for the initiative to invite an independent environmental review of the ANDRILL project.

5 RECOMMENDATIONS

5.1 The Parties undertaking ANDRILL consider providing the CEP with a post activity report, sharing lessons learnt for future scientific drilling projects, and highlighting examples of best environmental practice.

5.2 If future drilling programmes are undertaken, then mitigation strategies from environmental impact assessments are taken forward through a site Environmental Management Plan or checklist. Formal contingency plans should be prepared and implemented for any high risk scenarios identified.

Reference

Huston M, Gilbert N, Newman J, 2006. Final Comprehensive Environmental Evaluation (CEE) for ANDRILL McMurdo Sound Portfolio. Antarctica New Zealand, Christchurch. 152 pp.