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Investigation of radiation clearance procedures for vehicles leaving the Ranger mine

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Executive summary

Energy Resources of Australia (ERA), the operator of the Ranger uranium mine in the Northern Territory, advised the Assistant Secretary of the Office of the Supervising Scientist by telephone on 5 February 2004 that an incident had occurred in which two small earth-moving vehicles, called 'bobcats', had been returned in a mildly contaminated condition to the workplace of the Community Development and Employment Project (CDEP) in Jabiru. Written notification of the incident was provided by e-mail on the following day. The telephone notification described the contaminated material as being of 'low activity' and the incident was initially treated as being of a relatively minor nature.

On 29 March 2004, the Supervising Scientist was informed by a staff member of the Gundjeihmi Aboriginal Corporation that the manager of the CDEP was concerned about the incident and wished to meet with the Supervising Scientist to discuss the issue. The Supervising Scientist met with staff of CDEP on 30 March 2004 and, following discussion of the CDEP concerns, agreed to investigate the incident and to provide a report on completion of the investigation.

The investigation has revealed that there were at least three occasions on which vehicles left the Ranger mine site without adequate radiation clearance during 2003 and 2004. This report contains the results of the Supervising Scientist's investigation of the circumstances under which these vehicles left the Ranger mine and his assessment of the likely impact on the health of members of the public who were exposed to radioactive material contained on these vehicles.

Radiation clearance procedures at Ranger

This report has concluded that radiation clearance procedures at the Ranger mine are inadequate. This conclusion is based upon the following failure of procedures identified in this report:

- One vehicle left the Ranger mine on 5 January 2004 in a contaminated condition without having been cleaned or having received a radiation clearance certificate, and
- Two vehicles which were subsequently shown to contain partially leached uranium ore, one of which contained a substantial quantity of this material, left the Ranger mine on 28 November 2003 and 30 March 2004 with radiation clearance certificates.

It is recommended that radiation clearance procedures at Ranger be reviewed and upgraded to include much more specific instructions on the cleaning and inspection of vehicles and the inclusion of gamma dose rate monitoring equipment and that the procedures should be the subject of a regular, independent audit process.

It was also concluded that all staff involved in radiation clearance procedures need to be adequately trained in all practical aspects of radiation clearance and that ERA should review its procedures for the monitoring of the movement of vehicles on site to ensure that all vehicles that have been in controlled areas are checked for radiation clearance certificates at the Security Gate.

Two key groups involved in these incidents, the CDEP staff who carried out the maintenance work in the leach bunds and the staff who are responsible for security at the Ranger mine, were contractors rather than ERA staff. It is recommended that ERA should review the use of contracted labour at the Ranger mine within a risk assessment framework to ensure that its

key responsibilities for the protection of people and the environment are not jeopardised by the employment in key areas of staff over whom ERA has little or no direct control.

Radiation exposure of members of the public

One of the incidents investigated in this report resulted in the deposition of a relatively large quantity of partially leached uranium ore from the Ranger mine in two areas of the CDEP Yard in Jabiru. This resulted in the exposure of members of the public, the CDEP mechanic and his children, to low levels of radiation over a period of several months.

Estimates have been made of the radiation dose received by these members of the public as a result of this incident. We have concluded that the radiation dose received by the mechanic and his children was of the order of 1 mSv. It is not possible to be more precise but it is more likely that the actual dose received would have been less than rather than more than 1 mSv.

The annual dose limit for members of the public (excluding radiation doses from medical procedures) is 1 mSv above natural background. Hence, these radiation dose estimates imply that this limit may have been exceeded as a result of this incident. However, the conservative assumptions made in the calculations lead to the conclusion that it is more likely that the dose was smaller than 1 mSv.

It needs to be stressed that a radiation dose of 1 mSv does not present a significant health risk. For comparison, the average annual radiation dose received by Australians from natural background sources is approximately 2 mSv per year. Also, some diagnostic x-ray procedures deliver several mSv to the patient. Following the completion of these dose estimates, the SSD Health Physicist counselled the CDEP mechanic and his wife and reassured them that whilst this incident should not have occurred and the radiation exposure of the mechanic and his children was an unacceptable consequence, no adverse health effects were likely as a result.

Radiation protection culture at Ranger

The concentrations of radionuclides in material at the Ranger uranium mine are, given the average ore grade of about 0.3%, relatively low in comparison with some other mines in the world and are certainly low when compared with concentrations that occur in other parts of the nuclear fuel cycle. Hence, provided that a carefully designed radiation protection regime is in place and is implemented with diligence, it should be relatively easy to ensure that incidents that involve significant radiation exposure of employees or members of the public do not occur. The record at Ranger over the first 20 years of operations has demonstrated that this is so.

There have, however, been three such incidents in the past two years at Ranger. The first incident involved the exposure of workers who were replacing the roof of the precipitator building at the mine site in November 2002. The most exposed individual in that incident was estimated to have received a radiation dose approximately equal to the radiation exposure limit for workers.

The second incident was the potable water contamination incident that occurred on 23–24 March 2004. This incident was recently investigated by the Supervising Scientist and it was concluded that the maximum exposure of workers was likely to have been very much less than the radiation exposure limit for workers.

In the current incident, exposure estimates for members of the public are approximately equal to the dose limit for members of the public.

In addition to these incidents where actual exposure of workers or members of the public has taken place, there have been a number of occasions over the past two years on which the Supervising Scientist has expressed concerns about incidents in which ERA failed to carry out monitoring specified in either the Ranger or the Jabiluka (also operated by ERA) Authorisations.

Further, in the recent Audit of performance of ERA against the Draft Mining Management Plan (MMP) for Ranger, it was identified that dust monitoring of an operator in the crusher control room and personal dust monitoring in the acid control room were not undertaken despite there being commitments in the MMP that this monitoring would be carried out. When questioned by the Supervising Scientist at the meeting of the Alligator Rivers Region Advisory Committee on 17 August 2004, the ERA General Manager Operations advised that the decision not to proceed with the required monitoring was made by the Radiation Safety Officer and that neither the Manager Environment, Safety and Health nor the General Manager Operations had been advised of this decision.

It is the Supervising Scientist's view that the recent occurrence of radiation exposure incidents and the failure to carry out monitoring that is required under the Ranger and Jabiluka Authorisations has been due, at least in part, to a change in the culture of radiation protection within ERA. There is also evidence that insufficient resources have been allocated by ERA to radiation protection over the past two years.

It appears that complacency has characterised the ERA approach to radiation protection in recent years. That this is so is borne out by a number of the comments from the ERA reports examined in this investigation which demonstrate that the significance of the incident was generally downplayed and that it was simply assumed that no significant radiation exposure had occurred without an appropriate measurement program or adequate estimation of radiation dose.

It is recommended that ERA should immediately implement a program to bring about a change in the radiation protection culture at Ranger and that ERA should review the resources allocated to radiation protection at Ranger and ensure that they are adequate to meet all of the requirements specified in the Environmental Requirements and under Northern Territory law.

Environmental Requirements and the Ranger General Authorisation

Energy Resources of Australia (ERA) is required to comply with the Commonwealth Environmental Requirements (the ERs) for the Ranger mine as attached to the Authority issued under Section 41 of the Commonwealth *Atomic Energy Act 1953* and to the export permit for uranium granted under the *Customs (Prohibited Exports) Regulations 1958*.

This report has reviewed the extent to which ERA may have been in breach of the Ranger Environmental Requirements. It has been demonstrated that the transport of contaminated material in a vehicle from the Ranger mine resulted in radiation exposure of a member of the public and his children. While the estimates of the doses received are slightly greater than the annual dose limit for members of the public, the uncertainties in these estimates are such that it could be difficult to establish in a court of law that the dose limit had certainly been exceeded.

However, it has been demonstrated that the radiation clearance procedures adopted at Ranger were inadequate in a number of ways and that the radiation exposure of members of the public could have been avoided if reasonable, best practice procedures had been in place at Ranger. The Supervising Scientist has, therefore, concluded that the radiation doses received

by members of the public were not 'as low as reasonably achievable' and that this constitutes a breach of Environmental Requirement 5.1.

It has been concluded that since the radiation clearance procedures in use at Ranger were inadequate to ensure the protection of the health of members of the regional community, ERA has also been in breach of ER 1(c) and ER 12.1. The Supervising Scientist has also concluded that it could be strongly argued that ERA has not employed adequate numbers of competent, appropriately qualified and experienced staff to ensure that it can provide the required level of protection of human health and that ERA may have been in breach of ER 14.1.

The Supervising Scientist has therefore concluded that the Commonwealth Government should consider whether action should be taken by the Commonwealth in response to the established breach of Environmental Requirements 1, 5.1 and 12.1.

Recommendations

The recommendations arising from this investigation are listed below.

Recommendation 1:

The Commonwealth Minister for Industry, Tourism and Resources should advise the Northern Territory Minister for Mines and Energy that the radiation clearance procedures at Ranger need to be revised to include much more specific instructions on the cleaning and inspection of vehicles, should include the use of gamma dose rate monitoring equipment as well as the surface contamination meters currently used, and should be the subject of a regular, independent audit process.

Recommendation 2:

Energy Resources of Australia should ensure that staff who undertake radiation clearance procedures are adequately trained in all practical aspects of radiation clearance, should review its procedures for the monitoring of the movement of vehicles on site and should ensure that all vehicles that have been in controlled areas are checked for radiation clearance certificates at the Security Gate.

Recommendation 3:

Energy Resources of Australia should review the use of contracted labour at the Ranger mine within a risk assessment framework to ensure that its key responsibilities for the protection of people and the environment are not jeopardised by the employment in key areas of staff over whom ERA has little or no direct control.

Recommendation 4:

Energy Resources of Australia should immediately implement a program to bring about a change in the radiation protection culture at Ranger. This culture needs to be based on the recognition that, while concentrations of radionuclides in materials at Ranger are relatively low and that, therefore, radiation related incidents should be easily avoided, this will only be achieved if a carefully designed radiation protection regime is in place and it is implemented with diligence.

Recommendation 5:

Energy Resources of Australia should review the resources allocated to radiation protection at Ranger and ensure that the resources allocated are adequate to meet all of the requirements specified in the Environmental Requirements and under Northern Territory law.

Recommendation 6:

The Commonwealth Minister for Industry, Tourism and Resources should consider whether action should be taken by the Commonwealth in response to the established breach of Environmental Requirements 1, 5.1 and 12.1.

Preface

On 29 March 2004, the Supervising Scientist was informed by a staff member of the Gundjeihmi Aboriginal Corporation that the manager of the Community Development and Employment Project (CDEP) in Jabiru was concerned about incidents involving contaminated vehicles leaving the Ranger mine site and being returned to the CDEP Yard in Jabiru and that he wished to meet with the Supervising Scientist to discuss the issue. The Supervising Scientist met with staff of CDEP on 30 March 2004 and, following discussion of the CDEP concerns, agreed to investigate the incidents and to provide a report on completion of the investigation.

This report contains the results of the Supervising Scientist's investigation of the circumstances under which these vehicles left the Ranger mine and his assessment of the likely impact on the health of members of the public who were exposed to radioactive material contained on these vehicles.

I would like to thank the staff and management of the Jabiru Community Development and Employment Project for their assistance throughout the investigations. This included making themselves available on several occasions to be interviewed, to accompany SSD staff on site inspections and to discuss results. Equally, thanks must be extended to the Management and Staff of ERA at the Ranger mine in providing assistance to the investigating officers whenever it was requested and for the provision of documentation relevant to the investigation.

I would also like to thank staff of the Supervising Scientist Division who assisted me in the conduct of my investigation and in the preparation of this report.

Dr Arthur Johnston

Supervising Scientist
August 2004

Investigation of radiation clearance procedures for vehicles leaving the Ranger mine

1 Introduction

Energy Resources of Australia (ERA), the operator of the Ranger uranium mine in the Northern Territory, advised the Assistant Secretary of the Office of the Supervising Scientist by telephone on 5 February 2004 that an incident had occurred in which two small earth-moving vehicles, called 'bobcats', had been returned in a mildly contaminated condition to the workplace of the Community Development and Employment Project (CDEP) in Jabiru. Written notification of the incident was provided by e-mail on the following day. The telephone notification described the contaminated material as being of 'low activity' and the incident was initially treated as being of a relatively minor nature.

On 29 March 2004, the Supervising Scientist was informed by a staff member of the Gundjeihmi Aboriginal Corporation that the manager of the CDEP was concerned about the incident and wished to meet with the Supervising Scientist to discuss the issue. The Supervising Scientist met with staff of CDEP on 30 March 2004 and, following discussion of the CDEP concerns, agreed to investigate the incident and to provide a report on completion of the investigation.

The investigation has revealed that there were at least three occasions on which vehicles left the Ranger mine site without adequate radiation clearance during 2003 and 2004. This report contains the results of the Supervising Scientist's investigation of the circumstances under which these vehicles left the Ranger mine and his assessment of the likely impact on the health of members of the public who were exposed to radioactive material contained on these vehicles.

2 Investigation of the incidents

2.1 Vehicle movements

ERA has regularly contracted the Community Development and Employment Project (CDEP) based in Jabiru to provide staff and equipment to assist in operations at the Ranger uranium mine. The Project is managed by the Djabulukgu Association and operates from a yard at the Jabiru Industrial Area. The vehicles most often employed have been two small earthmoving machines known as 'bobcats' (see figure 1), and a Hino tipper truck (see figure 2).

CDEP also frequently provides operators for the vehicles. The vehicles are used on a variety of tasks but most frequently to remove process residues such as slurry and small oversize rocks (scats: 20–40 mm in size) from controlled areas of the site, such as the leach bund and the secondary crushing area, and subsequent disposal into the No 1 Pit tailings repository. These materials are ore grade rocks ground to be as fine as silt or clay in some cases and which may have been subjected to some degree of processing to remove uranium.

The levels of radioactivity are such that the work is carried out in controlled areas and the CDEP staff working as equipment operators are required to have undergone a suitable site induction, especially regarding issues of radiation safety. In particular, CDEP staff were advised that vehicles were to be cleaned and obtain a radiation clearance certificate before removal from the mine site for any reason.

The movements of three vehicles and contaminated material associated with them were investigated. Two of these vehicles were bobcats and the third was a Hino truck. The most significant contamination was found to have been associated with one of the bobcats and it was important to establish when this vehicle had left the mine site to ensure that realistic radiation exposure estimates could be made. This proved to be quite difficult because the bobcats had no external means of identification. The information provided below was deduced from discussions with CDEP and ERA staff and from records of radiation clearance certificates maintained by ERA. ERA, CDEP and SSD agree that the movement record provided is probably correct and is certainly one that provides a maximum estimate of radiation exposure.

2.1.1 The Bobcat contamination incidents

The First Bobcat

On 20 November 2003, a CDEP Bobcat was being operated by CDEP staff in the leach bund area at the Ranger mine. The leach bund is within the general processing plant area and is a concrete lined rectangular pit in the ground approximately 80 m in length and 40 m wide. Its base is about 1.5 m below the surrounding ground level. The area contains 7 leach tanks each about 12 m diameter and 20 m tall. The tanks contain stirring mechanisms which agitate a mixture of ground ore and sulfuric acid to extract the uranium.

From time to time the contents of these tanks may be discharged into the bund area to allow servicing or repair of the agitators or removal of excess residue. The residues flow into the bunded area and are subsequently collected (using the bobcats) and taken to the pit for disposal (using the truck). This is the task undertaken by the CDEP equipment and operators.

During these operations on 20 November 2003, the bobcat stalled and the CDEP staff were unable to restart the machine or remove it from the slurry. Consequently they left the machine. Later the same day ERA staff removed the machine from the bund and washed the exterior of the machine. When an attempt was made to restart the machine on 27 November there was an major engine failure which required the machine to be returned to the CDEP workshop in Jabiru for repair. The machine was cleaned and a radiation clearance certificate issued before being removed from site and returned to the CDEP yard on 28 November 2003.

Upon delivery to the CDEP yard, the bobcat was placed under a carport. That day, the CDEP mechanic removed the ‘belly plate’ from the bobcat resulting in approximately 20 litres of ‘grey mud’ dropping from the bobcat onto the ground. The mechanic collected this material and placed it in a pile under the carport.

Soon after its return to the CDEP yard, probably on 29 November 2003, the bobcat was moved from the carport to the workshop area in the CDEP yard. The CDEP mechanic removed the engine of the bobcat, washed it down, and sent it into Darwin for repair. The CDEP mechanic continued to work on other elements and systems of the machine until the engine was returned to Jabiru shortly after completion of its repair on 18 December 2003. These activities resulted in more material, estimated to be up to 100 L, falling to the ground in the workshop area. The mechanic refitted the engine during January 2004, after the Christmas break. The exact date is unclear. Following installation of the repaired engine, the bobcat was removed from the workshop area to the carport where it remained until 5 February 2004.

Figure 1 Bobcat excavator at work in the CDEP Yard, Jabiru

Figure 2 Hino tipper truck at work in the CDEP yard

Figure 3 Bobcat partially dismantled in CDEP yard, 30 March 2004

The Second Bobcat

On 5 January 2004, a CDEP operator removed the Second Bobcat from the site without it being cleaned and without a radiation clearance. This machine was left in the CDEP yard in an uncleaned state until it was reported to ERA by CDEP representatives on 4 February 2004. ERA inspected the yard and both bobcats on 5 February, observed that they were contaminated with a grey material and removed them to Ranger to be cleaned. Only one bobcat was returned to CDEP. The other bobcat was considered to be contaminated in such a way that further thorough cleaning, including sand blasting, would be required before clearance could be obtained. ERA also requested that CDEP staff gather up all of the material which had fallen from the First Bobcat in the two previously identified areas of the CDEP Yard. This material was removed from the site to Ranger where it was deposited in No 1 Pit.

2.1.2 The Hino truck contamination incident

In addition to the two bobcats, CDEP regularly hired a Hino tipper truck to ERA for use by mill personnel for general haulage duties as well as by CDEP operators to support the bobcat operations. The material hauled by the truck included scats (small ore pieces up to 50 mm) and slurry from the secondary crushing and leaching operations. The truck was required to be cleaned and to obtain a radiation clearance before leaving site.

During the inspection of the bobcats in the CDEP yard on 30 March 2004 by SSD staff, the Hino truck was returned to the yard. The visual appearance gave rise to concerns that it had not been adequately cleaned (see figure 5) although it did have a radiation clearance certificate issued on that day. A check by SSD personnel showed that there was detectable radioactive contamination in the cab and on other parts of the truck was well as the visible contamination. The truck was returned to Ranger for further cleaning. Subsequently the truck failed to obtain a radiation clearance on two occasions, despite further washing. Eventually it was necessary to modify the truck to assist the cleaning of internal parts and the tray was sandblasted before radiation clearance was obtained.

2.2 Radiological characterisation of the CDEP Yard

Following his discussions with CDEP staff on 30 March 2004, the Supervising Scientist requested staff of the Supervising Scientist Division (SSD) to conduct a full investigation of the incident. This included an inspection of the CDEP yard in Jabiru and a radiation survey of relevant areas of the yard. This inspection and survey was carried out on 30 March 2004 by an officer from the Environmental Research Institute of the Supervising Scientist (***eriss***). A full report on this inspection and survey is provided in Appendix 1. A summary of the main results is provided below.

On the basis of discussions with CDEP staff it was established that there were two areas in the yard where work had been carried out on the First Bobcat. The first location (Site A in Appendix 1) was under a carport and the second location (Site B) was part of the undercover workshop. CDEP advised that both of these areas had been cleaned by CDEP staff acting under the instructions of ERA on 5 February 2004, the day after CDEP had first contacted ERA to express its concerns about possible contamination.

The inspection identified the presence of grey material mixed in with the natural soil at both locations. A radiation survey was carried out at both locations using two instruments to measure gamma radiation and alpha/beta radiation respectively. The results obtained (see Appendix 1) show that radiation levels at both sites were very low but that there were areas where a small increase above the natural background was observable in the alpha/beta monitoring data.

Figure 4 Close up of material deposited inside bobcat cabin

Figure 5 Contamination on CDEP Hino truck, 30 March 2004

Figure 6 Modifications on Hino truck to facilitate internal cleaning, 16 April 2004

Two samples were collected for further detailed analysis. One was provided by a CDEP staff member who had collected and retained a sample of the material that had been cleared from the site on 5 February. The other was a sample obtained by scraping the surface of the soil in the workshop area where the grey material was evident. These samples were subsequently analysed by gamma-ray spectroscopy at the ***eriss*** radiation laboratory in Darwin. The analytical results obtained are given in table 1.

Table 1 Radionuclide analyses for samples of material collected from the CDEP Yard and the Hino truck

Sample No.	U-238 [Bq/g]	Ra-226 [Bq/g]	Pb-210 [Bq/g]	Ra-228 [Bq/g]	Th-228 [Bq/g]
JT04002	17.81 ± 0.55	22.26 ± 0.27	31.55 ± 1.09	0.10 ± 0.03	0.05 ± 0.01
JT04003	9.31 ± 0.24	14.65 ± 0.13	22.36 ± 1.51	0.06 ± 0.02	0.06 ± 0.01
JT04004	10.99 ± 0.34	11.10 ± 0.14	15.32 ± 0.54	0.06 ± 0.02	0.05 ± 0.01
JT04005	3.30 ± 0.16	17.24 ± 0.21	23.44 ± 0.81	0.06 ± 0.02	0.05 ± 0.01

The results given in table 1 indicate that the sample (JT04002) of material collected by a CDEP staff member on 5 February 2004 and retained until provided to SSD on 30 March 2004 was essentially ore grade material which had been partially leached to remove some of the uranium. This result is consistent with the material that would be expected to be in the leach bund at Ranger. The results for the second sample (JT04003) which was collected from the workshop area of the CDEP Yard on 30 March indicate that this sample contains the same leach bund material partially diluted by the presence of natural soil from the CDEP Yard.

It has, therefore, been concluded that:

- The First Bobcat, which left the Ranger mine site with a radiation clearance certificate on 28 November 2003, contained a significant quantity of partially leached uranium ore and that this material, following maintenance work on the vehicle, remained at two locations in the CDEP Yard for the period from 28 November 2003 until 5 February 2004;
- An assessment is needed of the probable radiation exposure of members of the public during the period that the material remained in the CDEP Yard;
- The remedial work conducted at the CDEP Yard on 5 February was only partially successful and further remedial action was required;
- The radiation clearance procedure for this vehicle had clearly been inadequate.

Following a meeting between representatives of SSD, CDEP and ERA, held at the Supervising Scientist's Jabiru Field Station on 16 April 2004, it was agreed that ERA would carry out a further cleaning of the CDEP yard. It was agreed that this work was to be undertaken by ERA rather than CDEP personnel with SSD staff observing and to include scraping the entire contaminated surface of the yard to an appropriate depth to ensure any remaining traces of material were removed. This task was undertaken on 22 April 2004 and the ERA Senior Radiation Safety Officer confirmed the completion of the operation with a suitable radiation survey.

During the SSD inspection and survey of the CDEP Yard on 30 March 2004 (~1230 hrs), a Hino tip truck returned to the CDEP yard from Ranger and was observed to be dirty, both externally (see figure 5) and on the floor of the driver's cabin. Radiation scanning of the truck by SSD staff confirmed that contamination was present. Samples were collected from the exterior of the truck and from the floor of the driver's cabin and were sent to the ***eriss***

laboratories in Darwin for analysis. ERA was informed of the presence of contaminated material on the truck and the truck was removed from the CDEP Yard and returned to Ranger.

The results of these analyses are also presented in table 1. The results show that the material collected from the exterior of the truck (sample JT04004) and the material collected from the floor of the driver's cabin (sample JT04005) was partially leached uranium ore. It has been concluded that the radiation clearance process for this vehicle had also been inadequate.

3 Assessment of the incidents

3.1 Radiation exposure

3.1.1 The radiation exposure scenario

The First Bobcat was returned from the Ranger mine to the CDEP yard on 28 November 2003 for repairs. Upon delivery to the CDEP yard, the bobcat was placed under a carport. That day, the CDEP mechanic removed the 'belly plate' from the bobcat resulting in approximately 20 litres of 'grey mud' dropping from the bobcat onto the ground. The mechanic collected this material and placed it in a pile under the carport.

The following day (29 November 2003), the bobcat was moved from the carport to the workshop area in the CDEP yard. The workshop area is also a carport-like structure contiguous with another CDEP building. The CDEP mechanic removed the engine of the bobcat, washed it down, and sent it into Darwin for repair. This, together with other mechanical work undertaken by the CDEP mechanic on the bobcat on 29 November 2003, and during the following week resulted in approximately 100 litres of 'grey mud' being washed/removed or dropping onto the ground from the bobcat. The bobcat remained in this location until the engine was returned from Darwin shortly after completion of its repair on 18 December 2003. The CDEP mechanic installed the engine into the bobcat in January after the Christmas break and then relocated the cleaned and repaired bobcat back to the carport. The mechanic continued to work on other jobs in the workshop area in which the 'grey mud' from the bobcat remained.

At the time, the CDEP mechanic lived with his wife and two children aged 5 and 7 years old in a relocatable building on the CDEP site. The two children often play under the carport, especially during rain periods in the wet season. SSD was advised, however, that they never play in the workshop area. Whilst playing under the carport, the children discovered the pile of grey mud from the bobcat and played with it, for example building sandcastles, putting it in tins, carrying it around.

On 5 February 2004, the great majority of the grey mud was removed from the CDEP site. An initial rapid analysis of the sample of material collected by a CDEP staff member and retained until it was provided to SSD on 30 March 2004 indicated that it was partially leached uranium ore. These initial analyses estimated that Th-230 and subsequent members of the uranium series of radionuclides were present at a specific activity of approximately 32 kBq/kg and that the radionuclides between U-238 to U-234 were present at a specific activity of about 16 kBq/kg. The specific activity of actinium series isotopes was about 1.5 kBq/kg. The specific activity of Thorium series isotopes is 2-3 orders of magnitude lower than the Actinium series. These concentrations were used to make radiation dose estimates. The final analyses of the samples provided in table 1 confirm that the values used in the dose estimate procedure were sufficiently accurate.

3.1.2 The critical group

It is possible that any visitor or worker at the CDEP yard would have received a radiation dose from the partially leached uranium ore. However, the people who would have received the largest doses are the CDEP mechanic and his children.

3.1.3 Dose assessment – children

The children played with the approximately 20 litres of grey mud that was left under the carport but never went into the workshop area. To determine the total time of exposure to the mud, it is assumed that the children spent a total of 207 hours playing with or near quantities of the mud during the 69 day period between 28 November 2003 and 4 February 2004. This equates to an average of 3 hours per day, 7 days per week and is considered to be a worst case scenario.

The ingested activity was calculated using the ingestion rate of soil for children of 10 mg/h used in an IAEA assessment (IAEA 2003) of radiation dose due to the use of depleted uranium weapons. Given that the grey mud was partially leached uranium ore, all compounds present will be in an insoluble form. The default ingestion dose coefficients recommended by ICRP (ICRP Publications 67, 69, 71 and 72) were reduced for isotopes of uranium and polonium by a factor of 10 as ICRP notes a reduction in the absorbtion of these elements (between a factor of 5 and 25 for U and a factor of 10 and 100 for Po) when in a relatively insoluble form. For the remainder of the elements present in the grey mud, ICRP does not explicitly indicate such a reduction in absorption for insoluble compounds and so no reduction was applied to the default dose coefficients.

The inhaled activity was calculated using the breathing rate recommended by ICRP for children aged 2–7 years old undertaking light exercise (0.57 m^3/h) and a mass concentration of grey mud dust in their breathing zone of 2.0 mg/m^3. This figure was derived by considering the range of mean dust loadings for work groups at Ranger mine (based on 2002 Annual Radiation Report for Ranger). Considering that range, the type of work undertaken by the various work groups, and the potential for dust generation by the children, the mass concentration of grey mud to which the children were exposed was based upon monitoring in the dry end of the mill at Ranger.

To assist in estimating gamma dose rates, ERA and SSD staff conducted a short trial in the leach bund at Ranger. A mound of material in the leach bunds was constructed using about 100 L of material spread over about 4 square metres. The dose rate measured at a height of 0.3 m above this mound was measured to be about 2 μSv/h. Three samples of the material were taken and were analysed at the ***eriss*** radiation laboratory. The results are presented in table 2. The radionuclide concentrations in these samples are approximately half the values obtained from the sample of material (JT04002) that was collected at CDEP on 5 February and retained for subsequent analysis by a CDEP staff member. Hence the gamma dose rate from about 100 L of this latter material at a distance of about 0.3 m would be expected to be about 4 μSv/h.

Table 2 Radionuclide analyses for samples of material collected from Ranger leach bund

Sample No.	U-238 [Bq/g]	Ra-226 [Bq/g]	Pb-210 [Bq/g]	Ra-228 [Bq/g]	Th-228 [Bq/g]
RM04010	1.65 ±0.06	6.20 ± 0.05	11.86 ± 0.80	0.04 ± 0.01	0.04 ± 0.01
RM04011	2.65 ± 0.06	6.64 ± 0.14	15.43 ± 0.45	0.03 ± 0.01	0.04 ± 0.01
RM04012	11.20 ± 0.32	10.18 ± 0.12	15.14 ± 0.52	0.04 ± 0.01	0.04 ± 0.01

Since the children played with a smaller volume of the material (about 20 L), and in so doing, distributed the material within the CDEP yard, the gamma dose rate from these small quantities of the material would have been significantly less than that measured directly above 100 L of the material. In the dose estimate calculations a conservative value of 2 μSv/h was assumed. The average gamma dose rate to which the children would have been exposed whilst playing with or near to the grey mud would probably have been less than 2 μSv/h, but this figure has been used for the purposes of the dose assessment.

3.1.4 Dose assessment – CDEP mechanic

The mechanic worked on the contaminated bobcat and then on other equipment in the workshop area. Some tens of litres of partially leached uranium ore remained in the workshop area between 29 November 2003 and 4 February 2004 during which the mechanic worked in very close proximity to the material, including laying on the material. It has been assumed that he spent 5 hours per day for each of the 44 working days between 29 November 2003 and 4 February 2004 working in this area. Thus his exposure time has been assumed to be 220 hours. Again, this is considered to be a worst case scenario.

The ingestion rate of the material was assumed to be 5 mg/h, the ingestion rate for soil for adults used in the same IAEA dose assessment referred to in the dose assessment for children above. Ingestion dose coefficients for adults recommended by ICRP and reduced by a factor of 10 for isotopes of uranium and polonium as described in the children dose assessment were applied.

The inhaled activity was based upon a breathing rate of 1.2 m^3/h and a mass dust loading of 2 mg/m^3. The average gamma dose rate to which the mechanic was exposed was assumed to be 4 μSv/h, equal to that estimated above 0.3 m above approximately 100 L of the material.

3.1.5 Dose assessment results

Details of the full radiation dose calculations are provided in appendix 2 and the results are summarised in table 3.

Table 3 Estimates of radiation dose for members of the public arising from the material in the CDEP Yard in Jabiru

Exposure Pathway	Adult	Child
Gamma dose (mSv)	0.9	0.4
Inhalation dose (mSv)	0.7	0.6
Ingestion dose (mSv)	0.05	0.3
Total dose (mSv)	**1.6**	**1.3**

There are significant uncertainties in the dose estimates shown in table 3. Those uncertainties arise from the need to make assumptions in determining the exposure scenarios. Whilst we have attempted to construct exposure scenarios that are as realistic as possible considering all of the information available, we have tended towards overestimating rather than underestimating the dose received. Our conclusion is that the radiation dose received by the mechanic and his children was of the order of 1 mSv. It is not possible to be more precise but it is more likely that the actual dose received would have been less than rather than more than 1 mSv.

The annual dose limit for members of the public (excluding radiation doses from medical procedures) is 1 mSv above natural background. Hence, the radiation dose estimates given in table 1 imply that this limit may have been exceeded as a result of this incident. However, the

conservative assumptions made in the calculations lead to the conclusion that it is more likely that the dose was smaller than 1 mSv.

It needs to be stressed that a radiation dose of 1 mSv does not present a significant health risk. For comparison, the average annual radiation dose received by Australians from natural background sources is approximately 2 mSv per year. Also, some diagnostic x-ray procedures deliver several mSv to the patient. Following the completion of these dose estimates, the SSD Health Physicist counselled the CDEP mechanic and his wife and reassured them that whilst this incident should not have occurred and the radiation exposure of the mechanic and his children was an unacceptable consequence, no adverse health effects were likely as a result.

3.2 Radiation clearance and cleaning procedures at Ranger

3.2.1 Existing procedures

Plant cleaning procedures

The systems ERA had in place at the time of the incidents for the cleaning of equipment prior to it leaving the minesite required the plant or vehicle to be cleaned by washing with a pressure hose at the appointed cleaning location. The water used for this cleaning is usually sourced from one of the retention ponds on site and the used water returns to the pond. At the time of the incidents there was no specific written procedure for the cleaning of a bobcat. The instructions were simply to wash off all visible contamination and submit the vehicle for clearance by the radiation safety officer. In some instances it may be determined that the contamination is associated with rust on steel parts of the machine. Such contamination has to be removed by sandblasting since washing alone is insufficient.

Radiation clearance procedures

A written procedure for radiation clearance was available at the time of the incidents. This was identified as follows:

Radiation Safety Section Standard Operating Procedure. Document GO2 Issue date 14/02/00
CLEARANCE OF ITEMS FROM SITE

The document describes a procedure using a surface contamination meter and suggests that the item is checked for alpha (α) radiation only. At the end of the procedure the radiation safety officer is given instructions as to how the radiation clearance certificate is to be completed, a total of 9 items to be recorded, and then finally the distribution instructions for the various copies of the certificate.

3.2.2 Assessment of radiation clearance procedures at Ranger

In the course of the investigation, SSD personnel conducted interviews with several members of the ERA and CDEP staff involved in the incidents, examined incident reports prepared by ERA, carried out inspections of the machinery and the various locations including the leach bunds and the CDEP yard. In addition relevant documentation was examined in the radiation safety office at Ranger and SSD staff observed radiation clearance procedures in progress.

It is clear that the radiation clearance procedures in use are inadequate as demonstrated by the following:

- A radiation clearance certificate was not issued prior to removal of a vehicle from the mine site (the Second Bobcat);

- Security staff failed to prevent a contaminated vehicle leaving site without a radiation clearance certificate (the Second Bobcat);
- A radiation clearance certificate was issued when visual contamination remained (the Hino truck); and
- Radiation clearance staff failed to identify locations on the first bobcat where a significant quantity of contaminated material remained.

In the radiation clearance procedure document referred to above, there is no mention of the final check procedure at the security gate, nor is there any mention of checking for gamma (γ) or beta (β) radiation contamination. In the case of machinery which has been used for tasks in tailings or similar materials, contaminated material could build up inside structures. In such cases, the standard procedure adopted at Ranger is not considered adequate because α radiation will not penetrate through these structures and, hence, will not be detected. Only γ radiation from internal contamination can be detected.

The radiation clearance officer who issued the radiation clearance certificate for the First Bobcat was a graduate employed on a fixed term basis. This employee certainly had the required knowledge of radiation safety, detection and measurement but he was relatively inexperienced. It appears that the training provided to him by ERA on the practical aspects of radiation clearance was insufficient to ensure that the task would be completed to the required high standard.

ERA provided a copy of the internal incident report No 3276 (appendix 3C) which included an attached report from the radiation clearance officer involved in clearing the First Bobcat. The report was unsigned and undated and had been edited by a supervisor after it was written. During the investigation, the radiation clearance officer completed his fixed term employment at ERA as planned and left Jabiru. SSD staff spoke with the officer concerned and faxed him the document from the incident report. After examining the document, he advised that the editing had been inconsequential. Whilst the editing was apparently of little material significance, the lack of proper procedure in this matter is of concern.

The standards applied by some ERA staff in undertaking the radiation clearance process appear to be below that which would be accepted as good practice and the auditing and monitoring of performance in this area has been inadequate. This is evidenced by the failure to identify contaminating materials present in confined areas (eg behind removable guards) of the equipment, and the poor quality of information recorded on radiation clearance certificates.

Whilst the removal of the uncleared bobcat from the Ranger mine was a failure on the part of the operator employed by CDEP to observe required work practices, it was also a serious breach of process at Ranger. The gate guard did not challenge the operator and permitted the plant to leave site without a radiation clearance certificate. Ultimately, responsibility for ensuring that contaminated equipment does not leave the site rests with ERA and can not be delegated to contractors.

We have concluded that:

- The radiation clearance procedures at Ranger need to be revised to include much more specific instructions on the cleaning and inspection of vehicles and should include the use of gamma dose rate monitoring equipment as well as the surface contamination meters currently used.
- ERA needs to ensure that staff who undertake radiation clearance procedures are adequately trained in all practical aspects of radiation clearance.

- Radiation clearance procedures at Ranger should be subject to a regular audit process to ensure that the procedures are being properly implemented and that due process is being followed.
- ERA should review procedures for the monitoring of the movement of vehicles on site and to ensure that vehicles that have been in controlled areas are checked for radiation clearance certificates at the Security Gate.

3.3 Incident reporting

The removal of a contaminated bobcat from Ranger was first reported to SSD by phone on 5 February 2004. The ERA Environment Manager advised the Assistant Secretary, OSS, that CDEP had requested that ERA should inspect bobcats at the CDEP yard which had been used in bunds at Ranger before Christmas. ERA had inspected the vehicles the previous day and observed grey, caked material on parts of the equipment. Although ERA staff had not yet identified the material, it was reported to be of 'low activity'. It was stated that an investigation report was being prepared and that CDEP staff were assisting in the investigation.

On the following day, 6 February 2004, ERA notified SSD, NTDBIRD and the NLC of the incident by e-mail (appendix 3A). The e-mail message noted that more details would be provided once the investigation had been completed. The written notification did not refer to radiation measurements or the level of radioactivity involved even although this had been advised verbally.

Formal notification of the incident was provided by ERA to stakeholders on 1 March in the Environmental Incident Report Summary for February 2004 (appendix 3B). This report notes against an entry for 5 February 2004; 'CDEP Bobcat found to have fine traces of dried slurry during maintenance'. No mention was made of the fact that ERA had removed a substantial quantity of this slurry from the CDEP Yard on 5 February and the use of the words 'fine traces' together with the original telephone advice clearly misled stakeholders on the possible significance of the incident. The only action identified by ERA was further training of CDEP personnel in radiation clearance procedures.

On 31 March 2004, following the advice to the Supervising Scientist by CDEP staff and the commencement of the Supervising Scientist's investigation, ERA provided to SSD a copy of its internal investigation report No 3276 (appendix 3C). Attached to this report was a report entitled 'Radiation report for the Issue of CDEP Bobcats'.

In these two documents, it is reported that radioactive material was found at the CDEP yard on 5 February 2004. However, reporting of the incident is characterised by understatement in these documents and in earlier correspondence. The material is referred to as mud, dirt or dust when it is in fact partially leached uranium ore. The use of such imprecise wording may have misled senior management although the location where the bobcats had been operating at Ranger should have alerted management to the possible significance of the material.

The potential radiological hazard posed by the material is not adequately reflected in ERA's reports. For example, in the report entitled 'Radiation report for the Issue of CDEP Bobcats' (attachment to appendix 3C), it is stated that:

> the exposure levels do not represent any form of health risk for people working on, operating or working near either vehicle or the area where the mud was washed off. Nor does it represent a health risk for people who handled the mud.

There are no supporting data or health assessment to substantiate this statement even though it was recognised that the material had been at the CDEP site for some time. This recognition is

demonstrated by the reference to 'a layer of thick mud was clearly visible inside the engine bay compartment covering the floor of the engine bay' and the fact that the dates on which the 2 bobcats were thought to have left Ranger were recorded in the covering report (No 3276) as 12 December 2003 (this date was subsequently revised to 28 November 2003 later in this investigation) and 5 January 2004, about two months and one month respectively before the date on which the inspection was made.

The report goes on to say of an inspection of the site later in the afternoon of 5 February:

> removal of all the grey dust from those areas had been performed adequately and readings from the site were at normal background levels.

It is questionable whether the survey was carried out with due diligence as there was still visible contamination of grey material in the CDEP yard and SSD staff were able to detect alpha/beta radiation levels above background at a later date.

Thus, whilst ERA's reporting of this incident to the regulatory authorities was prompt, the potential radiological hazard associated with the incident was not adequately recognised or addressed in those reports. The relative inexperience of the ERA employee who issued the radiation clearance certificate for the bobcat and then produced the incident report would have been a contributing factor but the failure of more senior ERA employees to ensure the adequacy of the report prior to its completion and the appropriateness of the actions taken is of concern.

There is an issue of timeliness of communication between ERA and the staff at CDEP. CDEP has commented to the Supervising Scientist in a letter dated 29 March 2004 that they had, despite frequent requests for information following cleanup procedures on 5 February 2004, received no report or further information from ERA concerning the incident until 29 March 2004, when they received the incident report No 3276.

3.4 Environmental Requirements and Ranger Authorisation

3.4.1 Commonwealth Environmental Requirements

The Commonwealth Environmental Requirements (the ERs) for the Ranger mine are attached to the Authority issued under section 41 of the Commonwealth *Atomic Energy Act 1953*, to the export permit for uranium granted under the *Customs (Prohibited Exports) Regulations 1958* and are incorporated, as appropriate, into regulatory instruments issued by the Northern Territory Department of Business, Industry and Resource Development (the regulator). They articulate the Commonwealth's expectations of ERA in relation to environmental and human health protection and ERA is legally obliged to comply with them. The Commonwealth Minister for Industry, Tourism and Resources administers section 41 of the *Atomic Energy Act 1953* and the *Customs (Prohibited Exports) Regulations 1958*.

Environmental Requirement 5.1 is directly relevant to this incident and is reproduced below:

> *5.1 The company must implement a system to control the radiological exposure of people and the environment arising from its mining and milling activities. The system and the dose limits applied must comply, at the minimum, with relevant Australian law taking into account the most recently published and relevant Australian standards, codes of practice, and guidelines. Subject to clause 5.3, the company must achieve the following outcomes:*
>
> > *a) Radiation doses to company employees and contractors must be kept as low as reasonably achievable and must always remain less than the dose limit for workers.*

b) Radiation doses to people who are not company employees or contractors must be kept as low as reasonably achievable and must always remain less than the dose limit for members of the public.

c) Ecosystems surrounding the Ranger Project Area must not suffer any significant deleterious radiological impacts.

It has been demonstrated in Section 3.1 that the the release of contaminated equipment from the Ranger mine resulted in radiation exposure of the CDEP mechanic and his children, all members of the public to which ER 5.1 (b) applies. The estimates of the doses involved, presented in table 3, are slightly greater than the annual dose limit for members of the public, 1 mSv. The uncertainties in these estimates are, however, such that it could be difficult to establish in a court of law that the dose limit had certainly been exceeded.

However, it has been demonstrated in Section 3.2 that the radiation clearance procedures adopted at Ranger were inadequate in a number of ways. For the clearance of the vehicle that gave rise to the radiation exposure, the First Bobcat, these included the absence of gamma radiation screening and inadequate vehicle inspection and cleaning procedures. It is the Supervising Scientist's view that the radiation exposure of the CDEP mechanic and his children could have been avoided if reasonable, best practice procedures had been in place at Ranger. The Supervising Scientist has, therefore, concluded that the radiation doses received by members of the public were not 'as low as reasonably achievable' and that this constitutes a breach of Environmental Requirement 5.1 (b).

The Primary Environmental Objectives for the Ranger mine are specified in ER 1 and ER 1 (c) states that:

1. The company must ensure that operations at Ranger are undertaken in such a way as to be consistent with the following primary environmental objectives:

(c) protect the health of Aboriginals and other members of the regional community;

It has been concluded in this report that the radiation clearance procedures in use at Ranger were inadequate to ensure the protection of the health of members of the regional community. For this reason, the Supervising Scientist has concluded that ERA has been in breach of ER 1(c).

Environmental Requirement 12 defines Best Practicable Technology and requires its application at Ranger as follows:

12.1 All aspects of the Ranger Environmental Requirements must be implemented in accordance with BPT.

12.4 BPT is defined as:

That technology from time to time relevant to the Ranger Project which produces the maximum environmental benefit that can be reasonably achieved having regard to all relevant matters including:

(b) the level of environmental protection to be achieved by the application or adoption of the technology and the resources required to apply or adopt the technology so as to achieve the maximum environmental benefit from the available resources;

This report has concluded that the radiation exposure of members of the public could have been avoided if adequate radiation clearance procedures, including thorough cleaning and

inspection of vehicles and the use of gamma dose rate meters, had been in place at Ranger. 'Environment' is defined in the Environmental Requirements to include people and communities and radiation protection of people is an aspect of the Ranger Environmental Requirements. The Supervising Scientist believes that the resources required to improve the radiation clearance procedures at Ranger would have been far outweighed by the enhancement of the level of environmental protection achieved. He has concluded, therefore, that radiation protection at Ranger has not been implemented according to Best Practicable Technology and that ERA has been in breach of ER 12.1.

Environmental Requirement 14.1 requires that:

> *14.1 The company must employ adequate numbers of competent, appropriately qualified and experienced staff to ensure that it can provide the required level of protection to the environment, human health, and Aboriginal culture and heritage.*

This report has concluded that the employee who issued the radiation clearance certificate for the vehicle involved in the radiation exposure incident had the required knowledge of radiation safety, detection and measurement but that he was relatively inexperienced and had not been adequately trained by ERA on the practical aspects of radiation clearance. We have also concluded that there was a failure on the part of more senior ERA staff to ensure the adequacy of his report prior to its completion and to assess the appropriateness of the actions taken. The Supervising Scientist has, therefore, concluded that it could be strongly argued that ERA has not employed adequate numbers of competent, appropriately qualifed and experienced staff to ensure that it can provide the required level of protection of human health and that ERA may have been in breach of ER 14.1.

3.4.2 The Ranger General Authorisation

The Ranger General Authorisation (RGA) is issued by the Northern Territory Minister for Mines and Energy under the *Mining Management Act 2001*.

The RGA sets out the conditions with which ERA must comply and incorporates, as appropriate, the Commonwealth's Environmental Requirements. Some of these conditions are stipulated in detail in the Authorisation, however most of the detailed procedural requirements are contained in the reports or plans which are required under the General Authorisation and assessed by the Regulator.

It is the role of the Northern Territory Government, particularly the Department of Business, Industry and Resource Development, to assess whether or not ERA has been in breach of the *Mining Management Act 2001* and the RGA. However, since ERs 1, 5.1 and 12 are included as requirements in the RGA, it seems likely that the NT Government would conclude that ERA has been in breach of its requirements under Northern Territory law.

4 Conclusions and Recommendations

Radiation clearance procedures at Ranger

This report has concluded that radiation clearance procedures at the Ranger mine are inadequate. This conclusion is based upon the following failure of procedures identified in this report:

- One vehicle left the Ranger mine on 5 January 2004 in a contaminated condition without having been cleaned or having received a radiation clearance certificate, and

- Two vehicles which were subsequently shown to contain partially leached uranium ore, one of which contained a substantial quantity of this material, left the Ranger mine on 28 November 2003 and 30 March 2004 with radiation clearance certificates.

Thus radiation clearance procedures at Ranger need to be reviewed and upgraded.

Recommendation 1:

The Commonwealth Minister for Industry, Tourism and Resources should advise the Northern Territory Minister for Mines and Energy that the radiation clearance procedures at Ranger need to be revised to include much more specific instructions on the cleaning and inspection of vehicles, should include the use of gamma dose rate monitoring equipment as well as the surface contamination meters currently used, and should be the subject of a regular, independent audit process.

Recommendation 2:

Energy Resources of Australia should ensure that staff who undertake radiation clearance procedures are adequately trained in all practical aspects of radiation clearance, should review its procedures for the monitoring of the movement of vehicles on site and should ensure that all vehicles that have been in controlled areas are checked for radiation clearance certificates at the Security Gate.

It is also worth noting that two key groups involved in these issues, the CDEP staff who carried out the maintenance work in the leach bunds and the staff who are responsible for security at the Ranger mine, were contractors rather than ERA staff. It needs to be questioned whether these types of operations should be carried out by staff over whom ERA has little or no control.

Recommendation 3:

Energy Resources of Australia should review the use of contracted labour at the Ranger mine within a risk assessment framework to ensure that its key responsibilities for the protection of people and the environment are not jeopardised by the employment in key areas of staff over whom ERA has little or no direct control.

Radiation exposure of members of the public

One of the incidents investigated in this report resulted in the deposition of a relatively large quantity of partially leached uranium ore from the Ranger mine in two areas of the CDEP Yard in Jabiru. This resulted in the exposure of members of the public (the CDEP mechanic and his children) to low levels of radiation over a period of several months.

Estimates have been made of the radiation dose received by these members of the public as a result of this incident. We have conclude that the radiation dose received by the mechanic and his children was of the order of 1 mSv. It is not possible to be more precise but it is more likely that the actual dose received would have been less than rather than more than 1 mSv.

The annual dose limit for members of the public (excluding radiation doses from medical procedures) is 1 mSv above natural background. Hence, these radiation dose estimates imply that this limit may have been exceeded as a result of this incident. However, the conservative assumptions made in the calculations lead to the conclusion that it is more likely that the dose was smaller than 1 mSv.

It needs to be stressed that a radiation dose of 1 mSv does not present a significant health risk. For comparison, the average annual radiation dose received by Australians from natural background sources is approximately 2 mSv per year. Also, some diagnostic x-ray procedures

deliver several mSv to the patient. Following the completion of these dose estimates, the SSD Health Physicist counselled the CDEP mechanic and his wife and reassured them that whilst this incident should not have occurred and the radiation exposure of the mechanic and his children was an unacceptable consequence, no adverse health effects were likely as a result.

Radiation protection culture at Ranger

The concentrations of radionuclides in material at the Ranger mine are, given the average ore grade of about 0.3%, relatively low in comparison with some other mines in the world and are certainly low when compared with concentrations that occur in other parts of the nuclear fuel cycle. Hence, provided that a carefully designed radiation protection regime is in place and is implemented with diligence, it should be relatively easy to ensure that incidents that involve significant radiation exposure of employees or members of the public do not occur. The record at Ranger over the first 20 years of operations has demonstrated that this is so.

There have, however, been three such incidents in the past two years at Ranger. The first incident, reported in the Annual Report of the Supervising Scientist 2002–2003, involved the exposure of workers who were replacing the roof of the precipitator building at the mine site in November 2002. The most exposed individual was estimated to have received a dose of approximately 20 mSv although it was noted that the actual dose received was likely to have been less than this.

The second incident was the potable water contamination incident that occurred on 23–24 March 2004. This incident was recently investigated by the Supervising Scientist (Supervising Scientist 2004) and it was concluded that the maximum exposure of workers was likely to have been less than 0.5 mSv. In this case, however, one reason why the dose was low was that other metals and salts were present in the water at such high concentrations that staff could not have consumed significant quantities of water without reacting to the taste and spitting the water out.

In the current incident, exposure estimates for members of the public are about 1 mSv which is equal to the dose limit for members of the public.

In addition to these incidents where actual exposure of workers or members of the public has taken place, there have been a number of occasions over the past two years on which the Supervising Scientist has expressed concerns about incidents in which ERA failed to carry out monitoring specified in either the Ranger or the Jabiluka (also operated by ERA) Authorisations. These incidents were all reported in the Supervising Scientist's Annual Report 2002–2003. In summary they involved:

- Failure to monitor uranium emissions from the calciner and product packing stacks at Ranger in April 2002. ERA advised that this monitoring had not been carried out because of a conflict that occurred between staffing resources and the availability of the calciner and product packing stacks. The Supervising Scientist requested that the regulator, the NT Department of Business, Industry and Resource Development (DBIRD), determine whether this inaction constituted a breach of the Ranger General Authorisation (RGA). DBIRD did not advise that such a breach of the RGA had occurred.
- During the two quarters ending 30 June 2002 and 30 September 2002, ERA did not undertake personal dust monitoring for workers who spent time in the underground workings at Jabiluka. ERA advised that this monitoring was not completed because the activities undertaken by the workers in the decline did not involve dust generation. The Supervising Scientist advised that ERA should not have taken a decision not to undertake

monitoring that is required under the Jabiluka Authorisation. DBIRD advised on 4 October 2002 that, in its opinion, the lack of personal dust monitoring did not constitute a breach of the Jabiluka General Authorisation.

- Personal dust monitoring required under the Jabiluka Authorisation was once again not performed in the March 2003 quarter on the basis that ERA considered that there was no potential for a radiological risk to the employee who was maintaining a water pump in the decline.

Further, in the Audit of performance of ERA against the Draft Mining Management Plan for Ranger (November 2003) carried out on 24–28 May 2004, it was identified that dust monitoring of an operator in the crusher control room and personal dust monitoring in the acid control room were not undertaken despite there being commitments in the MMP that this monitoring would be carried out. When questioned by the Supervising Scientist at the meeting of the Alligator Rivers Region Advisory Committee on 17 August 2004, the ERA General Manager Operations advised that the decision not to proceed with the required monitoring was made by the Radiation Safety Officer and that neither the Manager Environment, Safety and Health nor the General Manager Operations had been advised of this decision.

It is the Supervising Scientist's view that the recent occurrence of radiation exposure incidents and the failure to carry out monitoring that is required under the Ranger and Jabiluka Authorisations has been due, at least in part, to a change in the culture of radiation protection within ERA. There is also evidence that insufficient resources have been allocated by ERA to radiation protection over the past two years. For example, lack of staffing resources was quoted as a contributing factor to the failure to monitor stack emissions at Ranger in April 2002.

It appears that complacency has characterised the ERA approach to radiation protection in recent years. That this is so is borne out by a number of the comments from the ERA report No 3276 and its attachment that were quoted in Section 3.3 of this report which demonstrate that the significance of the incident was generally downplayed and that it was simply assumed that no significant radiation exposure had occurred without an appropriate measurement program or adequate estimation of radiation dose.

Recommendation 4:

Energy Resources of Australia should immediately implement a program to bring about a change in the radiation protection culture at Ranger. This culture needs to be based on the recognition that, while concentrations of radionuclides in materials at Ranger are relatively low and that, therefore, radiation related incidents should be easily avoided, this will only be achieved if a carefully designed radiation protection regime is in place and it is implemented with diligence.

Recommendation 5:

Energy Resources of Australia should review the resources allocated to radiation protection at Ranger and ensure that the resources allocated are adequate to meet all of the requirements specified in the Environmental Requirements and under Northern Territory law.

Environmental Requirements and the Ranger General Authorisation

Energy Resources of Australia (ERA) is required to comply with the Commonwealth Environmental Requirements (the ERs) for the Ranger mine as attached to the Authority

issued under Section 41 of the Commonwealth *Atomic Energy Act 1953* and to the export permit for uranium granted under the *Customs (Prohibited Exports) Regulations 1958*.

This report has reviewed the extent to which ERA may have been in breach of the Ranger Environmental Requirements. It has been demonstrated that the transport of contaminated material in a vehicle from the Ranger mine resulted in radiation exposure of a member of the public and his children. While the estimates of the doses received are slightly greater than the annual dose limit for members of the public, the uncertainties in these estimates are such that it could be difficult to establish in a court of law that the dose limit had certainly been exceeded.

However, it has been demonstrated that the radiation clearance procedures adopted at Ranger were inadequate in a number of ways and that the radiation exposure of these members of the public could have been avoided if reasonable, best practice procedures had been in place at Ranger. The Supervising Scientist has, therefore, concluded that the radiation doses received by members of the public were not 'as low as reasonably achievable' and that this constitutes a breach of Environmental Requirement 5.1.

It has been concluded that since the radiation clearance procedures in use at Ranger were inadequate to ensure the protection of the health of members of the regional community ERA has also been in breach of ER 1(c) and ER 12.1. The Supervising Scientist has also concluded that it could be strongly argued that ERA has not employed adequate numbers of competent, appropriately qualified and experienced staff to ensure that it can provide the required level of protection of human health and that ERA may have been in breach of ER 14.1.

Recommendation 6:

The Commonwealth Minister for Industry, Tourism and Resources should consider whether action should be taken by the Commonwealth in response to the established breach of Environmental Requirements 1, 5.1 and 12.1.

References

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International Atomic Energy Agency 2003. *Radiological conditions in areas of Kuwait with residues of depleted uranium*. Report by an international group of experts, Vienna.

Supervising Scientist 2004. *Investigation of the potable water contamination incident at Ranger mine March 2004*. Supervising Scientist Report 184, Supervising Scientist, Darwin NT.

Appendix 1 Report on the radiological assessment of the CDEP offices and workshop at Jabiru

On 30 March 2004 an officer from the Environmental Radioactivity Section of ***eriss*** attended the CDEP yard at Jabiru at the request of the Supervising Scientist. The Supervising Scientist had been advised the previous day that there were concerns about possible radiological contamination of machinery and equipment at the yard, which had previously been working at the Ranger mine. The officer was advised that at some time in January 2004 a CDEP bobcat had returned from Ranger uranium mine site and was covered in a fine grey mud. The bobcat was unloaded and put into an undercover workshop area. As the CDEP staff began to work on the bobcat large pieces of grey mud fell off into the workshop area (figs A5 & A7) and lay there for a week. The CDEP workers continued working in this area for the following week.

The officer was then shown a second undercover work area approximately 25 metres away where the bobcat was also worked on. This area (figs A1 & A2) was smaller than the previous area and he was told there was not as much mud present in this area, but there had been a substantial amount of dust generated from the mud.

Much of the material had been cleaned up by CDEP staff acting on instructions from ERA on the 5 February 2004. The SSD officer was informed that there were still chunks of the grey mud remaining in the workshop after Ranger mine employees had cleaned up. CDEP staff provided a sample, which was bagged and taken back to the Darwin SSD laboratory for analysis (table A4). There were also small amounts of material left in the workshop (fig A15) that were scraped up and bagged and taken back to the Darwin SSD laboratory for analysis.

The officer was then shown a second bobcat that had come back from Ranger mine that had small amounts of grey material on the guards and around the motor (figs A9, A10, A11). The officer then undertook a radiological survey of the two sites and the machinery where possible.

The survey consisted of grid based readings in the two undercover workshop areas and surface contamination measurements on the equipment. The results of the surveys are presented in the following sections of this report.

As the survey work came to an end a Hino truck was returned to the yard after working at the Ranger site. CDEP staff were concerned about the cleanliness of the truck and asked if a further radiological check could be undertaken. In particular CDEP staff were concerned about material on the cab floor and material on the tray of the truck. After an inspection (figs A12, A13 & A14) samples were collected from the cab floor and from the tray area. These samples were taken back to the Darwin laboratory. The officer advised that there were levels of radioactive contamination present. ERA staff visited the site and the truck was used to transport the material cleaned up from the yard back to Ranger for disposal before being re-submitted for cleaning and radiation clearance.

Survey details for site A, site B, truck, bobcat and offices are recorded in tables A1, A2 and A3.

Survey details

Survey Site A

Undercover Area sizes 6 metres by 3 metres (figure A2).

Meters Used:

Mini Instruments Environmental Meter Type 6-80 – GM3

Probe height from ground: 1 metre

Count Time period: 60 seconds

NE Portable Contamination Meter Type PCM 5/1 Serial Number: 1924

Probe Number: 3490 Type: DP24A

Probe Number: 8940 Type: DP24A

Probe height from ground: 1-4 mm

Table A1 Survey results for survey area A

Position	Counts/60 sec	μGy/h in air	Surface cts/sec	Radiation	Ratio alpha/beta
0,0	146	0.15	5	Beta	
0,1	151	0.15	5	Beta	
0,2	150	0.15	8	Beta/alpha	1/15
0,3	163	0.16	10	Beta/alpha	1/12
1,0	159	0.16	7	Beta	
2,0	159	0.16	7	Beta	
1,1	161	0.16	7	Beta	
2,1	155	0.15	7	Beta	
2,2	161	0.16	9	Beta	
1,2	163	0.16	6	Beta	
1,3	155	0.15	8	Beta	
2,3	163	0.16	5	Beta	
Backgd	139	0.14	6	Beta	

Figure A1 Area A survey site

Undercover work area, some hydrocarbon contamination, machinery and car parts litter site. Small 1 metre by 1 metre portion of area where work was carried out slightly elevated (see table position 0,3)

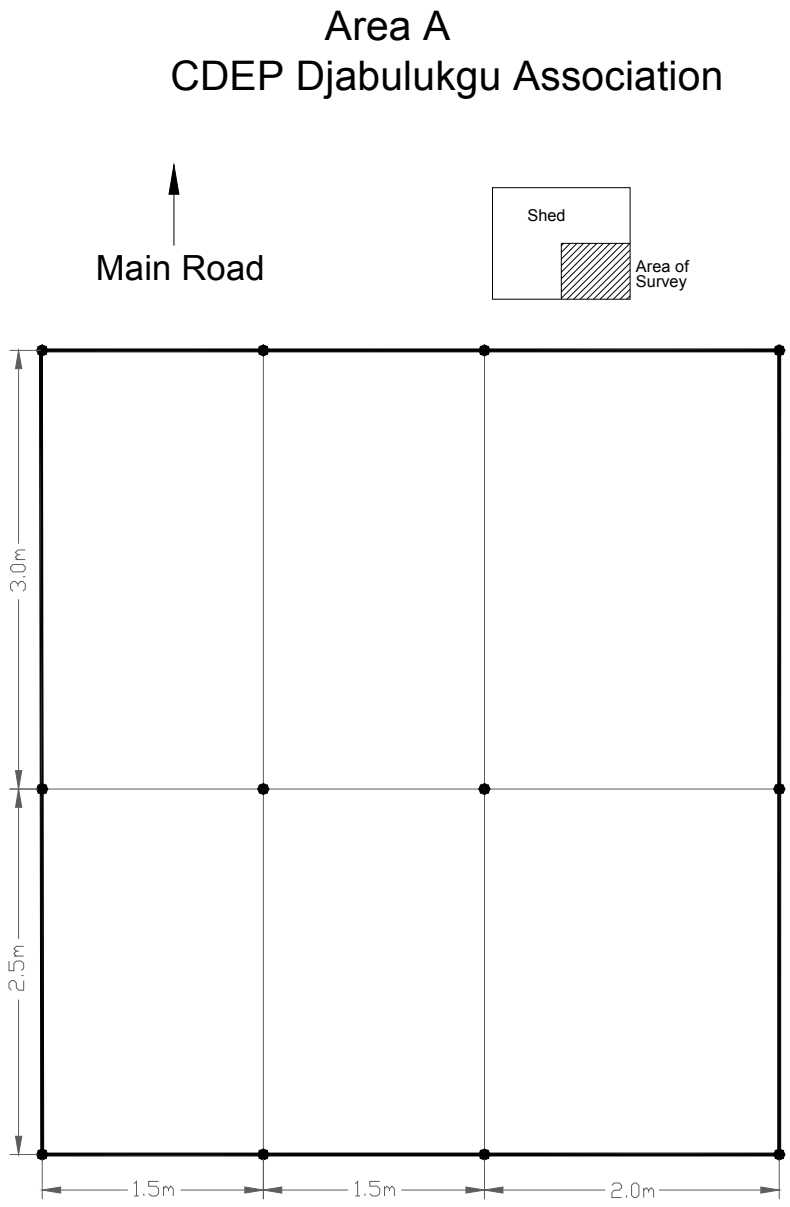


Figure A2 Site plan of survey site A CDEP workshop Djabulukga Association, Jabiru NT

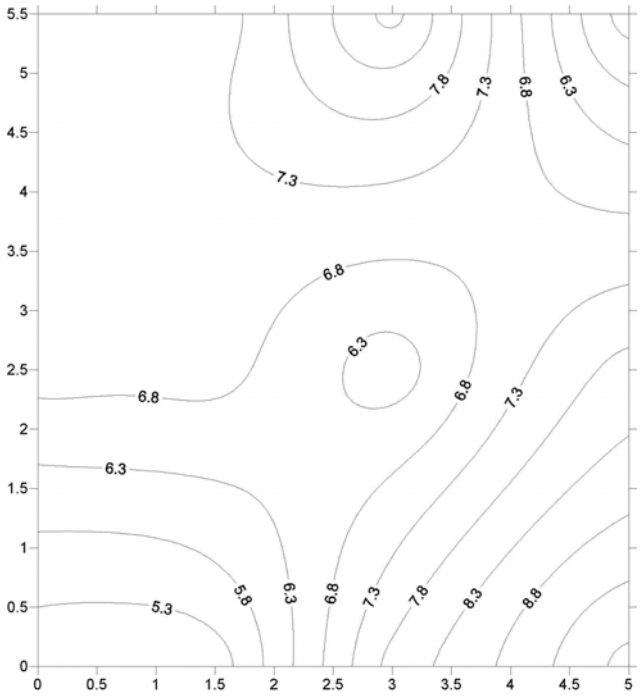


Figure A3 Surface counts per second alpha and beta radiation, survey area A

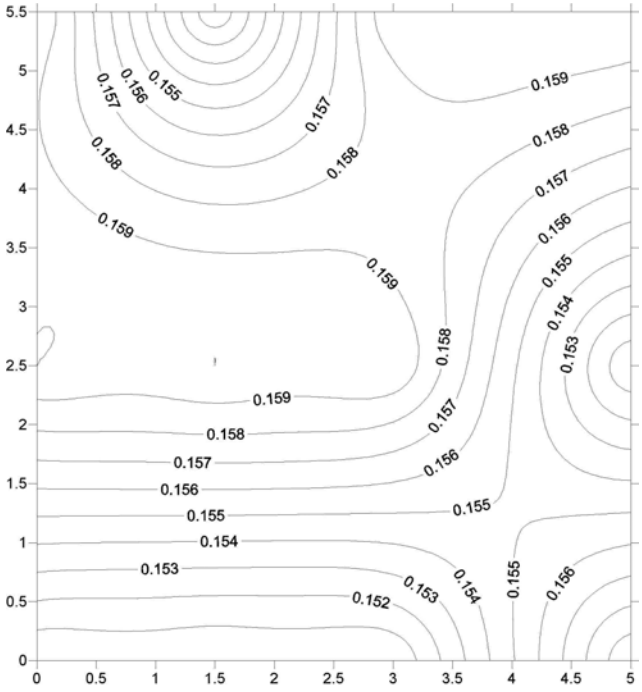


Figure A4 Gamma dose rate (μGy/hr) in air at survey area A

Survey Site B

Undercover Area size L Shaped 11.5 metres by 6.2 by 10 metres by 5.3 metres (figure A7).

Meters Used

Mini Instruments Environmental Meter Type 6-80 – GM3

Probe height from ground: 1 metre

Count Time period: 60 seconds

NE Portable Contamination Meter Type PCM 5/1 Serial Number: 1924

Probe Number: 3490 Type: DP24A

Probe Number: 8940 Type: DP24A

Probe height from ground: 1-4 mm

Table A2 Survey results for survey area B

Position	Cts/60 Sec	μGy/hr in air	Surface cts/sec	Radiation	Ratio alpha/beta
1,1	145	0.14	9	Beta	
1,3	167	0.17	8	Beta	
1,6	160	0.16	8	Beta	
1,8	142	0.14	8	Beta	
3,8	160	0.16	9	Beta	
3,10	136	0.14	10	Beta	
3,6	149	0.15	7	Beta	
3,3	145	0.14	7	Beta	
3,1	130	0.13	7	Beta	
5,1	159	0.16	6	Beta/alpha	1/20
5,3	154	0.15	7	Beta	
5,6	172	0.17	7	Beta	
5,8	122	0.12	7	Beta	
5,10	134	0.13	7	Beta/alpha	1/10
7,1	144	0.14	7	Beta	
9,1	145	0.14	9	Beta/alpha	1/5
7,3	149	0.15	9	Beta/alpha	1/8
9,3	138	0.14	11	Beta/alpha	1/5
11,3	155	0.15	12	Beta/alpha	1/10
14,3	164	0.16	7	Beta	
4,3.5	158	0.16	18	Beta/alpha	1/20
Backgnd	139	0.14	6	Beta	

Physical description of site – see photos

Undercover work area, more hydrocarbon contamination than Site A, machinery, trailers and car parts litter site. Two small 1 metre by 1 metre areas where work was carried out slightly elevated (see table position 0,3) and some material left < 100 grams – removed to Labs.

Figure A5 Area B survey site

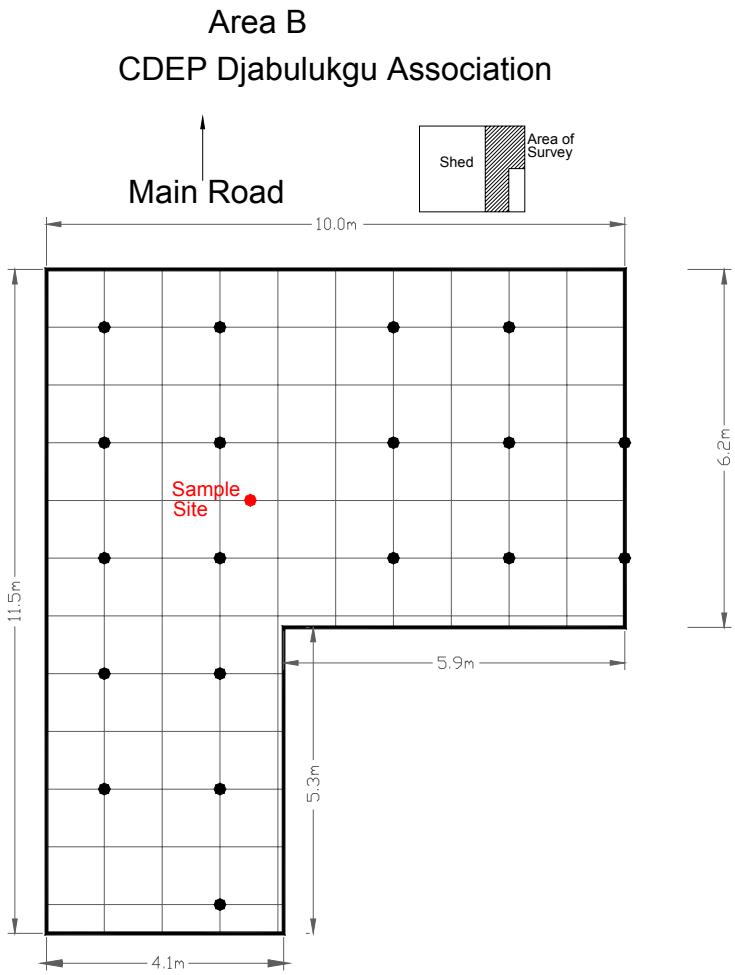


Figure A6 Site plan of survey site B CDEP workshop Djabulukga Association, Jabiru NT

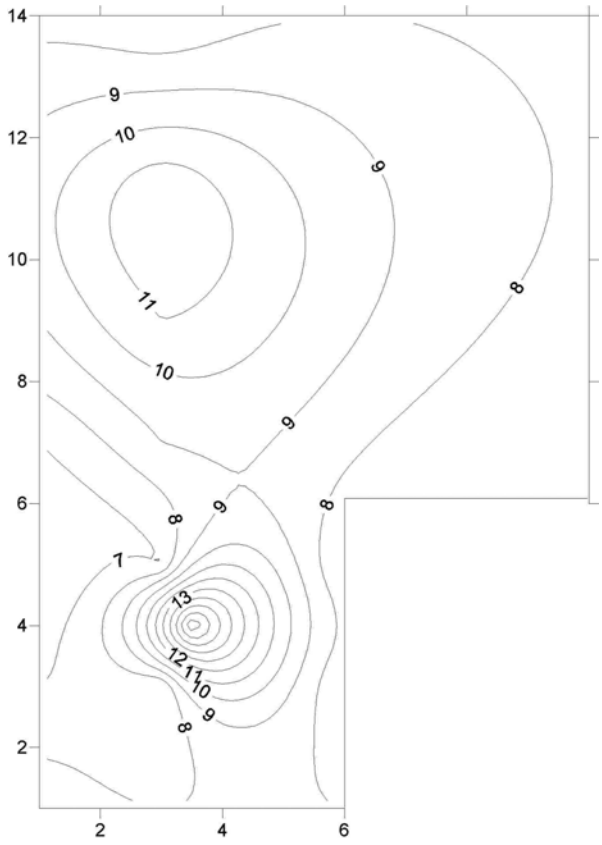


Figure A7 Surface counts per second alpha and beta radiation, survey area B

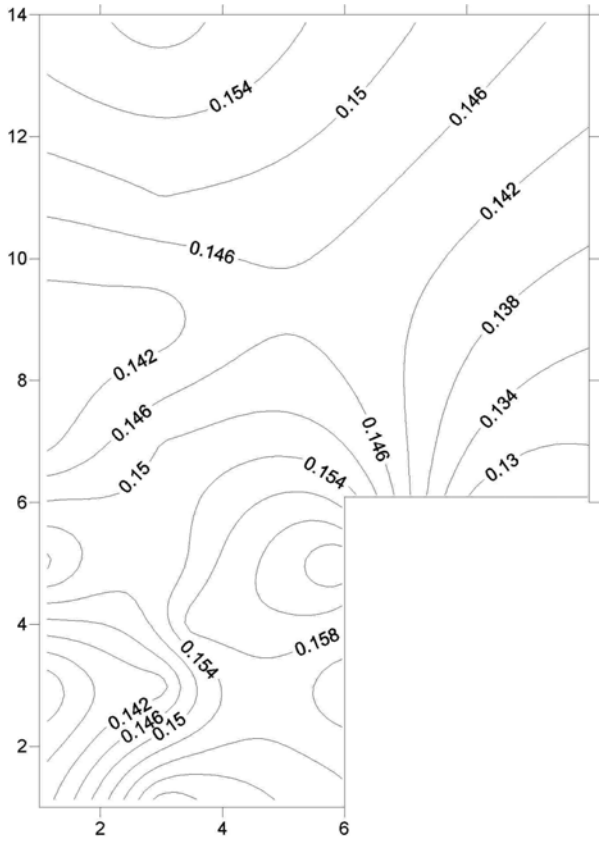


Figure A8 Gamma dose rate (μGy/hr) in air at survey area B

Survey site bobcat, CDEP truck 2 and office area

Meters Used

Mini Instruments Environmental Meter Type 6-80 – GM3

Count Time period: 60 seconds

NE Portable Contamination Meter Type PCM 5/1 Serial Number: 1924

Probe Number: 3490 Type: DP24A

Probe Number: 8940 Type: DP24A

Probe height from ground: 1-4 mm

Table A3 Survey results for survey of CDEP Truck, bobcat and office area

Position	μGy/hr in air	Counts/60 Sec	Surface cts/sec
At floor of truck	0.14	141	25
At truck tray	0.14	146	25
At seat in cab	0.14	143	8-10
Bobcat guards	0.14	150	12
Under seat	0.14	146	11
Tina's office			5-6
Drawers			5-6
Paper Flowers			5-6
Background	0.14	139	6

There has been a significant amount of time from the time of cleanup to the time of this survey. There are slightly elevated signals from the surface contamination meter following the drainage line from the work area in Site B. This signal covers two metres approximately and indicates some small amounts of residual fine material mixed in with the ground cover.

Figure A9 CDEP bobcat on site at CDEP Djabulugka workshop

Figure A10 Grey material on bobcat

Figure A11 Grey material on bobcat

Figure A12 Grey material on CDEP Hino tip truck

Figure A13 Grey material on CDEP Hino tip truck floor

Figure A14 Grey material on CDEP Hino tip truck tray

Table A4 Sample analysed using gamma spectrometry (HPGe detector)

Sample code	Cast code	Location
JT04002	JQ240	CDEP Workshop. Sample given by admin officer T Holland
JT04003	JQ241	CDEP Workshop scrape sample (plate 9)
JT04004	JQ246	CDEP Hino truck tray (plate 8)
JT04005	JQ242	CDEP Hino truck floor
RM04010	JQ243	Sample 1 (figure 9) Ranger mine
RM04011	JQ244	Sample 2 (figure 9) Ranger mine
RM04012	JQ245	Sample 3 (figure 9) Ranger mine

Figure A15 Residual material taken to SSD laboratories for analysis from survey site B

Appendix 2 Dose assessment calculations

Exposure Parameters		Comment
Ingestion Rate - 5 y child (g/h)	**1.00E-02**	From IAEA DU Radiological Assessment
Ingestion Rate - Adult (g/h)	5.00E-03	From IAEA DU Radiological Assessment
Breating Rate - 5y child (m3/h)	5.70E-01	ICRP rate for light exercise for 2-7y child
Breating Rate - Adult (m3/h)	1.20E+00	Occupational average rate for adults
Dust loading (mg/m3)	2.00E+00	Mean for mill dry end area monitoring at Ranger, 2002
Exposure Time - 5 y child (h)	2.07E+02	3h/day 7 days per week (69 days)
Exposure Time - adult (h)	2.20E+02	5h/day 5 days per week (44 days)
Gamma dose rate (Sv/h) - 5y child	2.00E-06	Estimated for smaller (20L) volume
Gamma dose rate (Sv/h) - adult	4.00E-06	Measured 0.3m above approx 100l of material spread over approx 4 square metres

Results Summary		
Exposure Pathway	**Adult**	**5y child**
Gamma dose (Sv)	8.80E-04	4.14E-04
Inhalation dose (Sv)	7.10E-04	5.92E-04
Ingestion dose (Sv)	4.92E-05	2.50E-04
Total dose (Sv)	**1.64E-03**	**1.26E-03**

Uranium Series			Inhalation Dose Calculations			
Isotope	**Activity (Bq/Kg)**	**Type**	**Einh - adult (Sv/Bq)**	**Einh 5y child (Sv/Bq)**	**Dose - Adult (Sv)**	**Dose - 5y child (Sv)**
U-238	1.60E+04	S	8.00E-06	1.60E-05	6.76E-05	6.04E-05
Th-234	1.60E+04	S	7.70E-09	1.70E-08	6.50E-08	6.42E-08
Pa-234	1.60E+04	S	4.00E-10	1.10E-09	3.38E-09	4.15E-09
U-234	1.60E+04	S	9.40E-06	1.90E-05	7.94E-05	7.17E-05
Th-230	3.20E+04	S	1.40E-05	2.40E-05	2.37E-04	1.81E-04
Ra-226	3.20E+04	S	3.20E-06	6.30E-06	5.41E-05	4.76E-05
Rn-222	3.20E+04		N/A	N/A		
Po-218	3.20E+04		N/A	N/A		
Pb-214	3.20E+04	S	1.50E-08	2.80E-08	2.53E-07	2.11E-07
Bi-214	3.20E+04	M	1.40E-08	3.10E-08	2.37E-07	2.34E-07
Po-214	3.20E+04		N/A	N/A		
Pb-210	3.20E+04	S	5.60E-06	1.10E-05	9.46E-05	8.31E-05
Bi-210	3.20E+04	M	9.30E-08	1.90E-07	1.57E-06	1.43E-06
Po-210	3.20E+04	S	4.30E-06	8.60E-06	7.27E-05	6.49E-05
Actinium Series						
U-235	1.47E+03	S	8.50E-06	1.70E-05	6.60E-06	5.90E-06
Th-231	1.47E+03	S	3.30E-10	7.60E-10	2.56E-10	2.64E-10
Pa-231	1.47E+03	S	3.40E-05	5.20E-05	2.64E-05	1.80E-05
Ac-227	1.47E+03	S	7.20E-05	1.30E-04	5.59E-05	4.51E-05
Th-227	1.47E+03	S	1.00E-05	1.90E-05	7.76E-06	6.59E-06
Ra-223	1.47E+03	S	8.70E-06	1.50E-05	6.75E-06	5.20E-06
Rn-219	1.47E+03		N/A	N/A		
Po-215	1.47E+03		N/A	N/A		
Pb-211	1.47E+03	S	1.20E-08	2.70E-08	9.31E-09	9.37E-09
Bi-211	1.47E+03		N/A	N/A		
Tl-207	1.47E+03		N/A	N/A		
					Adult	**Child**
				Dose (Sv)	**7.10E-04**	**5.92E-04**
				Dose Rate (Sv/h)	3.23E-06	2.86E-06

Uranium Series			Ingestion Dose Calculations				
Isotope	**Activity (Bq/Kg)**	**Type**	**Eing - adult (Sv/Bq)**	**Eing 5y child (Sv/Bq)**	**Inorganic Compound Factor**	**Dose - Adult (Sv)**	**Dose - 5y child (Sv)**
U-238	1.60E+04	S	4.50E-08	8.00E-08	1.00E-01	7.92E-08	2.65E-07
Th-234	1.60E+04	S	3.40E-09	1.30E-08	1.00E+00	5.98E-08	4.31E-07
Pa-234	1.60E+04	S	5.10E-10	1.70E-09	1.00E+00	8.98E-09	5.63E-08
U-234	1.60E+04	S	4.90E-08	8.80E-08	1.00E-01	8.62E-08	2.91E-07
Th-230	3.20E+04	S	2.10E-07	3.10E-07	1.00E+00	7.39E-06	2.05E-05
Ra-226	3.20E+04	S	2.80E-07	6.20E-07	1.00E+00	9.86E-06	4.11E-05
Rn-222	3.20E+04		N/A	N/A			
Po-218	3.20E+04		N/A	N/A			
Pb-214	3.20E+04	S	1.40E-10	5.20E-10	1.00E+00	4.93E-09	3.44E-08
Bi-214	3.20E+04	M	1.10E-10	3.60E-10	1.00E+00	3.87E-09	2.38E-08
Po-214	3.20E+04		N/A	N/A			
Pb-210	3.20E+04	S	6.90E-07	2.20E-06	1.00E+00	2.43E-05	1.46E-04
Bi-210	3.20E+04	M	1.30E-09	4.80E-09	1.00E+00	4.58E-08	3.18E-07
Po-210	3.20E+04	S	1.20E-06	4.40E-06	1.00E-01	4.22E-06	2.91E-05
Actinium Series							
U-235	1.47E+03	S	4.70E-08	8.50E-08	1.00E-01	7.60E-09	2.59E-08
Th-231	1.47E+03	S	3.40E-10	1.20E-09	1.00E+00	5.50E-10	3.65E-09
Pa-231	1.47E+03	S	7.10E-07	1.10E-06	1.00E+00	1.15E-06	3.35E-06
Ac-227	1.47E+03	S	1.10E-06	2.20E-06	1.00E+00	1.78E-06	6.69E-06
Th-227	1.47E+03	S	8.80E-09	3.60E-08	1.00E+00	1.42E-08	1.10E-07
Ra-223	1.47E+03	S	1.00E-07	5.70E-07	1.00E+00	1.62E-07	1.73E-06
Rn-219	1.47E+03		N/A	N/A			
Po-215	1.47E+03		N/A	N/A			
Pb-211	1.47E+03	S	1.80E-10	7.10E-10	1.00E+00	2.91E-10	2.16E-09
Bi-211	1.47E+03		N/A	N/A			
Tl-207	1.47E+03		N/A	N/A	**Adult**	**Child**	
				Dose (Sv)	**4.92E-05**	**2.50E-04**	
				Dose/gram (Sv/g)	**9.83E-03**	2.50E-02	

Appendix 3 ERA reports on the First Bobcat Incident

Appendix 3A Email notification of the bobcat incidents

Michelle Iles - Potential incident involving CDEP earthmoving equipment

From: "Leiner, Chris (ERA)" <Chris.Leiner@era.riotinto.com>
To: <Alan.Hughes@nt.gov.au>, "Elaine Glen" <GlenEl@nlc.org.au>, "Alex Zapantis" <Alex.Zapantis@deh.gov.au>
Date: 6/02/2004 12:00 PM
Subject: Potential incident involving CDEP earthmoving equipment
CC: "Dawe, Chris (ERA)" <Chris.Dawe@era.riotinto.com>, "Sauer, Glen (ERA)" <Glen.Sauer@era.riotinto.com>, "Marshman, Ian (ERA)" <Ian.Marshman@era.riotinto.com>

Alan

As notified to you this afternoon, following is information regarding the incident in which "grey muddy material" was found on CDEP earthmoving equipment.

The issue was raised yesterday afternoon by the Djabulukgu Assoc when they contacted Pat Carrick from ERA on the basis that the equipment had recently been used on-site at Ranger. The equipment was inspected this morning by the relevant Supervisor from the Production Department. Radiation screening of the material was done at the same time.

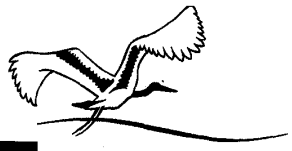
Based on the activities undertaken by the equipment when it was at Ranger, one option is that the material may be a hardened remnant of the mud removed from the leach tank bund and/or neutralisation tank bund. The full incident investigation needs to confirm the source.

I will provide more details once the investigation has been completed.

Regards,
Chris

Not yet confirmed as an "incident"
12/2/04

Appendix 3B Environmental incident report on two issues including the bobcat incidents



ERA **Energy Resources of Australia Ltd**
ABN 71 008 550 865

MEMORANDUM

TO : Tony McGill, Alan Hughes, Alex Zapantis, Peter Waggitt, Elaine Glen, Brendan Lewis, Alan Laird
COPIES : Simon Prebble, Matt Coulter, Amanda Buckley, John Milsom, Catherine Gale
FROM : Chris Leiner
SUBJECT : **Environmental Incident Report Summary – February 2004**
DATE : 1 March 2004

Please be advised that for February 2004 there were two environmental incidents reported with a moderate risk ranking value.

There were no incidents reported rated as low, high or critical.

The following environmental incidents were reported:

Incident Date	Area/Location	Incident Summary	Risk Ranking
5/2/04	ESH / Offsite	CDEP Bobcat found to have fine traces of dried slurry during maintenance	Mod
23/2/04	Processing / Acid Plant	Water from power station containing oil overflowed the neutralisation sump	Mod

Corrective actions were implemented for both incidents.

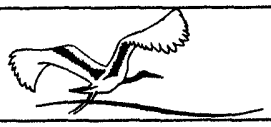
Stakeholders were notified by telephone on 5 February of the incident involving the CDEP Bobcat. The Bobcat had been used in March 2003 for cleanup work to remove leached material from the leach bund at the process plant. In October 2003, the same equipment was used to cleanup material from the neutralisation tank. CDEP personnel were inducted and received instructions on the process for radiation clearance of equipment. The Bobcat eventually left site on 5 January 2004. The investigation, involving CDEP personnel, has shown that:

- Build up of dirt on the engine guard of the Bobcat was difficult to access.
- The operator was not aware of how to lift the engine guard to clean that area.

Key actions arising from the incident include the training of CDEP personnel in the radiation clearance process.

Initial outcomes of the root cause analysis into the overflow of the neutralisation sump link to an overflow of the waste oil tank at the power station. The investigation suggests that the volume of oil in the waste oil tank increased, resulting in the tank overflowing into the bund and creating a well-mixed oil/water suspension. The high volume of oil/water suspension overwhelmed the oil/water separator system and passed through without separation to the neutralisation sump. The sensor arrangement designed to shutdown flow through the separator, if the depth of oil is too great, failed.

Appendix 3C ERA internal incident report on the bobcat incidents



ERA RANGER MINE – INCIDENT REPORT FORM
Must be notified in SiteSafe within 24 hours
Incident Number: **3276**

Incident Date: ___2/5/2004_____ **Time:** _08:00____ **Reported Date:** 5th Feb 04

Department Responsible: _____ **Dept Manager:**_____

Area/Location of the Incident: _Djabulukgu Association Jabiru

Reported By: __Patrick Carrick_____ **Responsible Supervisor:** _Glen Sauer

Person/s Involved / Injured: _____

Witness Names: _____

DESCRIPTION OF INCIDENT (Brief description of what happened):

Weds 4th Feb 4-15pm: Djabulukgu Assoc contacted Pat Carrick ERA /CR to arrange to meet at Djabulukgu at 8-30am Thurs 5th Feb to look at material on CDEP Bobcats previously used on Ranger site.

Thurs 5th Feb 8-30am: Pat Carrick at Djabulukgu Association, discussion with manager, inspected material.

Thurs 5th Feb 9-00am: Pat Carrick called Glen Sauer explained situation.

Thurs 5th Feb 9-30am: Glen Sauer arrived with Cameron Lawernce, Cameron conducted inspection of equipment and wash site. Cameron and Glen informed Manager CDEP of outcome of inspection and agreed on follow up action.

Action Taken: ☐ Alcohol and Drug Tests ☐ Return to Work ☐ First Aid ☐ Medical Centre ☐ Hospital

For Injury/Illness related Incidents, what treatment has been given:

Treatment Given By: _____ **Patient Record Form Attached?** _____

Incident Type: ☐ Environmental ☐ Equipment Damage / Loss ☑ External Issue ☐ Fire ☐ Security

☐ Injury / Illness ☐ Motor Vehicle Accident ☐ Near Hit

Note: Please circle the primary incident type and tick the boxes of all relevant types of incidents.

SPECIFIY THE IMMEDIATE CORRECTIVE ACTION: Tasks already completed, by whom and when.

1.The issue of the dirt found on the bobcats was reported to Glenn Sauer Production Coordinator.
Pat Carrick 5-2-04

2.Glenn Sauer and Cameron Lawerance Radiation Officer checked bobcats and workshop area at CDEP.
Glenn Sauer & Cameron Lawerance 5-2-04

3. Action plan developed for the removal of the dirt and the return of the bobcats to the Ranger site for further cleaning.
Glenn Sauer, Cameron Lawerance & Bob Kelly 5-2-02.

4.

Initial Risk Ranking: Analyse the potential for the incident to happen in the future without additional controls in place.

Step 1 - Select Consequence – Identify the most likely outcome of an accident or incident if additional controls are not put in place and select the corresponding number (1 to 5).

Circle all relevant sections of the SAFER model by identifying their corresponding consequence. Use the most severe consequence in calculating any Risk Assessments.

	S Safety & Health	A Assets: Plant/ Equipment Damage	F Finance: Business Interruption and Corrective costs	E Environment: Land, Air, Flora, Fauna and Authorisations	R Reputation: Media, Community
1	Severe injury/illness resulting in irreversible damage or fatality. Indefinite rehabilitation	>$10M	Ongoing production operations severely compromised. Immediate corrective action required. Loss of production > 6 months. >$10M remediation costs.	Widespread severe and permanent Environmental damage. Could lead to closure. Prosecution very likely.	Severe national public and media negative opinion. National denouncement of operations by key stakeholders. Prosecution very likely.
2	Injury/illness resulting in extended lost time and admission to medical facilities for corrective and/or surgical procedures. Rehabilitation required to effect full recovery.	$1M – 10M	Major impact on production. Significant action required to correct situation. Loss of Production 1 week to 6 months. $1M-$10M remediation costs.	Substantial or permanent damage, prosecution likely. Major stakeholder concerns	Widespread national public attention and media scrutiny. Serious key stakeholder concern. Damage to ERA's corporate image.
3	Short term admission to medical facility resulting in treatment and/or lost time. Rehabilitation achieves complete recovery.	$100k – 1M	Moderate impact to operations. Loss of production <1 week. Corrective actions require immediate planning. $100,00 - $1M remediation costs.	Substantial temporary or permanent minor damage. Possible breach of authorization and prosecution. Stakeholder enquires.	Attention from Northern Territory public and media services. Public complaints from key stakeholders.
4	Low-level physical injury resulting in onsite first aid treatment.	<$100k	Minor damage that requires no resulting production loss. Corrective action requires short plan time. $10,000 - $100,00 remediation costs.	Temporary impact – minor effect. No publicity likely and with no stakeholder concerns.	Minor localised public scrutiny and minimal media attention.
5	No identified effects with no First Aid required. Information only.	Minor Damage	Insignificant damage to operation resulting in low level planned action to rectify. <$10,000 remediation costs	No measurable impact on the environment. Non-reportable with no publicity.	No public interest in incident.

Step 2 – Select Probability – Estimate the likelihood that the most severe Consequence will occur again if no additional controls are put in place.

	Almost Certain:	Common or repeating occurrence (weekly).
	Likely:	Known to occur (it has happened several times a yea
	Moderate:	Could occur or have heard of it happening.
	Unlikely:	Not likely to occur (once in 20 years).
	Rare:	Practically impossible (once in 200 years).

Step 3 – Assign a Risk Ranking – Using the identified values for Consequence and Probability in the Risk Matrix below, identify the Risk Ranking Value for the Initial Risk Assessment.

		-1-	-2-	-3-	-4-	-5-
	-A-					15
	-B-				14	
	-C-			13		
	-D-		12			
	-E-	11				

Initial Risk Ranking:

Risk ranking when NO additional corrective actions are put in place:
Note the identified consequence and probability in the spaces provided:

Consequence: 4
Probability: B
Risk Ranking: 14

Based on the Initial Risk Ranking, who needs to be notified:

Ranking of 1 – 3: CEO
Ranking of 4 – 10: GM Operations
Ranking of 11-25: Departmental Manager

☑ Dept Manager ☐ GM Operations ☐ CEO

Note what external organisataions may require notification of this incident. If in doubt, discuss with your supervisor.

☐ Rio Tinto ☑ DBIRD ☐ NLC ☐ OSS

Investigation Team	Name / Position: Glenn Sauer Production Coordinator Name / Position: Cameron Lawerance Radiation Officer Name / Position: Bob Povey Safety Adviser. Name / Position: Wayne Chandler CDEP Supervisor Name / Position: Tina Holland CDEP HR/Safety rep.

Sequence of Events: Record the sequence of events.

CDEP were engaged for cleanup work in the leach area of the Ranger Processing plant in March 2003. CDEP operators used the CDEP equipment to remove leached dirt from the leach bund. In October 2003 after the failure of the neutralization tank, the CDEP contractors were involved in the cleanup of the dirt remaining from the hosing out of this tank. As the cleanup work was completed the CDEP personal and equipment left site on 12-12-03. A request was made to supply a bobcat over the Christmas period and this bobcat left site on 5-1-04.

After the Christmas period the CDEP mechanic commenced working on the bobcats and after stripping various parts from the machines he noticed a build up of grey dirt.

As the CDEP personnel were level 1 contractors they received all the necessary inductions and instructions to work on the ranger site. These instructions included the procedure for the radiation clearing of equipment before it left site and the instruction on how to clean the equipment. During the investigation Wayne was able to confirm that he was aware of our procedures and that he had on several occasions been asked to take equipment back to receive further cleaning before a clearance was issued.

Contributing Factors: What are the Human, Environment, Design and Systems (HEDS) factors that contributed to the incident?

Human Factors

The CDEP operator had not been trained in the method of opening the cab to access the engine area.

Environment Factors

Dirt found on the bobcats and in the CDEP workshop.
Working in the dirt left in the leach bund.

Design Factors

The guard on the bobcat engine bay allows dirt to build up and is difficult to clean.

System Factors

Radiation clearance procedure.

Essential Factors: Based on the above identifications determine what the Essential Factors of the Incident were. (Please note what factor type they were as well ie HEDS)

The bobcat was not cleaned well enough before it left site. Build up dirt on the engine guard was difficult to access. (Design Factor)

CDEP operator had been told to clean under the engine bay but did not know how to lift the cab to access that area. (Human Factor)

The radiation procedure had been followed on many occasions during the time that the bobcats were on site but evidence it was followed on the 5-1-04 (the last time that the bobcat was removed from site) could not be found. (System Factor)

Root Cause Analysis: For the Essential Factor(s) Ask WHY this was allowed to occur/not occur.

Lack of training of the operator resulted in not being able to lift the cab and clean under the engine bay.

Further checks and investigation must be made into the issue of a radiation clearance being issued on 5-1-04 to allow further root cause analysis.

Actions 1,2 & 3 were completed 12-2-04.

1. Ian was contacted and did not recall being asked to clear a bobcat on 5-1-04. He also confirmed the clearance procedure (copy of the SOP attached).
2. CDEP could not find a copy of the radiation clearance for 5-1-04.
3. CDEP confirmed that the bobcat identified with the large build up of dirt was the one removed from site on 5-1-04

Specify the Additional Corrective Actions to be Taken for the root cause and the contributing factors. (tasks not yet completed – all tasks must be entered into SiteSafe and accompanied by a W/R number if applicable)

Action	Assigned to	Due Date
1. Ian Marshman to be contacted to ascertain whether or not he issued a radiation clearance on 5-1-04. Ian also to advise the radiation clearance procedure.	Bob Povey	9-2-04
2. CDEP to check for their copy of the radiation clearance from 5-1-04	Wayne Chandler	9-2-04
3. CDEP to confirm which bobcat was the one which left site on 5-1-04	Wayne Chandler	9-2-04
4. A procedure for cleaning bobcats to be developed to include the area around the engine bay.	Glenn Sauer	27-2-04
5. Training session to be held with CDEP personnel on the radiation clearance procedure.	Bob Povey	12-2-04
6. CDEP to notify Ranger Safety/radiation personnel before they bring equipment to site so that a training session on the radiation clearance procedure can be held with CDEP personnel before the commencement of work	Bob Kelly	Before CDEP come to site.
7.		
8.		

Final Risk Analysis: analyse the potential for the incident to happen in the future AFTER actions have been completed. Use the risk Matrix on page 3 for your calculations and assign a risk score below.

Final Risk Assessment:

Consequence: 4

Probability: D

Risk Ranking: 21

Staple all statements, attachments and photo's here

Please attach any Sketches, RCA Diagrams or Additional Information here. Please staple to this form if required:

Reviewed by Team Leader / Superintendent:	**Signature:**	**Date:**
Additional Comments:		
Reviewed by Department Manager:	**Signature:** Christopher Leist	**Date:** 24/2/04
Additional Comments: Corrective Action #6 which is inherently part of the contractor management process is perhaps the most important step to follow. The checking of equipment for radiation clearance like welds will be reinforced in ongoing embedding of the contractor m'ment procedure.		
Reviewed by Manager/Representative ESH: **Date:**	**Signature:**	
Additional Comments:		
Reviewed by General Manager:	**Signature:**	**Date:**
Additional Comments:		

Radiation Report for the Issue of CDEP Bobcats.

On the morning of the 5/2/04 I was informed of a possible issue with some CDEP bobcats that had apparently been cleared off site and were now at the CDEP workshop. Workers at CDEP had reported that the inside of the bobcats were coated in a layer of grey mud and dust. Previously the bobcats had been used on site around the tailings neutralization plant and the leech tanks.

Travelling to the CDEP workshop with Glenn Sauer I used the surface contamination meter, one generally used for radiation clearances, to inspect the mud and dust on the vehicles and ground. On one of the bobcats a layer of thick mud was clearly visible inside the engine bay compartment covering the floor of the engine bay. The second bobcat had a clean engine bay but dried mud had been removed from sections of the vehicle when parts were removed for servicing. Readings were performed on both pieces of equipment, the removed clumps and on the two areas of ground where the vehicles were cleaned. The result of the readings indicated to me that there were high enough emissions from the mud that the vehicles should not have been removed from the mine site without further cleaning.

It should be clearly noted that one vehicle was much more dirty than the other. It is also noted that on the cleaner vehicle the positions of the mud would have shielded the low emissions from the detector and only the removal of cover plates would have allowed for the mud to be visible and measurable to the detector. Without resorting to removal of parts the cleaner vehicle would have passed a thorough radiation clearance inspection. The dirty vehicle was visibly covered in mud inside the engine bay and should have been cleaned again upon a visual inspection.

The exposure levels do not represent any form of health risk for people working on, operating or working near either vehicle or the area where the mud was washed off. Nor does it represent a health risk for people who handled the mud.

If the latest calibration on the instrument used is still valid then the levels taken from the dust on the ground and clumps removed were not in excess of 50cps (8Bq/cm^2) with normal background for the area being between 5-10cps (0.8-1.5Bq/cm^2).

I recommended that the equipment be returned to site for a proper wash down as well as the areas on the ground that had been contaminated be shovelled up and bought to the site. The dirtier vehicle had to have contaminated rust removed from various locations. Both vehicles were cleaned to meet the requirements for radiation clearance, have been issued with clearance certificates and have been removed off site back to the CDEP workshop.

I also returned to the CDEP workshop for another inspection of the ground areas that had been identified to me previously later on the afternoon of 5/2/04. Removal of all the grey dust from those areas had been performed adequately and readings from the site were at normal background values.

Signed,

[redacted]
Radiation Safety Officer
Ranger Mine
ERA.