Rösssing Uranium Limited
Working for Namibia

Report: Risk Assessment on the Rössing Uranium Car Park area

Effective date	20 September 2014
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Contents

Acronyms and abbreviations

The following acronyms and abbreviations are used in this report:

µSv – micro-sievert, ie 10^{-6} sievert
µSv/a – micro-sieverts per annum, ie micro-sieverts per year
µSv/h – micro-sieverts per hour
mSv – milli-sievert, ie 10^{-3} sievert
ICRP – International Commission on Radiological Protection
Necsa – South African Nuclear Energy Corporation SOC Limited
RMP – Rössing Uranium Limited's *Radiation Management Plan*

1. Introduction

Rössing Uranium Limited operates an open pit uranium mine located in the Namib Desert, about 60 km inland from the coastal town of Swakopmund and about 10 km from the town of Arandis, which is home to many Rössing Uranium personnel – people currently employed at the mine site as well as those that have retired.

The purpose of this report is to provide a public dose assessment for the car park area for light and heavy vehicles at the Rössing Uranium main gate, as shown in Figure 1. This assessment is intended to give perspective on the real and perceived risks associated with the small amounts of tailings sand that might have been deposited in the area prior to the construction of the car park.

Radiation protection at Rössing Uranium is managed according to the principles of justification, optimisation and limitation formulated by the International Commission on Radiological Protection (ICRP) [1], as documented in Rössing Uranium's *Radiation Management Plan* (RMP, [2]). The RMP is updated annually and yearly inspections by the National Radiation Protection Authority (NRPA) are performed to verify compliance of the site operations with the approved RMP and with the National Radiation Protection Regulations [3].

According to the ICRP principle of optimisation, radiation exposure doses to workers and members of the public must be as low as reasonably achievable when economic and social factors have been taken into consideration. Exposure optimisation also implies that tailings material, which is weakly radioactive, may not be used for any construction purposes unless an impact assessment can demonstrate that the resulting exposure doses are negligible.

According to the ICRP principle of limitation, the effective dose to members of the public must not exceed an annual dose of 1,000 micro-sieverts (μSv), subject in addition to the principles of optimisation and justification.

The principle of justification requires detriment and benefit of each exposure to be weighed against each other and to have a net benefit, with social and economic factors being taken into consideration.

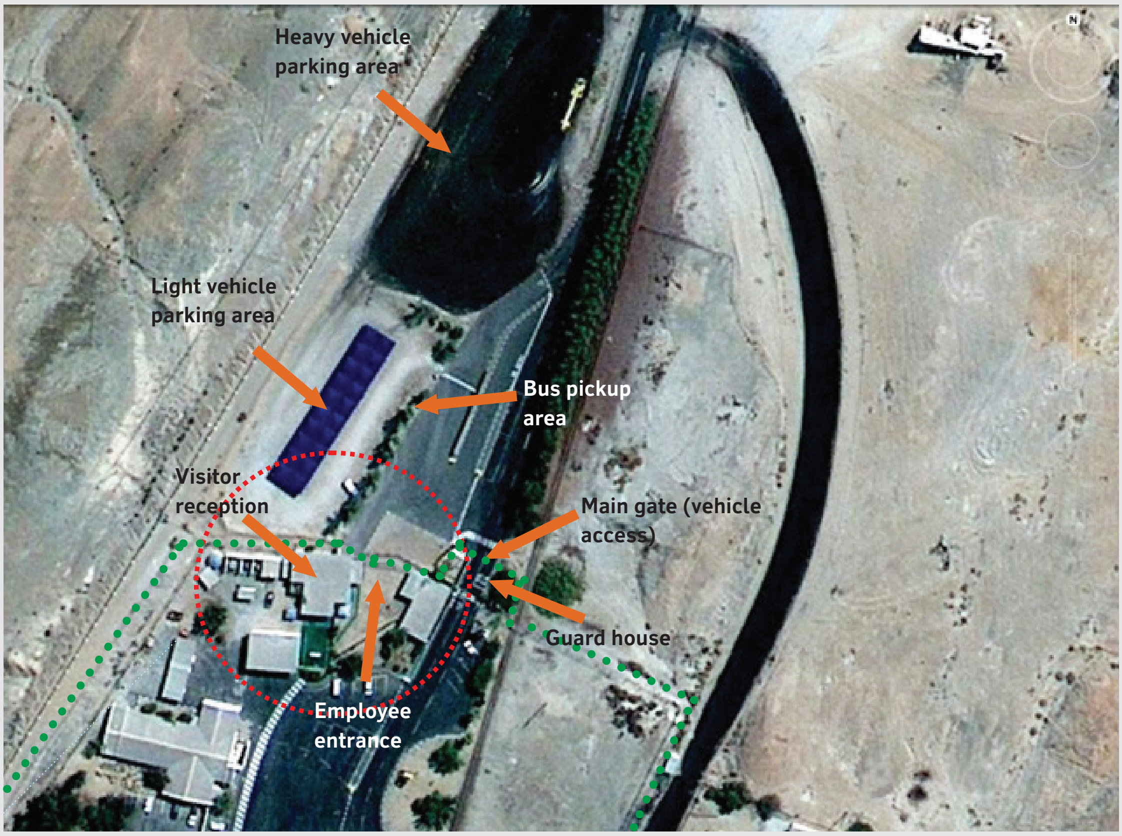

Figure 1: Aerial view of the Rössing Uranium Car Park area showing main gate for vehicle access, entrance for employees, bus pickup area, parking areas for light and heavy vehicles, and the visitor reception area. The security fence is indicated with a dotted green line, and the area potentially contaminated by tailings material is circled in red. (Source of map: Google Earth)

2. Dose rate survey for Rössing's Car Park area

A comprehensive survey of the Car Park area was undertaken by the Radiation Safety Section in August 2014 using a portable Thermo™ Electra GM dose rate meter. Monitoring positions were recorded by handheld GPS and dose rates on contact with the ground at each location were integrated over an interval of one minute.

An aerial image of the Car Park site and surroundings is shown in Figure 1; the approximate area where it is possible that small amounts of tailings sand material might be found is circled in red.

Historically, tailings material was used for surface levelling prior to the construction of the buildings near the main gate area and some of this material may have spilled over onto the land that was later converted into the light vehicle Car Park.

The resulting dose rate distribution is displayed in Figure 2. Dose rates are colour coded from 0.2 micro-sieverts per hour (μSv/h, coded blue) through to the maximum value measured, 2.8 μSv/h (coded red).

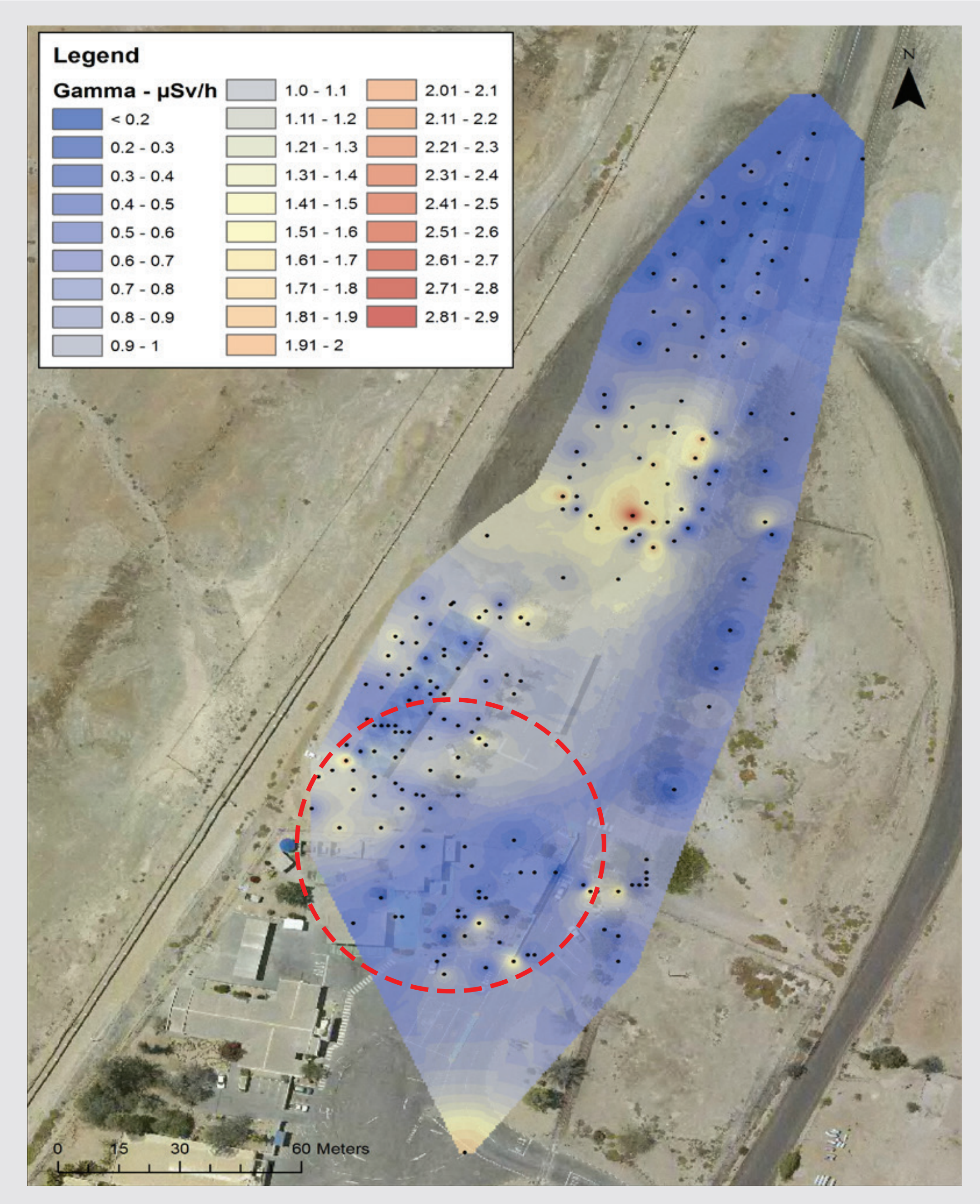

Figure 2: Dose rate contours around the Rössing Uranium main gate and adjacent Car Park areas from the risk assessment survey. The dotted circle indicates the area that is potentially contaminated with underlying tailings sand material. (Source of map: Google Earth)

3. Risk assessment based on monitoring results

The average background dose rate for the whole Rössing Uranium mining area was determined by Necsa in 2002: at 1 m above ground level, the average background dose rate was found to be 0.2 μSv/h [4]. During the risk assessment survey activity, background dose rates in the Car Park area in question and its surroundings were not found to be consistent; this is not surprising given that this area is rich in granite, some of which hosts uranium. Dose rates recorded ranged from less than 0.1 μSv/h to more than 2 μSv/h, depending on the substrate. It must be cautioned, however, that the dose rates measured in this present survey were contact measurements on the ground, not 1 m above the ground as in the Necsa survey. Measuring 1 m above the ground reduces the measured value to between 40 and 90 per cent of the values measured on contact with the ground.

The measurement points (see Figure 2) were spaced randomly, allowing an estimate for the representative dose rate in the surveyed area. When this was done, a median dose rate of 0.5 μSv/h was found. The average of all values sampled was 0.7 μSv/h, with a standard deviation of 0.5 μSv/h. As can be seen from the contour map, this average is sensitive to the choice of sampling locations as this influences the number of 'hot spots' located in the sampling. Because of the large variability of data, the median value of 0.5 μSv/h can be regarded as the most representative.

Hot spots indicated on the contour map are not necessarily related to tailings material on the ground. For example, the spot with the largest measured dose rate is located in the heavy vehicle Park area, ie not in the area potentially affected by tailings material. Another hot spot is located next to the vehicle gate and consists of solid rock with no filling material underneath, thus also representing a naturally-occurring hot spot.

Based on the measured median values for the 2002 mine site background dose rate and that of the light vehicle Car Park area recently surveyed, the excess dose rate in this location is therefore 0.3 μSv/h. For a visitor spending an entire day (ie eight hours) at this location, the public dose would amount to a trivial 2.4 μSv. For a hypothetical visitor spending an entire working year (ie 2,000 hours) in the parking area in question, the public dose from gamma radiation would amount to 600 micro-sieverts per annum (μSv/a), significantly below the legal public dose limit of 1,000 μSv/a. The additional dose to such a visitor from the inhalation of radon decay products and ore dust would not amount to more than 200 μSv/a, leading to a maximum overall annual dose of 800 μSv/a.

However, a visitor or a member of staff spending all his/her working year in this Car Park area would definitely be considered an 'occupationally-exposed person' for whom an occupational dose limit of 20 milli-sieverts per annum (or 20,000 μSv/a) then applies.

The occupationally-exposed persons working in this area comprise members of the Rössing Protection Services team. Occupational exposure monitoring is done for these staff members as per the 'Field workers' similar exposure group and is recorded to give an average gamma dose of 300 μSv/a, ie only half of what would be expected from the measured maximum dose rate given above. This is not surprising, since:

- The risk assessment survey dose rate measurements were taken on contact with the ground, giving the maximum possible value instead of the more realistic value at 1 m above the ground, and
- The average occupational dose for workers is a personal measurement based on the actual dose experienced at work. The dosimeter is worn throughout the shift by the worker while at his/her workplace, ie not only while spending time in the Car Park area.

For comparison, the average gamma dose for office workers working on site is also 300 μSv/a, ie the same as that for field workers who spend time working in the light vehicle car park area. This means that this Car Park area and its immediate surroundings do not constitute an area in which anyone is being exposing to dose rates above the 2002 median natural background dose rate in the Rössing mining area.

4. Summary and conclusions

The gamma dose rate in the light vehicle Car Park area is variable and can be regarded as similar to the background dose rate in the general vicinity, which was found to present hot spots associated with elevated uranium concentrations in the ground. The dose rate distribution in the area which is potentially affected by contamination with tailings material is not different than that in unaffected locations in the Car Park area, and the exposure doses experienced in this area are not affected by the presence of tailings material.

For visitors to the area the additional risk from this particular area is trivial, even if such visitors were to spend several days in the light vehicle Car Park and its surroundings. Similarly, the Rössing Protection Services team's gamma dose exposure from working in the Car Park area is no different from that of field or office workers working on site.

There is a possibility that during surface levelling prior to the construction of the buildings near the main gate area, some tailings material may also have spilled onto the Car Park outside the Rössing Uranium main gate. This dose assessment indicates that the additional risk to workers or to members of the public from spending time in this area is negligible: removing all the material and re-surfacing the light vehicle Car Park area is therefore regarded as unnecessary when taking social and economic factors into account.

5. References

[1] ICRP: *The 2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 103, Ann. ICRP 37 (2-4), 2007, Elsevier

[2] Rössing Uranium, *Radiation Management Plan,* Version 2.1, August 2014

[3] *Radiation Protection And Waste Disposal Regulations*: Atomic Energy and Radiation Protection Act, 2005 (Act No. 5 Of 2005), Ministry of Health and Social Services, 2011

[4] de Beer, G.P., Ramlakan, A. and Schneeweiss, R. *An Assessment of the Post-Closure Radiological Impact of Rössing Uranium Mine*, Necsa 2002