Rio Tinto

Rössing Uranium Limited
Working for Namibia

Implementation of the Radiation Management Plan

Annual Report for Rössing Uranium Limited

2018

Contents

Acronyms and abbrevisations

Throughout this document, the following acronyms and abbreviations are used:

Bq	—	becquerels, decays per second (unit for measuring radioactivity)
g	—	grams
GIS	—	Geographic Information System
HSEC	—	Health, Safety, Environment and Communities
kBq	—	kilo-becquerels (1,000 Bq)
LLRD	—	Long-lived radioactive dust
mBq/L	—	milli-Becquerels per litre (10^{-3} Bq per litre)
mSv	—	milli-Sieverts (sieverts/1,000)
µSv	—	mico-Sieverts (sieverts/1,000,000)
µSv/a	—	mico-Sieverts per annum
mSv/a	—	mSv per annum
mg/m^3	—	milligrams per cubic metre (1/1,000th of a gram per cubic metre)
µg/m^3	—	micrograms per cubic metre (1/1,000,000th of a gram per cubic metre)
µg/L	—	micrograms per litre (10^{-6} grams per litre)
NRPA	—	National Radiation Protection Authority
ppm	—	parts per million
PM_{10}	—	Particulate matter with particle size below 10 microns
RMP	—	Radiation Management Plan
RPO	—	Radiation Protection Officer
RSO	—	Radiation safety officer (statutory role)
SEG	—	Similar exposure group
TLD	—	Thermo luminescent dosimeter
TEA Lab	—	Trace Element Analysis Laboratory
NECSA	—	South African Nuclear Energy Corporation
TSF	—	Tailings Storage Facility
NUI	—	Namibian Uranium Institute
UOC	—	Uranium oxide concentrate
WHO	—	World Health Organization
XRF	—	X-ray fluorescence

1. Introduction

Under the Radiation Protection Regulations[1], an annual narrative report to the National Radiation Protection Authority (NRPA) about the implementation of the site Radiation Management Plan (RMP) is a requirement.

We are hereby presenting the sixth narrative report since the implementation of this requirement. The previous reports (2013 to 2017) are publicly available on the Rössing website, http://www.rossing.com/reports-research.htm.

As required, this report is accompanied by data reported separately in the prescribed format, including:

- average exposure dose records for each similar exposure group (SEG) for the year 2018, for each of the three pathways monitored separately;
- personal dose records for the past year for each employee working at the mine in 2018;
- cumulative dose reports for all employees who have left the company in the past year;
- a list of sealed sources on the mine with the current source activities and the location of each source;
- a list of the uranium oxide exports undertaken in 2018; and
- a summary of the radioactive waste deposited or stored, both mineral and non-mineral in origin.

[1] Radiation Protection And Waste Disposal Regulations: Atomic Energy And Radiation Protection Act, 2005 (Act No. 5 of 2005)

2. Organisational arrangements

2.1 Organisational structure

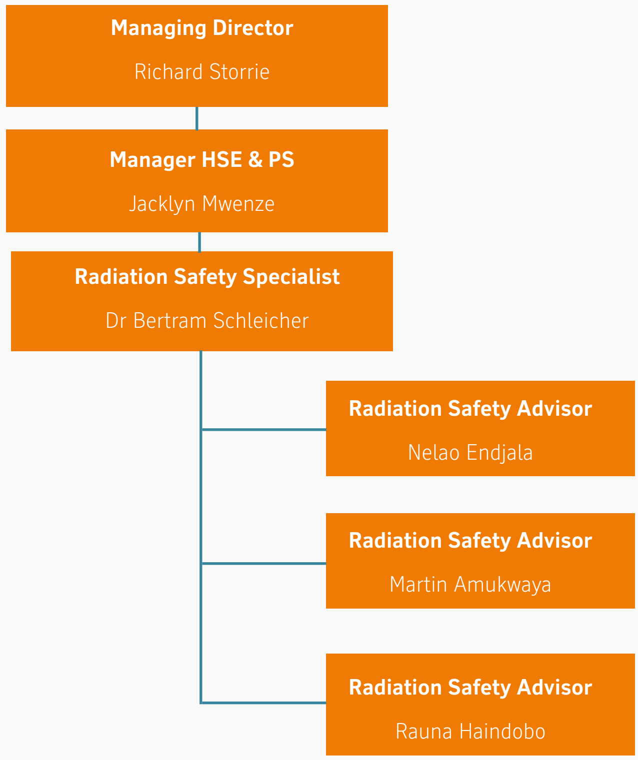
The organisational structure relating to Radiation Safety in 2018 is shown in Figure 1.

In September 2018, the head of the section, Dr Gunhild von Oertzen, left the employment of Rössing and was succeeded by the internal Radiation Safety Specialist, Dr Bertram Schleicher. Dr Bertram Schleicher was also appointed as the new RSO of the Rössing Uraniume.

In March 2018, Nelao Endjala was promoted from a Radiation Safety Officer to an Advisory position. In September and October, the section welcomed two new Radiation Safety Advisors, Martin Amukwaya and Rauna Haindobo.

In order to promote on-the-job coaching and succession planning, Nelao Endjala continues as an understudy to Dr Bertram Schleicher, with coaching and training undertaken on a continuous basis.

Figure 1: Organisational structure for Radiation Safety Section, end 2018



3. Occupational exposure protection

2.2 Capacity building

In order to reinforce the importance of radiation protection and the skills bases needed for effective radiation protection, Rössing continues to support and contribute towards the training programme for Radiation Safety Officers (RSO) offered at the Namibian Uranium Institute (NUI).

In 2018, the annual RSO workshop took place in November 2018 and has focused on three aspects, namely latest radon and dust measurements in Erongo Region, performance check and use of different instruments, and quantitative computational skills regularly required when working with radiation protection. Nelao Endjala from Rössing's radiation safety team participated in the workshop, while Dr Bertram Schleicher was one of the presenters of the course.

Further to the training programmes offered via the NUI, Dr von Oertzen also chaired a Radiation Safety Working Group (RSWG) until she left at the end of August 2018. The RSWG, hosted by the NUI, brings together professionals from the region to discuss and align on practices in radiation safety. In 2018, the scope of the working group was broadened to include more radiation safety professionals who have an interest in the discipline.

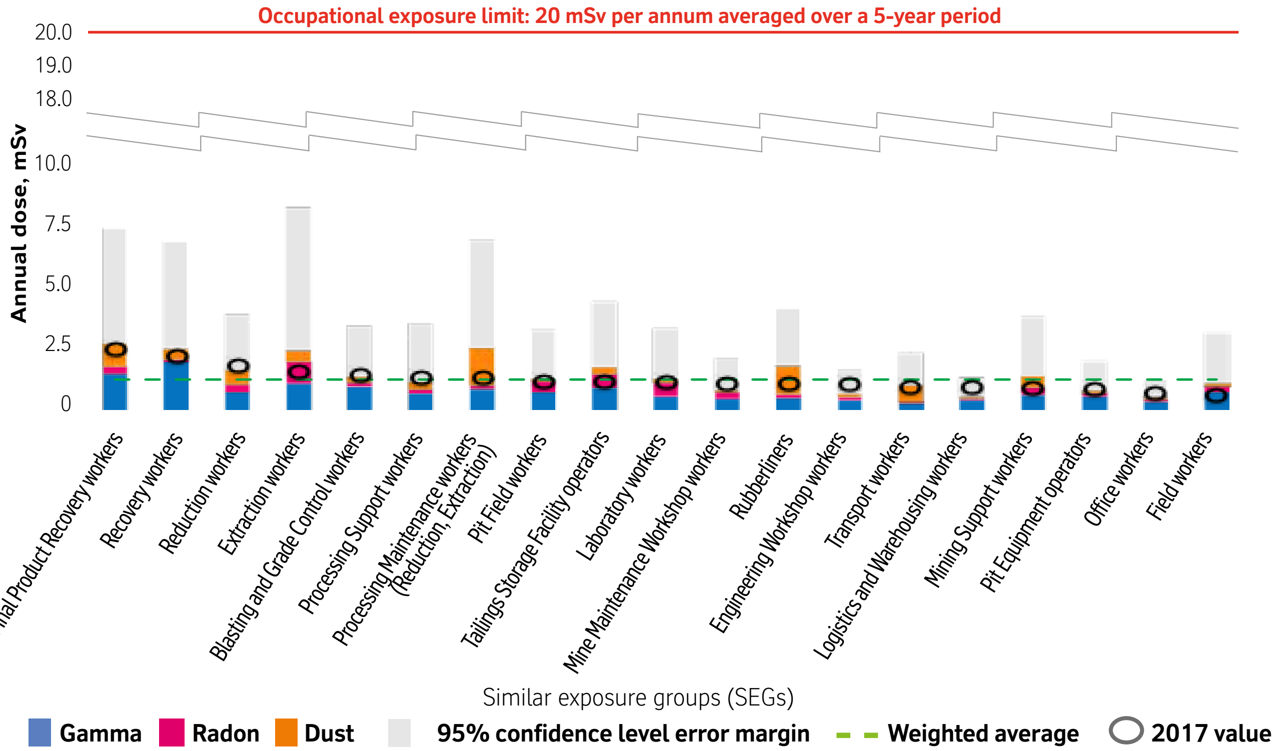
3.1 Radiation dose monitoring results for 2018

In 2018, no SEG has received an annual dose of more than 5 mSv. The annual dose averaged over the entire workforce was 1.2 mSv, as it has been recorded consistently for the past five years. Assuming a working year of 2,000 hours, the annualised and averaged dose by SEG is displayed in Figure 2. The average annual dose is shown for each SEG, broken down into contributions from gamma radiation, dust inhalation, and radon inhalation. The weighted average annual dose of 1.2 mSv per annum is displayed as a dotted green line.

In terms of exposure risk, the three radiation exposure pathways for each SEG were randomly monitored. In 2018, over one thousand personal radiation exposure data, and additional samples of area dose rates were collected.

In addition to the randomly collected samples, a continuous record of the gamma dose for radiation workers (namely the Final Product Recovery SEG and the Recovery SEG) was obtained.

Figure 2: Average radiation dose recorded by pathway and SEG, in 2018
Regulatory annual dose limit: 20 mSV (Annual dose in milli-sievert)



3.2 Radiation workers and controlled areas

We consider anyone at risk of receiving an annual dose of 5 mSv (from all exposure pathways combined) or more to be a radiation worker. All the workers belonging to the similar exposure groups of Final Product Recovery or Recovery are classified radiation workers. The average dose of 2.7 and 2.5 mSv/a respectively were recorded for these groups.

The area exhibiting the highest risk in terms of radiation exposure is the Final Product Recovery (FPR) area. This a controlled radiation area with access restriction, fingerprint access and contamination checks for exiting personnel. We perform regular monitoring of surface contamination, inhalation dose rate for radioactive dust, and area gamma dose rate. To ensure clean working conditions, we have set an internal target of a maximum average surface contamination of 1 Bq/cm^2 for the area, and a maximum average dust inhalation dose rate of 10 µSv/h without applying a correction for respirator protection. In the FPR area, workers need to wear respirators for protection.

In 2018, our internal target of 1 Bq/cm^2 surface contamination was exceeded (the target was reached in 2017).

To reduce the surface contamination, the production of the FPR area was interrupted for repair and maintenance work in November. As a result, the surface contamination dropped to about 0.6 Bq/cm^2, which is well below the internal target.

A summary of the average surface contamination measurements for the year is provided in Figure 3.

Radiation workers receive a continuous gamma monitor in the form of a thermo luminescent dosimeter (TLD), which are replaced at intervals of three months. The annual dose for the workers with the highest deep/gamma dose is far below 20 mSv[1].

Radiation workers undergo regular urine testing to check for accidental ingestion of uranium, female radiation workers undergo monthly pregnancy testing so as to detect pregnancy at an early stage and enable the prompt removal of pregnant females from these working areas.

In 2018, a total number of 752 urine samples were collected for analysis. However, the accreditation for the local service provider, TeaLab, has expired and some of the results were doubtful. The samples then had to be sent to alternative laboratories (including NECSA and PathCare which is based in South Africa) for analysis. Currently, for all results received there was no indication of concentrations which would exceed the warning level for uranium in urine of 20 µg/L. According to our internal standards, the results cannot be reported externally.

Figure 3: Average surface contamination levels in the FPR area, 2018. *The MPEL refers to the maximum permissible contamination level, as per procedures documented in the RMP.*

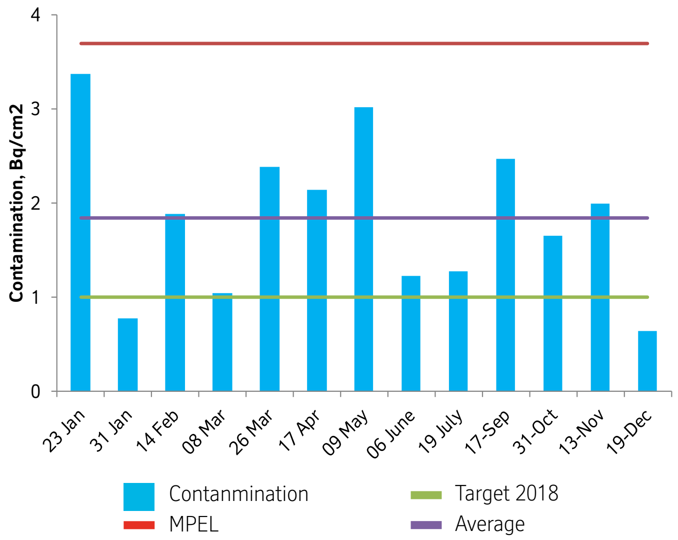


Figure 4: Deep dose/gamma dose rates for FPR workers, 2018

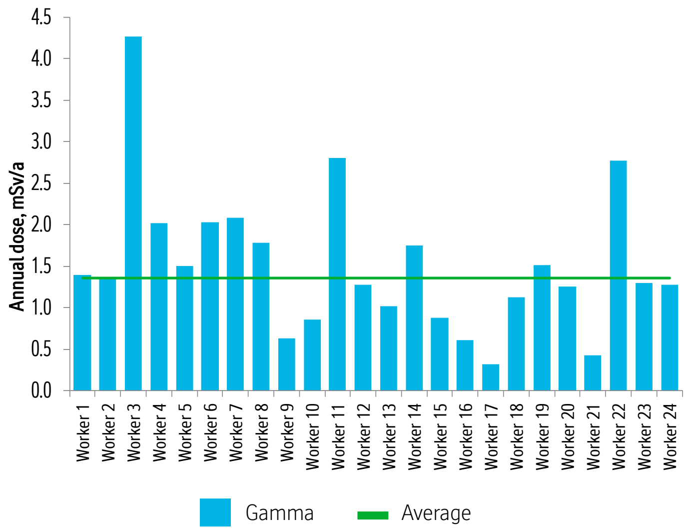
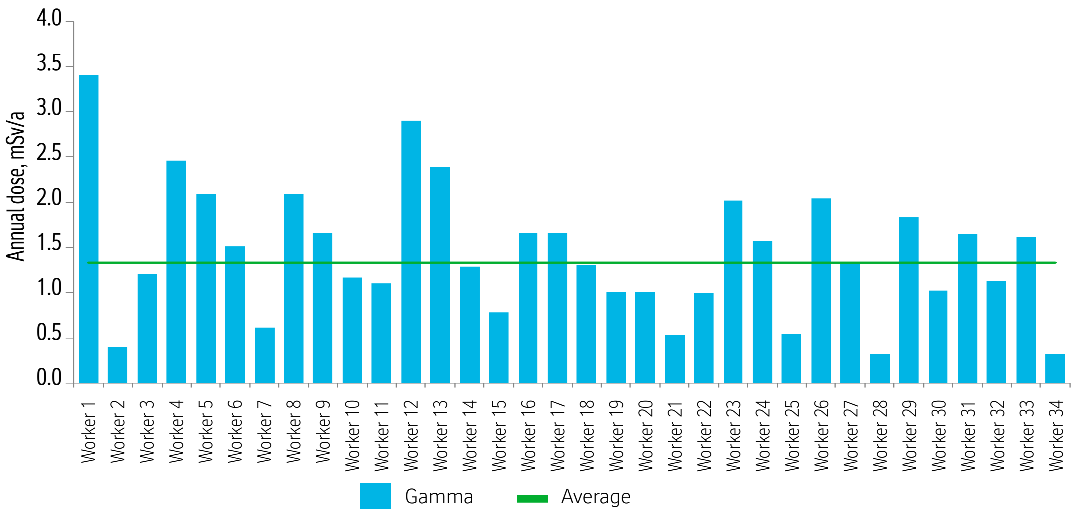


Figure 5: Deep dose/gamma dose rates for recovery workers, 2018



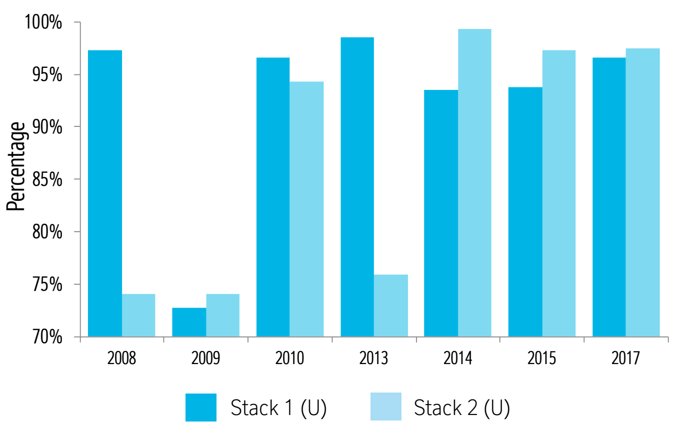
3.3 FPR stack monitoring

In FPR area, five stacks are employed, three of which are low-emission venting stacks from the FPR building and two of which hail from the FPR roasters. As the latter two are fed with the exhausts from the uranium roasting process, the emissions need to be closely monitored and controlled. For the past eleven years, stack efficiency was monitored on an annual basis (with the exceptions of the years 2011, 2012, 2016 and 2018) by external accredited consultants.

Because of the large variability of stack flows and scrubbing operation efficiency, the monitoring frequency is found to be unreliable in yielding representative results. Based on the extrapolated results from the past years, it is concluded that the stack scrubbing efficiency needs to be improved, and monitoring needs to take place continuously. Therefore, Rössing has embarked on an in-depth investigation of the stack scrubbing system to improve the scrubbing efficiency. Additional equipment to transition from annual stack sampling to continuous monitoring have been procured and installed. This was done to supplement and complement the annual sampling, which is a requirement of the programme in place at Rössing.

A summary of the extrapolated stack scrubbing efficiency is provided in Figure 6, separately for each of the two FPR stacks. A new ventury-type scrubbing is now considered and the design parameters are being studied to maximise efficiency. When this project is concluded, it should increase the efficiency sustainably to the desired efficiency of 98 per cent. In 2018, a group of professionals visited Rössing's sister company, Energy Resources Australia (ERA) based in Australia, to better understand its scrubbing system.

Figure 6: FPR scrubber efficiency for uranium removal, 2008-2017



3.4 Radiation awareness training

Raising awareness about radiation and maintaining appropriate perspective on the associated risks in the workplace remains one of the mine's most important focal areas. Rössing continued providing individualised training tailor-made for each work area. In order to render the workplace rules and regulations more accessible for the workforce, Rössing has adopted two methods of radiation awareness training, namely classroom training and web-based training. In 2018, we implemented the web-based training to facilitate technology-based learning.

A total of 430 employees and contractors were trained for radiation awareness in 2018.

In order to share information about our radiation protection programmes with the public, Rössing makes many of its reports, fact sheets and booklets available on its website, under the 'Reports and Research' tab. Apart from the RMP and RMP implementation reports, Rössing shares technical reports on environmental risk, as well as fact sheets and booklets about radiation protection in uranium mining. Information in the form of fact sheets, articles and brochures is also shared via the NUI, as well as mining trade fairs and other industry expositions.

3.5 Communication of monitoring outcomes to employees

After each week of personal radiation exposure monitoring, a group report is prepared summarising and explaining the monitoring outcome. This report is shared with the affected team during team discussions where possible. The results are also shared via email communication. At end of the year when the monitoring plan has concluded, all reports are shared with respective teams during team discussions. The analysed monitoring results are also published in Rössing's Annual Stakeholder Report which is available publically.

Urine sampling results are communicated to individuals only if an exceedance of the warning or action levels has occurred, or upon request.

All personal exposure dose results and urine sampling results are available to employees via the Rössing intranet. The results displayed are only those of the person logged on to the computer, ensuring the confidentiality of the results. Most Rössing workers have access to computers in their working areas, others can access their dose results via the Radiation Safety Section.

3.6 Dust levels in FPR

Personal monitoring of the dust inhalation dose in the FPR area serves to establish the inhalation by the workers in the area. However, in order to further minimise the risk and proactively manage dust levels, area dust monitoring is also performed in order to target specific areas of concern. For this purpose an internal target dust dose level of 10 µSv/h without correction for respirator use has been set. Significant improvements in this regard have been made, mainly by providing a separation between the drum filling area and the remainder of the FPR processing building.

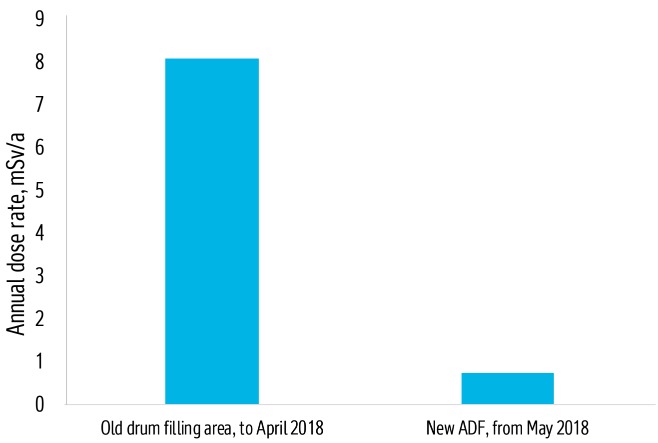
A new enclosed, automated drum filling assembly was installed in early 2018. This assembly unit (see Image 1 on the next page) has significantly reduced the radioactive dust concentration.

Image 1: The new Automated Drum Filling (ADF) area

Unlike the old way of drumming where the dust could escape from the drum, the new method ensures that the filling compartment is totally enclosed whereby little to no dust escapes into the building.

The dust exposure comparison for the old drum filling method and the new Automated Drum Filling (ADF) method is shown in Figure .

Figure 7: Comparison of dust exposure at FPR's old drum filling area to the new ADF area



4. Public exposure protection

4.1 Background

The dose limit for public exposure resulting from mining activities is 1 mSv per year. This dose limit does not include background sources, be they natural or man-made. The natural background radiation in the Erongo Region is approximately 1.8 mSv/a. As it is not possible to exactly quantify the public dose[2] directly, they are calculated from first principles, after determining the factors potentially contributing to this public dose.

At Rössing, the critical group relevant to the inhalation of radon and the inhalation of radioactive dust are the persons living in Arandis. For potential groundwater contamination, there is currently no critical group that can be affected through this pathway, as the direction of water flow from the mine is to the south, towards the Khan River. Nevertheless, groundwater contamination is well controlled with no impact on the groundwater in the immediate environment.

4.2 Water monitoring

Exposure through the aquatic pathway could result from the potential seepage of contaminated water from the Tailings Storage Facility (TSF) into the Khan River aquifer.

Tailings from the processing of uranium ore at Rössing are stored in a single TSF. The tailings impoundment has an existing footprint of about 1,377 ha, and a maximum wall height of around 100 m. The ultimate footprint for the life of mine configuration in 2025 is planned to stay about 1,377 ha with an increased wall height and a total storage capacity of 600 million dry tonnes. Fine tailings are pumped and coarse tailings conveyed to the facility where they are mixed and hydraulically deposited into an active paddock. Decant water from the facility is recycled back to the Processing Plant.

Surface seepage from the TSF is captured in a down-gradient seepage collection dam. (See Image 2 on the next page of the TSF with surface seepage appearing at the toe of the TSF, and Image 3 of the Processing Plant with a view of the seepage dam visible in the background). This water is recycled back to the Processing Plant. Process water in the decant ponds on the TSF typically has a pH of 2, contains some dissolved uranium and has a total dissolved solids concentration of about 25 g/L, reaching up to 70 g/L. Percolation towards the base of the TSF results in neutralisation and precipitation of contaminants.

[2] The additional dose to the public due to mining related activities is referred to as the 'public dose', and this explicitly excludes background related sources of radiation exposure dose.

Image 2: Rössing's TSF with seepage appearing at the bottom toe of the dam.
The view is towards the north. (Photograph by Karl André Terblanche)

Image 3: Rössing's Processing Plant with seepage dam visible at the top of the image.
The view is towards the south. (Photograph by Karl André Terblanche)

A system of monitoring boreholes surrounds the TSF. Water quality is measured regularly and analysed as to its chemical constituents. For a selected number of boreholes, Rössing also determines the radioactivity of the main radionuclides of the uranium and thorium chains, on an annual basis. The isotope ratio allows a determination of the origin of water resources as either naturally occurring, or resulting from seepage from the TSF[3].The location of the boreholes from which we obtain a radionuclide analysis is strategically placed along the frontier of the seepage plume. This allows a quick judgement to determine if there has been a change in the position of the seepage plume front.

[3] The principles behind alpha recoil and its potentials for monitoring are explained in the RMP, and in the articles 'Water quality monitoring at Rössing Uranium mine using isotope techniques', and 'Using alpha recoil as a tool for contamination control in the Khan River aquifer'. All of these are available on the Rössing website.

In Image 4 on the next page, the current seepage plume is indicated together with boreholes close to the edge of the plume. Boreholes close to the edge but outside the plume are monitored regularly; this will be sufficient to obtain information on the potential advancement of the plume. Boreholes within the plume need not be monitored, as it is already known that they are affected by seepage.

In the figure, green-coloured dots indicate borehole water unaffected by contamination, and red-coloured dots indicate water contaminated by tailings. The detailed radionuclide monitoring results are summarised in Table 1.

In 2018, boreholes in the Khan River and the barriers or cut-off trenchers display a U-234/U-238 ratio in excess of 1 (indicated by green-coloured dots), showing a predominantly natural occurrence of uranium in the water. Hence, there is no risk of seepage of contaminated water into the aquifer of the Khan River.

Image 4: Delineation of the seepage plume surrounding the tailings storage facility (yellow line). Boreholes are indicated in green or red according to the radionuclide ratio; green indicates background sources and red indicates mining related sources of uranium.

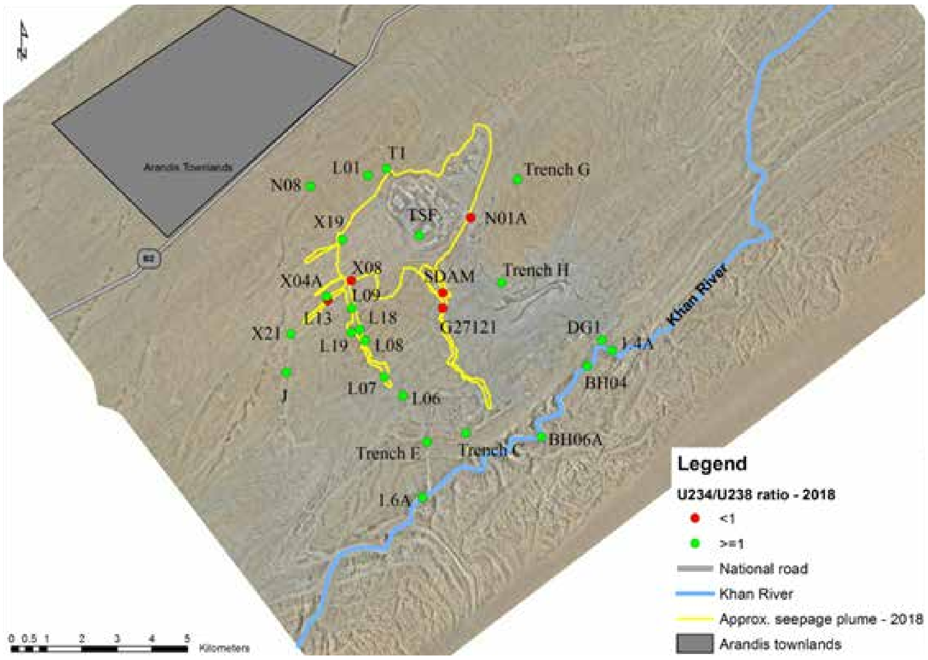


Table 1: Radionuclide sampling analysis for monitoring boreholes as of 2018 (sampling done in September 2018)

Borehole Code	U-234 Activity Concentration mBq/L	U-234 Activity Concentration mBq/L	Ratio U-234/U-238 2018	2017	Comment on location of borehole
1.4A	800	610	1.31	1.22	Khan River and Seepage barrier trenches
1.6A	310	270	1.15	1.28	Khan River and Seepage barrier trenches
BH4	11	6	1.90	1.29	Khan River and Seepage barrier trenches
DG1	6,560	5,090	1.29	1.31	Khan River and Seepage barrier trenches
G27121	276	294	0.94	1.08	Upstream of SJ Pit
J	1,600	1,460	1.10	1.05	Panner Gorge
L01				1.00	North of TSF
L13	4,120	4,520	0.91	1.05	Panner Gorge
L18	280	250	1.12	1.22	Panner Gorge
L19	8,780	7,050	1.25	1.21	Panner Gorge
L6	7,060	5,720	1.23	1.29	Panner Gorge
L7	9,270	7,200	1.29	1.18	Panner Gorge
L8	13,300	11,100	1.20	1.22	Panner Gorge
L9	9,000	7,550	1.19	1.02	Panner Gorge
N1A	11,100	11,200	0.99	1.07	East of TSF
N8	1,310	960	1.36	1.14	Panner Gorge
Seepage Dam	12,100	12,700	0.95	0.95	Surface water, freshly extracted uranium
T01	51	38	1.34	1.33	North of TSF
TSF	553,000	534,000	1.04	0.94	Surface water, freshly extracted uranium
Trench C	10,700	9,140	1.17	1.27	Khan River and Seepage barrier trenches
Trench E	5,470	3,990	1.37	1.24	Khan River and Seepage barrier trenches
Trench H	49,600	46,300	1.07	1.01	Khan River and Seepage barrier trenches
X19	32,600	31,900	1.02	1.02	Panner Gorge
X21	104	87	1.20	1.18	Panner Gorge
X2				1.00	Panner Gorge
X4A	4,700	4,320	1.09	1.05	Panner Gorge
X8	34,900	35,500	0.98	1.01	Panner Gorge
BH06A	2,730	2,070	1.32		Khan River and Seepage barrier trenches
Trench G	2,240	2,180	1.03		Khan River and Seepage barrier trenches

4.3 Dust monitoring

The public dose from the inhalation of dust can be calculated through the measurements of the concentration of dust in the air breathed. The size of particles inhaled is directly linked to their potential for causing health risks. Small particles less than 10 micrometres in aerodynamic diameter pose the greatest risk, because they can enter the lungs (inhalable dust).

Several dust monitoring stations are placed in strategic locations around the mine site, where the concentration of dust particles smaller than 10 microns is measured in 15-minute intervals. This dust is referred to as particulate matter smaller than 10 microns, or PM_{10} in short. The locations of the PM_{10} stations include, amongst others, one at Arandis, one at the Rössing TSF and one at the western mine boundary.

The PM10 sampler at Arandis provides the PM_{10} dust concentration (Figures 8 and 9), wind speed and wind direction in intervals of 15 minutes. This allows the allocation of a dust concentration as mining related (if the wind blows from the mine) or background (when the wind is blowing in any other direction). This principle is illustrated in Image 4 on the next page.

The overall average PM_{10} dust concentration measured was on average 18 μg/m^3, which is just below the WHO guideline value for outdoor air quality of 20 μg/m^3 when averaged annually (Figure 8). The 2018 value is about the same as the dust concentration in 2017, which was 19 μg/m$_3$.

To give an upper limit of the annual dose by the mine dust, it is assumed that all PM_{10} dust in Arandis is ore dust coming from the mine. We futher make the realistic assumption that the ore dust is in secular equilibrium, the particles have an aerodynamic diameter of on average 5 μm, and the ore dust contains 300 ppm uranium.

A PM_{10} concentration of 18 μg/m^3 of such ore dust corresponds to an annual dose of about 18 μSv per year, or 0.018 mSv per year.

The legal annual dose limit for the public is 1 mSv per year, meaning all the PM_{10} dust in Arandis assumed to be radioactive ore dust can only contribute to about 2 per cent of the legal limit. Hence, the contribution of potential radioactive dust to the public dose is negligible.

In 2018, we found that the wind blowing in the south-southeastern and east-southeastern directions (that is, directions coming from the mine) towards Arandis was 13 per cent of the time, as shown in Figure 10. The wind monitoring is consistent with the 2017 result, when 14 per cent of the wind in Arandis was coming from the mine.

Figure 8: Arandis PM10 concentrations averaged per month, 2018

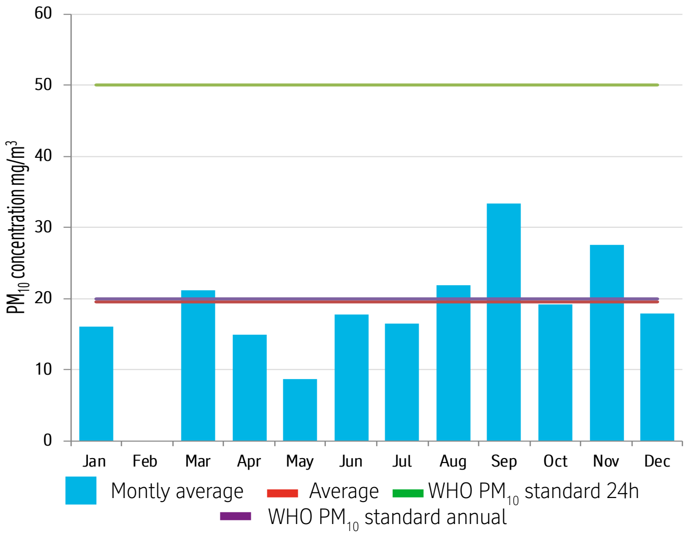


Figure 9: PM10 concentration at Arandis, measured in intervals of 15 minutes, 2018

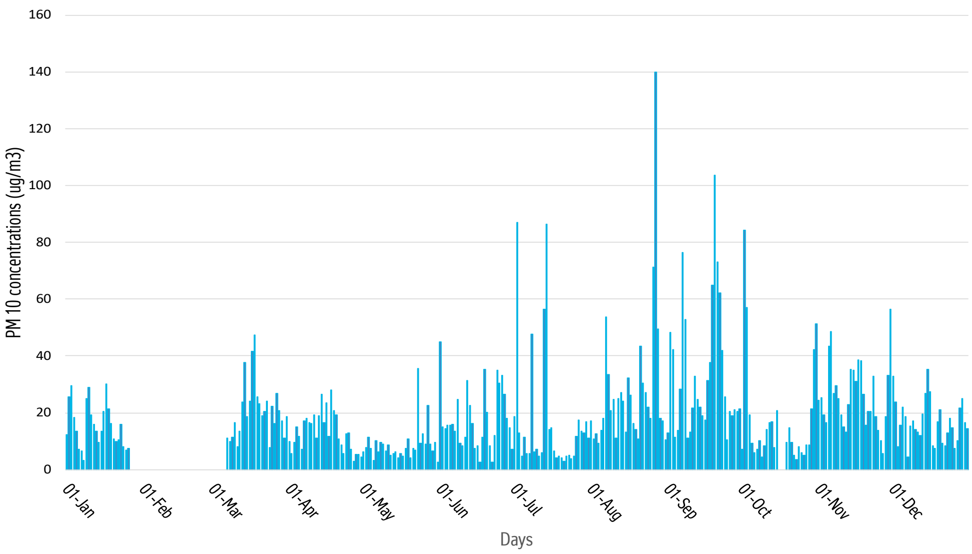
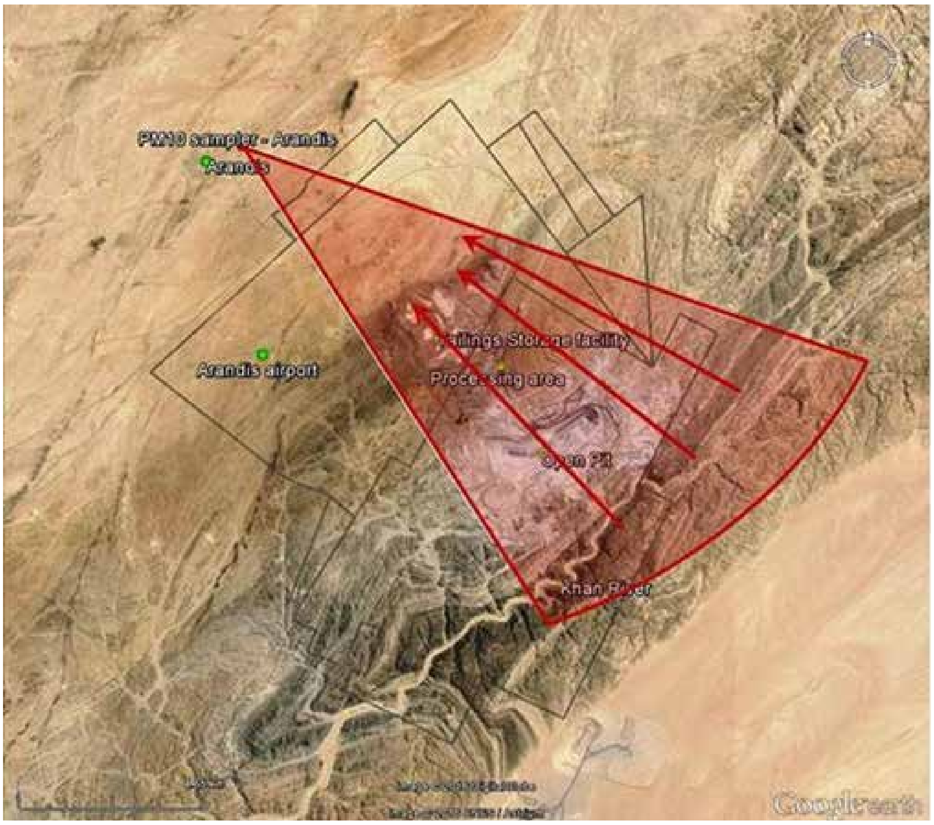
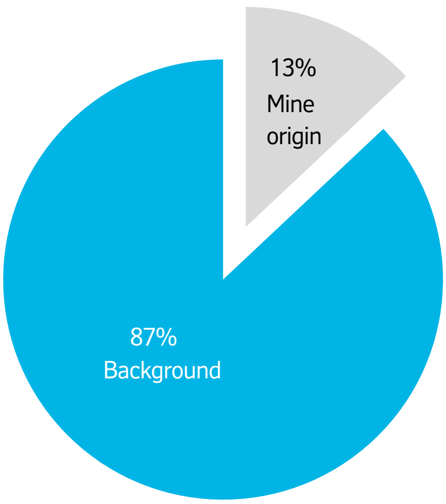


Image 4: A satellite image showing those wind directions at the mine that could result in radioactive dust exposure at Arandis



The fact that about 87 per cent of the time the wind in Arandis is not coming from the mine leads to the conclusion that a major part of the particle concentration is not a contribution from the mining operations or activities of Rössing Uranium.

Figure 10: Fraction of wind directions, with wind coming from mine in grey.



4.4 Radon monitoring

As there have been no changes to the mining operations that could result in a measurable increase of the radon emitted from the site, no new radon measurements were performed in 2018.

The average radon concentration at Arandis is measured at the radon station operated by the NUI and owned by the Ministry of Mines and Energy. The station is located at the Arandis Namwater reservoir some 6 m above ground level.

Between 2011 and 2014, the average radon concentration measured there was found to be 21 Bq/m^3, consistent with background radon concentrations found in the 2011 SEA report[4].

[4] H Liebenberg-Enslin, J van Blerk, ID Kruger, Strategic Environmental Assessment (SEA) for the Central Namib 'Uranium Rush' Radiation and Air Quality Theme Report, 2010.

5. Safety and security of sources

5.1 Sealed source register

By December 2018, all sealed sources have been removed from operation and stored safely in the onsite Radiation Storage Facility (i.e. bunker). Four of the sealed sources were used as level measuring devices in the two primary crushers and have been replaced with equipment which does not require the use of sealed sources.

Another source previously at FPR has become redundant with the commissioning of the automated drum filling (ADF) equipment.

All the sources on site are being stored in the Radiation Storage Facility. Refer to Table 2 for a complete list of sources held at the mine. The license issued for use and operation of all our sources is SSL/113/13 and expires in June 2019.

Table 2: List of sealed sources at Rössing Uranium (radionuclide of all sources is Cs-137)

Serial Number	Activity (GBq)	Location	Use	Comment
27255 N	38,8	Radiation Store	Level	Not in use
004/12	33,1	Radiation Store	Level	Not in use
H500081140	39,6	Radiation Store	Level	Not in use
005/12	31,6	Radiation Store	Level	Not in use
70682	0,2	Radiation Store	Level	Not in use
2771	13,8	Radiation Store	Level	Not in use
PA 304	0,3	Radiation Store	Density	Not in use
PA 299	0,3	Radiation Store	Density	Not in use
PA 301	0,3	Radiation Store	Density	Not in use
PA 302	0,3	Radiation Store	Density	Not in use
PA 298	0,3	Radiation Store	Density	Not in use
PA 297	0,3	Radiation Store	Density	Not in use
2772	13,8	Radiation Store	Level	Not in use
2770	13,8	Radiation Store	Level	Not in use

In addition, three low activity calibration sources are kept at the Radiation Safety Laboratory (Table 3).

Table 3: List of calibration sources at Rössing Uranium

Nuclide	Type of source	Half-life (years)	Initial activity (kBq)	Date of manu-facture	Time elapsed (years)
Cs-137	Beta	30	3	2011/12/13	6
Th-230	Alpha	75 Thousand	1	2011/12/16	6
Nat U	Alpha	4.5 billion	1.4	2017/07/01	1

5.2 Sealed source checks

Leak tests of sources in operation are performed two-monthly, while sources not in use are only tested at six-monthly intervals. Currently, all sources are stored in the Radiation Source Bunker, which is access restricted.

5.3 X-ray generating equipment

TThe Rössing chemical laboratory is making use of two analytical x-ray units, as per registration and license EPR/113/01/12, which expires in 2021.

6. Transport of radioactive material

With the authorisation TRM/113/01/18/ET, Rössing transported uranium oxide to overseas converters. A total of 2,391 tonnes of uranium oxide of chemical composition U_3O_8 (with a content of 2,028 tonnes of uranium) were exported in 2018, as summarised in Table 4.

Table 4: List of UOC shipments from Rössing Uranium in 2018

Shipping date	Country of final destination	Quantity of exported (kg)	Quantity of contained element (kg)
4 February 2018	France	125,003.700	106,003.138
28 February 2018	France	108,943.344	92,383.956
28 February 2018	France	53,216.725	45,127.783
18 March 2018	France	107,135.672	90,851.050
30 March 2018	France	122,142.074	103,576.479
13 April 2018	France	86,400.642	73,267.744
7 May 2018	France	177,176.082	150,245.318
16 June 2018	France	159,796.753	135,507.647
23 June 2018	France	163,187.082	138,382.646
7 August 2018	France	107,578.403	91,226.486
7 August 2018	France	122,995.861	104,300.490
30 August 2018	France	177,455.521	150,482.282
3 October 2018	France	208,244.504	176,591.339
16 October 2018	France	191,529.628	162,417.125
8 November 2018	France	159,593.642	135,335.408
25 November 2018	France	143,012.513	121,274.611
27 December 2018	France	178,203.977	151,116.972
Total in tonnes		2,391	2,018

7. Emergency preparedness and response

The Rössing emergency response to uranium spills, as outlined in the procedure *JK60/PRD/009- Uranium Oxide Spillage*, was rehearsed as a mock dril on 26 October 2018.

The drill was conducted together with other uranium mines from Namibia (see Image 5).

The newly-appointed advisors Rauna Haindobo and Martin Amukwaya actively took part in the drill on behalf of Rössing. Dr Bertram Schleicher observed their performance and the drill activities of the members of the other mines.

After the drill, the overall performance was discussed at the NUI and all opportunities for improvement shared with the participating members for implementation.

Image 5: Mock drill of final product spillage along the B1 road, October 2018

8. Disposal of radioactive waste

8.1 Disposal of contaminated non-mineral waste

Contaminated waste is deposited on the TSF, which in itself is a contaminated waste site.

In 2018, a total of 1,272 tonnes of contaminated waste was deposited on the TSF. The cumulative total of the stored non-mineral hazardous waste is 28,272 tonnes.

8.2 Mineral waste

Both tailings material and waste rocks deposited without processing are regarded as mineral waste.

In 2018, Rössing deposited 8, 851,288 tonnes of tailings onto the TSF, which now holds the cumulative amount of roughly 436 million tonnes of tailings material. The exposed surface area of the TSF remains unchanged at 1,377 ha.

Rössing deposited 11,459,319 tonnes of waste rock onto the waste rock dumps, bringing the cumulative total of waste rock material deposited to date to roughly 966 million tonnes of material.

9. Research

In 2014, Rössing started to conceptualise a study to establish whether there are any potential links between workforce exposure to occupational risks, notably radiation exposure, and health effects.

The research, which is explained in detail in the Implementation of Radiation Management Plan 2017, shall be concluded with a final report in mid-2019. The final data sets necessary were provided in October 2018.

More information and updates on the Rössing health study are published on the Rössing website, http://www.rossing.com/reports-research2.htm. This site is also used to share more detailed information on Rössing's performance with the public. Environmental impact assessments and closure plans, environmental and biodiversity management plans and discussion of some frequently asked questions about the mine's management of health and environment are also published there. Rössing's RMP and its annual reports to the NRPA are presented on the website for public information.

10. Conclusions

The monitoring results show a radiation exposure at Rössing Uranium is very low. The monitoring data for the public clearly indicate an annual dose limit around 1 mSv per year, which is the legal public limit.

We will continue making relevant information available to the public, in order to empower our communities with the knowledge to successfully put the risks relating to radiation safety into perspective.

Awareness about radiation risk remains a focus, and awareness sessions by suitably trained experts with all workers remain an important deliverable.

For the coming year, we have decided to focus on the following:

- Succession planning, training, and performing an understudy programme for one of our team members;
- Reducing levels of uranium dust in the Final Product Recovery area further;
- Optimising FPR stack scrubbing efficiency and stack monitoring systems;
- Implementing new monitoring system to ensure safe work conditions;
- Completing a dust survey around the mine which will be incorporated in GIS mapping; and
- Completing the Rössing health study.