Implementation of Radiation Management Plan

Annual Report for Rössing Uranium Limited

2022

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Abbreviations

Bq	—	becquerels, decays per second, unit for measuring radioactivity
FPR	—	Final Product Recovery
g	—	grams
HSE & PS	—	Health, Safety, Environment and Protection Services
kBq	—	kilo-becquerels, 1,000 Bq
LLRD	—	Long-Life Radioactive Dust
mBq/L	—	milli-becquerels per litre, 10^{-3} Bq per litre
mSv	—	milli-sieverts, sieverts/1,000
µSv	—	micro-sieverts, sieverts/1,000,000
µSv/a	—	micro-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, 1/1,000,000th grams per litre
NRPA	—	National Radiation Protection Authority
Ppm	—	parts per million
PM	—	Particulate matter
PM10	—	Particulate matter with particle size below 10 microns
%	—	Percent
RUL	—	Rössing Uranium Limited
RMP	—	Radiation Management Plan
RSO	—	Radiation Safety Officer (statutory role)
SEG	—	Similar Exposure Group
TLD	—	Thermo-luminescent dosimeter
TEA Lab	—	Trace Element Analysis Laboratory
TSF	—	Tailings Storage Facility
MEFT	—	Ministry of Environment, Forestry and Tourism
NUI	—	Namibia Uranium Association Uranium Institute
UOC	—	Uranium oxide concentrate
WHO	—	World Health Organisation

1. Introduction

1.1 Rössing Uranium's Radiation Management Plan

To comply with Radiation Protection Regulations[1], Rössing Uranium Limited (RUL) prepares an annual narrative report to the National Radiation Protection Authority (NRPA) about the implementation of the site Radiation Management Plan (RMP) as required.

Herewith we present the eighth narrative report since the implementation of this regulation. Reports for the years 2013 to 2021 are available to the public on the Rössing website, http://www.rossing.com/reports-research.htm.

This report is accompanied by data presented separately in the prescribed format, which includes:

- average exposure dose records for each similar exposure group (SEG) for the year 2022, for each of the three pathways monitored separately;
- personal dose records for the past year for each employee working at the mine during that year;
- cumulative dose reports for all employees who have left the organisation during the past year;
- a list of sealed sources on the mine with current source activities and the location of each source;
- a list of uranium oxide exports in 2022; and
- a summary of radioactive waste deposited or stored, both mineral and non-mineral in nature.

2. Organisational arrangements

2.1 Rössing Organisational re-arrangements and structure

Johan Coetzee remains the Managing Director for Rössing Uranium with Renate Lemke permanently appointed in the role of Radiation Safety Officer (RSO) and Senior Advisor Occupational Hygiene and Radiation since December 2022. Nelao Endjala, who fulfilled the role as RSO and Specialist Radiation Safety since November 2020, resigned in 2022 and the Superintendent Health Management, Susan Labuschagne, was acting in the RSO role until Renate Lemke was permanently appointed.

The Radiation Safety Officer (RSO) role currently reports to the Superintendent Health Management, Susan Labuschagne, who reports to the Manager HSE & PS, Jacklyn Mwenze. The HSE & PS department remains within the Organisational Resources Division under the leadership of Liezl Davies, who is serving as the General Manager for the division. The organisational structure governing Radiation Safety up to November 2022 is depicted in Figure 1(a) and the current structure, effective December 2022 in Figure 1(b).

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

Currently, the Radiation Safety section is manned by the RSO and three Radiation Advisors who are carrying out the implementation of the RMP.

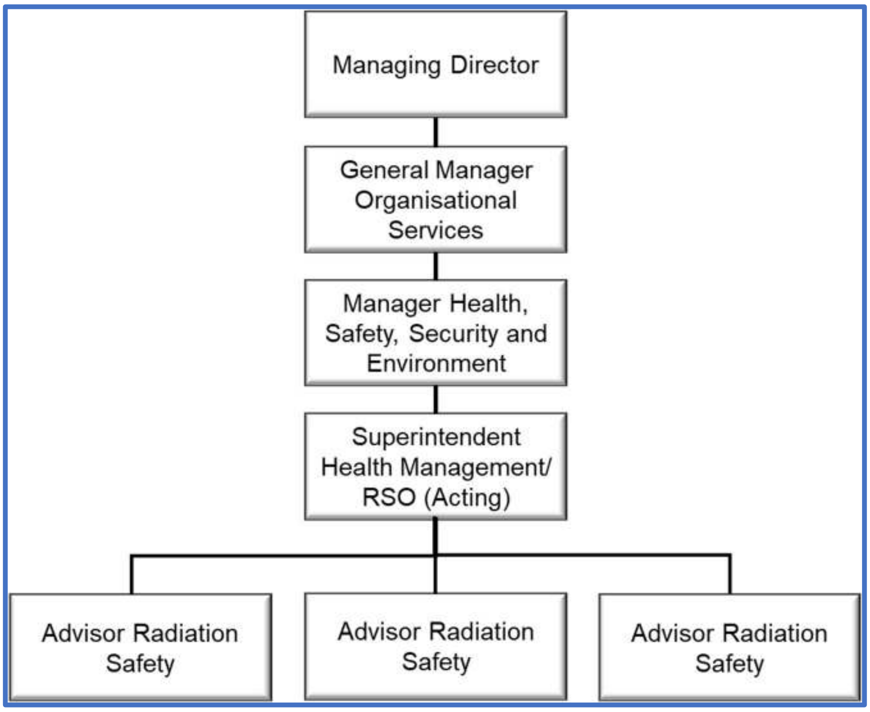

Figure 1(a): Organisational structure for the Radiation Safety Section, January to November 2022

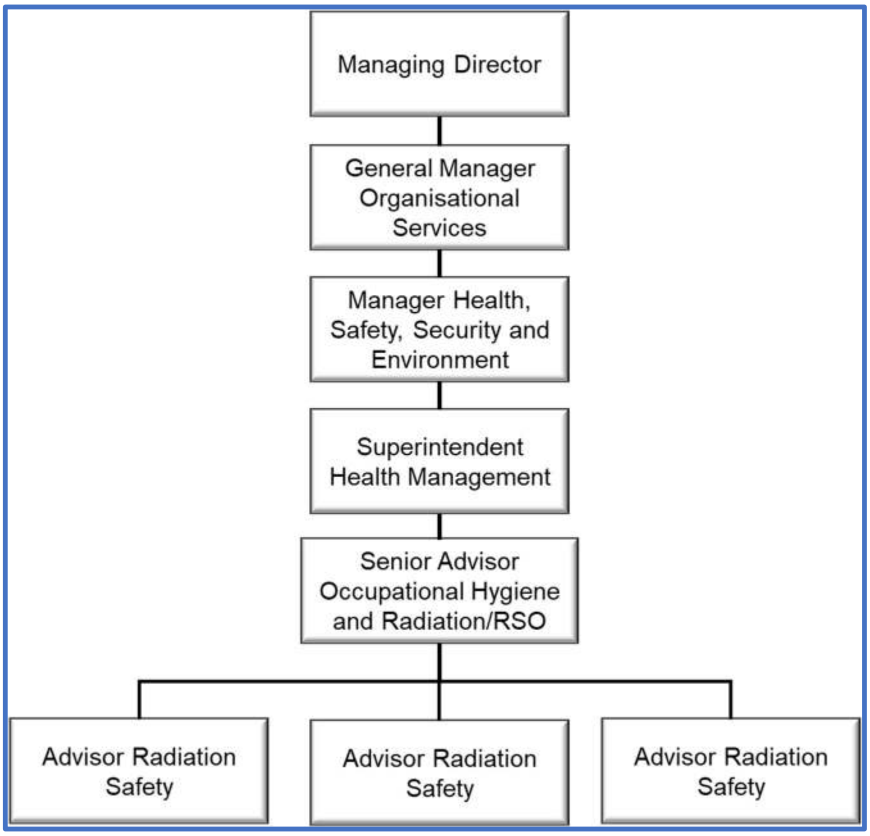

Figure 1 (b): Organisational structure for the Radiation Safety Section, December 2022

2.2 Capacity building

To emphasise the importance of radiation protection and the skills needed for effective radiation protection, Rössing continues to support and contribute towards the training programme for Radiation Safety Officers (RSO) offered by the Namibian Uranium Institute (NUI).

The Radiation Safety team are members of the NUI's Radiation Safety Working Group. Martin Amukwaya and Renate Lemke has completed the RSO refresher course in 2022. Martin Amukwaya also attended the Atomic Energy Board-organised conference on nuclear technology in Windhoek.

3. Occupational exposure protection

3.1 Radiation-dose monitoring results

In 2022, exposure of workers to radiation was monitored by measuring exposure to external gamma radiation, long-lived radioactive dust (LLRD) and radon decay products. A worker wearing radiation monitoring instruments is depicted in figure 2. A total of 905 workers in 17 different similar exposure groups (SEGs) were monitored. Extrapolated annual doses for the individual SEGs (graded approach) are summarised in figure 3.

Figure 2: A worker wearing radiation monitoring instruments

Our monitoring applied a risk-based approach: areas subjected to historically higher levels of exposure were monitored more frequently than areas subjected to lower exposure. In addition, some of the SEGs, which showed similar and low exposures during previous years, were assigned the same dose rates. This graded approach helps focus on key areas in the assessment where the highest doses and risk are to be expected.

Overall, the average annual dose for the entire workforce was 1.54 mSv per year, a level slightly higher than the 1.4 mSv per year monitored in 2021 (Figure 3). This increase can in part be explained by the higher ore grade mined in 2022, increased maintenance activities as a result of breakdowns, Life of Mine Extension (LOME) test work and projects. The average annual dose of 1.54 mSv is significantly lower than the occupational legal limit of 20 mSv/a.

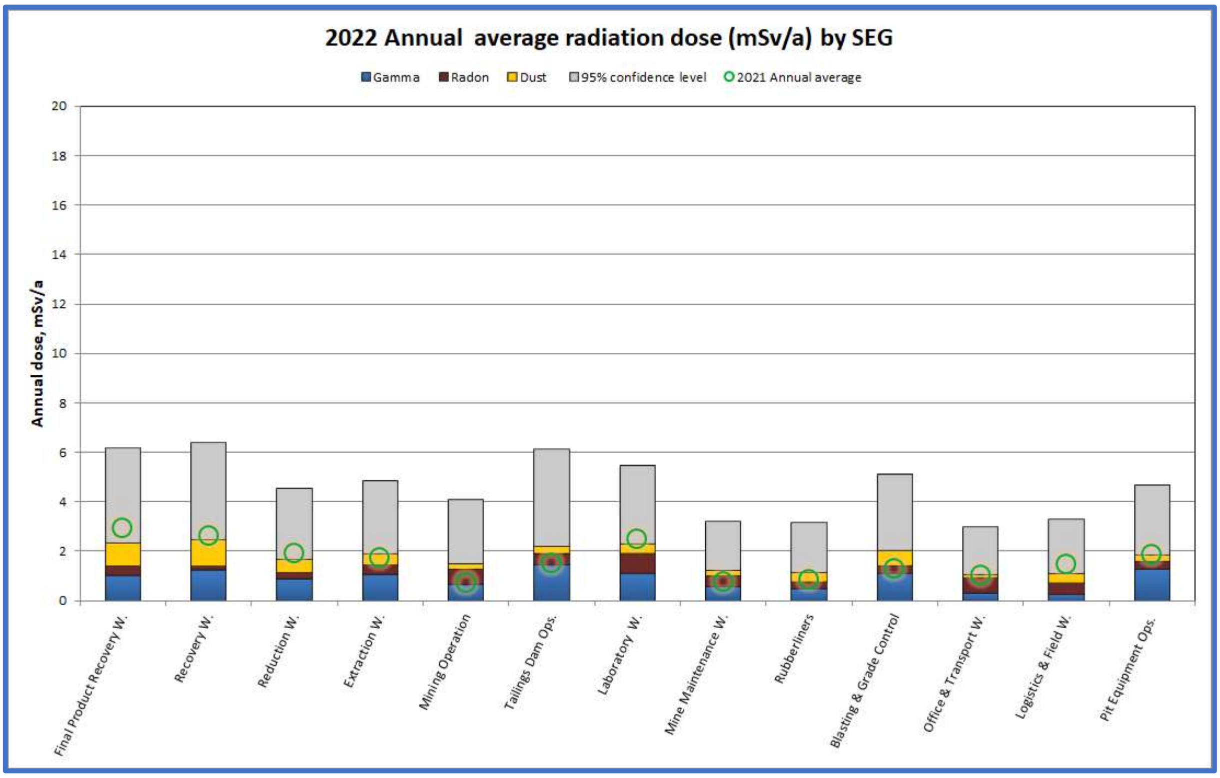

Figure 3: Annual average radiation dose recorded by pathway and SEG in 2022

3.2 Designated Radiation workers and controlled areas

Workers who are classified as “designated radiation workers” are at risk to receive a dose of 5 mSv/a or more from all exposure pathways combined. These workers, who belong to the SEGs of Final Product Recovery (FPR) and Recovery Workers (RW), are provided with thermoluminescent dosimeters (TLDs) as depicted in figure 4. The TLD’s are replaced at intervals of three months. New TLD boards have been installed in the designated areas.

Figure 4: Designated radiation worker wearing TLD.

In 2022, the annual total doses recorded were 2.4 mSv/a for FPR workers and 2.5 mSv/a for Recovery workers. The dose for both FPR and Recovery workers decreased from 2.9 mSv/a, and 2.6 mSv/a measured in 2021, respectively. The highest percentage of the total dose for FPR workers was the external (gamma) dose with about 44% of the total dose, while LLRD and radon contributed 40% and 16% , respectively. The exposure distributions for RW were 51% by gamma, 43% caused by LLRD, and by radon decay products. The total effective doses for FPR and RW from 2011 to 2022 have been consistently below 5 mSv/a (Figure 5).

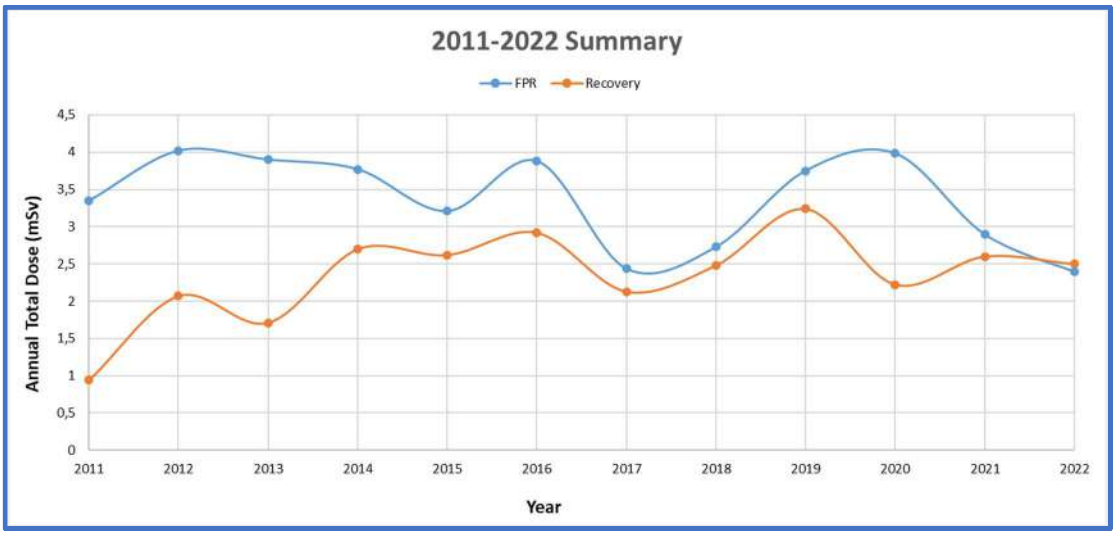

Figure 5: compares the average annual doses for FPR and Recovery workers from 2011 to 2022

The Final Product Recovery (FPR) area is a restricted, controlled area, with access restriction, fingerprint control and contamination checks for exiting persons. Due to exposure of uranium dust, the wearing of respiratory protection is mandatory. It is conservatively assumed the use of respirators reduces the annual LLRD dose by 90% (respiratory factor). To ensure clean working conditions, we have set a target of a maximum average, non-fixed surface contamination of 1 Bq/cm^2 and a maximum average dust inhalation dose rate of 10 µSv/h. Employees exiting the FPR plant are required to be monitored for contamination. In figure 6 a worker exiting FPR is checking for contamination.

Figure 6: Contamination checks before exiting FPR

During 2022, the average non-fixed surface contamination in the FPR area was maintained below the internal target of 1 Bq/cm^2 and measured 0,59 Bq/cm^2 (Figure 7). This is an improvement from level of 0,79 Bq/cm^2 measured in 2021.

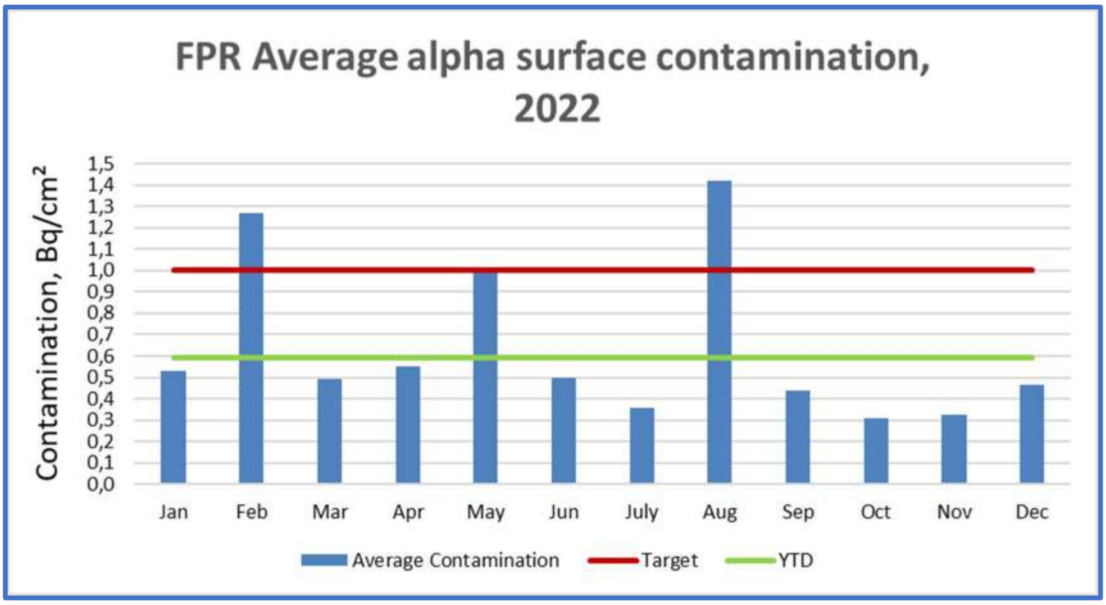

Figure 7: Summary of the average non-fixed surface contamination measurements for 2022 in FPR

Radiation workers provide monthly urine samples for testing of its uranium content. The urine testing serves to confirm the adequacy of controls that are put in place. Monthly pregnancy tests ensure that pregnant radiation workers are moved immediately to a less exposed area.

A total of one thousand nine hundred and seventy one (1971) urine samples were analysed, during 2022, to determine their uranium concentration.

Samples were mainly analysed by the Trace Element Analysis Laboratory (TEA Lab) in Swakopmund and some samples duplicated were sent to Pathcare Laboratory as a quality check.

A detection (i.e. threshold) limit for uranium in urine is about 5 µg/L, with the warning level of 20 µg/L, and the action level of 40 µg/L. Majority of the individual results for 2022 were below 10 µg/L (Figure 8). One individual reached the warning level of 20 µg/L and one exceedance was reported.

The exceedance was reported to the NRPA and investigated with corrective actions implemented. Compulsory quantitative respirator fit testing was introduced as an access requirement to FPR as one of the actions identified from the investigations.

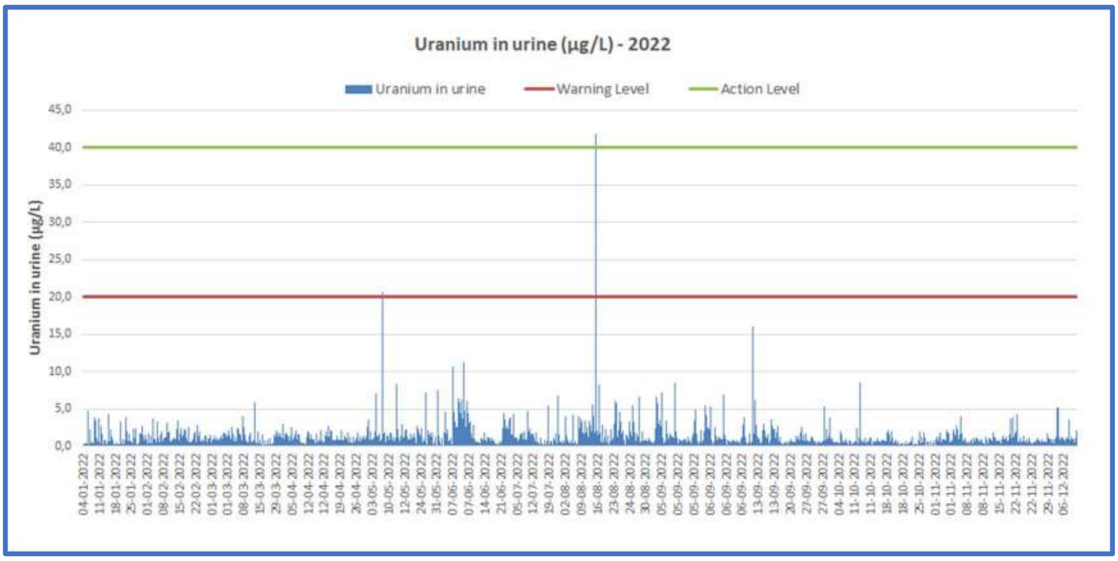

Figure 8: Uranium in urine results, 2022

We conducted twenty-six (26) pregnancy tests of female radiation workers, as well as additional pregnancy tests of females not classified as radiation workers, which were all negative.

3.3 FPR stack monitoring

In the FPR area, five stacks are employed, three of which are low-emission and venting stacks from the FPR building and two are from the FPR roasters. As the latter two are fed with exhaust from the uranium roasting process, emissions are monitored and controlled.

Stack emissions monitoring or sampling is an annual exercise and commitment as per Rössing commitment in the Rössing internal criteria on air quality to manage and monitor impacts all sources. The commitment is as per international best practice, because there are no defined limits and regulations on stack emissions in the Namibian regulatory framework. Therefore, emissions limits from the South African Listed Activities legislation (GN 893 of 2013) have been used as emissions guidelines. Subcategory 4.1, described as “drying and calcining of mineral solids including ore”, is most applicable to the roasters at Rössing. Emissions guidelines have only been applied to the outlet of Roaster Scrubber 2 and the baghouse, and not the roaster inlet. The roaster inlet concentrations were only measured so that the efficiency of the roaster scrubbers could be evaluated.

Emissions sampling was conducted on the five stacks/ducts by a contracted company, Yellow Tree, during the period 09 to 16 June and 28 September to 01 October 2022. The most relevant stacks in this report are FPR stacks.

The efficiency of the scrubbers was within the following ranges. For Particulate Matter (PM) emissions were found to be 71-87%, while 93-95% was the range for uranium and 77-84% was for other metals. It is encouraging to note that PM and uranium are removed at a very similar efficiency, as most of the uranium is in particulate form.

The average PM and uranium emissions from the outlet have, however, exceeded the guidelines, while the remainder of the pollutant concentrations from the roaster scrubber outlet were below the emissions guidelines, except for Cl_2. These emissions are checked and regularly tracked at business level and is part of annual improvement plan/strategies. The roaster replacement project's construction phase has commenced in 2022, for the first roaster. Construction for the second roaster planned for 2023.

3.4 Radiation Awareness Training

Radiation awareness training at Rössing continued in 2022. These included the Radiation Safety Induction and Refresher Courses as well as Final Product Recovery and the Recovery areas training modules. A total of 500 Rössing employees and contractors were trained in several courses of which ninety-eight (98) completed the Radiation refresher course online. Last year the online training module commenced for those that have access to computers and classroom training continued to be provided to the majority who do not have access to computers. The ALARA campaign continued in 2022, with internal communications to the workforce highlighting radiation controls (Figure 9).

Figure 9: Some of the ALARA campaign communications to the workforce

To share information about Rössing's radiation protection programmes with the public, we make many of our reports, fact sheets and booklets available on the Rössing website under the 'Reports-and-Research' tab. Apart from the RMP and RMP implementation reports, we share technical information regarding environmental risk as well as fact sheets and booklets about radiation protection in uranium mining. Information on Radiation Safety is also shared via the Uranium Institute and at mining and trade fairs.

3.5 Communication of monitoring outcomes to employees

One week after personal radiation exposure monitoring, a group report is prepared summarising and explaining the monitoring outcome. This report is shared with the respective team in team discussions and safe-shift starts (SSS) where practicable, but in most cases, results are shared through email. At the end of the year, all reports are shared with respective teams via emails.

Results of urine sampling are communicated to individuals only if they exceed the warning or action levels or upon request.

All individual exposure dose results and urine sampling results are treated as confidential but are available to the individual worker via the Rössing intranet. Each employee only has access to their own data. Workers without computer access can receive their uranium-in-urine levels via the Radiation Safety Section.

3.6 Dust levels in FPR

Monitoring programmes for radioactive dust in selected FPR areas supplement the personal dust monitoring data. We have established an internal LLRD target of 10 μSv/h without correction for respirator use.

In 2022, we have experienced operational and maintenance challenges with the roasters which has resulted in high average airborne dust. The average dose rate for 2022 was 7.1 μSv/h. Towards the end of last year, an additional real-time dust monitoring instrument was installed in the Upper Control room. Employees continue to use half-face respirators in this area and full-face respirators in the roaster areas. Compulsory quantitative respirator fit testing using the Portacount is a requirement for employees entering the FPR area, figure 10 showing a quantitative respirator fit testing session in progress.

Figure 10: Quantitative Respirator Fit Testing with Porta Count in progress

4. Medical exposure

Not applicable.

5. Public exposure protection

The dose limit for public exposure to mining activities at Rössing is 1 mSv per year on average. This dose limit does not factor exposure to background sources, neither natural nor man-made. The natural background radiation in the Erongo Region is approximately 1.8 mSv/a, while an additional dose from mining activities to critical groups in the public can be described as “low”. It is therefore not possible to measure the public dose[2] directly; it must be calculated from first principles after determining the factors that potentially contribute to this public dose.

At Rössing, the critical population group subject to radiation exposure are the residents of Arandis. No critical group has been identified that would be affected through groundwater

[2] The additional dose to which the public is exposed due to mining-related activities is referred to as the “public dose”. This factor explicitly excludes background-related sources of radiation exposure dose

contamination, since the direction of water flow from the mine is to the south, towards the Khan River. Nevertheless, groundwater contamination is controlled.

5.1 Water monitoring

At Rössing, wet tailings from processing uranium ore are stored on an unlined tailings storage facility (TSF). There exists a hydrologic connection between the TSF and the Khan River aquifer, which is located down-gradient, through alluvium & fractured rock aquifers. The Khan River aquifer is identified as the sensitive receiving environment which is to be protected against seepage emanating from the TSF.

Processed water recovery starts at the decant ponds, where upon deposition on the TSF, surface runoff water is directed to the engineered low point within an active paddy and pumped as return dam solution into the processing plant. Water which infiltrates the TSF is retrieved through pumping from several networks of abstraction boreholes, sumps, and trenches. The abstraction network starts on the TSF and extends further down-gradient into the fractured rock & alluvium aquifers (Figure 11).

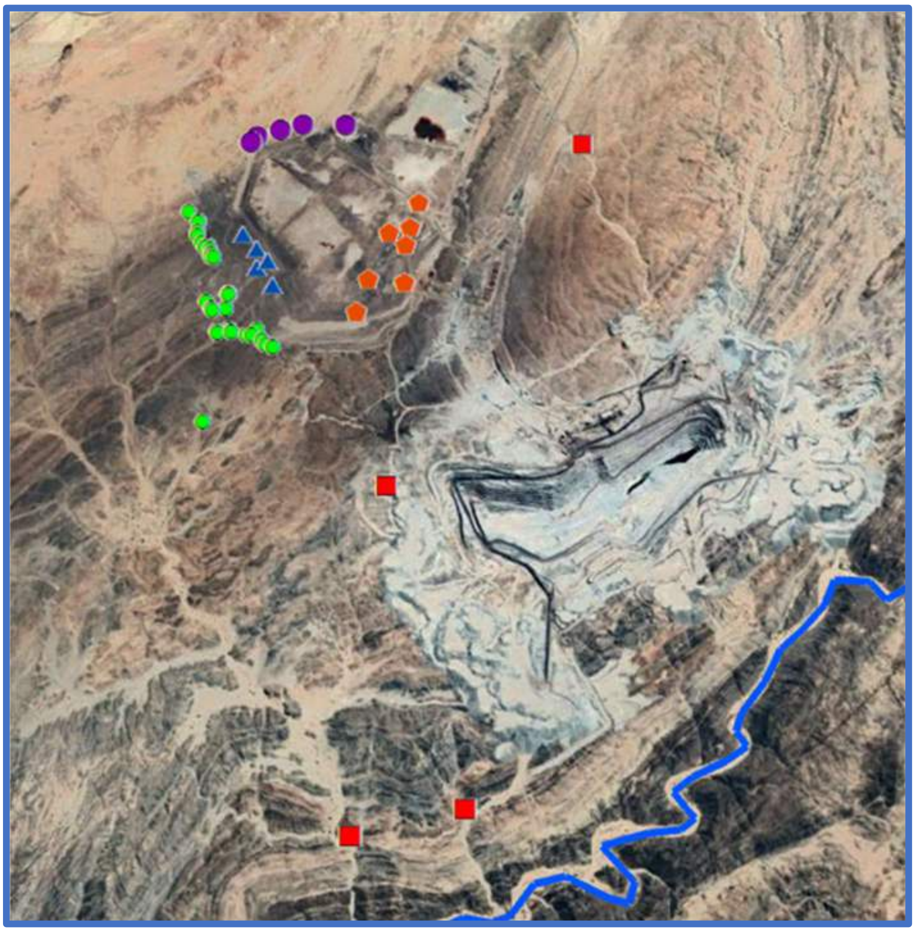

Figure 11: RUL seepage control pumping sites (NTSC in purple circles, TDDS in blue triangles, TDX in orange pentagons, DW in green circles& TRENCHES in red squares) and Khan River (blue solid line)

Water monitoring at Rössing entails checking variations in water levels and water quality across a network of monitoring boreholes which are located around the TSF, along the aquatic pathway towards and within the Khan River. Increases in water levels (outside natural recharge due precipitation) are used as early indicators of seepage movement, they are often followed by changes in chemical composition of groundwater particularly in mining environments.

Water quality monitoring is conducted based on an adaptive sampling schedule which is agreed upon with the regulator (Ministry of Agriculture, Water and Land Reform), in 2018.

In Figure 12 below, boreholes used for seepage plume delineation are depicted, also shown are sample locations where radionuclide analysis were conducted; here uranium ratios (234U/238U) are given. All data presented in figure 12 is summarised in table 1 further below.

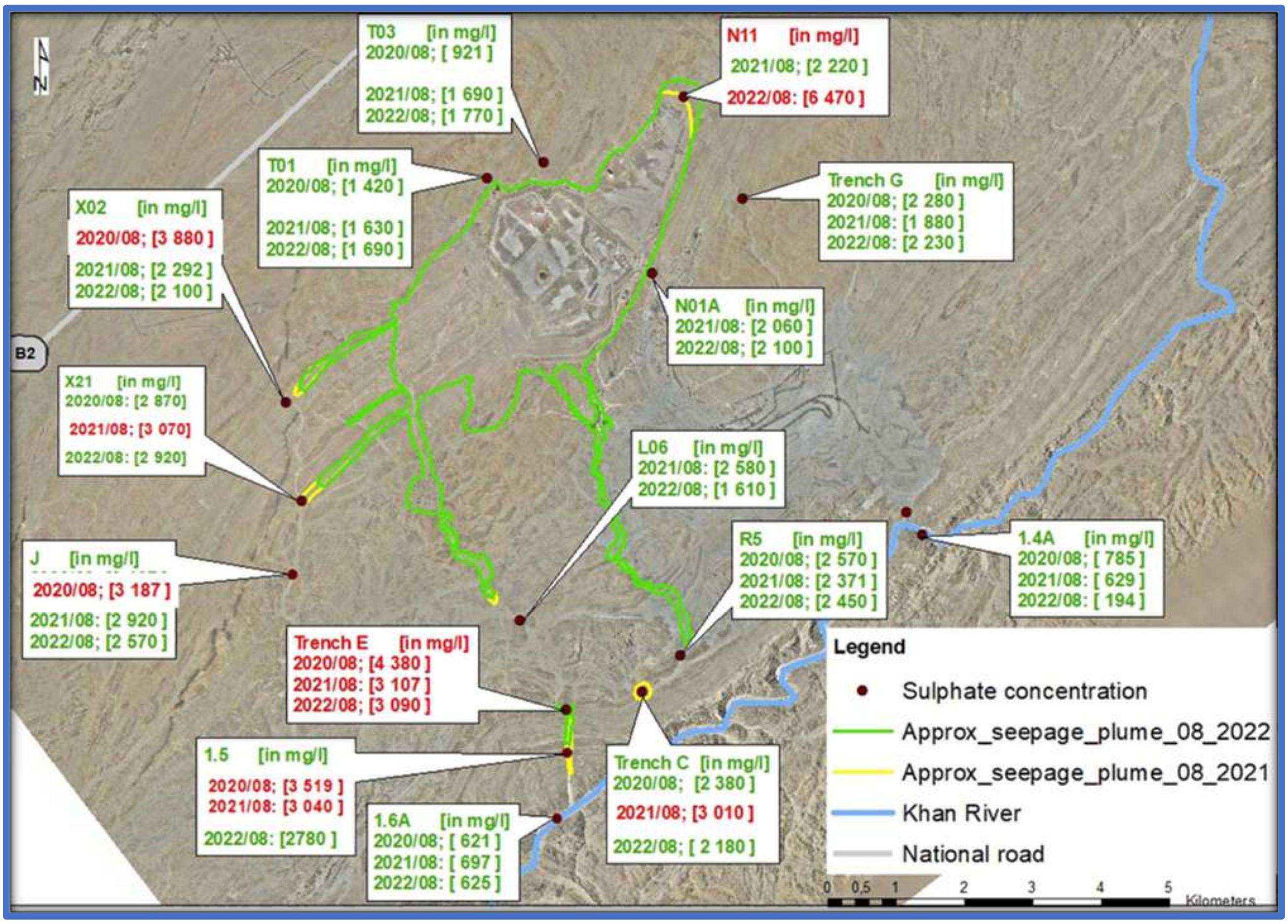

Figure 12: Sampling locations for sulphate and radionuclides, 2022 in relation to 2021

Rössing continuously investigates scientific methods to better track the seepage plume. It is widely accepted best practice, to validate any hypothesis obtained by statistical means with one or several supporting methods.

In 2022, sixteen (16) groundwater samples were taken for **radionuclide analysis** and sent to an accredited laboratory. Based on the analysed uranium isotopes, the boreholes are categorised into ratio:

< 1	uranium from mining related activities
≥ 1	uranium from natural sediment.

In figure 13 below, uranium ratio calculations at each location, is depicted, with consideration to the relative expanded measurement uncertainty, U [%].

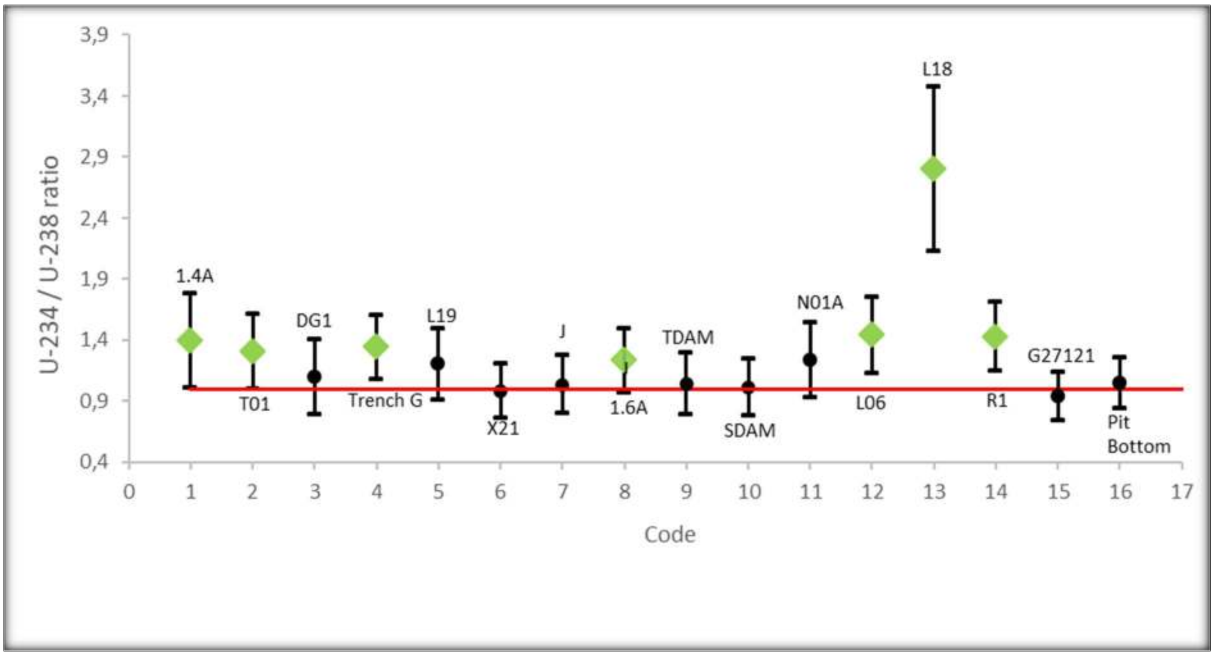

Figure 13: Uranium ratios with associated analytical errors, 2022

The interpretation is conclusive for the 7 samples (with green diamonds), as indicative of uranium from natural sediment (Figure 13). No ratio shows a definitive value smaller than one, which would indicate the source of uranium related to mining. The remaining 9 results are inconclusive, when considering the analytical error margins as that plots them as both naturally occurring & mining impacted.

The correlations between uranium isotope ratios and sulphate concentrations for the sampled boreholes are summarised in table 1 below.

In 2022, physiochemical analysis was done on water samples collected from 66 locations (boreholes and ponds). Figure 14 below, depicts **sulphate concentrations** for some locations; only those locations where radionuclide analysis was done and those locations which are classified as primary locations (under the RUL sampling procedure) are included in the chart. According to the sulphate concentration method, concentrations above 3 000 ppm are within the seepage plume.

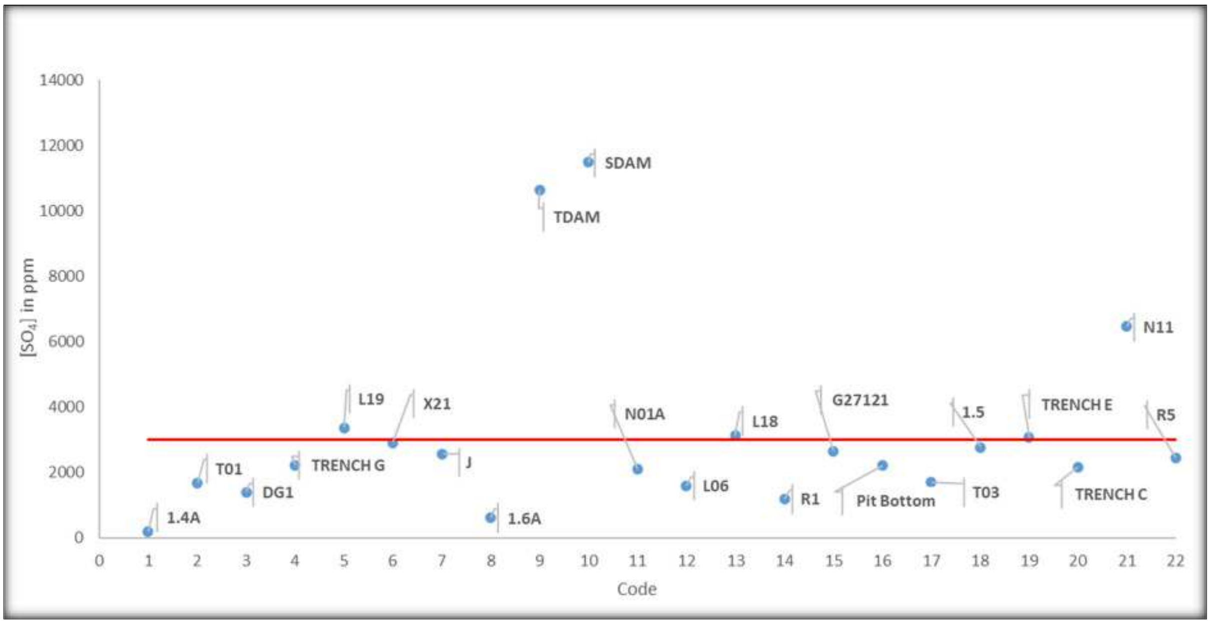

Figure 14: Sulphate sampling locations

The objective behind plotting figure 14, is to show how using the uranium ratio method (shown in figure 13 above) correlates against the sulphate concentration for specific boreholes. The RUL plume delineation is only based on the sulphate concentration method, observations from figure 13 and figure 14 are summarised in table 1 below.

Table 1: Comparison on Uranium ratio against sulphate concentrations

Location	U_{234}/U_{238}		$[SO_4]$ ppm	Remarks
	Ratio	Error ratio		
1.4A	1,4	0,4	194	Methods agree that location is not impacted by seepage.
T1	1,3	0,3	1690	Methods agree that location is not impacted by seepage.
DG1	1,1	0,3	1410	Borehole not impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
Trench G	1,3	0,3	2230	Methods agree that location is not impacted by seepage.
L19	1,2	0,3	3370	Borehole impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
X21	1,0	0,2	2920	Borehole not impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
J	1,0	0,2	2570	Borehole not impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
1.6A	1,2	0,3	625	Borehole not impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
TDAM	1,0	0,3	10649	Borehole impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
SDAM	1,0	0,2	11489	Borehole impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
N01A	1,2	0,2	2100	Methods agree that location is not impacted by seepage.
L06	1,4	0,3	1610	Methods agree that location is not impacted by seepage.
L18	2,8	0,7	3150	Borehole impacted by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
R1	0,3	0,3	1200	Methods agree that location is not impacted by seepage.
G27121	0,9	0,2	2650	Borehole impacted by seepage, however, methods do not concur definitifely for both analytical error on the uranium ratio & sulfate concentration.
T03	N/A	N/A	1711	Not impacted by seepage. Borehole not on the radionuclide analysis list.
1.5	N/A	N/A	2780	Not impacted by seepage. Borehole not on the radionuclide analysis list.
Trench E	N/A	N/A	3090	Impacted by seepage. Borehole not on the radionuclide analysis list.
Trench C	N/A	N/A	2180	Not impacted by seepage. Borehole not on the radionuclide analysis list.
N11	N/A	N/A	6470	Impacted by seepage. Borehole not on the radionuclide analysis list.
R5	N/A	N/A	2450	Not impacted by seepage. Borehole not on the radionuclide analysis list.
BH06A	N/A	N/A	625	Not impacted by seepage. Borehole not on the radionuclide analysis list.

Although the sulphate concentration method is accepted for plume delineation, differences observed in the two methods are summarised in table 1. Of the fifteen (15) boreholes were both uranium isotope and sulphate concentrations are available, data indicates that six (6) boreholes are conclusively not impacted by seepage. The highest inconsistent in the two methods is observed with the TDAM (Tailings Dam) and SDAM (Seepage Dam) samples which record the highest sulphate concentrations. These two samples are at the centre of seepage deposition; however, the uranium isotope ratio indicates natural occurrence and is inconclusive when analytical error margins are also considered.

Rössing Uranium approved the Permeable Reactive Barrier installation for completion in 2023. The project, a first of its kind, will trail the use of natural reactive material (Iron Oxide & Marble which is a Calcium carbonate) to treat mine seepage.

5.2 Dust monitoring

The public dose from dust inhalation can be calculated through measurements of the concentration of dust in the air. The size of particles inhaled correlates inversely to the potential health risks. Small particles, i.e., less than 10 micrometres in aerodynamic diameter, pose the greatest risk, because they can enter the lungs as inhalable dust.

Several dust monitoring stations have been placed at strategic locations around the mine site. Here 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} for short. The locations of PM_{10} stations include, among others, Arandis, the Rössing TSF and the western mine boundary.

The PM_{10} sampler at Arandis provides the PM_{10} dust concentration, wind speed and wind direction in intervals of 15 minutes. This justifies the allocation of a dust concentration as mining related (if the wind blows from the mine) or identifies it as background (when the wind is blowing in any other direction). This principle is illustrated in figure 15.

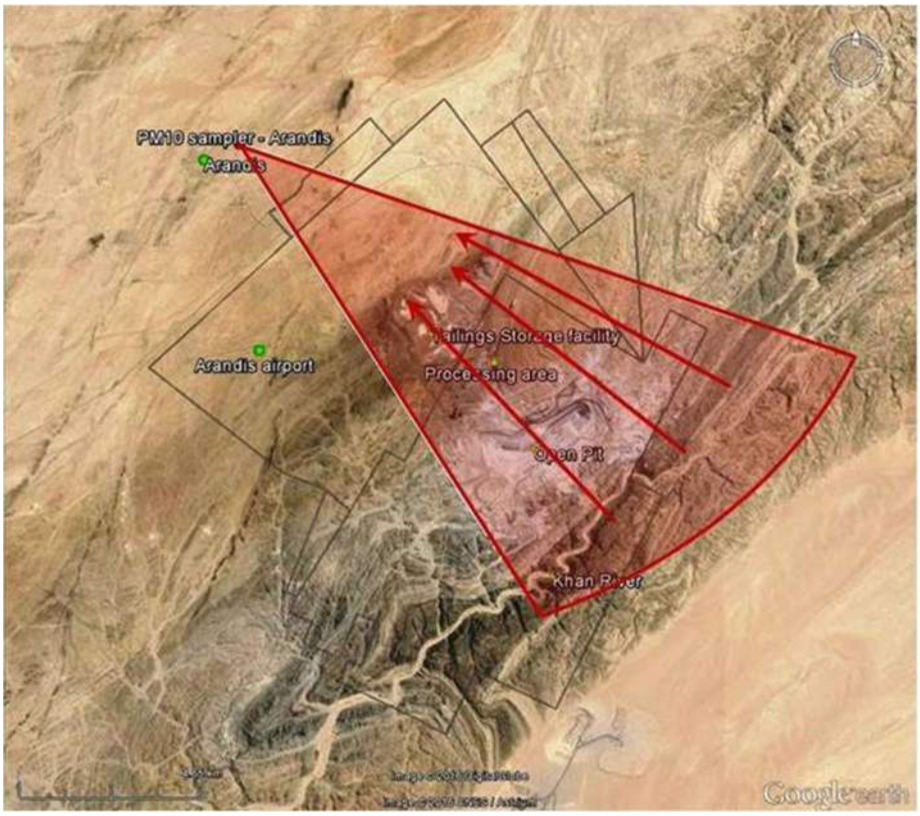

Figure 15: A satellite image showing those wind directions at the mine that could result in radioactive dust exposure at Arandis.

The overall average PM_{10} dust concentration measured at Arandis was on average 5 μg/m^3, which is below the WHO guideline value for outdoor air quality of 75 μg/m³ when averaged over one year (Figure 16). Challenges with the power supply to the monitor resulted in an interruption of the data recording during September and October.

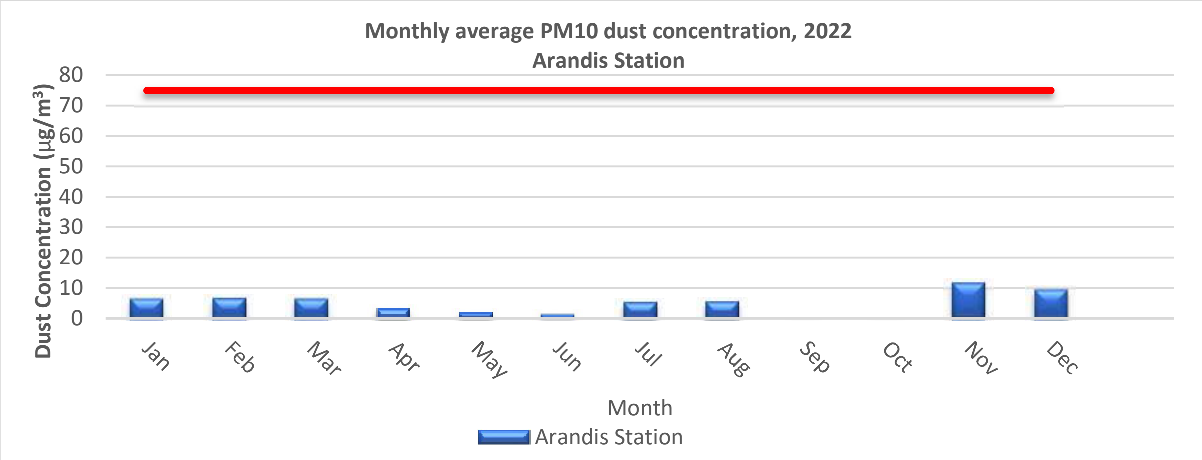

Figure 16: Arandis PM10 concentrations averaged per month, 2022

To establish an acceptable upper limit of the annual dose by mine dust, it is assumed that all PM_{10} dust in Arandis is ore dust coming from the mine. We further make the realistic assumption that the ore dust is in secular equilibrium, the particles have an aerodynamic diameter of 5 µm on average, and that the ore dust contains 400 ppm uranium. A PM_{10} concentration of 5 µg/m^3 of such ore dust corresponds to an annual dose of about 4.7 µSv per year.

Given these conditions, the overall public dose for adults at Arandis is found to be 4.7 µSv/a, very small compared to the annual dose limit of 1,000 µSv/a. It must be emphasised that this dose is the overall result, which includes all sources of background radiation in the inhaled dust.

It is therefore not considered necessary to establish how much of the dust concentration measured at Arandis is of mining origin, as the resulting inhalation dose to the public is negligible.

5.3 Radon monitoring

In 2022 Rössing carried out public monitoring for radon decay products concentration directly for outdoor with a radon cups around Arandis town. However, it is difficult to distinguish the radon contributions of mining operations from those of background contributions.

The radon progeny exposure for the members of the public in Arandis was found to be 0,71 mSv/a.

6. Safety and security of Sources

6.1 Source register

Rössing is no longer in possession of any sealed sources only sources used for calibration (Table 2)

Table 2: List of calibration sources at Rössing

Nuclide	Type of source	Half-life (years)	Initial activity (kBq)	Date of manufacture	Time elapsed (years)
Cs-137	Beta	30	3	2011/12/13	11
Th-230	Alpha	75 000	1	2011/12/16	11
Nat U	Alpha	4.5 billion	1.4	2017/01/09	5

6.2 X-ray generating equipment

The Rössing chemical laboratory uses two analytical x-ray units, as per registration and license EPL/349/21/01/PU, which will expire in June 2023.

6.3 Incident with source (Geology)

On 13 July 2022, a Neutron Probe with a radioactive source attached to it, got stuck in drillhole GT22DD018. The incident happened while a contractor was lowering the probe in the drillhole as part of the Geophysical logging process. The probe was left in the drillhole following the incident, because there were challenges and risk identified with removing the probe.

Due to the risks and challenges associated with the three options considered, a decision was made to leave the probe in the drillhole. The decision was also strongly supported by the information received on the remaining life of the radioactive source, which is 5 years and the fact that mining activities are not planned to take place around the probe within those 5 years.

7. Transport of radioactive material

7.1 Transport and export of UOC

With the authorisation TRM/113/02/22/ET, Rössing transported uranium oxide to overseas converters. A total of 3 210,8 tonnes of uranium oxide of chemical composition U_3O_8 (whose content was 2 722. 8 tonnes of uranium) were exported in 2022 (Table 3).

Table 3: List of UOC shipments from RUL in 2022

Shipping date	Country of Final destination	Quantity of Exported (kg)	Quantity of Contained Element (kg)
02 January 2022	Canada	91 305,0	77 426,7

17 January 2022	France	255 491,8	216 657,1
24 February 2022	Canada	146 173,9	123 955,4
06 March 2022	France	126 802,3	107 528,3
07 April 2022	USA	197 380,0	167 378,2
07 April 2022	USA	196 333,2	166 490,6
04 May 2022	France	138 294,1	117 273,4
04 May 2022	France	208 983,6	177 218,1
21 June 2022	France	214 182,3	181 626,6
21 June 2022	France	124 014,3	105 164,1
10 August 2022	France	156 512,0	132 722,1
10 August 2022	France	106 694,8	90 477,2
02 October 2022	Canada	308 646,8	261 732,5
02 October 2022	USA	35 051,7	29 723,8
10 November 2022	China	353 229,5	299 538,6
12 December 2022	China	345 029,0	292 584,6
12 December 2022	France	206 670,9	175 257,0
		3 210 795,2	2 722 754,4
Total in Tonnes		3 210,8	2 722,8

8. Emergency preparedness and response

An internal uranium spill drill was conducted by Rössing Uranium on 19 October 2022. The scenario simulated was a container that tipped over from a moving train, a drum fell out and caused an uranium spillage. Recommendations for improvement identified will be actioned and include acquiring new instruments.

Rössing Uranium participated in a uranium spill drill on 11 of November 2022, hosted by Swakop Uranium observed by the Namibian Uranium Association. The scenario simulated was a truck carrying uranium container to the harbour that overturned between Husab mine and B2 road, container fell and drums laying on the ground with product having spilled and needs to be recovered. Areas of improvement has been identified for implementation by Rössing Uranium.

The drill was observed by other operators in the industry, through the Namibian Uranium Association The report of this drill is attached to this document. However, Rössing also has a procedure, *JK60/PRD/009-Uranium Oxide Spillage* in place for emergency response to uranium spills. This procedure is reviewed on a regular basis.

9. Disposal of radioactive waste

9.1 Disposal of contaminated non-mineral waste

In 2022, a total of 2,362 tonnes of contaminated solid waste were deposited on the TSF. The cumulative total of stored non-mineral contaminated waste is 34,568 tonnes.

9.2 Mineral waste

Both tailings material and waste rocks deposited without processing are regarded as mineral waste. In 2022, a total of 8.97 million tonnes of tailings were deposited onto the TSF, which now holds a cumulative amount of roughly 492.77 million tonnes of tailings material. Another 7.36 million tonnes of waste rock were deposited onto the Waste Rock Dumps bringing the cumulative total of waste rock material deposited to roughly 1009.16 million tonnes of material. The exposed surface area of the two mineral waste storage facilities remained approximately the same since 2016 by covering an estimated area of 1,488 ha.

9.3 New radioactive waste disposal site

RUL is proposing to dispose radioactively contaminated mechanical waste into one of three designated areas (options) on site. The waste is currently disposed within the Tailings Storage Facility (TSF), however the TSF has limited space and cannot accommodate additional waste, including waste which will be generated from the progressive rehabilitation projects. This waste is currently being stored and contained on-site as there is no disposal facility for radioactive waste in Namibia.

For this reason, RUL appointed Knight Piésold Consulting (Pty) Ltd (KP) to prepare a desktop scoping study on three possible dumping sites to consider the environmental risks / impacts of the proposed activity on the receiving environment. The three areas are discussed below:

- **Option 1:** Dispose the waste into an area of the open pit called the Northwest Corner (NWC).
- **Option 2**: **Dispose the waste into the ex-pit North site (located within waste dump WD5 along strike) and immediately south-west of the pit.**
- **Option 3**: Dispose the waste into the ex-pit South site (located within waste dump WD2) just south of the northern site.

The hydrogeological assessment report by AQ2, who were appointed as subject matter experts by KP accompanied the official letter which was submitted to the Authority's office in September 2021. The report which is based on groundwater modelling recommends Option 2 as the preferred option due to the following factors:

- Option 2 is located within the capture zone of the pit and there is no potential for any leachate to migrate away from the pit and make its way to any downstream environments (Figure 17).
- Particle trace modelling confirms that any such leachate would flow towards the pit.
- The surface water impacts from the disposal site are rated as LOW before and after mitigation measures.

The waste will be covered with waste rock generated during mining operations.

RUL has not received any official feedback from Ministry of Environment, Forestry and Trourism (MEFT) on this application.

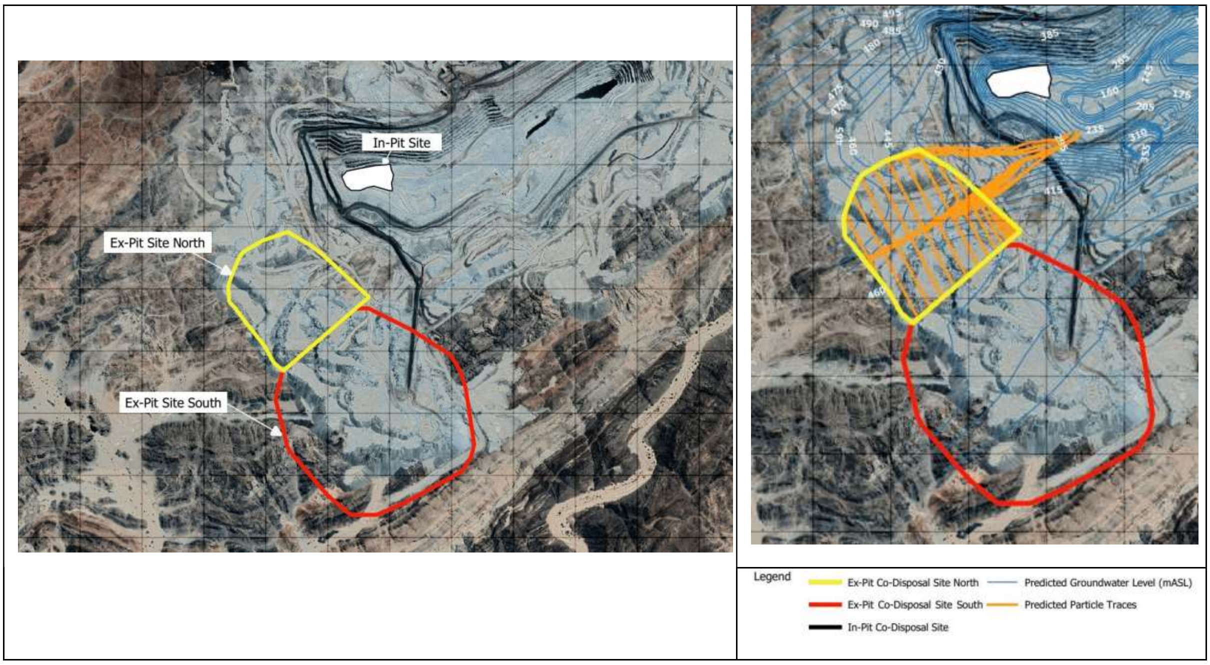

Figure 17: Disposal site locations

10. Research

10.1 The health study

In 2015 the University of Manchester (UoM) was appointed by Rio Tinto, (the majority shareholder in Rössing until 16 July 2019), to conduct an independent study to investigate the potential link between radiation and other occupational exposures and developing cancer in the workforce at the Rössing mine.

The study has been successfully completed and the outcome has been communicated to stakeholders in January 2021.

The University of Manchester obtained approval from the Ministry of Health and Social Services to have the article peer reviewed for publication in a reputable scientific journal. The peer review is still in process.

11. Conclusion

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

We will continue making relevant Radiation Safety information available to the public. This will help the stakeholders like communities to put risk into perspective and to address concerns to the relevant persons at Rössing.

Awareness of the risks related to radiation remains a focus, and awareness sessions facilitated by trained experts for all workers remain an important and deliverable programme.

In addition to the regular monitoring activities described above, we decided to especially focus on:

- ALARA campaign to continue during 2023.
- Acquisition of a whole-body radiation contamination monitor for FPR.
- Improve on respirator care and maintenance in FPR.
- Improve change house facilities in FPR.
- Strict enforcement of the Clean Shaven Policy.
- Internal and external training for all Radiation Safety team members and taking part in online workshops/conferences.
- Strengthen our induction training approaches for the workforce.
- Continue with the implementation of the graded monitoring approach.
- Support the Maintenance and Projects teams in the replacement of the roaster at Final Product Recovery (FPR) area.
- Intensify radon monitoring on site and public monitoring in general;
- Continue radioactive dust survey at the mine.