CNNC Rössing Uranium
Working for Namibia

Implementation of Radiation Management Plan

Annual Report for Rössing Uranium Limited

2023

Table of Contents

Abbreviations

Bq	— becquerels, decays per second, unit for measuring radioactivity
FPR	— Final Product Recovery
g	— grams
HSE & PS	— Health, Safety, Environment and Protection Services
IAEA	— International Atomic Energy Agency
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
$\mu g/m^3$	— 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 eleventh narrative report since the implementation of this regulation. Reports for the years 2013 to 2020 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 2023, 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 calibration sources on the mine with current source activities;
- a list of uranium oxide exports in 2023; 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, Senior Advisor Occupational Hygiene and Radiation Safety, in the role of Radiation Safety Officer (RSO).

The Radiation Safety Officer (RSO) role continues to report 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 in 2023 is depicted in Figure 1.

The Radiation Safety section is manned by the RSO and three Radiation Advisors who are carrying out the implementation of the RMP. In October 2023 one Radiation Advisor, Rauna Haindobo, resigned and the position was advertised. At the time of writing this report, the position has been filled in February 2024.

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

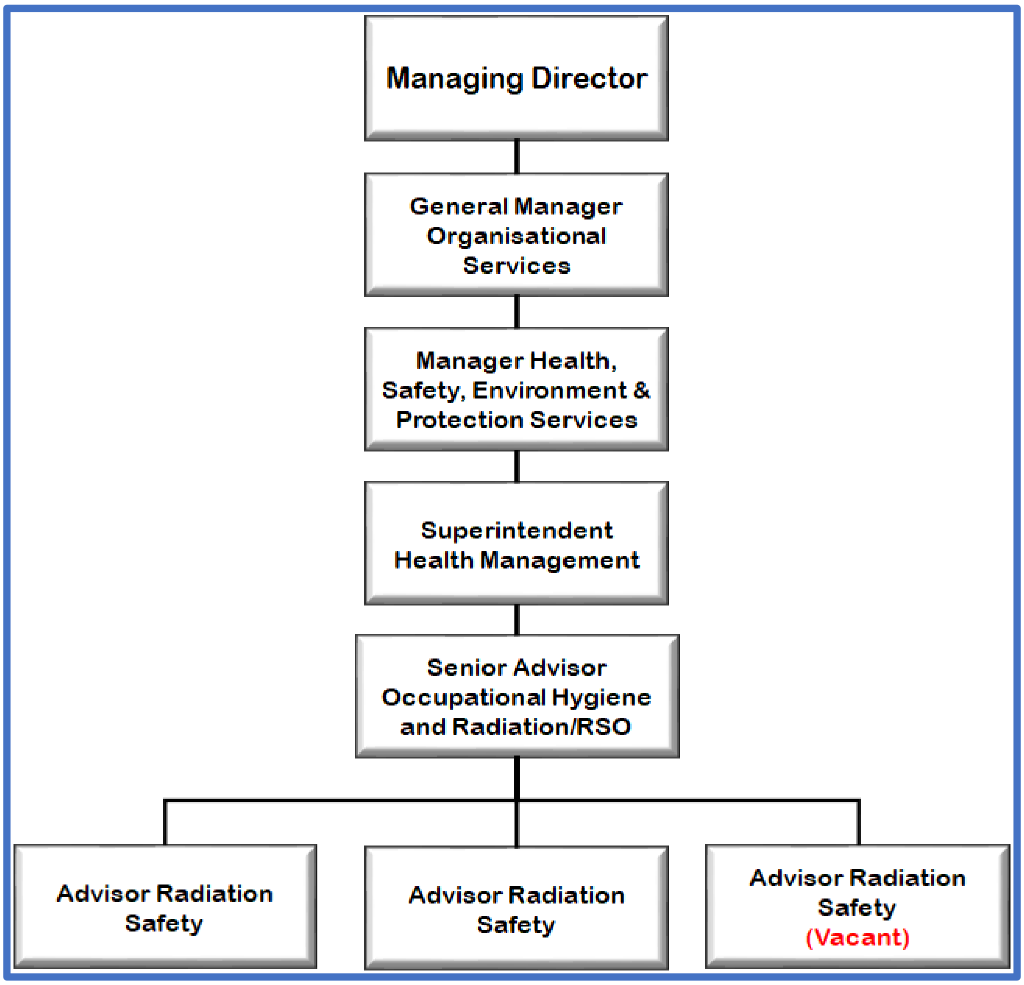

Figure 1: Organisational structure for the Radiation Safety Section, December 2023

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. Abigail Shidute has successfully completed the RSO II and RSO III courses in 2023. Renate Lemke attended the International Atomic Energy Agency (IAEA) Nuclear Safeguards training that took place in Swakopmund. Martin Amukwaya also attended an online conference presented by the IAEA which included aspects such as presenting reports on production of dose coefficients.

3. Occupational exposure protection

3.1 Radiation-dose monitoring results

Throughout 2023, 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 903 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 1.40 mSv per year (Figure 3), a reduction from the 1.54 mSv per year monitored in 2022. The most significant decrease was in the Laboratory Workers SEG and can in part be explained by improvements made in this area with regards to practices including housekeeping and sample storage. The most significant decrease was recorded for the Laboratory Workers, Pit Equipment Operators and Final Product Recovery Workers.

The three SEG’s that increased from the previous year were Final Product Recovery, Recovery Workers, Tailings Dam, and Rubberlining. The average annual dose of 1.40 mSv is significantly lower than the occupational legal limit of 20 mSv/a.

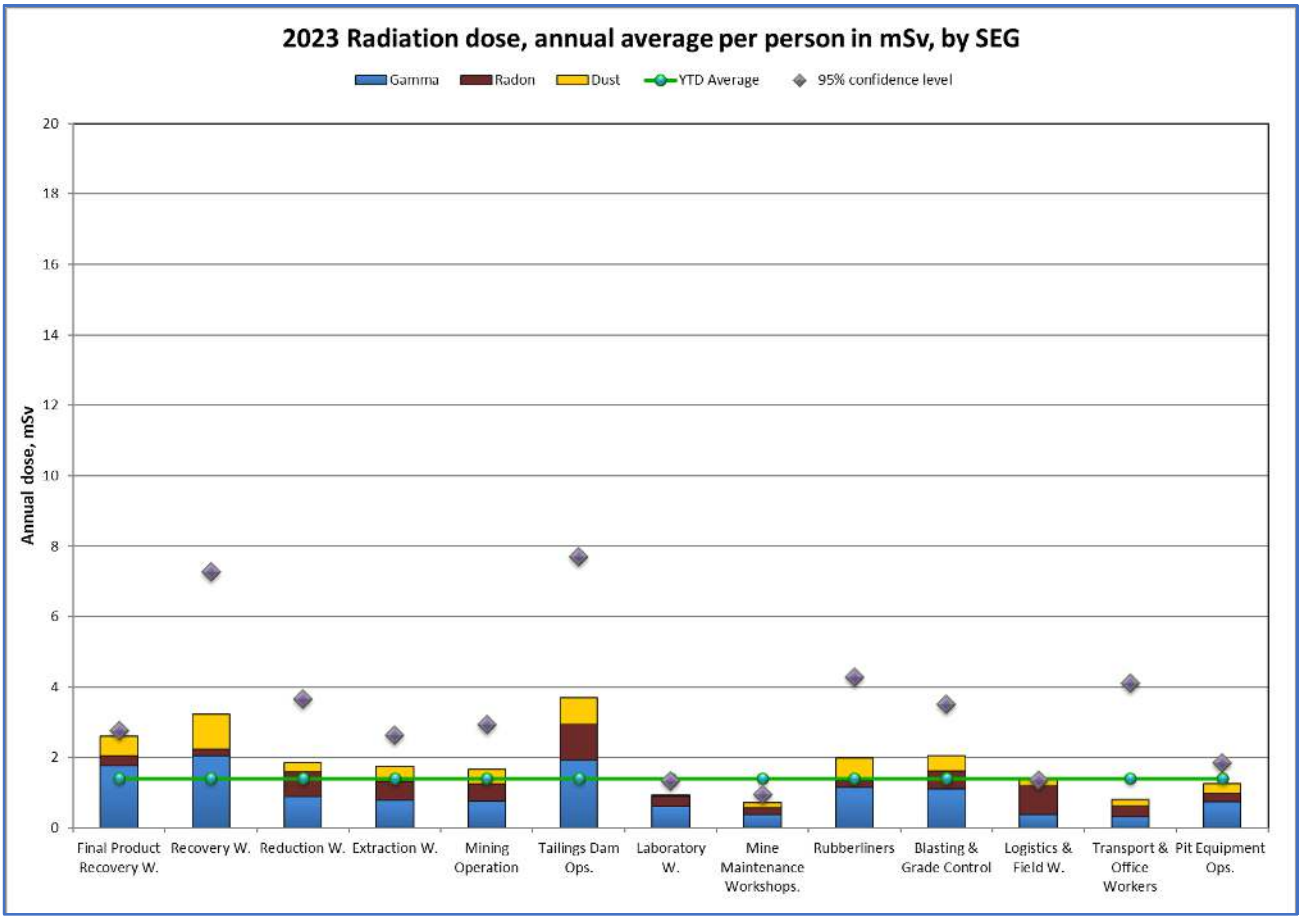

Figure 3: Annual average radiation dose recorded by pathway and SEG in 2023.

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.

Figure 4: Designated radiation worker wearing TLD.

In 2023, the annual total doses recorded were 2.60 mSv/for FPR workers and 3.22 mSv/a for Recovery workers. Both doses for FPR and Recovery workers increased from 2.4 mSv/and 2.5 mSv/a, respectively in 2022. The highest percentage of the total dose for FPR workers was the external (gamma) dose with about 69% of the total dose, while LLRD and radon contributed 30% and 11%, respectively. The exposure distributions for RW were 64% by gamma, 30% by LLRD, and 6% by radon decay products. The total effective doses for FPR and RW from 2013 to 2023 have been remained consistently below 5 mSv/a (Figure 5).

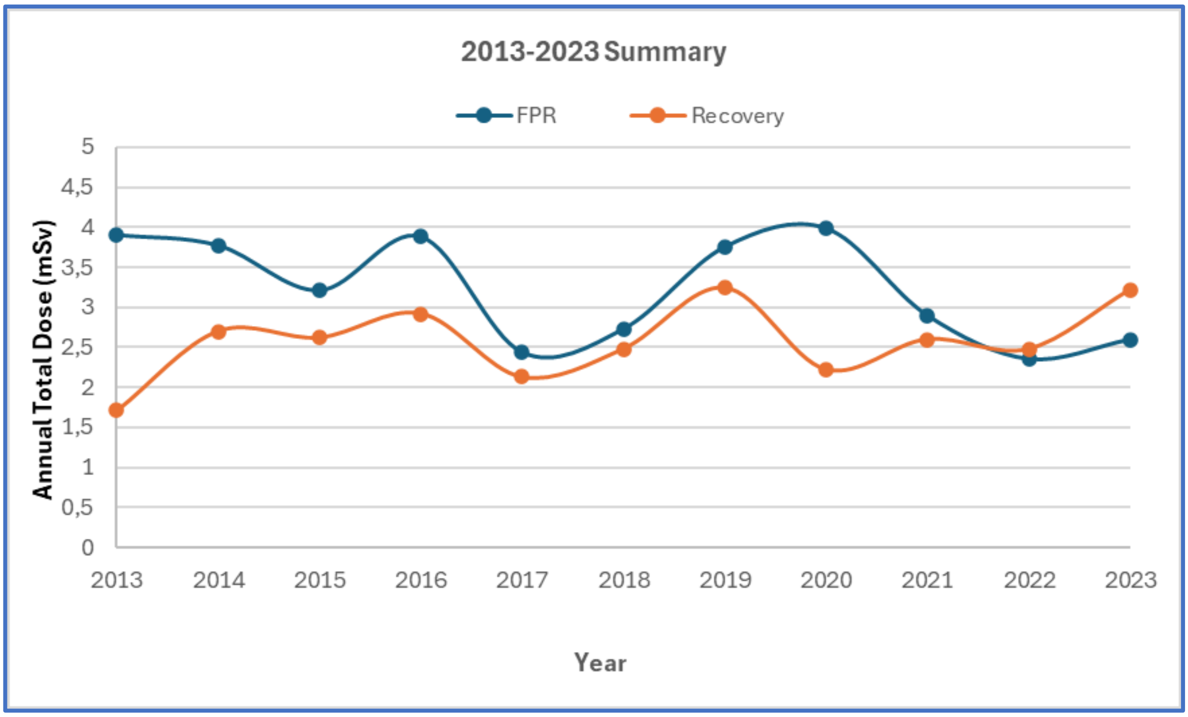

Figure 5: Compares the average annual doses for FPR and Recovery workers from 2011 to 2023.

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.

During 2023, the average non-fixed surface contamination in the FPR area was maintained below the internal target of 1 Bq/cm^2 and measured 0,65 Bq/cm^2 (Figure 7). This is an increase from the level of 0,59 Bq/cm^2 measured in 2022. Towards the end of May 2023, the FPR yellow cake thickener stopped due to a mechanical malfunction. The thickener contents was transferred to a standby tank in order for the recovery process to continue while the thickener was drained for maintenance. This process and subsequent maintenance activities resulted in several spills resulting in elevated results during June to August.

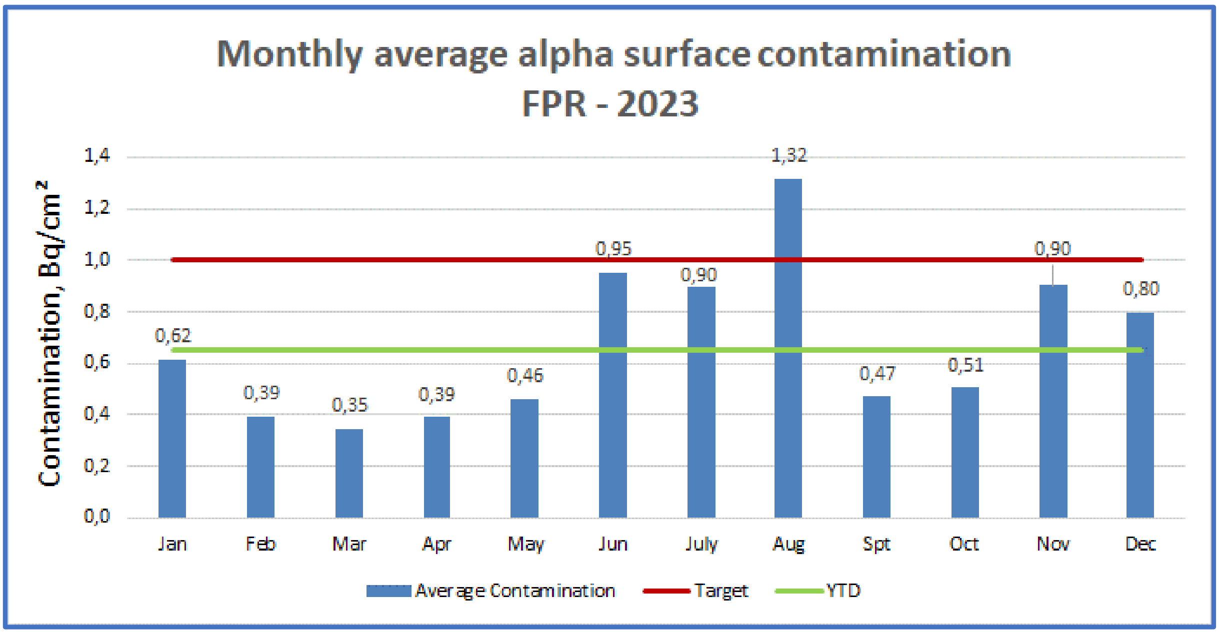

Figure 7: Summary of the average non-fixed surface contamination measurements for 2023 in FPR

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.

A total of two thousand and ninety-four (2094) urine samples were analysed, during 2023, to determine their uranium concentration.

Samples were analysed by the Trace Element Analysis Laboratory (TEA Lab) in Swakopmund.

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 2023 were below 5 µg/L (Figure 8). No exceedances of the action level was reported and two individuals recorded uranium in urine in excess of the warning level of 20 µg/L.

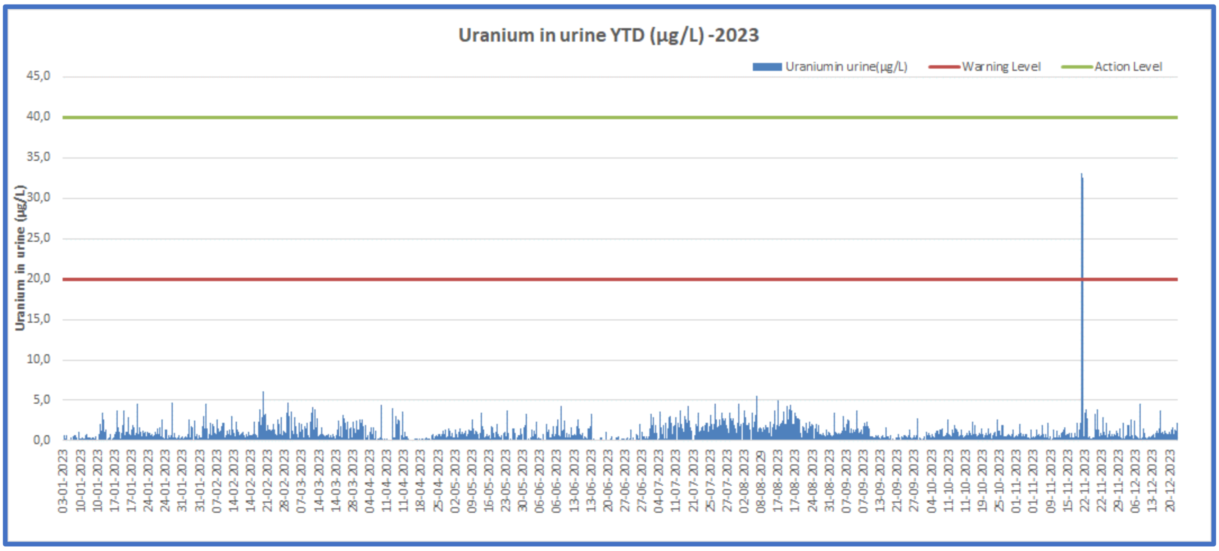

Figure 8: Uranium in urine results, 2023

Monthly pregnancy tests ensure that pregnant radiation workers are moved immediately to a less exposed area. We conducted twenty-six (26) pregnancy tests of female radiation workers, all of which were negative.

3.3 FPR stack monitoring

Stack emissions monitoring or sampling is an annual exercise and commitment as per Rössing commitment in the internal air quality criteria 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.

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. Emissions sampling was conducted on the five stacks/ducts by a contracted company, Yellow Tree, during the period 18th -25th July 2023. The most relevant stacks in this report are the Roaster scrubbers 1 and 3.

The scrubbers performed well however on Roaster 1’s scrubber, the average PM (110 mg/Nm3) and metals emissions (i.e. the sum of Pb, As, Sb, Cr, Co, Cu, Mn, Ni and V) (0.63 mg/Nm3) from the outlet exceeded the emissions guidelines. These emissions are checked and regularly tracked at business level and is part of annual improvement plan/strategies. In 2023, the roaster replacement for roaster 3 was successfully completed and the results shows all pollutant concentrations from the scrubber outlet were below the emissions guidelines from the Listed Activities legislation. In addition, uranium emissions of 0.02 kg/day were below the internal RUL guideline of 1.5 kg/day. The wet scrubber removed an average of 73.2 % of PM, 42.0 % of metals, and 98.6 % of uranium (absolute emissions).

The roaster replacement and completion of project for the second roaster is planned for 2024.

3.4 Radiation Awareness Training

Radiation awareness training is one of the key training requirements at Rössing and this continued in 2023. These included the Radiation Safety Induction and Refresher Courses as well as Final Product Recovery and the Recovery areas training modules. A total of seven hundred and fifteen (715) Rössing employees and contractors received Radiation training, six hundred and three 603 did class room training for several courses and one hundred and twelve (112) completed the Radiation refresher course online. The ALARA campaign has proven to be an effective way of communicating radiation risks and highlighting radiation controls. This campaign continued in 2023, shared with the workforce through with internal communications (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 and at the various safety meeting platforms. 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 workers via the Radiation Safety Section. Each employee only has access to their own data.

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 2023, we have seen an improvement in the average airborne dust in FPR. The average dose rate for 2023 was 4.1 µSv/h. Additional real-time dust monitoring instrument are being considered to be installed in the new Roaster areas. Employees continue to use half-face respirators in this area and full-face respirators in the roaster areas. The compulsory quantitative respirator fit testing requirement, using the Portacount is strictly enforced for employees entering the FPR area,

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 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

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[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

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.

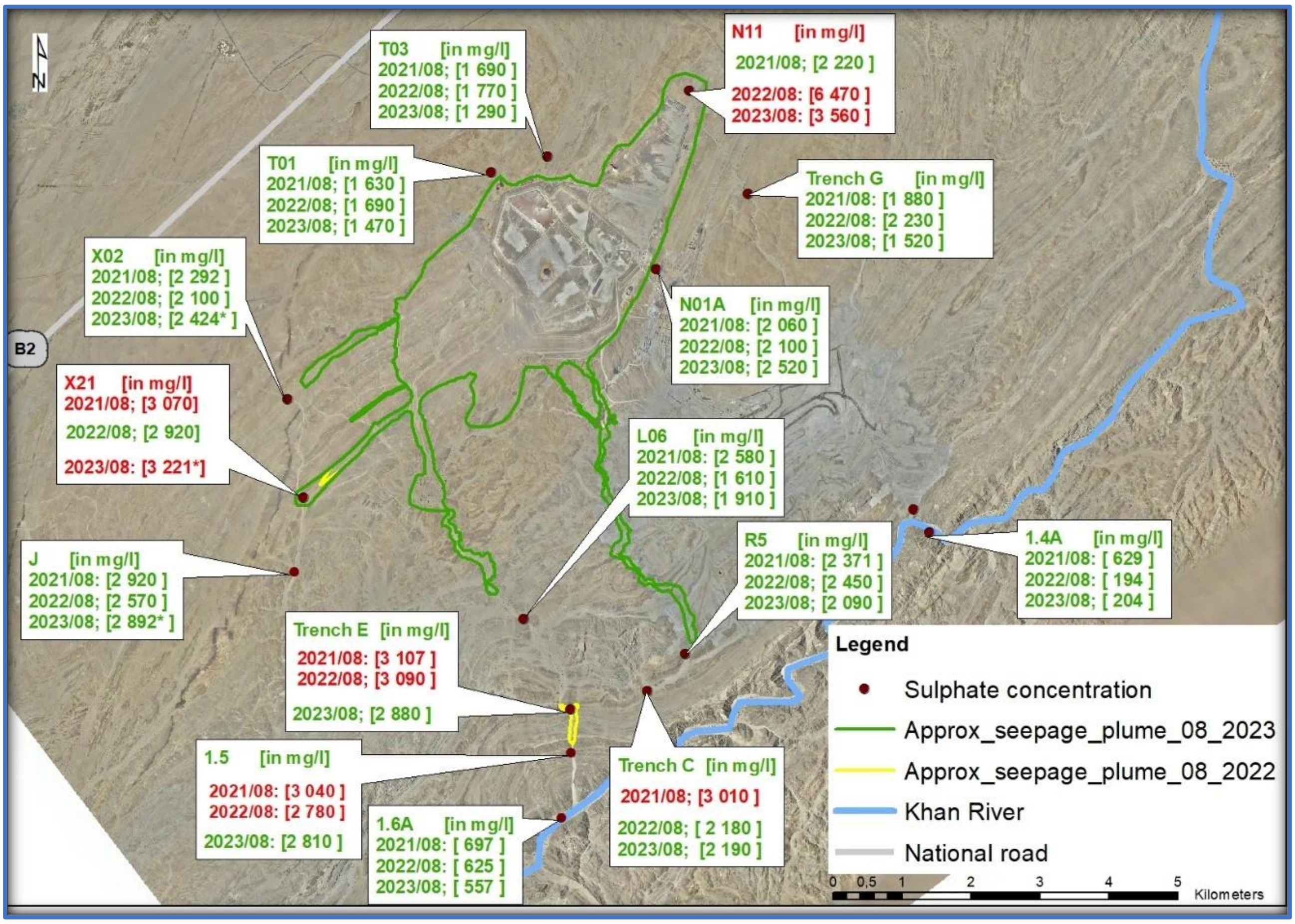

Figure 12: Sampling locations for sulphate and radionuclides, 2023 in relation to 2022.

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 2023, Twenty (20) 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 [%].

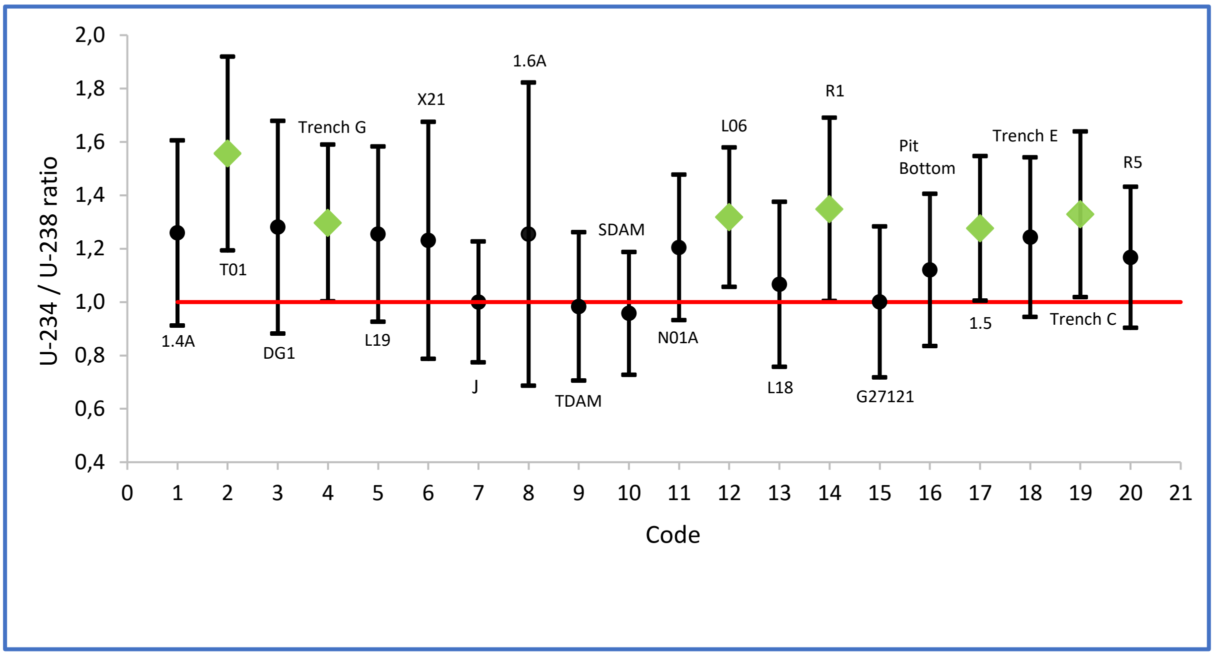

Figure 13: Uranium ratios with associated analytical errors, 2023

The interpretation is conclusive for the 6 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 14 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 2023, 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.

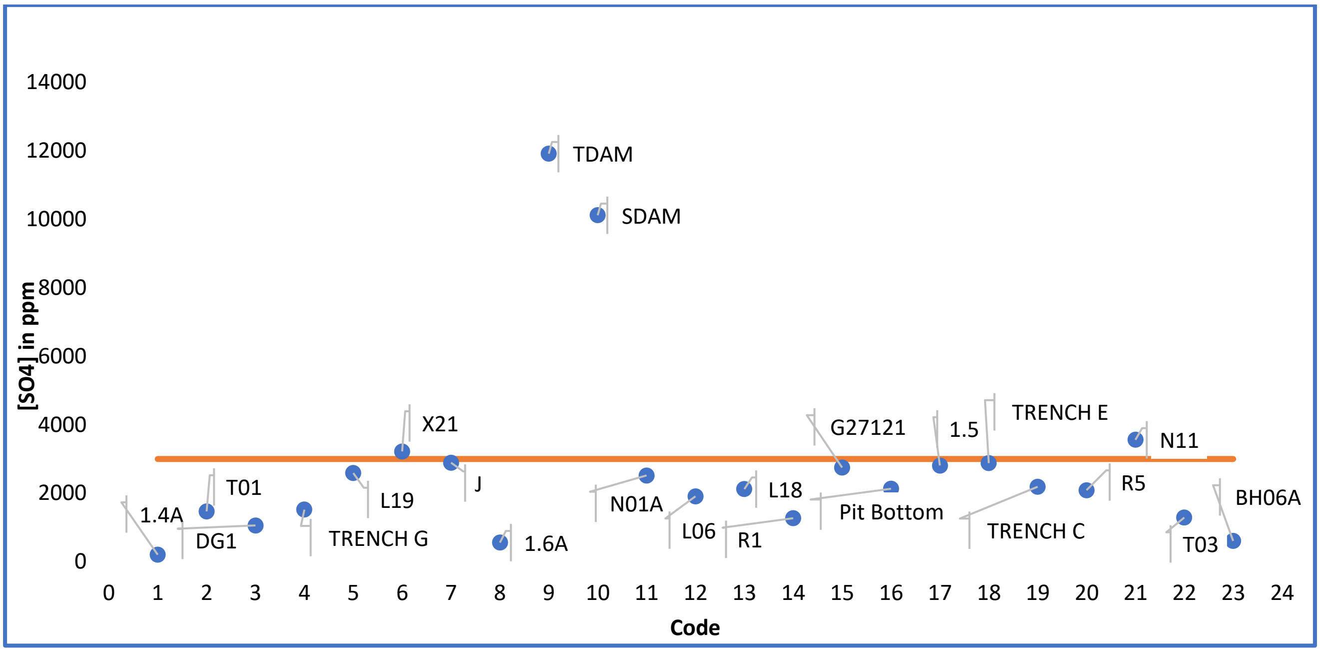

Figure 14: Sulphate sampling locations

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	1,26	0,3	204	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
T1	1,56	0,4	1470	Methods agree that location is **not impacted** by seepage.
DG1	1,28	0,4	1060	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
Trench G	1,30	0,3	1520	Methods agree that location is **not impacted** by seepage.
L19	1,25	0,3	2590	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
X21	1,23	0,4	3221	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
J	1,00	0,2	2892	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
1.6A	1,25	0,6	557	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
TDAM	0,98	0,3	11920	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
SDAM	0,96	0,2	10120	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
N01A	1,20	0,3	2520	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
L06	1,32	0,3	1910	Methods agree that location is **not impacted** by seepage.
L18	1,07	0,3	2120	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
R1	1,35	0,3	1270	Methods agree that location is **not impacted** by seepage.
G27121	1,00	0,3	2750	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
Pit Bottom	1,12	0,3	2130	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
1.5	1,28	0,3	2810	Methods agree that location is **not impacted** by seepage.
Trench E	1,24	0,30	2880	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
Trench C	1,33	0,3	2190	Methods agree that location is **not impacted** by seepage.
R5	1,17	0,3	2090	Borehole **not impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
N11	N/A	N/A	3560	Borehole **impacted** by seepage, however, methods do not concur when analytical error on the uranium ratio is considered.
T03	N/A	N/A	1290	Borehole **not impacted** by seepage.
BH06A	N/A	N/A	607	Borehole **not impacted** by seepage.

Although the sulphate concentration method is accepted for plume delineation, differences observed in the two methods are summarised in table 1. Of the twenty (20) 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 completed the Permeable Reactive Barrier installation 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.

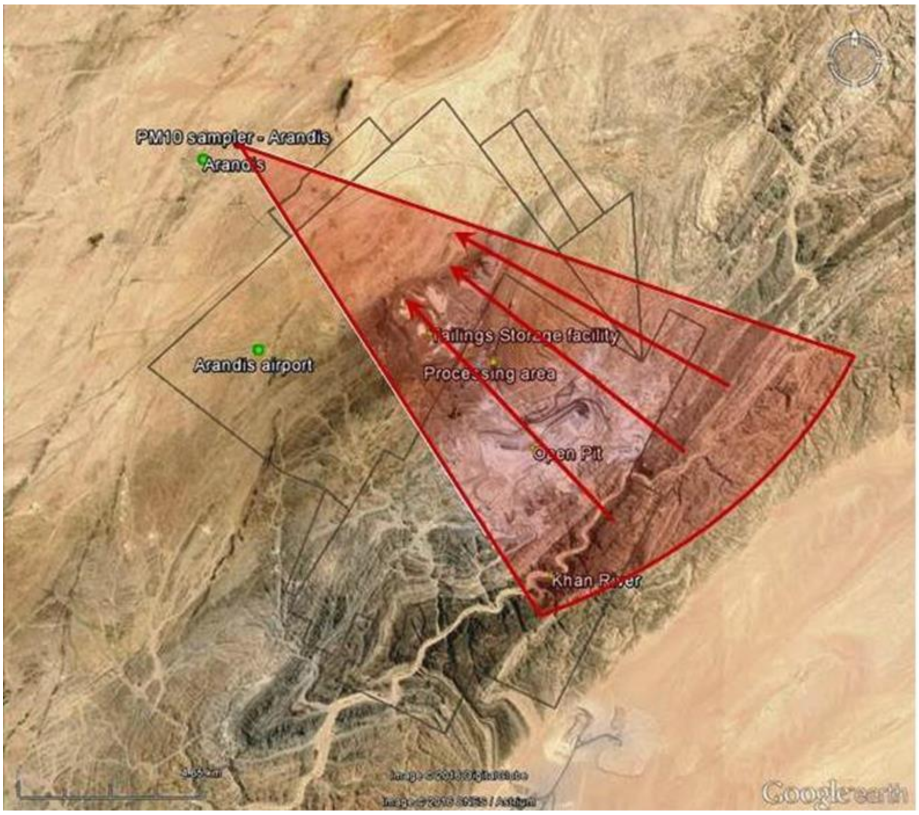

Figure 15: A satellite image showing those wind directions at the mine that could result in radioactive dust exposure at Arandis.

The overall average PM_{10} dust concentration measured at Arandis was on average 10 µg/m^3, which is below the WHO guideline value for outdoor air quality of 75 µg/m^3 when averaged over one year (Figure 16).

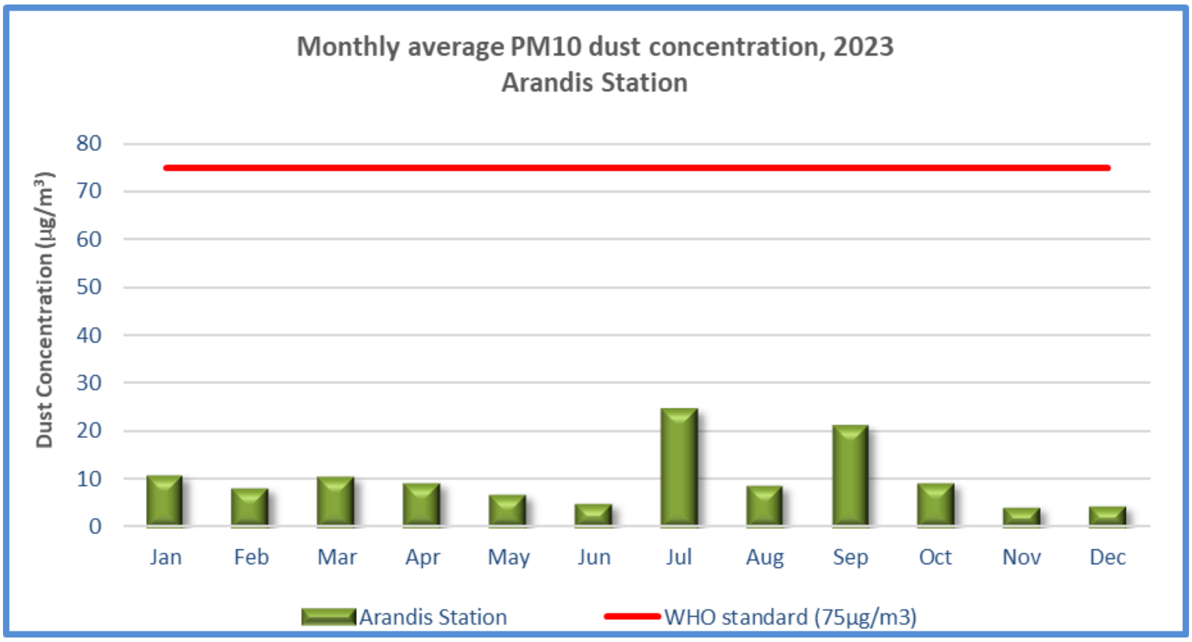

Figure 16: Arandis PM10 concentrations averaged per month, 2023

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 10 µg/m^3 of such ore dust corresponds to an annual dose of about 9.38 µSv per year.

Given these conditions, the overall public dose for adults at Arandis is found to be 9.38 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 2023 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 0,64 mSv/a.

6. Safety and security of Sources

6.1 Source register

Rössing is not 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)
Th-230	Alpha	75 000	1 kBq	13/12/2011	12
U-238 (Nat)	Alpha	4.5 billion	1.4 kBq	01/07/2017	6
Cs-137	Beta	30	3.3 kBq	16/12/2011	12
Cs-137	Beta	30	333 kBq	09/09/2022	1

6.2 X-ray generating equipment

The Rössing chemical laboratory uses two analytical x-ray units, as per registration and license EPL/349/23/01/PU, which will expire in July 2025.

6.3 Incidents

6.3.1 Neutron probe incident (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 fact that mining activities are not planned to take place around the probe within those 5 years.

An investigation led by the police and NRPA took place onsite on 01 August 2023, which included a visit to the incident site and interviews with Rössing employees involved. An investigation report and directives dated 09 September 2023, was issued by the NRPA. RUL responded by clarifying the inconsistencies contained in the report and requested for the report to be updated to reflect accurate information, no feedback was provided to date.

6.3.2 Unregistered handheld XRF

An attempt was made to use an unregistered handheld XRF Analyser (Niton XL3t) at Rössing Uranium Ltd mine site by a contracting company on the 18th of October 2023.

The control systems implemented at the main access gate to the mine picked up that the instrument that they intended to bring in is X-ray emitting above 30kV which requires it to be permitted. The NRPA was notified and provided further direction and guidance. For noting, the instrument was not used onsite and was safely detained on the RUL mine site, until the NAMPOL under direction by National Radiation Protective Authority (NRPA) collected the XRF from RUL on 21 October 2023.

6.3.3 Uranium Oxide in Arandis

A member of the public brought this matter to the attention of RUL Protection Services and provided a sample. RUL took the initiative to validate the authenticity of the sample through testing, confirming its composition as Uranium Oxide. However, the origin of the product remains uncertain since there are multiple producers of this substance in the region. It's essential to note that RUL maintains rigorous security measures to safeguard its product, and no reports of missing product have been recorded and/or confirmed at the RUL premises.
Given the lack of clarity regarding the source of the product and the potential hazards and risks associated with its exposure to the public, the appropriate authority (NRPA) was notified to initiate action investigating, tracing, and securing the product.

7. Transport of radioactive material

7.1 Transport and export of UOC

With the authorisation TRM/113/02/22/ET and TRM/113/02/23/ET, Rössing transported uranium oxide to overseas converters. A total of 3 014,8 tonnes of uranium oxide of chemical composition U_3O_8 (whose content was 2 556. 5 tonnes of uranium) were exported in 2023 (Table 3).

Table 3: List of UOC shipments from RUL in 2023

Shipping date	Country of Final destination	Quantity of Exported (kg)	Quantity of Contained Element (kg)
24-Jan-23	Canada	165 283,9	140 160,8
01-Feb-23	France	106 586,2	90 385,1
01-Feb-23	France	206 923,8	175 471,4
18-Mar-23	France	179 331,7	152 073,3
18-Mar-23	France	174 901,1	148 316,1
27-May-23	Canada	172 540,4	146 314,3

27-May-23	Canada	171 292,0	145 255,6
05-Aug-23	China	340 763,8	288 967,7
27-Oct-23	China	337 982,7	286 609,3
06-Oct-23	Canada	163 574,5	138 711,1
04-Nov-23	China	345 900,1	293 323,3
18-Nov-23	China	303 531,9	257 395,1
16-Dec-23	China	346 187,1	293 566,6
		3 014 799,3	2 556 549,8
Total in Tonnes		3 014,8	2 556,5

8. Emergency preparedness and response

An internal uranium spill drill was conducted by Rössing Uranium on 31 October 2023. The scenario simulated was a train transporting uranium oxide (U_3O_8) containers that derailed near Arandis bridge and one of the eight (8) containers capsized resulting in one drum being damaged and the contents of uranium oxide spilled from the damaged drum. Recommendations for improvement identified was actioned and included the acquisition of new equipment and training of new Protection Services personnel.

Rössing Uranium participated in a uranium spill drill on 29 November 2023, hosted by NAMPORT and Rössing Uranium, observed by the Namibian Uranium Association. The scenario simulated was that the Reach Stacker was hoisting a container filled with several drums full of Uranium Concentrate. The container dislodged, resulting in the container to fall 6m to the ground. The container door broke open on impact and one drum containing Uranium Concentrate spilled, resulting in the release of Uranium Concentrate in the area.
Recommendations have been implemented and a new uranium spillage trailer is expected to be delivered by end of April 2024.

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 2023, a total of 2,792 tonnes of contaminated solid waste were deposited on the TSF. The cumulative total of stored non-mineral contaminated waste is 37,360 tonnes.

9.2 Mineral waste

During 2023 a total of 16.09 (16 085 360) million tonnes of mineral waste were generated by the mine. This includes 9.30 (9 301 893) million tonnes of tailings and 6.78 (6 783 467) million tonnes of waste rock. By end of December 2023, the total cumulative mineral waste stored onsite is 1018.46 million tonnes of waste rock and 499.55 million tonnes of tailings.

9.3 New radioactive waste disposal site

RUL proposed 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. Based on the environmental risks/impacts study conducted by Knight Piésold Consulting (Pty) Ltd (KP) for the three possible dumping sites an area within the Waste 5 area has been identified (Figures 17.1 and 17.2). The waste will be covered with waste rock generated during mining operations.

The Ministry of Environment, Forestry and Tourism (MEFT) has issued RUL the Environmental Clearance Certificate (ECC 2300732) subject to the endorsement by the National Radiation Protection Authority (NRPA).

RUL prepared and submitted a Radioactive Waste Management Plan to the NRPA, however no feedback was provided by end of 2023.

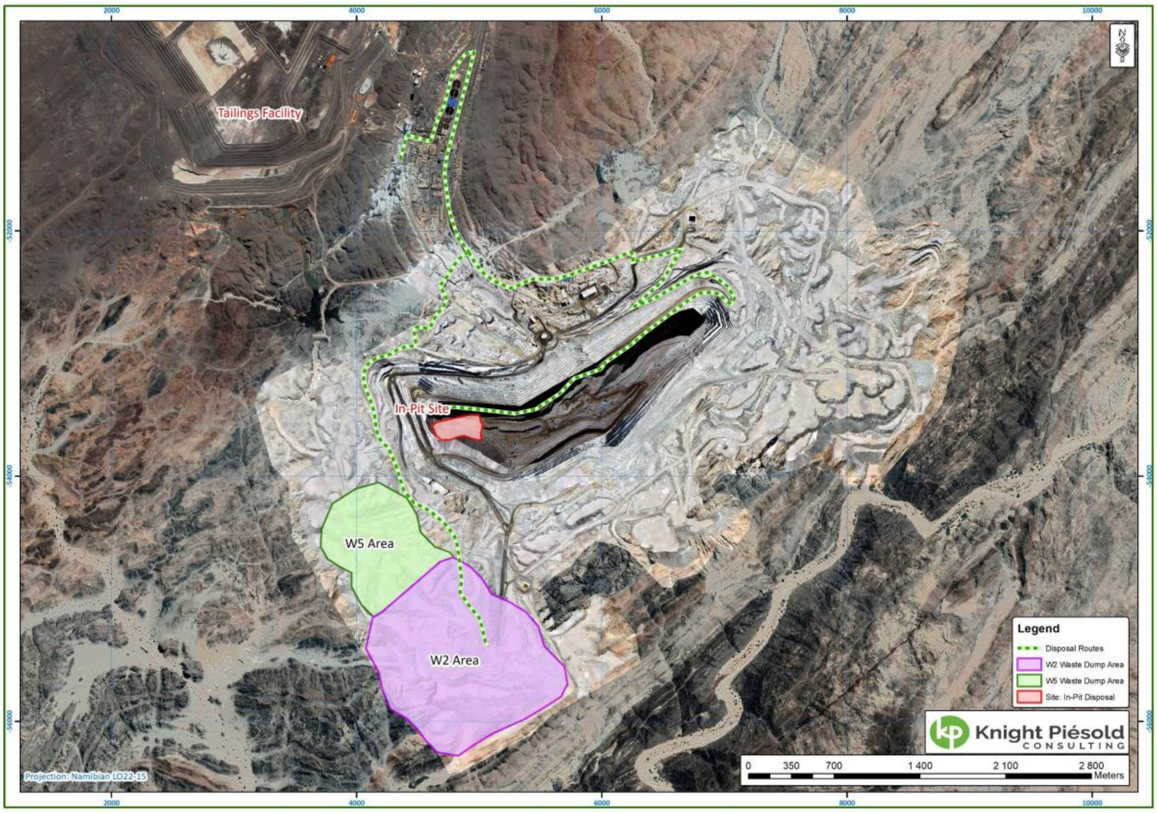

Figure 17.1: Proposed area (Waste 5) for mechanical waste disposal.

Figure 17.2: Exact location in Waste 5 area proposed for mechanical waste disposal.

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 article has been published in October 2023 in the Radiation Research Journal.

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 2024.
- Investigate feasibility of acquiring a suitable 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.
- Continue radon monitoring on site and public monitoring in general.
- Continue radioactive dust survey at the mine.