APP-004066

STORAGE AND HANDLING OF RADIOACTIVE SOURCE MATERIAL ON ERF 3954, SWAKOPMUND, ERONGO REGION

ENVIRONMENTAL ASSESSMENT SCOPING REPORT

Assessed by:

Geo Pollution Technologies Namibia

Assessed for:

Namaquanum Investment Two CC

July 2024

Project:	**STORAGE AND HANDLING OF RADIOACTIVE SOURCE MATERIAL ON ERF 3954, SWAKOPMUND, ERONGO REGION: ENVIRONMENTAL ASSESSMENT SCOPING REPORT**	
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NON-TECHNICAL SUMMARY

Introduction

Namaquanum Investment Two CC (the Proponent) has an existing workshop on erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund, Erongo Region. The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source materials used to calibrate and test logging while drilling (LWD) equipment used mainly in the oil and gas exploration industry. LWD tools are specialised tools attached to the drilling rod that measure and record various properties of rocks and fluids encountered while drilling a well. Clients from the oil and gas exploration industry will utilise the workshop and source materials on erf 3954, to periodically perform the necessary calibrations and tests on their LWD tools.

The Proponent requested Geo Pollution Technologies (Pty) Ltd (GPT) to apply for an environmental clearance certificate (ECC) for the proposed facility and operations planned for erf 3954. The ECC is required as per the Environmental Management Act No. 7 of 2007 (EMA). As part of the ECC application, an environmental assessment report and environmental and radiation management plan (ERMP) will be submitted to both the National Radiation Protection Authority and the Ministry of Environment, Forestry and Tourism's Directorate of Environmental Affairs.

Scope and Methodology

The environmental assessment is conducted to determine all environmental, safety, health and socio-economic impacts associated with the operations of the facility. Relevant environmental data has been compiled by making use of secondary data, a reconnaissance site visit and a specialist radiation risk assessment. Potential environmental impacts and associated social impacts were identified and are addressed in this report.

Development and Operations

Some LWD tools used in, for example, the current offshore exploratory oil drilling projects, contain radioactive material (referred to as "sources"), used to emit gamma or neutron radiation into the belowground formations. This type of equipment is generally referred to as nuclear tools and the resulting interactions of the radiation with the substrate, provide information on lithology (physical characteristics), mineral composition, porosity and fluid saturation of the substrate. This information is used in conjunction with data obtained from other methods of well logging, to determine, among others, in which direction to drill and the likelihood of oil being present. In laymen's terms, one can basically compare these techniques to x-rays used to "see" inside a person's body or inside luggage or cargo containers. In a similar way, exploration companies use this technology to "see" within the rock formations below the seabed surface.

As exploratory drilling is an extremely expensive exercise, it is crucial that the information received from the LWD tools are accurate. This ensures that the correct areas are targeted for drilling and time and resources are not wasted on drilling in areas that will likely not have any oil or gas. To ensure accuracy and reliability of the well logging tools, they require periodic calibration and testing. Therefore a dedicated facility is needed, which has the necessary equipment, and meets the required standards, for performing calibration and testing of the tools.

Calibration of the LWD tools require additional radioactive source material with known radiation activity. Such sources are typically a small volume of a radioactive element, sealed within a metal capsule (i.e. a sealed radioactive source (SRS)), that emits ionizing radiation such as alpha particles, beta particles or gamma rays. For the facility planned by the Proponent, the radioactive elements contained in the SRS will be Caesium-137 (Cs-137) and Americium-241 Beryllium (Am-241Be), both Caesium-137 and Beryllium being naturally occurring metals and Americium-241 being a manmade metal. As these SRS are radioactive, they must be stored within lead containers, called "pigs", which shields radiation. As an additional safety measure, the pigs will also be stored in a highly secure bunker, which will be lined with lead and concrete. Cs-137 emits gamma rays and beta particles, while Am-241Be is an alpha particle, gamma ray and neutron emitter.

Only when a SRS is needed for calibration activities, will the pig with the required SRS be removed from the bunker, and taken to a dedicated enclosed calibration area. There, the source will be removed from the pig using a special tool, inserted into the calibration equipment, the calibration procedure completed, and the SRS then immediately returned to the pig and to the bunker. All handling of the SRS will be by suitably trained professionals and all workers that may be exposed to radiation will be monitored for radiation exposure to ensure it does not exceed accepted levels. Only one SRS will be removed from the bunker per calibration exercise and the bunker will be surveyed for radiation prior to removal of the pig and after the pig is returned.

Transport of SRS and LWD tools to and from the site will be contracted to an authorised radioactive material transport company. Any source that will no longer be used, will be returned to the manufacturer for safe disposal, hence no radioactive material or waste will require disposal in Namibia.

Public Participation

As part of the environmental assessment process, public consultation was performed. This entailed placing a site notice at erf 3954, placing advertisements in two national newspapers, and notifying direct neighbours, identified interested and affected parties and relevant authorities. Numerous individuals registered as interested and affected parties for the project and concerns were raised regarding the potential danger posed by the proposed project. It was however mistakenly understood by many of the parties that the facility will be for the storage of radioactive waste, which is a completely different matter to the actual plans for the erf. All comments and concerns are addressed in the comments and responses table of this report.

Impacts

Positive impacts that will realise from the proposed facility and its operations, are mainly the provision of essential support services to the current offshore exploratory and well drilling industry; and other potential future exploratory drilling projects in the oil and gas industry. The development of Namibian oil resources shows promising results and will significantly benefit Namibia directly and indirectly in terms of employment, technological advancement, income generation and progress. The Proponent's project itself will be a world class, state of the art facility and a first for Namibia. It will entail significant investments to be made, thus stimulating the local economy. New technology will be brought to Namibia and employment and skills transfer will benefit the local labour force.

The major concern related to the operations of the facility, is that of potential radiation exposure to workers and the general public. This can be either if the source is not suitably stored on site, or if it is stolen, lost or incorrectly disposed of. Alpha particles are shielded by material as thin as paper and is thus only harmful if the radioisotope is ingested or inhaled. Beta particles can cause sunburn like symptoms and are also harmful when the radioisotope is ingested or inhaled. It is shielded by thin aluminium. Gamma rays are high in energy and can cause immediate damage to cells with high exposure, while long term low exposure results in cancer and DNA damage. To shield Gamma rays thick lead and concrete barriers are required. Neutrons also cause cell damage, but can be shielded by substances like water or polyethylene.

Based on the radiation risk assessment conducted for the project, normal approved operations of the facility and SRS, will not present a risk of significant radiation exposure to neighbours and the general public. This is because the storage of the SRS inside pigs and inside the bunker, shields radiation effectively. For example, for a residential area 100 m away from the SRS bunker, and assuming residents spends 2,922 hours outdoors at their home, the calculated dose is 0.004508 mSv per year, compared to the regulation limit of 1 mSV per year. For a similar scenario, but for the calibration facility, exposure will be 0.0007468 mSv. Even the combined exposure from the two facilities remains extremely low and the actual exposure will even by lower, as the calculations did not take into account the shielding properties of Erf 3954's own boundary wall, or any other structure that can potentially shield radiation, located between the facility and the residential area. Similar exposure scenarios were calculated for neighbouring business (at 50 m away) and pedestrians passing by. For both the exposure remained well below the annual allowed doses.

Calculations were made to assess how much radiation exposure one worker will receive, based on certain assumptions and given that he/she performs all activities related to the handling of the SRS for calibration purposes. Calculated exposure levels of 6.39 mSv per year are well below the internationally prescribed levels of exposure, which is 20 mSv. Should different workers be responsible for the various steps involved with collecting the SRS from the bunker, calibrating the LWD tools and returning it to the bunker, individual workers' exposures would be even less per year. Furthermore, similar calculations were made to assess the exposure of the worker responsible for surveying the bunker. Calculated exposure levels are very low at 0.38 mSv per year.

Assuming non-radiation workers on site are within 3 m of the bunker and SRS calibration facility for 30 minutes per day for 250 working days per year, their exposure will be 0.2060 mSv per year, well below the allowed 1 mSv per year. Non-radiation workers that may pass the proposed SRS calibration facility at 3 m away, while calibration of offshore instruments is being performed, for exposure times of 3.5 and 1.5 hours per year for the Cs-137 and AM/Be-241 SRS, respectively, will have exposure 0.8301 mSv per year. This is still less than the 1 mSv limit, but does suggest that optimisation of worker protection will be beneficial to reduce potential radiation exposure among non-radiation workers. This can be achieved by increasing distance, reducing exposure time or additional shielding.

During upgrade and construction of the existing and newly planned infrastructure on erf 3954, some noise generating activities will be performed, and traffic to and from the site will increase. Some construction and general waste will be produced. Operations will in general be typical of industrial areas with very limited impacts on nearby receptors.

Management of Impacts

Positive impacts can be enhanced by supporting local industries and contractors and appointment of local Namibian employees, as far as is practically possible. It should however be noted that the technologies are highly specialised and new to Namibia and will thus require international expertise in order to safely perform operations.

Negative impacts related to radiation exposure will be prevented by adherence to prescribed standards by the National Radiation Protection Authority, International Atomic Energy Agency, material safety data sheet instructions, and any related industry standards and practices. The environmental and radiation management plan must be implemented and all persons on site must be well versed on its contents. An emergency response plan must also be implemented for any unlikely event of accidental radiation exposure. The three mitigation measures for radiation risk are time, distance and shielding. Thus, shorter exposure time, over a greater distance, and with a shield between the source and the receptor, effectively reduce the level of exposure. To achieve this, adherence to the following is paramount:

<u>Shielding:</u> SRS must be stored inside pigs and inside the bunker at all times and may only be removed from the pig, when it is intended to be used or inspected. It may only be removed from the pig in the calibration room or bunker and the personnel involved must wear suitable personal protective equipment.

<u>Time:</u> Handling of the SRS outside the pig may only be by trained and authorised staff and must be limited to the shortest time possible. All equipment for calibration must thus be ready and in place prior to removing the SRS from the pig, and the SRS returned to the pig as soon as calibration is complete.

<u>Distance:</u> Although radiation is not expected to pass through both the pig and the bunker, as an additional safety measure, the bunker must be positioned on the erf in such a way to maximise the distance from neighbours. Removal and return of the SRS from and to the pig must be with a specialised tool which is 1.5 m long.

The International Atomic Energy Agency categorises SRS based on factors such as the physical and chemical forms, the type of shielding or containment employed, the circumstances of use, and accident case histories. Category 1 considered to be extremely dangerous to a person, while Category 5 is unlikely to be dangerous. The radiation impact assessment for the planned SRS to be stored and handled by the Proponent, calculated the categories for the individual Caesium-137 and Americium-241 Beryllium SRS as Category 4 and Category 3, respectively. A Category 4 SRS is, based on the International Atomic Energy Agency categorisation system, *unlikely to be dangerous to the person*, while a Category 3 SRS is considered *dangerous to the person* and *it could possibly, although unlikely, be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks*.

However, since 15 Caesium-137 and five Americium-241 Beryllium SRS will be stored in the bunker, the categories for the combined storage are Category 2. As such the facility will be treated as a

Category 2 facility, where Category 2 SRS is *very dangerous to the person* and *it could possibly be fatal to be close to this amount of unshielded radioactive material for a period of hours to days*. The International Atomic Energy Agency further assigns security levels to different categories of SRS with Security level A being the most secure and Security level C being the least secure. Since the storage facility will be treated as a Category 2, Security level B applies. Security requirements for this level requires an *intermediate level of protection of radioactive material against unauthorized removal*.

To prevent theft of an SRS, adhere to Security level B requirements, and prevent unauthorised (uniformed) persons from entering restricted areas, the erf and bunker must be under constant surveillance, access controlled, with intruder alarm systems and strict security protocols and measures. Attempts of unauthorised entry must immediately be communicated to response personnel who must then mobilize immediately to interrupt the unauthorized removal of radioactive material.

Suitable signage indicating restricted areas and the presence of radioactive material must be placed at all applicable areas. All workers that may potentially be exposed to radiation, must be informed of the risks and those working with the SRS must at all times wear dosimeters, to ensure that total allowable radiation exposure is not exceeded. Leak tests on SRS should regularly be performed. Should any leak or incident occur where radiation is not contained, the emergency response plan must be implemented and corrective action taken without delay.

During construction and operations, noise levels should meet the minimum requirements of the Health and Safety Regulations of the Labour Act and World Health Organisation guidelines for community noise. Should traffic impacts be expected at any stage due to the delivery of equipment, traffic management should be conducted and trucks should not be allowed to block roads or the entrances to neighbouring properties. Fire detection and firefighting equipment should be present on site. Waste management must be performed and waste should be contained and regularly disposed of at an approved waste disposal facility.

The environmental and radiation management plan included in section 11 and Appendix D of this document should be used as an on-site reference document during all phases (planning, construction (care and maintenance), operations and decommissioning) of the facility. All monitoring and records kept should be included in a report to ensure compliance with the environmental and radiation management plan. A health, safety, environment and quality policy, or similar, could be used in conjunction with the environmental and radiation management plan. Operators and responsible personnel must be taught the contents of these documents. Municipal or national regulations and guidelines must be adhered to and monitored regularly as outlined in the environmental and radiation management plan.

Conclusion

Based on the findings of the environmental and radiation risk assessment, there is no evidence that suggest that the proposed project cannot continue on erf 3954. The assessment highlighted two main findings: 1) that under normal operations of the facility there is no real risk to the public, including direct neighbours; and 2) that under normal operations, and by implementing the necessary safety and security measures, the exposure of workers to radiation is within the prescribed limits of Namibia and the International Atomic Energy Agency. That being said, it remains imperative that all personnel is suitably trained and authorised to work with radioactive sources, radiation exposure monitoring must be conducted, and an emergency response plan must be in place and all staff well versed on its contents. The environmental and radiation management plan as presented in this document should be adopted and the contents kept up-to-date as legislation, equipment and operational methods and conditions change. It is further suggested that the radiation safety assessment be updated once the facility comes into operation to address minor deviations in operational procedures or equipment. Optimisation of radiation protection should be investigated to reduce exposure doses as low as possible, while taking into consideration social and economic balances.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ALARA	As Low As Reasonably Possible
Am-241Be	Americium-241 Beryllium
Bq	Becquerel
CCTV	Closed Circuit Television
CSR	Corporate Social Responsibility
Cs-137	Caesium-137
DWA	Department of Water Affairs
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMA	Environmental Management Act No 7 of 2007
ERMP	Environmental and Radiation Management Plan
EMS	Environmental Management System
ES	Environmental Classification
GPT	Geo Pollution Technologies
HIV	Human Immunodeficiency Virus
IAEA	International Atomic Energy Agency
IAPs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
kVA	Kilo-Volt Amperes
$kWh/m^2/day$	Kilowatt hour per square meter per day
km/h	Kilometre per Hour
LWD	Logging While Drilling
m/s	Meter per second
mbs	Meters below surface
MEFT	Ministry of Environment, Forestry and Tourism
mm/a	Millimetres per annum
MSDS	Material Safety Data Sheet
mSv	Milli Sieverts
NaCl	Sodium chloride
NRPA	National Radiation Protection Authority
PPE	Personal Protective Equipment
ppm	Parts per million
RIA	Radiation Risk Assessment
Rem	Roentgen Equivalent Man
RMP	Radiation Management Plan
RSO	Radiation Safety Officer
SO_2	Sulfur dioxide
SRS	Sealed Radioactive Source
WHO	World Health Organization

GLOSSARY OF TERMS

Alternatives - A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Assessment - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

Becquerel - The unit of radioactivity in the International System of Units where one becquerel is defined as an activity of one decay (nuclear disintegration) per second.

Competent Authority - means a body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Construction - means the building, erection or modification of a facility, structure or infrastructure that is necessary for the undertaking of an activity, including the modification, alteration, upgrading or decommissioning of such facility, structure or infrastructure.

Cumulative Impacts - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Environment - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

Environmental Impact Assessment (EIA) - process of assessment of the effects of a development on the environment.

Environmental Management Plan (EMP) - A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.

Environmental Management and Radiation Plan (EMRP) - A working document on environmental and socio-economic mitigation measures, specifically also inclusive of radiation management measures, which must be implemented by several responsible parties during all the phases of the proposed project.

Environmental Management System (EMS) - An Environment Management System, or EMS, is a comprehensive approach to managing environmental issues, integrating environment-oriented thinking into every aspect of business management. An EMS ensures environmental considerations are a priority, along with other concerns such as costs, product quality, investments, PR productivity and strategic planning. An EMS generally makes a positive impact on a company's bottom line. It increases efficiency and focuses on customer needs and marketplace conditions, improving both the company's financial and environmental performance. By using an EMS to convert environmental problems into commercial opportunities, companies usually become more competitive.

Evaluation - means the process of ascertaining the relative importance or significance of information, the light of people's values, preference and judgements in order to make a decision.

Half Life - The time required for chemical or substance's activity to reduce by 50%. In terms of radioactivity it means how quickly unstable radioisotopes undergo radioactive decay. Such decay is exponential and this means that if the activity is for example 100, and the half life is 1 year, after one year the activity will be 50, after another year it will be 25, and after the next 12.5, and so on.

Hazard - Anything that has the potential to cause damage to life, property and/or the environment. The hazard of a particular material or installation is constant; that is, it would present the same hazard wherever it was present.

Interested and Affected Party (IAP) - any person, group of persons or organisation interested in, or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.

Lithology - general physical characteristics of rocks.

Logging While Drilling Equipment - Specialised tools forming part of the drilling rod that measure and record various properties of rocks and fluids encountered while drilling a well.

Mitigate - The implementation of practical measures to reduce adverse impacts.

Pig - A double layer, metal container with a cavity between the two layers that is filled with a material that can shield (or block) radiation from escaping the container when a radioactive isotope is placed in the container. For example gamma radiation is shielded when the cavity is filled with lead.

Proponent (Applicant) - Any person who has submitted or intends to submit an application for an authorisation, as legislated by the Environmental Management Act no. 7 of 2007, to undertake an activity or activities identified as a listed activity or listed activities; or in any other notice published by the Minister or Ministry of Environment and Tourism.

Public - Citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

Radioactive Isotope / Radioisotopes - Can be defined as the unstable form of an element - atoms that has an unstable nucleus that emit radiation.

Scoping Process - process of identifying: issues that will be relevant for consideration of the application; the potential environmental impacts of the proposed activity; and alternatives to the proposed activity that are feasible and reasonable.

Significant Effect/Impact - means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Stakeholder Engagement - The process of engagement between stakeholders (the proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term “public participation”.

Stakeholders - A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (IAPs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

Sustainable Development - “Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations” – the definition of the World Commission on Environment and Development (1987). “Improving the quality of human life while living within the carrying capacity of supporting ecosystems” – the definition given in a publication called “Caring for the Earth: A Strategy for Sustainable Living” by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

Wellbore - A hole that is drilled for the exploration and recovery of natural resources, including oil, gas or water.

1 INTRODUCTION

Namaquanum Investment Two CC (the Proponent) has an existing workshop on erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund, Erongo Region (Figure 1-1).The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source material used to calibrate and test logging while drilling (LWD) equipment used in the oil and gas exploration industry. Clients from the exploration industry will utilise the workshop and source materials on erf 3954, to perform the necessary calibrations and tests on their LWD equipment. In general, project development and operations of the facility involve:

- Upgrading of the existing warehouse on erf 3954 into a state of the art LWD tool testing and calibration centre.
- Construction of a bunker for storage of sealed radioactive sources (SRS).
- Construction of support infrastructure and a magnetic calibration tank.
- Storage of SRS used for calibrating and testing of LWD equipment.
- Calibrating and testing of LWD equipment.
- General operational activities and maintenance procedures associated with a LWD equipment calibration and testing facility.

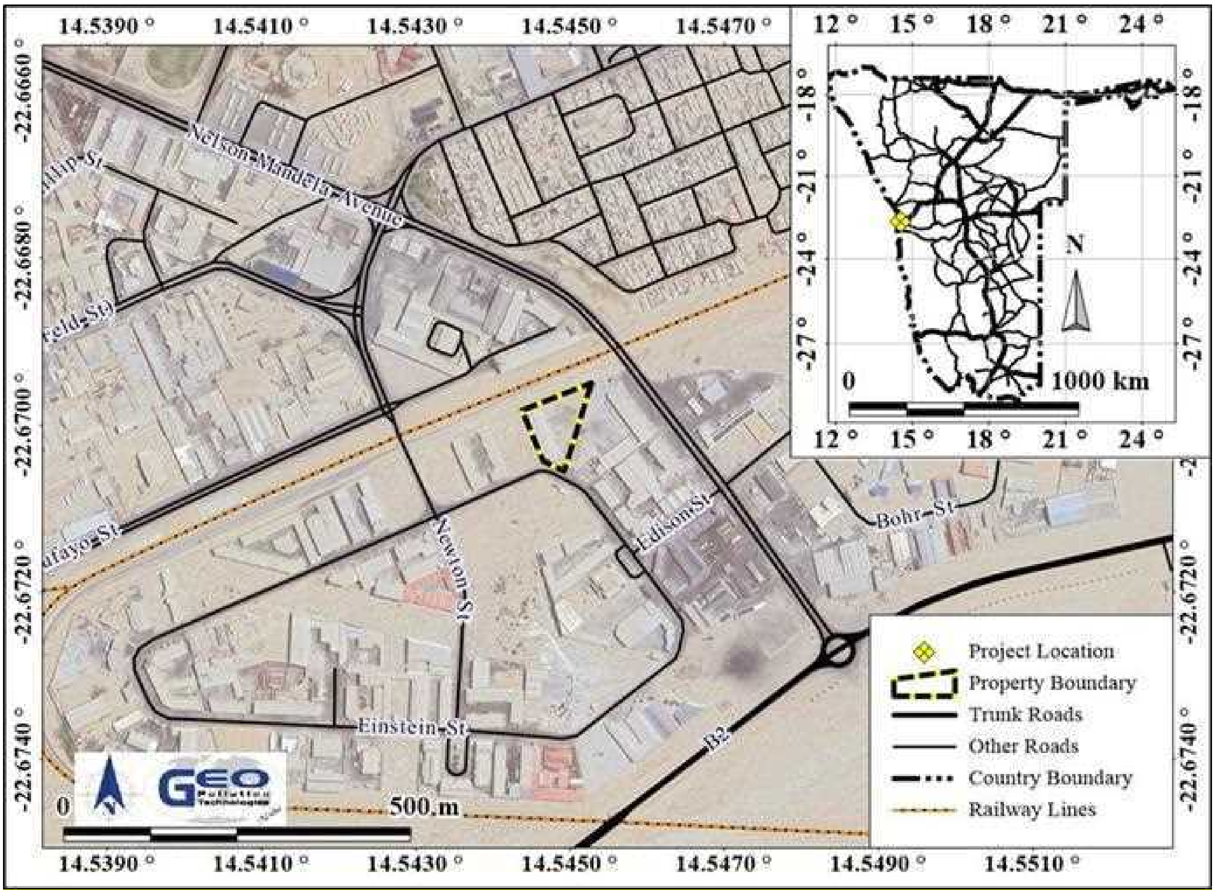


Figure 1-1 Project location

The Proponent requested Geo Pollution Technologies (Pty) Ltd, as an independent environmental consultant, to conduct an environmental impact assessment (EIA) to comprehensively evaluate the potential environmental implications associated with the proposed storage facility for radioactive materials in Swakopmund. The facility will store the radioactive isotopes Caesium-137 (Cs-137) and Americium-241 Beryllium (Am-241Be). Both these isotopes possesses distinct characteristics that presents human and environmental risks, necessitating a thorough examination of their potential environmental impacts.

The EIA was undertaken to determine the potential impact of the construction, operational and possible decommissioning phases of the project on the environment. The environment being defined in the

Environmental Management Act as “land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, paleontological or social values”.

This environmental assessment thus seeks to provide a comprehensive assessment of the proposed storage facility's potential impacts on soil, water, air quality, biodiversity, and human health. Through detailed analysis and assessment, preventative and mitigation measures are proposed, aimed at ensuring the facility’s adherence to regulatory requirements and best practices, safeguarding both the environment and the surrounding community.

The environmental assessment was conducted to apply for the necessary approvals from the National Radiation Protection Authority (NRPA) and an environmental clearance certificate in compliance with Namibia’s Environmental Management Act (Act No 7 of 2007).

Project Justification – Namibia has capitalised, through its rich and diverse mineral resources, and by leveraging the commodity boom, to draw investment into extracting raw materials. Furthermore, the country has focused on enhancing strategic infrastructure to optimize transportation and logistics efficiency. However, over-reliance on primary production and raw material exports has resulted in significant missed economic opportunities and income loss. This stems from the absence of value addition, the outsourcing of jobs to countries where value addition occurs, and the susceptibility to risks associated with dependence on finite commodities and market fluctuations. Accelerating Namibia's technological and manufacturing capacity and economic growth are imperative to ensure fair distribution of benefits across society and mitigation of income inequality. The recent offshore oil discoveries are promising and have resulted in large scale offshore exploratory drilling. The Proponent’s proposed project, as support service to the exploratory drilling industry, can realise the following benefits:

- Local development of state of the art industrial facilities that can service the exploratory oil and gas drilling industry.
- Capital investment through the acquisition of land, infrastructure and equipment to develop the facility.
- Revenue generation and support of local businesses and contractors.
- Employment and skills development and training.
- Cost and time savings for the exploratory drilling industry by having access to local LWD tool calibration and testing facilities.
- Support for potential additional investments and development in the town and Namibia as a whole.

2 SCOPE

The scope of the environmental assessment is to:

1. Comply with Namibia’s Environmental Management Act (2007), Atomic Energy and Radiation Protection Act 5 (2005), as well as the regulations of both acts.
2. Provide a description of the proposed project.
3. Determine the potential environmental impacts emanating from the construction and maintenance, operations and possible decommissioning activities of the facility.
4. Identify a range of management actions which could mitigate the potential adverse impacts to acceptable levels.
5. Provide sufficient information to the NRPA and the Ministry of Environment, Forestry and Tourism (MEFT) to make an informed decision regarding the construction and maintenance, operations and possible decommissioning of the facility and the issuance of an ECC.

3 METHODOLOGY

The following methods were used to investigate the potential impacts on the social and natural environment expected from the construction and maintenance, operations and possible decommissioning activities of the facility:

1. Baseline information about the site and its surroundings was obtained from existing secondary information as well as from a reconnaissance site visit.
2. A specialist radiation risk assessment (RIA) was commissioned specific to the Cs-137 and Am-241Be sources to be stored and used on site and an environmental and radiation management plan (ERMP) prepared.
3. As part of the EIA, interested and affected parties (IAPs) and authorities were consulted about their views, comments and opinions and these are put forward in this report.

4 BACKGROUND TO THE RADIOACTIVE SOURCES

This section aims at providing an easily understood description and explanation of the proposed radioactive sources and their uses, radioactivity and risks. In order to achieve this, some basic information regarding well logging and radiation is also provided.

4.1 WELL LOGGING

Well logging is a crucial technique used in the oil and gas industry to gather information about subsurface formations and reservoirs. It involves the measurement and recording of various properties of rocks and fluids encountered while drilling a well. This information helps in evaluating the potential productivity and characteristics of hydrocarbon reservoirs, aiding in decision-making during exploration, drilling, and production phases. Well logging techniques vary depending on the properties being measured and the objectives of the operation (Ellis and Singer, 2007). The following is a short overview of well logging, including different types of well logging.

Basic Principles: Well logging relies on the principle that different types of rocks and fluids exhibit distinct physical properties that can be measured using specialized tools lowered into the wellbore. These properties include electrical conductivity, natural radioactivity, acoustic velocity, and nuclear magnetic resonance, among others (Chopara *et. al.* 2005).

Types of Well Logging:

Electrical Logging: This involves measuring the electrical properties of subsurface formations. Resistivity logging measures the electrical resistance of rocks to the flow of current, providing information about formation porosity and fluid saturation. Induction logging measures electromagnetic properties to determine formation resistivity and conductivity.

Acoustic / Sonic Logging: Acoustic tools measure the speed of sound waves traveling through the formation. Sonic logging provides information about formation porosity, lithology, and mechanical properties, aiding in identifying potential fluid-bearing zones.

Nuclear Logging: Nuclear tools utilize radioactive sources to emit gamma or neutron radiation into the formation and measure the resulting interactions. Gamma-ray logging identifies lithology and mineral composition, while neutron logging measures formation porosity and fluid saturation.

Density Logging: Density tools measure the bulk density of formation rocks using gamma-ray attenuation. This information helps in determining lithology, porosity, and mineral composition.

Formation Evaluation Logging: This includes a combination of logging measurements to assess reservoir properties comprehensively. It may involve integrating data from electrical, acoustic, nuclear, and other logging tools to evaluate reservoir quality, fluid content, and production potential.

Production Logging: Production logging is conducted in completed wells to evaluate fluid flow and distribution within the wellbore. It helps in diagnosing production aspects such as fluid entry points, flow rates, and zonal contributions.

Data Interpretation:

Well logging data are processed and interpreted to generate logs, or graphical representations, of formation properties along the wellbore. Interpretation involves identifying lithology, porosity, fluid content, permeability, and other reservoir characteristics. Advanced interpretation techniques include computer modelling, inversion algorithms, and machine learning to extract meaningful insights from complex data sets.

Applications:

Exploration and Appraisal: Well logging plays a vital role in identifying prospective hydrocarbon-bearing formations during oil and gas exploration and appraisal drilling. It assists in making informed decisions regarding well placement, reservoir characterization, and resource estimation.

Drilling Optimization: Real-time logging measurements assist in optimizing drilling operations by providing continuous feedback on formation properties and drilling parameters. This helps in avoiding hazards, such as unstable formations or fluid influxes, and optimizing wellbore trajectory.

Reservoir Management: Well logging data are used in reservoir management activities, including reservoir modelling, production forecasting, and enhanced oil recovery planning. Continuous monitoring of reservoir properties through logging helps in optimizing production and maximizing hydrocarbon recovery over the life of the field.

In summary, well logging encompasses a diverse range of techniques aimed at characterizing subsurface formations and reservoirs. These techniques play a critical role in every stage of the oil and gas exploration and production process, from initial exploration to reservoir management, contributing to informed decision-making and maximizing hydrocarbon recovery.

4.2 BACKGROUND ON RADIATION AND THE RADIOISOTOPES TO BE STORED

Radiation permeates our environment from natural and artificial sources, posing both risks and benefits to human health. Naturally occurring radioactive materials are ubiquitous, present in the earth's crust, building materials, food, and even our own bodies. Cosmic radiation, originating from outer space, further contributes to our exposure. Alongside natural sources, human activities introduce additional radiation, including medical X-rays, fallout from nuclear testing, and emissions from power plants fuelled by coal or nuclear energy.

Radioactivity, a fundamental concept in understanding radiation, refers to the process of atomic nuclei disintegration, releasing energy in the form of radiation. This phenomenon occurs in atoms with unstable nuclei, which are called radionuclides. Each radionuclide has a characteristic rate of decay, measured in units called Becquerels, (which can also be converted to Curie), and a specific half-life, which can range from fractions of a second to billions of years. For instance, while Iodine-131 has a half-life of eight days, Uranium-238 has a staggering half-life of 4.5 billion years. Potassium-40, a prevalent source of radiation in our bodies, has a half-life of 1.42 billion years.

Radiation comes in various forms, each with distinct characteristics and penetration capabilities. Alpha radiation comprises heavy, positively charged particles, emitted by elements like uranium and radium. Though easily stopped by materials like paper or the epidermis, alpha-emitting substances can pose internal threats if ingested or inhaled. Beta radiation, consisting of electrons, is more penetrating and requires barriers such as aluminium to block. Gamma rays, akin to X-rays, exhibit high penetration, necessitating dense materials like concrete or lead for shielding. Neutrons, uncharged particles, interact with matter to produce secondary radiation, including alpha, beta, gamma, or X-rays, require substantial barriers like very thick concrete, water, or polyethylene (Niu, 2011).

Despite its invisible nature, radiation can be detected and quantified with specialized instruments (e.g. dosimeters), enabling meticulous monitoring and regulation to mitigate potential health risks associated with exposure.

The following are summaries about the radioactive material planned to be stored at the facility:

Caesium-137 (Cs-137):

Cs-137 is a radioactive isotope of caesium. It emits beta and gamma radiation and decays to stable barium-137. It is widely used as source of gamma radiation in various applications such as industrial radiography, medical radiation therapy, and various research applications.

Americium-241 Beryllium (Am-241Be):

An Am-241Be source has both americium, a man-made radioactive metal, and naturally occurring beryllium. Am-241is commonly employed in smoke detectors and industrial gauges, among other applications. It is a source of alpha and gamma radiation and it ultimately decays to stable bismuth. Beryllium is widely used in various industries and is important in the production of alloys. It does not naturally emit radiation, but when bombarded by alpha or gamma radiation, it emits neutrons. Hence, the combination of Am-241Be in a source results in a neutron-emitting radioactive source used in diverse applications such as neutron radiography and well logging.

4.3 RADIATION EXPOSURE LIMITS

Table 4-1 summarises the different levels of radiation exposure acceptable to both personnel working with radioactive material as well as for the general public. For more details refer to the RIA in Appendix A.

Table 4-1 Individual dose limits (ICRP, 1991; IAEA, 2014)

	Public	**Occupational**	**Occupational exposure of apprentices of 16 to 18 years of age**
Effective dose	1 mSv / year Special circumstances, allow an effective dose of up to 5 mSv in a single year provided that the average dose over five consecutive years does not exceed 1 mSv / year	20 mSv / year averaged over five consecutive years (100 mSv in 5 years) and of 50 mSv in any single year	An effective dose of 6 mSv in a year
Equivalent dose to the lens of the eye	15 mSv / year	20 mSv / year averaged over five consecutive years (100 mSv in 5 years) and of 50 mSv in any single year	20 mSv / year
Equivalent dose to the extremities (hands and feet) or to the skin	50 mSv / year	500 mSv / year	150 mSv / year

4.3.1 Reducing Radiation Risk

Preventative measures against radiation exposure are crucial for individuals working in environments where radiation is present, such as nuclear facilities, hospitals with radiation equipment, or even in certain industrial settings. Three primary methods for mitigating radiation exposure are often emphasized: time, distance, and shielding. These measures are:

Time:

Time refers to the duration of exposure to radiation. The longer an individual spends in a radioactive environment, the greater their cumulative dose of radiation. Therefore, minimizing the time spent in such environments is essential to reduce the risk of harmful effects. This principle is encapsulated in the ALARA (As Low as Reasonably Achievable) concept, which emphasizes minimizing radiation exposure to levels that are reasonably achievable with current technology and operational constraints.

Rotating Personnel: In workplaces where radiation exposure is a concern, rotating personnel frequently can help limit individual exposure times. This approach ensures that no one person is exposed to radiation for extended periods.

Limiting Exposure Periods: Implementing strict protocols that limit the time workers spend in radiation-prone areas can significantly reduce overall exposure. This may involve scheduling breaks or job rotations to minimize continuous exposure.

Remote Operations: Utilising remote-controlled equipment or robotic systems allows tasks to be performed in radioactive environments without direct human presence, thereby reducing the time workers are exposed to radiation.

Distance:

Distance refers to the physical space between a radiation source and an individual. The intensity of radiation decreases significantly as distance from the source increases, following the inverse square law. Therefore, increasing the distance from the radiation source is an effective way to reduce exposure.

Engineering Controls: Designing facilities and processes to maximize the distance between workers and radiation sources is fundamental. This may involve positioning radiation-emitting equipment further away from workstations or incorporating shielding barriers between sources and personnel.

Remote Handling: Similar to remote operations mentioned under time, using remote handling tools allows operators to manipulate radioactive materials or equipment from a safe distance, minimizing direct exposure.

Personal Protective Equipment (PPE): While not a direct means of increasing distance, wearing protective clothing, such as lead aprons or gloves, can act as a barrier between radiation sources and workers, effectively increasing the distance between the source and vulnerable body tissues.

Shielding:

Shielding involves placing barriers between the radiation source and individuals to absorb or block the radiation. The effectiveness of shielding depends on factors such as the type and energy of radiation, as well as the material and thickness of the shielding used.

Materials: Common materials used for shielding include lead, concrete, and water. Lead is particularly effective against gamma and X-ray radiation, while concrete provides effective shielding against neutron radiation.

Thickness: The thickness of shielding material is crucial. Thicker barriers attenuate more radiation. The design of shielding should consider the energy and type of radiation being emitted to ensure adequate protection.

Facility Design: Incorporating shielding materials into the design of facilities where radiation sources are present is critical. This may involve constructing walls, doors, and barriers using radiation-absorbing materials to create designated shielded areas.

Mobile Shielding: For situations where radiation sources need to be moved or transported, mobile shielding devices, such as lead-lined containers or casks, commonly referred to as “pigs”, are used to provide temporary protection during handling and transportation.

In summary, time, distance, and shielding are integral components of radiation protection strategies. Implementing these measures effectively requires careful planning, engineering controls, and adherence to safety protocols to minimize the risks associated with radiation exposure. Combining these measures can significantly enhance safety for workers in environments where radiation is present.

5 FACILITY CONSTRUCTION, OPERATIONS AND RELATED ACTIVITIES

The proposed facility on erf 3954 will primarily serve as a workshop for calibration and testing of drilling equipment utilised in the oil exploration industry and related fields. Although the site has an existing warehouse, it will require complete repurposing to meet the requirements for the proposed activities. Some additional infrastructure will also be constructed on site in support of the activities.

5.1 CONSTRUCTION AND MAINTENANCE

The Proponent plans to construct an aboveground storage facility, or bunker, for the storage of the radioactive source material. The bunker will conform to stringent industry safety specifications. The structure will be a 12.2 meter steel shipping container, lined on the inside with lead of 6 mm thickness. The container will be placed on a reinforced concrete surface of 200 mm thick and will be enclosed on the sides by hollow concrete masonry blocks, reinforced with steel rebar, and filled with mass concrete within the cavity. This will result in at least 220 mm thick concrete surrounding the container. Prefabricated reinforced concrete slabs of 150 mm thickness will be placed on the roof. Note that the original plan was to have the concrete barriers on the inside of the container. This is also what is presented in the RIA (Appendix A). This however limits the available space inside the bunker and it is preferred to have it on the outside. Ultimately it makes no difference to the effectiveness and safety of the bunker, as long as concrete thickness remains the same and the lead lining is used.

The bunker will have intruder alarms, an electronically locked door with access control and the area around it will be fenced, locked and entry strictly controlled. Warning signs will be placed, at minimum, at all entrances to the fenced area. The facility will be under 24 hour closed circuit television (CCTV) surveillance (outside and inside the container). The perimeter wall of the erf will have an electric fence. Two security guards will be on duty 24 hours per day.

The existing workshop will be transformed into a state of the art workshop for the calibration and testing of LWD equipment. The floor of the workshop will be covered with a new 15 cm thick, reinforced and sealed concrete floor. Various workspaces will be created for the various tests and calibrations to be performed. Utilities like telecommunications, electricity and earthing, water, drainage, ventilation and compressed air will be upgraded or newly installed. An equipment wash bay will be constructed and this, together with various drains, will be connected to an oil water separator. Additional emergency infrastructure and equipment will include a fire detection system, firefighting equipment, emergency eye wash stations, radiation detectors with audible and/or visual alarms, etc. A standby generator of 350 kVA will also be installed.

Figure 5-1 Existing site layout

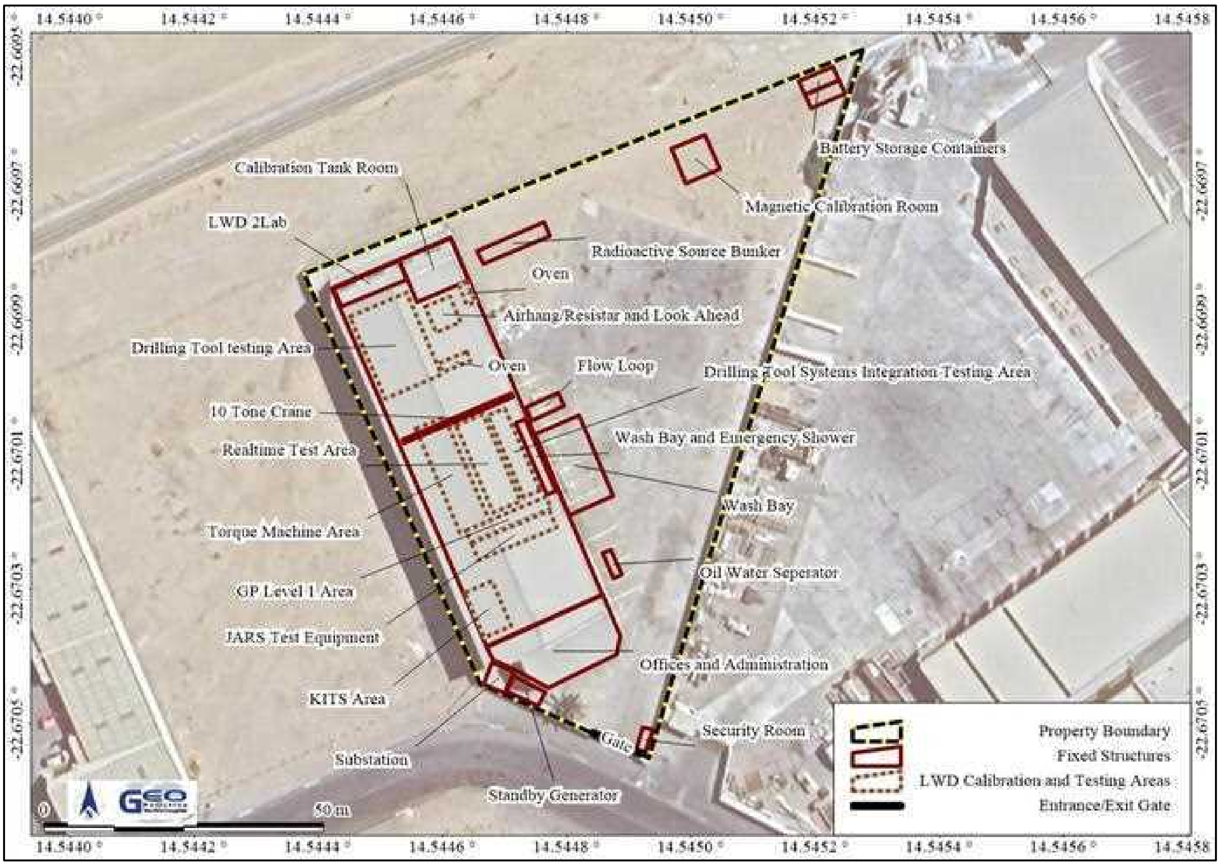


Figure 5-2 Proposed site layout

Photo 5-1 Western view of current site from the entrance

Photo 5-2 Point of view from the proposed magnetic calibration shack and battery storage

Photo 5-3 Current site eastern view from the entrance

Photo 5-4 Proposed location of the magnetic calibration shack and battery storage

Photo 5-5 Proposed location of the radioactive bunker

5.2 Operational Activities

Operational activities will commence once the required infrastructure is constructed and all permits and authorisations are in place.

5.2.1 Source Receipt and Storage

A maximum of 15 Cs-137 and five Am-241Be sources will be transported to the facility by a transport company authorised to transport radioactive materials. The sources will be contained inside containers specifically designed to protect the sources from damage and to shield radiation. These containers are referred to in the industry as "pigs". Cs-137 sources will be stored inside stainless steel pigs with a lead shield as lead efficiently absorbs alpha, beta and gamma radiation. Am-241Be sources will be stored in stainless steel pigs with both lead and polyethylene as shield. The lead absorbing the alpha and gamma radiation from the AM-241 while the polyethylene moderates (slows down) the neutrons produced by the Beryllium. All sources will be stored in their own individual pigs.

Once the sources arrive at the facility, they will immediately be placed inside the dedicated radioactive source storage bunker. They will remain here until such time as they are needed for calibration and testing of LWD tools. The storage bunker is regularly surveyed for any radiation (i.e. radiation leaks from pigs) and this occurs at least once before a source is removed from the bunker and once after it is returned, each time it is used.

Photo 5-6 An example of a sealed source containing Cs–137

Photo 5-7 An example of a sealed source containing Am-241/Be

Photo 5-8 An example of a pig containing a Cs-137 SRS

Photo 5-9 An example of a pig containing a Am-241Be SRS

5.2.2 Calibration and Testing of Well Logging Tools – Calibration Tank

Only one source will be removed from the bunker for calibration and testing purposes at any given time. The pig containing the source will be removed from the bunker and taken directly into the room with the calibration tank inside the warehouse. All instruments required for calibration and testing will be put in place and in the calibration tank. The LWD tool will be put into position and only when everything is ready, will the SRS be removed from its pig with a 1.5 m long handheld tool and inserted into the LWD tool. Once the SRS is secure, the LWD logging tool is lowered into the water and the calibration and testing begins. Once it is complete, the LWD tool is removed from the water, the SRS removed with the handheld tool and returned to the pig. The pig is then returned to the bunker.

The actual time required to remove the SRS from the pig and install it into the well logging tool takes less than one minute, while the entire process, from collecting the pig up to returning the pig to the bunker takes one hour.

5.2.3 Calibration and Testing of Directional Probes – Magnetic Calibration Room

The magnetic calibration room will be used to calibrate directional probes used in well drilling. These probes allow dynamic orientation of downhole drilling equipment by making use of magnetometers and accelerometers. Drilling thus starts vertically into the substrate, but can change direction to drill at various angles as information regarding the substrate is received and analysed. SRS from the bunker are not used inside the magnetic calibration room.

5.2.4 General LWD Activities

Various additional activities involving LWD tools will be performed on site. Table 5-1 provides a summary of the most important activities.

Table 5-1 List and purpose of equipment / amenities / activities planned for the facility

Equipment / Area (as indicated in Figure 5-2)	Description
LWD 2Lab	Logging while drilling (LWD) Level 2 Laboratory - An advanced facility dedicated to the analysis, calibration, and optimization of LWD tools and data.
LWD Testing Area	Testing of LWD tools for functionality and performance. Use of standardized test procedures to evaluate tool performance under simulated operating conditions. System integration testing of LWD tools.
Real-time testing	Calibration and validation of real-time sensors and measurement tools to ensure accuracy and reliability during operation.
Torque machines	Calibration of torque sensors used in well logging tools to measure rotational force.
Ovens	Calibration of drilling tools' electronics to ensure they perform accurately at elevated temperatures.
10 Ton crane	Used to move heavy equipment in the workshop.
Jars test equipment	Jars testing are performed here and jars are equipment used to get LWD tools unstuck.
KITTS area	Used for the preparation of equipment that will be sent to the rig. It could include spare parts, electronics and sundry items.
GP level 1 area	Used to test and prepare the Rotary Steerable Tools used on the rig for directional drilling.
Airhang / resistar and look ahead	Resistivity tools are heated in the oven and then positioned on racks as part of the cool down calibration process. Typically the tools are left barriered off for up to 12 hours while the tools run through a calibration process.

Flow loop	The flow loop area is used to flow test the downhole tool to simulate downhole conditions. The tools are hooked up to a piping system and then readings observed while the fluid is flowing through the tools. This is a means of performing a quality check on the tools prior to shipment to the rig.
Battery storage	Spent lithium battery storage area.

5.2.1 General Administrative and Support Activities

Operating a calibration and testing facility for LWD equipment utilising SRS, involves a combination of specialized processes, safety protocols, and equipment maintenance procedures. The facility's operations are designed to prioritise safety, accuracy, and compliance with regulatory standards to mitigate potential environmental impacts. This includes periodically planned stringent safety checks, radiation monitoring and personal protective gear to ensure the well-being of both personnel and the surrounding environment.

Upon receipt of incoming radioactive materials, comprehensive inventory management procedures are employed to document and track all shipments. Trained technicians then execute calibration and testing procedures within controlled environments, adhering to strict protocols to verify the accuracy of LWD equipment. Quality assurance measures are paramount throughout these processes, with routine checks and audits conducted to uphold performance standards and regulatory compliance.

A wash bay with emergency shower will be present inside the warehouse. A washbay will also be present outside and will be connected to a three stage oil water separator. General waste generated during operations will be managed in accordance with established protocols, prioritizing proper disposal or recycling to minimise environmental impact. No radioactive waste will be produced at the facility and any damaged or obsolete sources will be contained and shipped back to the suppliers for disposal. Security measures, including access control systems and surveillance, will be implemented to safeguard the facility and its contents from unauthorized access or theft.

Detailed record-keeping practices will be maintained to document all operational activities, including calibration procedures, waste disposal, and radiation monitoring. These records will be crucial for regulatory reporting purposes and to ensure transparency in the facility's operations.

Comprehensive emergency response plans have been developed to address potential incidents effectively, with personnel trained in emergency procedures to mitigate risks promptly. Routine maintenance schedules will be established to uphold the reliability and safety of equipment and facilities, with ongoing efforts dedicated to continuous improvement and compliance with evolving regulatory standards.

5.2.2 Radioactive Materials and Management of Radioactive Exposure

The Proponent will store fifteen Cs-137 SRS with an activity of 74 GBq (2 Ci) each and five Am-241Be with an activity of 15 Ci (555 GBq) each. The radiation emanating from the facility will constantly monitored using a variety of methods. Areas where radioactive sources are stored will be delineated as controlled and supervised areas. Table 5-2 indicates the Proponent’s proposed annual dose limits compared to the best practice standards. As indicated in the table, the Proponent has set the dose limits for workers below that of the internationally accepted standards. It also indicates the investigation action levels that are levels, which if exceeded, will result in an investigation into the source or reason for this level of radiation. It therefore acts as an early warning system for operational problems or equipment failure.

Table 5-2 Radiation levels according to regulations and the Proponent's proposed implemented and action levels

Personnel	Dose Type	Namibian Regulatory Annual Dose Limit	The Proponent's Implemented Annual Dose Limit	Investigation Action Level
Radiation Worker	Whole Body Dose	20 mSv per year average over 5 years with a single year not exceeding 50 mSV per annum	40 mSV	5.0 mSV / 3 months
	Lens Dose	150 mSV*	120 mSV	5.0 mSV / 3 months
	Extremity/Skin Dose	500 mSV	400 mSV	5.0 mSV / 3 months
Non-Radiation Worker	Whole Body Dose	5 mSV	5 mSV	N/A
Member of the Public	Whole Body Dose	1 mSV	1 mSV	N/A
Embryo / Fetus**	Whole Body Dose	5 mSV	5 mSV	0.5 mSV / month

* The International Commission on Radiological Protection (ICRP) is now recommending a limit for the lens of the eye of an average of 20 mSv per year, averaged over 5 years, with no single year exceeding 50 mSv. Namibia is likely to implement this new equivalent dose in future.
**Although embryo / fetus levels are indicated, Namibia's Labour Act does not permit pregnant or females suspected of being pregnant to work with radioactive material.

The disposal of SRS occurs when the source is retired, beyond the working useful life and / or if the source is in excess of what is needed. Such an SRS will be removed from the facility and be returned to the appropriate manufacturing facility. If a confirmed or suspected leaking SRS is encountered, no movement of such an SRS will occur without prior written approval and direction from the Radiation Safety Officer. In the event of a positive test for leaking, an immediate follow-up swipe test will be conducted, and a confirmatory leak test will be arranged promptly. Upon confirmation of leakage, the affected source will be promptly removed from service. Subsequently, the source will undergo decontamination, repair or shipment back to the supplier. Additionally, the equipment associated with the leaking source will be inspected for radioactive contamination. If contamination is detected, the equipment will undergo decontamination. These planned actions prioritize swift response and adherence to safety protocols to effectively address any identified radioactive leakage issues.

6 ALTERNATIVES TO THE PROPOSED FACILITY

Various alternatives related to the project are considered and each of these alternatives are discussed. The alternatives can roughly be grouped into three main groups namely:

- Location alternatives;
- Project planning and design alternatives;
- No go alternative.

6.1 LOCATION ALTERNATIVES

The site for the proposed project is located in an industrial area, with the closest residential area located approximately 120 meters away. Based on the findings of the RIA (Appendix A), no alternative location for the proposed facility is required.

6.2 PROJECT PLANNING AND DESIGN ALTERNATIVES

The construction of an above ground storage facility, as is discussed in section 5, is the preferred and recommended option for the operations of the facility. An alternative is the construction of an underground (partial or complete) storage facility. Due to the extremely hard rock formations in the area, this will entail blasting which may in turn result in damage to nearby buildings and structures. Given that the proposed aboveground bunker's efficiency in shielding radiation is sufficient to protect nearby receptors, the belowground option is therefore not recommended. This is further supported by the security measures that will be employed which will be similar for a below- or above-ground bunker.

Two options were considered for the lining of the aboveground bunker. The bunker is a metal shipping container lined on the inside with lead. A second barrier of concrete are then added, either on the inside of the bunker, or on the outside. In terms of the bunker's ability to shield radiation, either option can be used. The Proponent can thus ultimately decide on any of the two alternatives.

The original location proposed for the bunker was in the northeast corner of the property (Alternative 1 as indicated in Figure 6-1). However, when the environmental assessment was initiated, it was proposed to move the bunker towards the current proposed location, further away from neighbours (Alternative 2 as indicated in Figure 6-1).

Additional alternatives that the Proponent can consider include the installation of a solar plant to supplement electricity supply and reduce the demand from Erongo Red. This can be complemented by installing low energy lighting and related energy savings equipment where possible.

Figure 6-1 Bunker location alternatives

6.3 NO GO ALTERNATIVE

The proposed facility and its operations will be the first of its kind in Namibia. This provides contractors and exploration and well drilling companies the opportunity to calibrate and test their LWD tools locally. Should the project not receive an environmental clearance certificate, the current offshore oil exploration industry will have to make alternative arrangements for calibration and testing of their LWD tools. This may have both time and cost implication that will negatively affect the industry. There would be no capital investment, technological and skills development and less employment opportunities. This may lead to a decrease in the spending power of the local community. Finally, less revenue will be generated for Namibia and more money will be required for outsourcing of the related activities to other countries.

7 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

To protect the environment and achieve sustainable development, all projects, plans, programmes and policies deemed to have adverse impacts on the environment require an environmental assessment, as per the Namibian legislation. The legislation and standards provided in Table 7-1 to Table 7-4 govern the environmental assessment process in Namibia and/or are relevant to the facility.

Table 7-1 Namibian law applicable to the facility

Law	Key Aspects
The Namibian Constitution	• Promotes the welfare of people • Incorporates a high level of environmental protection • Incorporates international agreements as part of Namibian law
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	• Defines the environment • Promotes sustainable management of the environment and the use of natural resources • Provides a process of assessment and control of activities with possible significant effects on the environment
Environmental Management Act Regulations Government Notice No. 28-30 of 2012	• Commencement of the Environmental Management Act • Lists activities that requires an Environmental Clearance Certificate • Provides environmental impact assessment regulations
Atomic Energy and Radiation Protection Act Act No. 5 of 2005, Government Notice No. 50 of 2005	• Regulations contained in Government Notice No. 221 of 2011 • Regulates the nuclear industry • Makes provision for impact assessment • Makes provision for licencing to transport, store and handle radioactive materials • Sets occupational and public dose limits for ionizing radiation
Water Resources Management Act Act No. 11 of 2013	• Provides for management, protection, development, use and conservation of water resources • Prevention of water pollution and assignment of liability • Water Resources Management Act Regulations of 2023
Local Authorities Act Act No. 23 of 1992, Government Notice No. 116 of 1992	• Defines the powers, duties and functions of local authority councils • Regulates discharges into sewers
Public and Environmental Health Act Act No. 1 of 2015, Government Notice No. 86 of 2015	• Provides a framework for a structured more uniform public and environmental health system, and for incidental matters • Deals with integrated waste management including waste collection disposal and recycling; waste generation and storage; and sanitation
Labour Act Act No 11 of 2007, Government Notice No. 236 of 2007	• Provides for labour law and the protection and safety of employees • Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997)

Law	Key Aspects
Petroleum Products and Energy Act Act No. 13 of 1990, Government Notice No. 45 of 1990	• Regulates petroleum industry • Makes provision for impact assessment • Petroleum Products Regulations (Government Notice No. 155 of 2000) • Prescribes South African National Standards (SANS) or equivalents for construction, operation and decommissioning of petroleum facilities (refer to Government Notice No. 21 of 2002)
Atmospheric Pollution Prevention Ordinance Ordinance No. 11 of 1976	• Governs the control of noxious or offensive gases • Prohibits scheduled process without a registration certificate in a controlled area • Requires best practical means for preventing or reducing the escape into the atmosphere of noxious or offensive gases produced by the scheduled process
Hazardous Substances Ordinance Ordinance No. 14 of 1974	• Applies to the manufacture, sale, use, disposal and dumping of hazardous substances as well as their import and export • Aims to prevent hazardous substances from causing injury, ill-health or the death of human beings
Pollution Control and Waste Management Bill (draft document)	• Not in force yet • Provides for prevention and control of pollution and waste • Provides for procedures to be followed for licence applications

Table 7-2 Municipal by-laws, guidelines and regulations

Municipal By-laws, Guidelines or Regulations	Key Aspects
Local Authorities Act, 1992 Regulation No 273 of 2017 Municipality of Swakopmund: Regulations Relating to Sewerage and Drainage	• Regulates the discharge of effluent into sewers and prohibits the introduction of certain wastes or products into the sewers system. Requires prevention measures for leakage, or escape of certain substances onto any street or any premises or into any storm water drain or watercourse without permission.
Swakopmund Town Planning Amendment Scheme No.12. July 2002	• Proposed facility is classified as a noxious industry, therefore, a consent use application has to be submitted to the Municipality of Swakopmund.

Table 7-3 Relevant multilateral environmental agreements for Namibia and the development

Agreement	Key Aspects
Statute of the International Atomic Energy Agency (IAEA), 1956.	• The IAEA is the international centre for cooperation in the nuclear field. The Agency works with its member states and multiple partners worldwide to promote the safe, secure and peaceful use of nuclear technologies. Treaties and conventions under the IAEA include: o Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, 1986 o Convention on Early Notification of a Nuclear Accident, 1986 o Convention on the Physical Protection of Nuclear Material and Nuclear Facilities, 1980 • Safety standards that provide a robust framework of fundamental principles, requirements, and guidance to ensure safety related to radioactive materials.

Agreement	Key Aspects
Stockholm Declaration on the Human Environment, Stockholm 1972.	- Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment.
Stockholm Declaration on the Human Environment, Stockholm 1972.	- Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment.
1985 Vienna Convention for the Protection of the Ozone Layer	- Aims to protect human health and the environment against adverse effects from modification of the Ozone Layer are considered. - Adopted to regulate levels of greenhouse gas concentration in the atmosphere.
United Nations Framework Convention on Climate Change (UNFCCC)	- The Convention recognises that developing countries should be accorded appropriate assistance to enable them to fulfil the terms of the Convention.
Convention on Biological Diversity, Rio de Janeiro, 1992	- Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity.

Table 7-4 Standards or codes of practise

Standard or Code	Key Aspects
International Atomic Energy Agency (IAEA) Standards	- The IAEA standards involves adherence to comprehensive sets of guidelines to ensure the safe and secure use of nuclear technology. - Such standards involves guidelines to develop protocol for: o Radiation Protection o Nuclear facility safety o Emergency Preparedness and response o Security of nuclear material and facilities o Regulatory framework

The project is listed as an activity requiring an environmental clearance certificate as per the following points from:

Section 1 of Government Notice No. 29 of 2012: Energy Generation, Transmission and Storage Activities

- 1. (d) “nuclear reaction, including production, enrichments, processing, reprocessing, storage or disposal of nuclear fuels, radioactive products and waste.” – **The Proponent will store radioactive materials on site.**

Section 9 of Government Notice No. 29 of 2012: Hazardous Substance Treatment, Handling and Storage

- 9.1 “The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.” **The Proponent will store radioactive source material diesel for the backup generator on site.**
- 9.5 “Construction of filling stations or any other facility for the underground and aboveground storage of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin.” **The Proponent will store radioactive source material and diesel for the backup generator on site.**

8 ENVIRONMENTAL CHARACTERISTICS

This section lists pertinent environmental characteristics of the study area and provides a statement on the potential environmental impacts on each.

8.1 LOCALITY AND SURROUNDING LAND USE

The facility is located on erf 3954 on Einstein Street in Swakopmund (-22.6700, 14.5448) (Figure 1-1). The property is situated within the municipal area of Swakopmund and is currently zoned as general industrial. Access to the site is gained via Einstein Street. The greater area is generally classified as a general industrial area.

The adjacent land uses are listed in Table 8-1 and Figure 8-1. There are no heritage or cultural sites located on, or in close proximity to the site.

Table 8-1 Direct surrounding land use

Map No.	Direction	Land Use	Neighbour
1	East	Industrial	QCrete Readymix Concrete
2 & 3	South	Industrial	Currently empty erven of Namibia Breweries Ltd
4	West	Industrial	Currently empty erf of Kristian H Woker
5 & 6	North	Railway / Industrial	Railway line, no direct neighbour, with Industrial Investment 625 opposite the railway

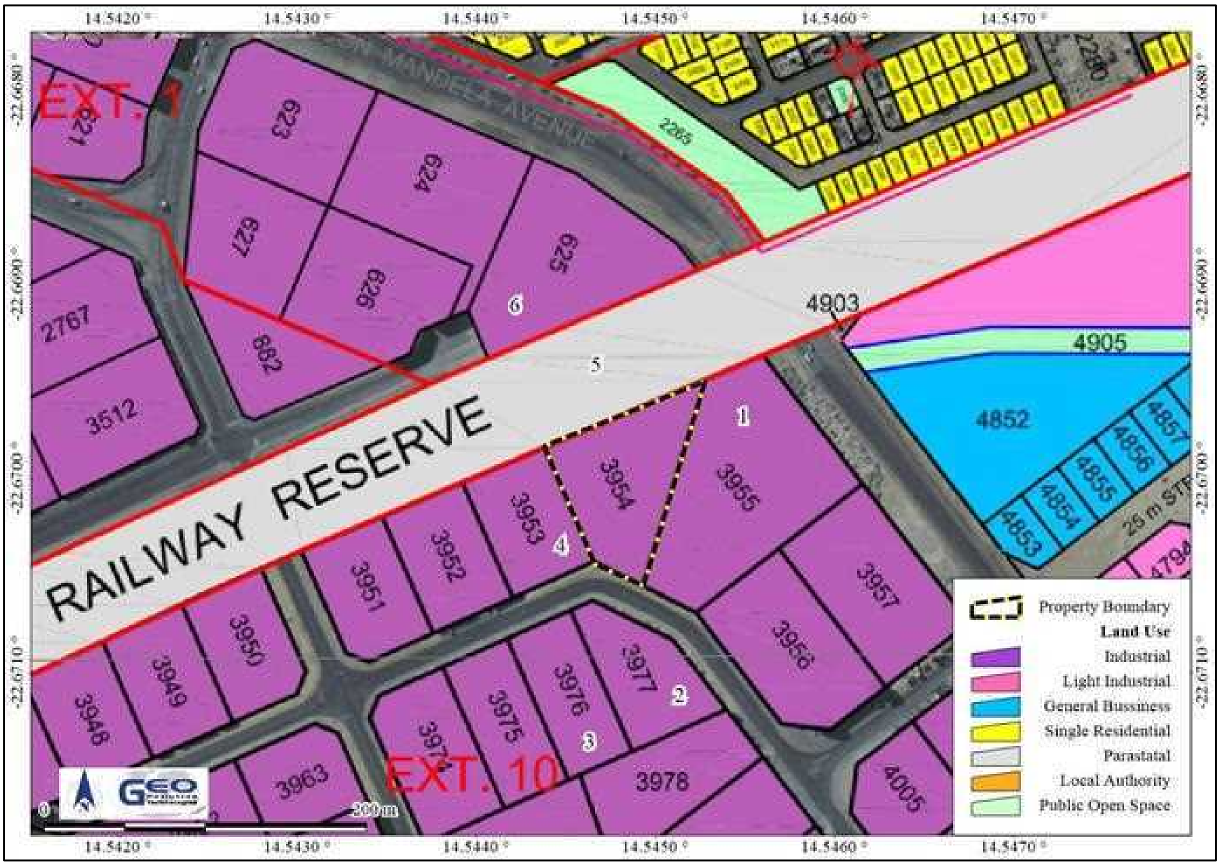


Figure 8-1 Surrounding land use

Implications and Impacts

The site is situated in an area zoned for general industrial purposes. Given the radioactive nature of the sources to be stored and handled on site i.e. noxious substances, consent is required from the Municipality for the proposed operations. Based on the safety protocols and safety distances to neighbours, no impact is expected on nearby receptors.

8.2 CLIMATE

According to the Köppen-Geiger Climate Classification system the project is located in a cold desert climate (BWk) (http://koeppen-geiger.vu-wien.ac.at/present.htm). This means that the area receives precipitation well below potential evapotranspiration and no more than 200 mm of precipitation annually, with a mean annual temperature of less than 18 °C. Average rainfall received range from 0 to 100 mm/a, with a variation of more than 100%. Monthly rainfall peaks in March. The potential evapotranspiration is 1,700 to 1,800 mm/a. By dividing the mean annual potential evapotranspiration into the mean annual precipitation, an aridity index value for the area was computed as 0, which indicates the area to be hyper arid. Thick fog or low stratus clouds are a regular occurrence in Swakopmund. This is due to the influence of the Benguela Current and forms the major source of water for the succulent and lichen flora in the Namib Desert.

The average annual minimum temperature is 10 to 12 °C, while the average annual maximum temperature is 26 to 28 °C, with an average annual temperature range of 16 to18 °C. An average diurnal temperature (difference between daily minimum and maximum temperature) for this area is around 10 to12 °C. Direct normal solar irradiance for the area is 5.084 kWh/m²/day.

Namibia is situated within an anti-cyclone belt of the Southern Hemisphere. Winds generated from the high-pressure cell over the West Coast Ocean blow from a southerly direction when they reach the Namibian coastline. As the Namibian interior is warm (particularly in summer), localised low-pressure systems are created which draws the cold southerly winds towards the inland desert areas. These winds manifest themselves in the form of strong prevailing south-westerly winds, which range from an average of 20 knots (37 km/h) during winter months to as high as 60 knots (110 km/h) during the summer. Winds near Swakopmund display two main trends; high velocity and frequency south to south-westerly winds in summer and high velocity, low frequency east to north-easterly winds during winter (Figure 8-2). During winter, the east winds generated over the hot Namib Desert have a strong effect on temperature resulting in temperature in the upper 30's degrees Celsius and tend to transport plenty of sand.

Table 8-2 Summary of climate data for Swakopmund (Atlas of Namibia)

Classification of climate	Desert
Precipitation	0-50
Variation in annual rainfall (%)	> 100
Average annual evaporation (mm/a)	2,600-2,800
Water deficit (mm/a)	1,701–1,900
Temperature °C	<16

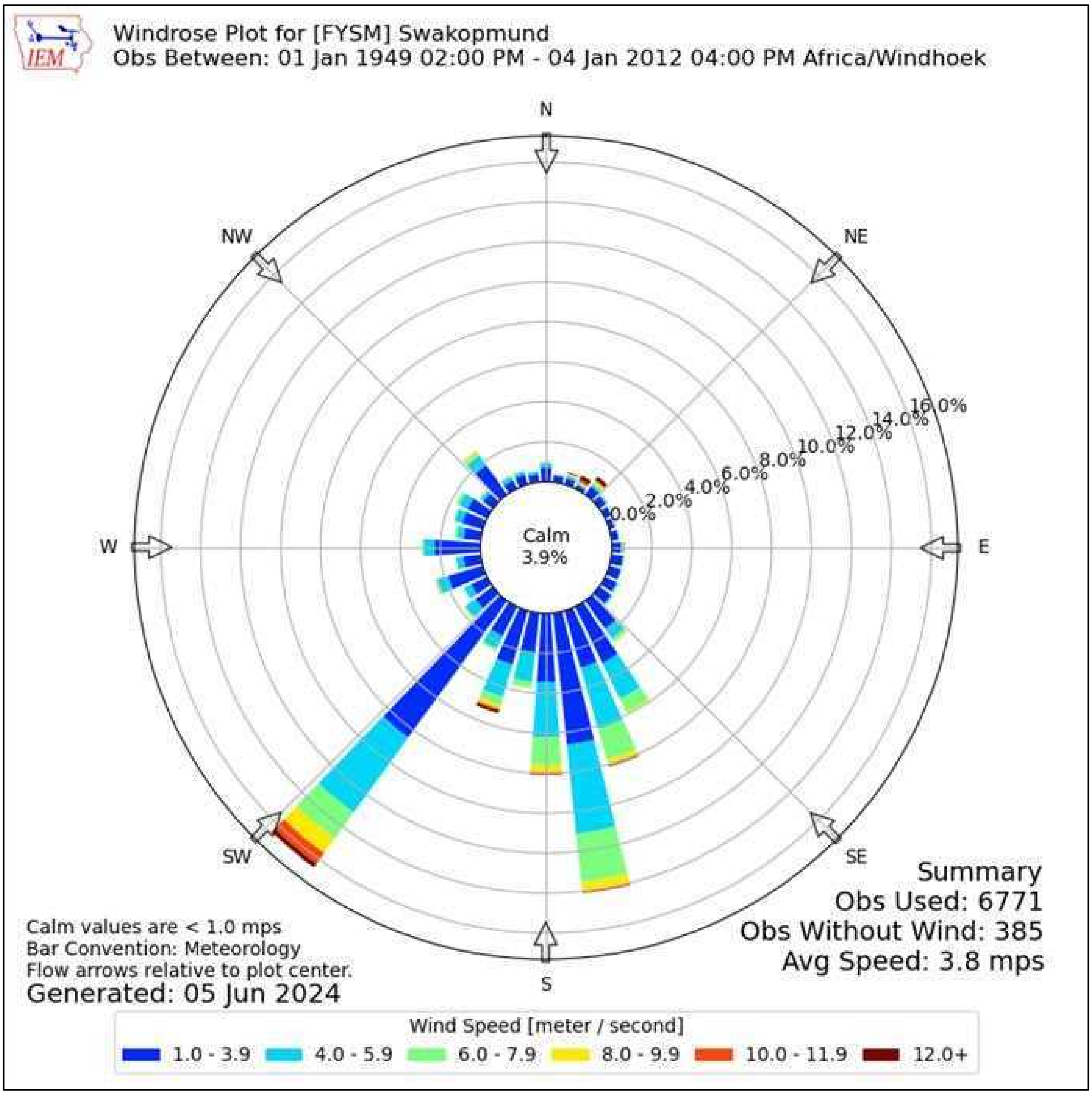


Figure 8-2 Wind rose (http://mesonet.agron.iastate.edu, 2024)

Average Monthly Rainfall (mm)											
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
0.2	**0.3**	**0.5**	**0.8**	**1.1**	**0.4**	**6.3**	**5.4**	**13.1**	**4.2**	**1.1**	**0.9**

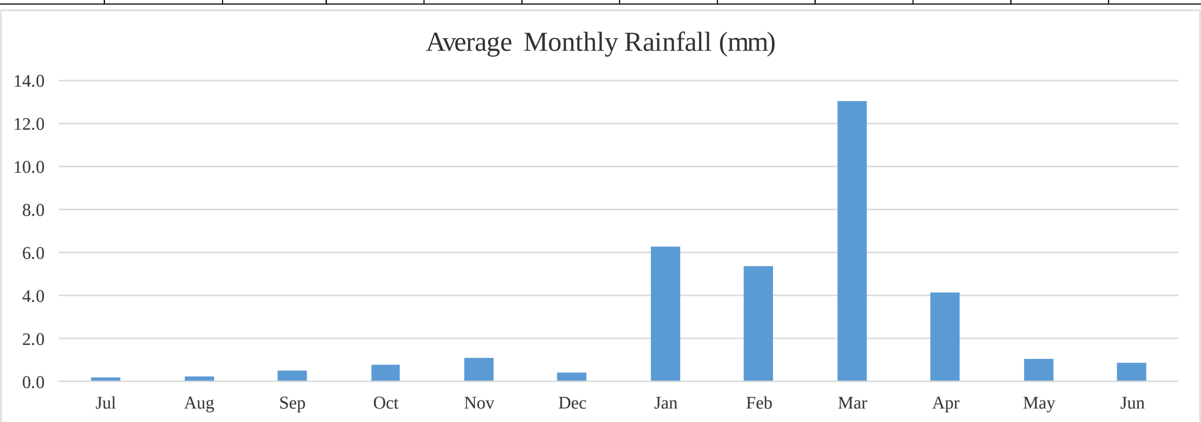


Figure 8-3 Monthly average rainfall

Implications and Impacts
The facility is not expected to be impacted by the typically expected weather conditions in Swakopmund.

8.3 CORROSIVE ENVIRONMENT

The corrosive environment of Swakopmund can be closely related to that of Walvis Bay. The corrosive environment, which may be attributed to the frequent salt-laden fog, periodic winds and abundance of aggressive salts (dominantly NaCl and sulphates) in the soil. The periodic release of hydrogen sulphide (H_2S) from the ocean is expected to contribute to corrosion (see Table 8-3 for corrosion comparison data with other centres).

Table 8-3 Average annual corrosion rate for various metals in different locations in southern Africa (from Nickel Development Institute: Stainless Steels in Architecture, Building and Construction. http://www.nickelinstitute.org)

	Pretoria CSIR	**Durban Bay**	**Cape Town Docks**	**Durban Bluff**	**Walvis Bay**	**Sasolburg**
Environment						
Location Type	Rural, Very low pollution	Marine, Moderate Pollution	Marine, Moderate Pollution	Severe marine, moderate or low pollution	Severe marine, low pollution	Industrial high pollution
SO_2 Range µg/m$_3$	6-20	10-55	19-39	10-47	NA	NA
Fog days/year	NA	NA	NA	NA	113.2	NA
Avg. rainfall (mm/year)	146	1,018	508	1,018	8	677
Relative humidity range %	26-76	54-84	52-90	54-84	69-96	49-74
Temp. Range °C	6-26	16-27	9-25	16-27	10-20	5-20
Unpainted galvanized steel life, years	5-15	3-5	3-7	3-5	0.6-2	5.-15
	Annual Corrosion Rate (mm/year)					
Stainless Steel						
Type 316	0.000025	0.000025	0.000025	0.000279	0.000102	NA
Type 304	0.000025	0.000076	0.000127	0.000406	0.000102	NA
Type 430	0.000025	0.000406	0.000381	0.001727	0.000559	0.000107
Aluminium Alloys						
AA 93103	0.00028	0.00546	0.00424	0.01946	0.00457	0.00281
AA 95251	0.00033	0.00353	0.00371	0.01676	0.00417	NA
AA 96063	0.0028	0.00315	0.00366	0.020	0.00495	NA
AA 96082	0.00033	0.00366	0.0034	0.02761	0.00587	NA
AA 85151	NA	NA	NA	0.0246	0.00375	0.00317
Copper	0.00559	0.0094	0.00711	0.0246	0.0384	0.014
Zinc	0.0033	0.0231	0.029	0.111	NA	0.0152
Weathering Steel	0.0229	0.212	0.0914	0.810	1.150	0.107
Mild Steel	0.0432	0.371	0.257	2.190	0.846	0.150

Implications and Impacts
The combination of high moisture and salt content of the surface soil can lead to rapid deterioration of subsurface metal (e.g. pipelines) and concrete structures. Chemical weathering of concrete structures due to the abundant salts in the soil is a concern.

8.4 TOPOGRAPHY AND DRAINAGE

The landscape is classified as being in a flat western coastal plain composed of mobile dunes and gravel sandy plains, an area of dissection and erosional cutback. The local landscape is thus generally flat with poorly developed drainage systems. The site and surrounding areas themselves are also generally flat and levelled for township development. The site is not located within a river catchment and surface runoff would be in a north-westerly direction towards the Atlantic Ocean (Figure 8-4). Erf 3954 has a very small catchment area and the entire surface drainage pattern of the larger area is significantly impacted by infrastructure development.

Figure 8-4 Surface drainage

The site is located about 11 m above the bed of the Swakop River at the river's narrowest point as dissected by line A-B in Figure 8-5. An obstruction in the river at this point will have to be in excess of 10 m high and more than 300 metres wide, before water will start inundating the built areas on the river banks. Such flood waters will not reach the project location as it will flood most of Swakopmund's lower lying areas (all west of the project location) and flow westwards into the ocean. A similar cross section is indicated at another point higher up in the river (line C-D in Figure 8-5).

Implications and Impacts

Any pollutants that are not contained and are transported via surface water flow will be transported out of the site via the storm water drainage lines and potentially pollute the surrounding environment. Therefore, the storage and use of radioactive material must be strictly controlled.

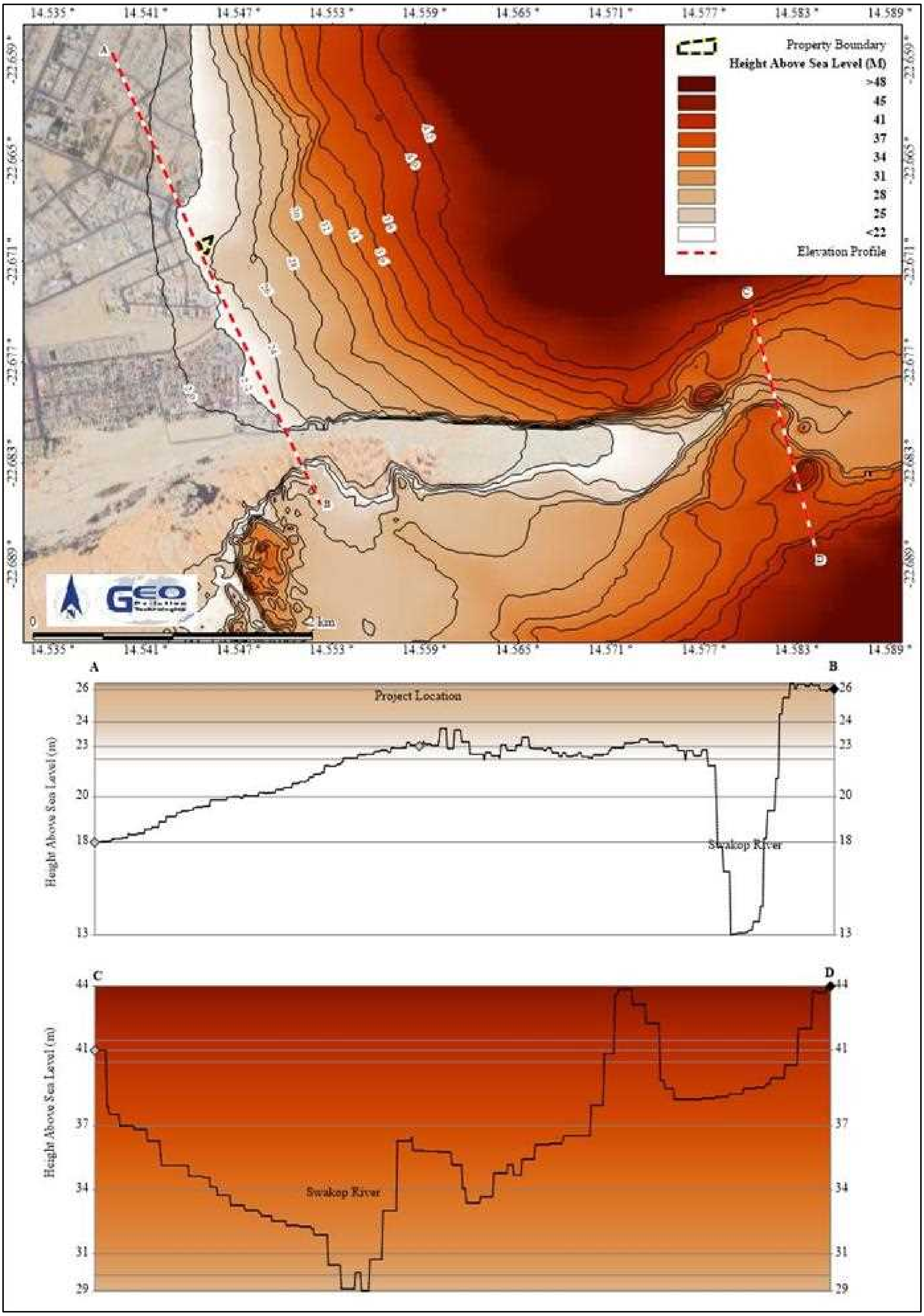
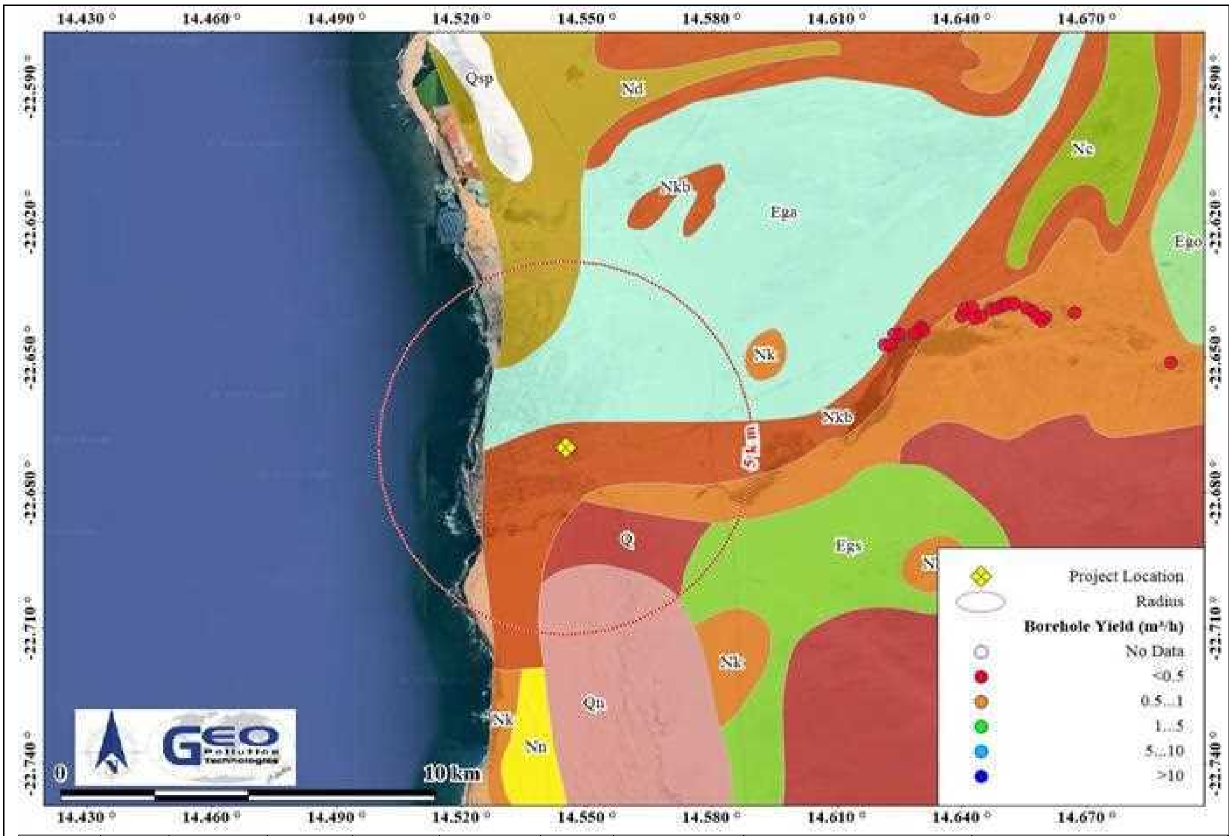


Figure 8-5 Topography and elevation above the Swakop River bed

8.5 GEOLOGY AND HYDROGEOLOGY

The dominant surface soil cover in the area is petric Gypsisols. Local geology in the area consists of marble, schist, ortho-amphibolite, quartzite, dolerite sills and dykes of the Namibian Age – Karibib Formation of the Swakop Group. Surface geology at the site consists of coarse brown sand. Groundwater flow would be mainly through primary porosity in the topsoil cover and along fractures, faults and other geological structures (secondary porosity) present within the underlying hard rock formations.

Groundwater flow from the site can be expected in a westerly direction towards the Atlantic Ocean. Local flow patterns may vary due to groundwater abstraction. No known boreholes are located within a 5 km radius from the site.



LITHCODE	AGE	FORMATION	SEQUENCE	GROUP	SUBGROUP	SUITE	INTRUSIVE_UNIT	ROCKTYPES	REMARKS
Ega	Cambrian					Red Granite		Syn- to post-tectonic gneissic red granite	
Ego	Cambrian					Red Granite	Ozombanda Granite	Post-tectonic homogeneous red granite	
Egs	Cambrian					Salem		Syn- to post-tectonic granite, granodiorite, monzonite, diorite	
Nc	Namibian	Chuos	Damara	Swakop/Otavi	Khomas/Tsumeb			Mixtite, minor schist, shale, quartzite, iron-formation, ortho-amphibolite, graphitic schist	
Nd	Namibian		Damara			SALEM		Schist, marble, quartzite, conglomerate, graphitic schist	Undifferentiated Swakop and Nosib Groups
Nk	Namibian	Kuiseb	Damara	Swakop	Khomas			Mica schist, minor quartzite, graphitic schist, marble	
Nkb	Namibian	Karibib	Damara	Swakop	Khomas			Marble, schist, ortho-amphibolite, quartzite	
Nn	Namibian		Damara	Nosib				Quartzite, conglomerate, schist, marble	
Q	Quaternary							Alluvium, sand, gravel, calcrete	
Qn	Quaternary			Namib				Sand sea of the Namib Desert	
Qsp	Quaternary							Coastal salt pan	

Figure 8-6 Geology

Implications and Impacts

Groundwater is not utilised in the area. Pollution of the groundwater is however still prohibited. Spill control structures installed and maintained to IAEA specifications or better would successfully prevent pollution of groundwater, surface water or soil.

8.6 PUBLIC WATER SUPPLY

Water to Swakopmund town is supplied by NamWater and is sourced from the Omdel Dam and Erongo Desalination Plant. The Omdel Dam (Omaruru Delta Water Scheme) is situated in the Omaruru River, about 30 km northeast of Henties Bay, on the C35 to Uis. The Erongo Desalination Plant is located 35 km north of Swakopmund near Wlotzkasbaken. No groundwater is abstracted for potable use in Swakopmund. The area does not fall within a Groundwater Control Area; however groundwater remains the property of the Government of Namibia.

Implications and Impacts

The facility is not expected to have an impact on public water supply. Furthermore it must adhere to national and internationally prescribed standards which should successfully prevent any contamination, leaks and structural damage.

8.7 ECOLOGY

It lies on the western edge of the Namib Desert Biome (Giess 1971), with the cold Atlantic Ocean to the west. The dry Namib Desert and cold Atlantic Ocean largely determine water availability and vegetation, and thus also animal biodiversity. The project location is situated in the transitional area between the Southern Desert and Central Desert vegetation types (Mendelsohn 2002), but is within a serviced and developed urban area. As such, the biodiversity in the immediate vicinity of the project area is significantly altered by anthropogenic activities.

The Namib Desert characterises the west of Namibia and stretches from north-western South Africa, along the entire Namibian coast, and into the southwest of Angola. The desert area around Swakopmund can broadly be divided into the Walvis Bay – Swakopmund dune belt, the Gravel Plains of the Central Namib, and the ephemeral Swakop River forming a boundary between the two. A narrow beach zone (the coastal plain), associated with a hummock dune belt and small isolated salt flats, is found south and north of Swakopmund. The coastline, forming the western boundary of Swakopmund, is mostly a sandy shoreline south of Patrysberg some 7 km away, with a rocky shoreline interspersed with sandy beaches from Patrysberg to north of Swakopmund.

The ecology of the area is largely influenced by the climatic conditions characterised by low and unpredictable rainfall with regular occurrences of fog. Many living organisms have thus largely evolved to survive with limited surface water by harvesting fog, or by obtaining water from food, as main source of water. As a result species richness and abundance are relatively low with a high level of endemism. Many species have also evolved to survive in areas with very specific conditions (micro-habitats), and are thus often range restricted.

While vertebrates are relatively well documented throughout Namibia, inventories of invertebrates are relatively patchy, and often associated with specific project areas (e.g. mines that conducted impact assessments). The desert conditions are more favourable to arthropods and reptiles while mammals are limited to relatively few desert adapted species. Birds are also largely associated with the coastline and river courses. The dunes of the Namib Sand Sea are relatively uninhabited while the gravel plains have increased diversity on rocky outcrops and in drainage lines with increased vegetation. Rocky outcrops include inselbergs and dolerite ridges where habitat differentiation is more pronounced.

Implications and Impacts

The facility is located within an already disturbed urban area. Thus no immediate threat to biodiversity in the area is expected, however, uncontrolled pollution may and can cause damage to any biodiversity surrounding the site. Structures may be used by birds for roosting or nesting. It is not foreseen that the facility’s operations will impact birds.

8.8 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

According to the preliminary results of the 2023 Population and Housing Census (National Planning Commission, 2024) the Erongo region has 240,206 people of which 44,725 resides in Swakopmund. Economic activities relate mostly to tourism and businesses within the area and around the site. The town is known as a tourist and commercial area.

Table 8-4 Demographic characteristics of Swakopmund, the Erongo Region and Nationally (Namibia Statistics Agency, 2024)

	Swakopmund	Erongo Region	Namibia
Population (Males)	37,950	122,322	1,474,224
Population (Females)	37,971	117,884	1,548177
Population (Total)	75,921	240,206	3,022401
Labour Force Participation Rate (2014) (15+ years)	Not available	79.7%	69.1
Literacy (2015) (15+ years)	Not available	94.4%	87.4%
Households considered poor (2015)	N/A	Not available	17.4%

Implications and Impacts

The facility provides employment to people from the area. Skills development and training will also benefit employees during the operational phase.

8.9 CULTURAL, HERITAGE AND ARCHAEOLOGICAL ASPECTS

There are no church, mosques or related buildings in close proximity to the site. No known archaeological resources have been noted in the vicinity since the urbanisation of the area. No other structures, sites or spheres of heritage of cultural significance was determined to be in close proximity to the site.

9 PUBLIC CONSULTATION

Consultation with the public forms an integral component of an environmental assessment investigation and enables Interested and Affected Parties (IAPs) e.g. neighbouring landowners, local authorities, environmental groups, civic associations and communities, to comment on the potential environmental impacts associated with the facility and to identify additional issues which they feel should be addressed in the environmental assessment.

Public participation notices were advertised twice in two weeks in the national papers: The Namibian Sun and Republikein on 7 and 14 February 2024. A site notice was placed on site and notification letters delivered to neighbours. The Swakopmund Municipality and the NRPA in the Ministry of Health and Social Services were also notified and both responded with regards to the notification. See Appendix B for proof of the public participation processes, registered IAPs, feedback and comments and responses table.

The public participation discussions regarding a proposed nuclear storage facility have been marked by spreading of misinformation and thus by significant resistance and scepticism. The public understood the project to be one for the storage of radioactive **waste**, which it clearly is not. Despite efforts to engage the community and provide correct information about the project, as well as its value (benefits), the safety measures of such a facility, there continued to be widespread apprehension and opposition. This also resulted in several radio stations and newspapers reporting on the so called radioactive **waste** storage facility. Nevertheless, the public's reluctance to accept the nuclear storage facility primarily stems from safety concerns and the potential risks associated with storing of radioactive source material in their vicinity. Past incidents at other nuclear facilities (internationally), have exacerbated these fears and fuelled distrust in assurances provided. Moreover, there is a lack of confidence in the transparency of decision-making processes and doubts about the adequacy of risk assessments conducted. Many members of the public feel marginalised and believe that their voices are not being adequately heard or considered in the decision-making process.

In order to foster greater public acceptance and trust, there is a clear need for transparent communication, robust risk assessment procedures, and meaningful engagement with the affected communities. Building consensus and addressing concerns will be crucial in moving forward with the establishment of the storage facility. As such, written communication (Appendix B) was provided to all registered parties, to assure them that all due processes to adequately assess the risks related to the project will be addressed, and that all permits and approvals will be in place before any radioactive material will be allowed on site. This was also stipulated in a radio interview on one of the private radio stations covering large parts of Namibia and Swakopmund in particular.

Upon completion of the EIA/ERMP and RIA, the documents were circulated to all registered IAPs for review. Of all IAPs registered, and those who commented during the public participation notification phase, only two IAPs commented on the circulated EIA/ERMP and RIA documents. There comments and responses to those comments are presented in Appendix C.

10 MAJOR IDENTIFIED IMPACTS

During the environmental assessment a number of potential impacts involved in the storage and handling of radioactive source materials, and the Proponent's project in general, were identified. These are discussed in this section.

10.1 RADIATION FROM RADIOACTIVE ISOTOPES

Radiation exposure is a significant concern associated with facilities handling radioactive source materials. Radioactive materials emit ionizing radiation, which can penetrate human tissue and cause various health effects. Such exposure can be low doses over long periods or acute high doses in a short period of time. Acute exposure is not likely for the current project, but, if the necessary safety measures are not implemented, low level exposure may be likely, mainly for employees on site.

Low-level radiation exposure, while typically less harmful than high-level exposure, can still have potential impacts on human health and the environment. Some of the potential impacts from low-level radiation exposure include contamination of soil, water, and ecosystems, potentially affecting wildlife and plant species. This contamination may persist for extended periods, impacting biodiversity and ecosystem functioning; low-level radiation exposure may trigger regulatory responses, including increased monitoring, restrictions on land use, and clean-up efforts. These measures can have economic implications for affected industries and communities; and impacts on human health and the environment (see section 10.5 for more details on health impacts).

Effective risk communication, monitoring, and mitigation strategies are thus essential for preventing these impacts and protecting public health and environmental quality.

10.2 NOISE IMPACTS

Construction Phase: During the construction phase of the facility, noise levels may increase due to activities such as site preparation, building construction, and installation of equipment. This can result in temporary disturbances to nearby residents or businesses.

Operational Phase: Once operational, the facility may generate ongoing noise from machinery, equipment operation, and vehicle movements. This continuous noise can impact surrounding areas, particularly if the facility operates around the clock or during night time hours. Noise mitigation measures such as sound barriers, acoustic enclosures, and scheduling noisy activities during off-peak hours may be necessary to minimize impacts on nearby residential area or sensitive receptors.

10.3 TRAFFIC IMPACTS

Construction Phase: Construction activities may lead to increased traffic in the vicinity of the facility, including heavy vehicles transporting construction materials and equipment to and from the site. This can result in congestion, road disruptions, and potential safety hazards for pedestrians and other road users.

Operational Phase: Once operational, the facility may generate regular traffic from employees, visitors, and service vehicles accessing the site. Increased traffic volumes can impact local road networks. Traffic management measures such as designated access points, parking facilities, and transportation planning may be implemented to minimize traffic impacts and ensure safe and efficient movement of vehicles in the area.

10.4 FIRE

Construction Phase: Construction activities involving welding, cutting, or other hot work processes can increase the risk of fire incidents on-site. Adequate fire prevention measures, such as fire extinguishers, fire blankets, and trained personnel, should be in place to mitigate the risk of fires during construction.

Operational Phase: The storage and handling of certain materials, including flammable substances or hazardous chemicals, may pose a fire hazard during the operational phase of the facility. Fire prevention measures such as fire detection systems, sprinkler systems, emergency response plans, and training for staff on fire safety protocols should be implemented to minimize the risk of fires and ensure prompt response in case of emergencies. The bunker itself is constructed from materials that are not flammable and the risk of a fire affecting its integrity is considered negligible.

10.5 HEALTH

Radioactive contamination can also pose health risks to nearby communities if radioactive materials migrate off-site through groundwater or air dispersion. Exposure to radiation can lead to various health issues, including increased cancer risks and other radiation-related illnesses (Shimura *et al.*, 2018).

Radiation Sickness: Acute exposure to high levels of ionizing radiation can result in radiation sickness, also known as acute radiation syndrome (ARS). Symptoms of ARS include nausea, vomiting, fatigue, weakness, and potentially life-threatening conditions such as bone marrow suppression, gastrointestinal damage, and neurological impairment. The severity of symptoms depends on the dose of radiation received and the duration of exposure (CDC, 2024).

Cancer: Prolonged exposure to low doses of ionizing radiation increases the risk of developing cancer, particularly leukaemia, thyroid cancer, and various solid tumours. Radiation damages DNA in cells, leading to mutations that can initiate the development of cancerous cells (Thomas and Symonds, 2016; Morgan and Sowa, 2015). The latency period between radiation exposure and the onset of cancer can be several years or even decades, making it challenging to attribute specific cases of cancer to radiation exposure (Mukherjee and Mircheva, 1991).

Genetic Damage: Radiation exposure can cause mutations in the DNA of reproductive cells (sperm and eggs), leading to hereditary genetic damage in offspring. This genetic damage may manifest as birth defects, developmental abnormalities, or an increased risk of cancer in future generations. It is important to note that the risk of hereditary effects from radiation exposure is generally considered to be low compared to the risk of somatic effects (effects on the exposed individual) (UNSCEAR 2001).

Chronic Health Effects: Long-term exposure to low levels of ionizing radiation can also increase the risk of chronic health effects, including cardiovascular disease, cataracts, and non-cancerous thyroid disorders. These effects may result from the cumulative damage to tissues and organs caused by continuous exposure to radiation over time (Thomas and Symonds, 2016; Kamiya *et al.,* 2015).

Occupational Hazards: Workers at facilities handling radioactive materials are at increased risk of radiation exposure compared to the general population. Proper safety measures, including the use of shielding, personal protective equipment, monitoring devices, and adherence to radiation safety protocols, are essential to minimize occupational exposure and ensure worker safety (Thomas and Symonds, 2016; Kamiya *et al.,* 2015).

Public Health Concerns: In addition to occupational exposure, there may be concerns about potential radiation exposure to the surrounding community, particularly if there are accidents, leaks, or releases of radioactive materials from the facility. Emergency response plans and public communication strategies are necessary to address these concerns and mitigate the potential impacts on public health.

The RIA (Appendix B) discusses the risk to workers and the public as a result of the proposed facility and its operations. It reached two main conclusions: 1) that under normal operations of the facility there is no risk to the public, including direct neighbours; and 2) that under normal operations and by implementing the necessary safety and security measures, the exposure of workers to radiation is within the prescribed limits of Namibia and the IAEA.

10.6 SOCIO-ECONOMIC IMPACTS

Concerns about radiation exposure, even at low levels, can lead to anxiety, stress, and psychological distress among affected individuals and communities. Fear of radiation-related health effects may also influence behaviours and decision-making.

Employment Opportunities: The facility would likely create job opportunities during both the construction and operational phases. Construction activities would require labour for site preparation, building construction, and installation of equipment, while operational activities would provide employment for technicians, engineers, administrative staff, and other support personnel. This could contribute to reduced unemployment rates and increased household income within the local community.

Skills Development: The facility could also facilitate skills development and training opportunities for local residents. Training programs may be offered to equip workers with the necessary skills and qualifications to work in various roles within the facility, enhancing their employability and potential for career advancement. This could contribute to the overall human capital development in the region.

Business Opportunities: The presence of the facility could stimulate business opportunities for local suppliers, contractors, and service providers. Local businesses may benefit from contracts for supplying materials, equipment, or services to support facility operations. This could foster entrepreneurship, economic diversification, and growth in the local business community.

Revenue Generation: The facility would contribute to local government revenue through various channels, including property taxes, licensing fees, and permits. This additional revenue could be allocated towards funding public services, infrastructure development, and community projects, thereby enhancing the overall quality of life for residents in Swakopmund.

Housing Demand: The influx of workers employed by the facility may increase demand for housing in Swakopmund, leading to opportunities for real estate development and investment. This could drive growth in the construction sector and stimulate the local housing market, albeit potentially putting pressure on affordable housing options for low-income residents.

Community Engagement and Corporate Social Responsibility (CSR): The facility could engage with the local community through CSR initiatives, such as supporting education, healthcare, environmental conservation, or social welfare programs. Engaging in community development projects and initiatives can foster positive relationships between the facility and the local community, enhancing social cohesion and corporate reputation.

Infrastructure Development: The facility may necessitate upgrades or expansions to existing infrastructure, such as roads, utilities, and telecommunications, to support its operations. Infrastructure investments could enhance connectivity, accessibility, and overall infrastructure quality in Swakopmund, benefitting both the facility and the broader community.

11 ASSESSMENT AND MANAGEMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts that are expected from the operational, construction (upgrades, maintenance, etc. – see glossary for "construction") and potential decommissioning activities of the facility. An Environmental Management Plan based on these identified impacts are also incorporated into this section.

For each impact an Environmental Classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). Impacts are assessed according to the following categories: Importance of condition (A1); Magnitude of Change (A2); Permanence (B1); Reversibility (B2); and Cumulative Nature (B3) (see Table 10)

Ranking formulas are then calculated as follow:

Environmental Classification = A1 x A2 x (B1 + B2 + B3)

The environmental classification of impacts is provided in Table 11.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Table 11-1 Environmental classification of impacts according to the Rapid Impact Assessment Method of Pastakia 1998

Environmental Classification (ES)	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

Table 11-2 Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit / disbenefit of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative disbenefit or change	-2
Major disbenefit or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3

Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2
Strong Cumulative Character	3

11.1 RISK ASSESSMENT AND ENVIRONMENTAL AND RADIATION MANAGEMENT PLAN

The ERMP provides management options to ensure impacts of the facility is minimised. An ERMP is a tool used to take pro-active action by addressing potential problems before they occur. The ERMP is partly based on the operator specific operational procedures and radiation management plan (RMP) presented in Appendix D. The ERMP and RMP should limit the corrective measures needed, although additional mitigation measures might be included if necessary. The environmental management measures are provided in the tables and descriptions below. These management measures should be adhered to during the various phases of the operation of the facility. This section of the report can act as a stand-alone document. All personnel taking part in the operations of the facility should be made aware of the contents in this section, so as to plan the operations accordingly and in an environmentally sound manner.

The objectives of the ERMP are:

- to include all components of construction activities (construction, upgrades, maintenance, etc.) and operations of the facility;
- to prescribe the best practicable control methods to lessen the environmental impacts associated with the project;
- to monitor and audit the performance of operational personnel in applying such controls; and
- to ensure that appropriate environmental training is provided to responsible operational personnel.

Various potential and definite impacts will emanate from the construction, operations and decommissioning phases. The majority of these impacts can be mitigated or prevented. The impacts, risk rating of impacts as well as prevention and mitigation measures are listed below.

As depicted in the tables below, impacts related to the operational phase are expected to mostly be of medium to low significance and can mostly be mitigated to have a low significance. The extent of impacts are mostly site specific to local and are not of a permanent nature. Due to the nature of the surrounding areas, cumulative impacts are possible and include groundwater contamination and health risks and radiation impacts.

11.1.1 Planning

During the phases of planning for future operations, construction and decommissioning of the facility, it is the responsibility of Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management measures are in place prior to and during all phases, to ensure potential impacts and risk are minimised. The following actions are recommended for the planning phase and should continue during various other phases of the project:

- Ensure that all necessary permits from the various ministries, local authorities and any other bodies that governs the construction and operational activities of the project are in place and remains valid.
- Ensure all appointed contractors and employees are enter into an agreement which includes the ERMP. Ensure that the contents of the ERMP are understood by the contractors, sub-contractors, employees and all personnel present or who will be present on site.
- Make provisions to have a radiation safety officer (RSO) on site who will be responsible for implementation of relevant standards for the storage, use and shipping of radioactive sources. The RSO oversees the local radiation monitoring program for

the area and personnel and ensures all local personnel are trained as per global requirements

- Make provisions to have a health, safety and environmental (HSE) coordinator to implement the ERMP and oversee occupational health and safety as well as general environmental and radiation related compliance at the site.
- Make provisions to have a community liaison officer on site who will handle complaints and community input, and through whom, where reasonable, monitoring data can be requested. Communicate the contact details of the community liaison officer to interested and affected parties when the project is initiated.
- Have the following on site, reasonable, to deal with all potential emergencies:
  - Radiation management plan / ERMP / emergency response plans and HSE manuals
  - Emergency response equipment, first aid kits, fire detection and firefighting equipment, dosimeters, security systems, etc.
  - Adequate protection and indemnity insurance cover for incidents.
- If one has not already been established, establish and maintain a fund for future ecological restoration of the project site should project activities cease and the site is decommissioned and environmental restoration or pollution remediation is required.
- Establish and / or maintain a reporting system to report on aspects of construction activities, operations and decommissioning as outlined in the ERMP.
- Prepare and submit environmental monitoring reports as per the conditions of the environmental clearance certificate.
- Appoint a specialist environmental consultant to update the environmental assessment and ERMP and apply for renewal of the ECC prior to expiry.

The typical main RSO and HSE tasks of international companies who may utilise the LWD tool calibration and testing facility are presented in

Table 11-3 Main RSO and HSE tasks at country, regional and global level

Level	Position	Task
Country	RSO	Implementation of relevant standards for the storage, use and shipping of radioactive sources. The RSO oversees the local radiation monitoring program for the area and personnel and ensures all local personnel are trained as per global requirements.
	HSE	Responsible for ensuring all radioactive activities are conducted as per local HSE requirements as outlined in the local emergency response plan.
Region	RSO	Reviews country quarterly audits, ensure training requirements are as per standards.
	HSE	Supports the country HSE in implementing HSE standards and reviewing local emergency response plan.
Global	RSO	Implements and reviews global standards, ensure RSO training is active and appointment letters for RSO are approved. Responsible to reviewing any non-conformance events. Oversees the radiation monitoring program implemented in each country
	HSE	Communicates the company strategy relating to radioactive source usage

11.1.2 Employment

Appointment of consultants already realises during the planning phase. This include those responsible for design, engineering and permitting (e.g. town planning and environmental). During the construction phase, various contractors will be appointed to, among others, transport building materials and equipment to the site, upgrade, construct and install various components of the warehouse and related support infrastructure, installation of services, etc. Local consultants, contractors, and their employees, are thus supported, and their livelihoods sustained, during the planning and construction phases. Some aspects may require expertise not locally available, in which case foreign consultants or contractors may be used.

As the proposed project is a completely new venture, it will require appointment of a completely new employee base. This will include unskilled, semi-skilled and specialist employees to perform all tasks from site cleaning, security, office administration to the highly specialised activities involved with testing and calibration of LWD equipment. Employment will be sourced locally, however specialised skills may not be locally available and may be sourced from outside of Namibia.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning / Construction	Sustaining employees in the construction industry during the construction phase as well as for future maintenance and upgrades	2	1	2	2	2	12	2	Definite
Daily Operations	Permanent employment opportunities and periodic appointment of consultants and third party contractors	3	1	3	2	2	21	3	Definite
Indirect Impacts	Decrease in overall unemployment at a National level	3	1	3	2	1	18	3	Definite

Desired outcome: To maximise the appointment of Namibian consultants, contractors and employees to contribute to the reduction in overall unemployment.

Actions

Enhancement:

- Employ local Namibians as far as practically possible. If the skills exist locally, employees must first be sourced from the town, then the region and then nationally.
- Appointment of highly specialised foreign contractors must be in line with the requirements of the Ministry of Home Affairs, Immigration, Safety and Security.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Labour Act
- Immigration Control Act
- Bi-annual summary report based on employee records with employee contracts on file.

11.1.3 Skills, Technology and Development

During the various phases of planning, construction and operations, knowledge sharing and skills transfer will take place. Training will be provided to a portion of the workforce to be able to maintain and operate various features of a facility according to the required standards. Skills may be transferred to an unskilled workforce for general tasks. The technology required for the development of the facility is new to the local industry. International experts will thus be involved and local contractors and employees will be exposed to their knowledge and expertise. Development of people and technology are key to economic development.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning / Construction	Technological development and transfer of skills	2	1	2	2	1	10	2	Probable
Daily Operations	Technological development and transfer of skills	3	1	3	2	2	24	3	Definite

<u>Desired outcome:</u> To see an increase in skills of local Namibians, as well as development and technology advancements in associated industries.

Actions

Enhancement:

- If the skills exist locally, contractors and employees must first be sourced from the town, then the region and then nationally. Deviations from this practice must be justified.
- Skills development and improvement programs to be made available as identified during performance assessments.
- Employees to be informed about parameters and requirements for references upon employment.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Records should be kept of training provided.
- Ensure that all training is certified or managerial reference provided (proof provided to the employees to improve their future employability) inclusive of training attendance, completion and implementation.

11.1.4 Revenue Generation and Economic Development

The change in land use will lead to changes in the way revenue is generated and paid to the national treasury. An increase of skilled and professional labour has already, and will continue to take place, due to the planning, construction and operational phases of the facility. As such, payment of income tax to the National treasury increases. The Proponent will also support local businesses and contractors for the procurement of services and goods. The presence of the facility may ultimately contribute to local opportunities for new businesses to establish and thus growth and economic development in the town's business sector.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning / Construction	Contribution to local economy through appointment of consultants and contractors	2	1	2	2	2	12	2	Definite
Daily Operations	Supporting the local economy and an increase in revenue generated and taxes paid to the National treasury	3	2	3	2	2	42	4	Definite
Indirect Impacts	Opportunities for the establishment of new businesses and service providers	3	1	3	2	1	18	3	Probable

Desired outcome: Contribution to national treasury and sustaining of livelihoods of local Namibian businesses and employees.

Actions
Enhancement:
- Employ local Namibian contractors and employees as far as practically possible. If the skills exist locally, contractors and employees must first be sourced from the town, then the region and then nationally.
- Remuneration of employees, contributions to social security, payment of taxes, etc. in line with Namibian legislation.
- Support local businesses and suppliers of services if available.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Labour Act, Income Tax Act
- Employment and financial records kept on file

11.2 IDEALS AND ASPIRATIONS FOR THE FUTURE

During the environmental assessment, pubic consultation was conducted with neighbours and interested and or affected parties. Information shared with the parties resulted in concern for their aspirations for the future. This was mainly due to misunderstanding the proposed project and/or the spread of misinformation on social media and the press. The main concern raised were that the facility will create a dangerous environment to work or live in and that, as a result of this, the local tourism industry will be negatively affected, thereby impacting livelihoods of many local businesses. The words "nuclear" and "radioactive" immediately raises concerns and if that is coupled to "waste" it is even more concerning.

It is often the "unkown" that causes concern. Various items encountered during your normal comings and goings may contain radioactive isotopes that one is not even aware about. As it is, equipment containing radioactive sources are used and stored throughout Namibia, often under much less stringent safety and security measures than what is proposed for the Proponent's facility. Such equipment include handheld gamma radiography equipment, a non-destructive testing method used to validate the integrity of poured concrete and welds on fluid vessels, pipelines, or critical structural elements; handheld x-ray fluorescence analysers used for example in the mineral exploration industry; and radioisotopes used for the treatment of certain types of cancer.

For another sector of society, the proposed project has a positive impact on their ideals and aspirations for the future. These are those who may benefit from employment in the oil and gas sectors and who sees these sectors as potentially benefiting the whole of Namibia. For them, the support industries that will assist the oil and gas industries to realise, are beneficial, even if they themselves do not directly benefit from such support industries.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Planning / Construction / Operations	Negative impact on society's ideals and aspirations for the future	2	-2	3	2	1	12	-2	Definite
After Preventative / Mitigation Measures									
Planning / Construction / Operations	Positive impact on society's ideals and aspirations for the future	2	2	3	2	1	12	2	Highly Probable

Desired Outcome: Continued sharing of accurate and easily understandable information and planned activities with IAPs and governing agencies to address fears and misinformation. Maintaining an open door policy with neighbours and employees.

Actions

Enhancement:

- Information sharing about the proposed project that addresses misinformation and explain in laymen's terms the potential risks and the safety and security measures preventing or mitigating these risks. This report being a main contributor to the sharing of such information.
- Major changes in operations, proposed expansions and or decommissioning activities should be made available to governmental agencies and interested and affected parties.
- Open communication regarding future development and employment opportunities to employees, through employees' management structures.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Records kept of all information shared with authorities, neighbours and employees.

11.2.1 Demographic Profile and Community Health

The project is reliant on labour during the construction and operational phases. The scale of the project is limited and it is not foreseen that it will create a change in the demographic profile of the local community (in-migration). Community health may be exposed to factors such as communicable disease and alcoholism/drug abuse associated with increased spending power of employees and the potential influx of foreigners into the area.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction / Operations	Communicable disease and alcoholism/drug abuse	2	-1	3	2	1	-12	-2	Probable
Indirect Impacts	The spread of disease	4	-1	3	2	1	-24	-3	Probable
After Preventative / Mitigation Measures									
Construction / Operations	Communicable disease and alcoholism/drug abuse	2	-1	3	2	1	-12	-2	Improbable
Indirect Impacts	The spread of disease	4	-1	3	2	1	-24	-3	Improbable

Desired Outcome: To prevent the in-migration and growth in informal settlements and to prevent the spread of communicable diseases and prevent / discourage socially deviant behaviour.

Actions:

Prevention:

- Employ only local people from the area, deviations from this practice should be justified appropriately.
- Adhere to all municipal by-laws relating to environmental health for the various facilities and sanitation requirements.

Mitigation:

- Educational programmes for employees on communicable diseases, alcohol and drug abuse and general upliftment of employees' social status.
- Appointment of reputable contractors.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Facility inspection sheet for all areas which may present environmental health risks, kept on file.
- Bi-annual summary report based on educational programmes and training conducted.
- Bi-annual report and review of employee demographics.

11.2.2 Radiation from Radioactive Isotopes

During the operational phase of this facility, radioactive isotopes will be stored and used in a designated areas. Radioactive isotopes, if not handled correctly, have the potential to cause serious harm to people and the environment through the ionising radiation it produces. However, the risks are well understood and effective risk prevention methods and equipment are available. These have and continue to allow radioactive isotopes to be used worldwide within populated areas and the workplace to the benefit of humanity. A common example is the radioactive isotopes used to treat cancer patients.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Daily Operations	Radiation from working in close proximity to radioactive material	2	-2	3	2	1	-24	-3	Highly Probable
Daily Operations	Radiation from working with radioactive material	1	-3	3	2	1	-18	-3	Definite
Daily Operations	Radiation exposure to persons of the public	2	-2	3	2	1	-24	-3	Probable
After Preventative / Mitigation Measures									
Daily Operations	Radiation from working in close proximity to radioactive material	1	-1	3	2	1	-6	-1	Improbable
Daily Operations	Radiation from working with radioactive material	1	-2	3	2	1	-10	-3	Probable
Daily Operations	Radiation exposure to persons of the public	1	-1	3	2	1	-6	-1	Improbable

Desired outcome: To ensure radiation exposure remains within the prescribed levels and prevent potential incidents that may increase the probability of radiation related exposure among workers or the public.

Actions

Prevention:

- Adhere to the Health and Safety Regulations of the Labour Act and the Regulations of the Atomic Energy and Radiation Protection Act aimed at the protection of workers against ionizing radiation.
- Implement the ERMP and ensure that all employees or contractors who are present on site or who will handle the sources are trained in the implementation of the ERMP.
- Develop and implement an emergency response plan.
- Only suitably qualified persons may handle radioactive sources and no female employee who is, or who is likely to be pregnant, may work in any area where she may be exposed to ionizing radiation.
- Regular toolbox talks should be conducted.
- Transport of radioactive sources should at all times be by an authorised transport company with a verified track record.
- The bunker must be constructed (and maintained) according to the specifications as specified in this report or better.
- The appropriate signage must be placed on the bunker and its fence to warn of the potential hazard of its contents. Signage should be multilingual in order to cater for the most common native languages spoken.
- Strict, 24 hour security measures inclusive of intruder alarms and security personnel should be on site to prevent the possibility of theft of the sources.

- Keep radiation decontamination kits on site, inclusive of a backup water supply in case of water supply interruptions and a contamination event coincides.
- All sources must at all times be stored within their applicable pigs with the correct shielding (i.e. lead for Cs-137 and polyethylene for Am-241Be) and in the bunker.
- Only one source should be removed from the bunker at a time for purposes of calibration and testing of LWD tools.
- The source should be taken to the workshop inside the pig and only removed immediately before it will be used and with the correct handling tool.
- The source should be returned to the pig immediately after its use and returned to the bunker.
- The bunker should be surveyed for radioactivity each time before a pig is removed and after it is returned.
- Regular leak tests should be performed on the pigs according to industry standards.
- Provide all employees with required and adequate personal protective equipment (PPE).
- All persons on site, who may potentially be exposed to radiation, especially those working with the sources, must wear radiation monitoring devices (e.g. dosimeters) and radiation exposure reports must be prepared regularly to ensure radiation exposure levels are not exceeded.
- Radiation monitoring devices should be placed on at least the boundary wall between the Proponent's erf and direct neighbours. Radiation exposure reports must be prepared regularly to ensure radiation exposure levels are not exceeded. This will not only ensure the safety of the public, but will also provide the Proponent with information to present to the public should concerns regarding radiation be raised.
- Implement a maintenance register for the bunker and all equipment whose failure may result in accidental ionizing radiation.
- Any source that becomes obsolete must be returned to its manufacturer for disposal and all safety and security procedures must continue to be implemented in its storage and handling until it is returned to the supplier.

Mitigation:

- Selected personnel should be trained in first aid and a first aid kit must be available on site. The contact details of all emergency services must be readily available.
- Minimize radiation exposure for those workers working with the sources by using the three common methods of, distance from the source, shielding from the source and time working with and in proximity to the source.
- Medicals for those workers exposed to radiation at intervals of every six months or as directed by the NRPA.
- Implement and maintain an integrated health and safety management system, to act as a monitoring and mitigating tool, which includes: colour coding of pipes, operational, safe work and medical procedures, permits to work, emergency response plans, housekeeping rules, MSDS's and signage requirements (PPE, radiation etc.).
- Implement the ERP and notify the NRPA should any incident occur that puts workers or the public at risk.
- In case a leaking SRS has been identified during post surveys or leak tests, the following steps shall be taken by an authorized person:

A. Prevent the spread of contamination of the accident by applying the S.W.I.M. method as follows:

I. Stop the source of the leak.
   a. Place the source in its transport shield or container and lock the container.
   b. Do not move the transport shield or container.

II. Warn other personnel in the area to evacuate the area immediately.

III. Isolate the area and establish contaminated and clean zones.
   a. To prevent the spread of contamination, perform a radiation survey of all personnel entering and exiting the area verifying the source of any radiation exposure identified.

b. Quarantine any personnel that could be contaminated in a restricted area immediately outside the contaminated area.

IV. Minimize exposure by restricting your access to the contaminated zone and increasing the distance between personnel and the radioactive material. Do not leave the source unattended during this time.

B. Immediately notify the GRSO of the location, time, source, and extent of the leakage.

C. Don protective clothing, nitrile gloves, safety glasses and shoe covers.

D. Survey the affected area to identify and document any contaminated personnel or areas.

E. Circle any identified contaminated area or personnel using waterproof felt tip marker.

F. Begin decontamination with areas of lowest contamination first and work from the edges inward.

I. In a water deficient environment, gently brush surface of contaminated area to remove and dislodge contamination.

II. In a water sufficient environment, wash contaminated area (or have patients/victims wash themselves) with tepid water and soap, without damaging or abrading contaminated surface.

III. Add mild soap (neutral pH) to water to emulsify and dissolve contamination.

IV. Direct contaminated wastewater directly into a collection receptacle rather than over uncontaminated areas.

V. Use disposable washcloths, gauze pads or surgical sponges to avoid recontamination.

VI. Place all cloths, pads, or sponges used on the contaminated employee or area into a single, airtight container (e.g. property bag) and label with:

a. Employee's name (if applicable)
b. Date and time of collection
c. Location of collection
d. Radiation warning label

G. Store property bags, contaminated water, and other contaminated supplies in secure location designated by RSO for appropriate disposal.

H. Perform two decontamination cycles with a radiation survey after each cycle.

I. Repeat this process until the release limits are below set action limits as provided by the NRPA.

J. Wrap the transport container or shield in a non-permeable plastic cover such as shrink wrap or garbage bags and seal closed using duct tape or similar product.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Health and Safety Regulations of the Labour Act
- Regulations of the Atomic Energy and Radiation Protection Act
- Record should be kept of all training provided to workers.
- Records should be kept of dosimeter cumulative radiation exposure monitoring and all radiation related surveys (e.g. leak tests).
- Records should be kept of radiation monitoring at areas around the facility and radiation hotspots.

11.2.3 Health, Safety and Security (Excluding Radiation)

Construction and operations requires the handling of various products and equipment that can potentially harm the handler or nearby persons. This include working at heights, heavy lifting, moving parts, handling chemicals, tripping and falling, etc. Security risks are related to unauthorized entry, theft and sabotage.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Physical injuries, exposure to chemicals and criminal activities	1	-3	2	2	2	-18	-3	Highly Probable
Daily Operations	Physical injuries, exposure to chemicals and criminal activities	1	-3	3	2	2	-21	-3	Highly Probable
After Preventative / Mitigation Measures									
Construction	Physical injuries, exposure to chemicals and criminal activities	1	-3	2	2	1	-15	-2	Probable
Daily Operations	Physical injuries, exposure to chemicals and criminal activities	1	-3	3	2	1	-18	-3	Probable

Desired Outcome: To prevent injury, health impacts and theft.

Actions

Prevention:

- All Health and Safety Regulations specified in the Labour Act should be complied with.
- Ensure that all personnel receive adequate training on operation of equipment / handling of hazardous substances.
- Clearly label dangerous and restricted areas as well as dangerous equipment and products.
- Provide all employees with required and adequate personal protective equipment (PPE).
- Implementation of maintenance register for all equipment and fuel/hazardous substance storage areas.
- Equipment must be locked away on site in a way that does not encourage unauthorised access and / or criminal activities (e.g. theft).
- Security procedures and proper security measures must be in place to protect workers and clients.
- Strict security that prevents unauthorised entry during construction and operational phases.

Mitigation:

- Selected personnel should be trained in first aid and a first aid kit must be available on site. The contact details of all emergency services must be readily available.
- Implement and maintain an integrated health and safety management system, to act as a monitoring and mitigating tool, which includes: colour coding of pipes, operational, safe work and medical procedures, permits to work, emergency response plans, housekeeping rules, MSDS's and signage requirements (PPE, flammable etc.).

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Any incidents must be recorded with action taken to prevent future occurrences.
- A report should be compiled every 6 months of all incidents reported. The report should contain dates when training were conducted and when safety equipment and structures were inspected and maintained.

11.2.4 Traffic

The presence of the facility may increase traffic flow to the site during both construction and operations. An increase in traffic to the and from the site may, but probably will not, increase congestion and increase the risk of incidents and accidents.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Traffic impacts during delivery of large equipment and building materials	2	-2	2	2	2	-24	-3	Probable
Daily Operations	Increase traffic, road wear and tear and accidents	2	-2	3	2	2	-28	-3	Probable
After Preventative / Mitigation Measures									
Construction	Traffic impacts during delivery of large equipment and building materials	2	-1	2	2	2	-12	-2	Improbable
Daily Operations	Increase traffic, road wear and tear and accidents	2	-1	3	2	2	-14	-2	Improbable

Desired Outcome: Minimum impact on traffic and no transport or traffic related incidents.

Actions
Prevention:
- Erect clear signage regarding access and exit points at the facility.
- Trucks delivering equipment may not block entrances or parking areas of nearby businesses.

Mitigation:
- If any traffic impacts are expected, traffic management should be performed to prevent these.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- Any complaints received regarding traffic issues should be recorded together with action taken to prevent impacts from repeating itself.
- A report should be compiled every six months of all incidents reported, complaints received, and action taken.

11.2.5 Fire

Construction and operational activities may increase the risk of the occurrence of fires as a result of storage of fuel (diesel in the standby generator) and chemicals (e.g. solvents for painting during construction) or the creation of sparks by equipment such as grinders. The site is located in an industrial area and is easily accessible for firefighting trucks and teams. The nature of the operation does not pose a significant fire risk.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Fire and explosion risk	2	-2	2	2	1	-20	-3	Probable
Daily Operations	Fire and explosion risk	2	-2	3	2	1	-24	-24	Probable
After Preventative / Mitigation Measures									
Construction	Fire and explosion risk	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Fire and explosion risk	2	-1	3	2	1	-12	-2	Improbable

Desired Outcome: To prevent property damage, possible injury and impacts caused by uncontrolled fires.

Actions:

Prevention:

- A holistic fire protection and prevention plan is needed. This plan must include an emergency response plan, firefighting plan.
- Fire extinguishers must be placed throughout the facility. Although a fire at the bunker is highly unlikely (it is not constructed from any flammable materials), a fire detection and suppression system dedicated to the bunker is still recommended.
- Train selected personnel in firefighting at a level adequate for the products and operations on site.
- Ensure all chemicals are stored according to MSDS instructions.
- Maintain regular site, mechanical and electrical inspections and maintenance.
- Maintain firefighting equipment, good housekeeping and personnel training (firefighting, fire prevention and responsible housekeeping practices).

Mitigation:

- Implement the emergency response plan and firefighting plan and notify emergency services.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- A report should be compiled every six months of all incidents reported. The report should contain dates when fire drills were conducted and when fire equipment was tested and training given.

11.2.6 Noise

Noise pollution will exist due to heavy and light motor vehicles accessing the site during the construction and operational phases. Construction (maintenance and upgrade) may generate short term excessive noise.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Excessive noise generated from construction activities – nuisance and hearing loss	2	-2	2	2	2	-24	-3	Highly Probable
Daily Operations	Noise generated from the operational activities – nuisance and hearing loss	2	-2	3	2	2	-28	-3	Probable
After Preventative / Mitigation Measures									
Construction	Excessive noise generated from construction activities – nuisance and hearing loss	2	-1	2	2	2	-12	-2	Probable
Daily Operations	Noise generated from the operational activities – nuisance and hearing loss	2	-1	3	2	2	-14	-2	Improbable

Desired Outcome: To prevent any nuisance and hearing loss due to noise generated.

Actions

Prevention:

- Follow Health and Safety Regulations of the Labour Act to protect workers and World Health Organization (WHO) guidelines on community noise (Guidelines for Community Noise, 1999) to prevent nuisances to neighbours.

Mitigation:

- Hearing protectors as standard PPE for workers in situations with elevated noise levels.
- All machinery must be regularly serviced and placed on vibration dampers where required to ensure minimal noise production.
- All vehicles of the contractors and Proponent’s must have adequate noise dampening installed and should not be left idling for prolonged periods.
- Forklifts and other vehicles on site can be fitted with white noise audible warning systems and flashing / strobe lights to minimize the noise impacts typically created by the typical audible signals of these equipment.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Health and Safety Regulations of the Labour Act and WHO Guidelines.
- Maintain a complaints register.
- Bi-annual report on complaints and actions taken to address complaints and prevent future occurrences.

11.2.7 Waste Production

Various forms of waste are produced during the construction and operational phases. Waste may include hazardous waste associated with the decommissioning of radioactive sources and any material accidentally contaminated by radioactivity. Under normal operations, the facility will produce no radioactive waste other than possibly obsolete sources. Domestic waste is generated by the facility and related operations. Waste presents a contamination risk and when not removed regularly may become a fire hazard. Construction waste may include building rubble and discarded equipment contaminated by hydrocarbon products. Hydrocarbon contaminated soil and water is considered as a hazardous waste.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Excessive waste production, littering, illegal dumping, contaminated materials	1	-2	2	2	2	-12	-2	Definite
Daily Operations	Obsolete radioactive sources or contaminated materials	3	-4	3	2	1	-72	-5	Definite
Daily Operations	Excessive waste production, littering, contaminated materials	1	-2	3	2	2	-14	-2	Definite
After Preventative / Mitigation Measures									
Construction	Excessive waste production, littering, illegal dumping, contaminated materials	1	-2	2	2	2	-12	-2	Definite
Daily Operations	Obsolete radioactive sources or contaminated materials	3	-2	3	2	1	-36	-3	Improbable
Daily Operations	Excessive waste production, littering, contaminated materials	1	-1	3	2	2	-7	-1	Definite

Desired Outcome: To reduce the amount of waste produced, and prevent pollution, especially radioactive in nature, and littering.

Actions

Prevention:

- A waste management plan should be developed and implemented.
- Waste reduction measures should be implemented and all waste that can be re-used / recycled must be kept separate.
- Ensure adequate temporary waste storage facilities are available.
- Ensure waste cannot be blown away by wind.
- Prevent scavenging (human and non-human) of waste storage.
- Ensure obsolete radioactive sources remain stored and handled in a similar way as those still in use (i.e. in pigs and in the bunker) until they can be shipped back to the supplier.

Mitigation:

- Waste should be disposed of regularly and at appropriately classified disposal facilities, this includes hazardous material (empty chemical containers, contaminated rugs, paper water and soil).
- See the material safety data sheets available from suppliers for disposal of contaminated products and empty containers.
- Liaise with the municipality regarding waste and handling of hazardous waste.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- A register of hazardous waste disposal should be kept. This should include type of waste, volume as well as disposal method/facility.
- Any complaints received regarding waste should be recorded with notes on action taken.
- The oil water separator must be regularly inspected and all hydrocarbons removed once detected. Outflow water must comply with effluent quality standards.
- All information and reporting to be included in a bi-annual report.

11.2.8 Ecosystem and Biodiversity Impact

The nature of the operational activities is such that the probability of creating a habitat for flora and fauna to establish is low. No significant impact on the biodiversity of the area is predicted as the site is currently void of natural fauna and flora. Impacts are therefore mostly related to pollution of the environment.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Impact on fauna and flora. Loss of biodiversity due to pollution	2	-1	2	2	2	-12	-2	Improbable
Daily Operations	Impact on fauna and flora. Loss of biodiversity due to pollution	2	-2	3	2	2	-7	-28	Probable
After Preventative / Mitigation Measures									
Construction	Impact on fauna and flora. Loss of biodiversity due to pollution	1	-1	3	2	2	-7	-1	Improbable
Daily Operations	Impact on fauna and flora. Loss of biodiversity due to pollution	1	-1	3	2	2	-7	-1	Improbable

Desired Outcome: To avoid pollution of and impacts on the ecological environment.

Actions.
Mitigation:
- Report any extraordinary animal sightings to the Ministry of Environment, Forestry and Tourism.
- Mitigation measures related to waste handling and the prevention of groundwater, surface water and soil contamination should limit ecosystem and biodiversity impacts.
- Prevent scavenging of waste by fauna.
- The establishment of habitats and nesting sites at the facility should be prevented where possible.

Responsible Body:
- Proponent

Data Sources and Monitoring:
- All information and reporting to be included in a bi-annual report.

11.2.9 Groundwater, Surface Water and Soil Contamination

Operations entail the storage and handling of various radioactive sources which may present a contamination risk if the container of the source fails. Such material may contaminate surface water, soil and groundwater. Similarly, diesel oil or hydraulic fluid spills can also contaminate soil where concrete surface cover is not present.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Contamination from hazardous material spillages	1	-2	2	2	2	-12	-2	Probable
Daily Operations	Contamination from hazardous material spillages and radioactive leakages	3	-4	3	2	1	-72	-5	Probable
After Preventative / Mitigation Measures									
Construction	Contamination from hazardous material spillages.	1	-1	2	2	1	-5	-1	Probable
Daily Operations	Contamination from hazardous material spillages and radioactive leakages	3	-2	3	2	1	-36	-3	Improbable

Desired Outcome: To prevent the contamination of water and soil.

Actions
Prevention:
- Training of operators of equipment must be conducted on a regular basis.
- All products that can potentially pollute water or soil must be stored according to their MSDS instructions and industry accepted standards.
- The procedures followed to prevent environmental damage during service and maintenance, and compliance with these procedures, must be audited and corrections made where necessary.

Mitigation:
- Any radiation leaks must be reported to the relevant authorities and the ERP implemented.
- Refer to section 11.2.2 for procedures if a leak is detected.
- Surfactants (soap) may not be allowed to enter the oil water separator e.g. soap usage on spill control surfaces.

Responsible Body:
- Proponent
- Contractors

Data Sources and Monitoring:
- A report should be compiled bi-annually of all spills or leakages reported. The report should contain the following information: date and duration of spill, product spilled, volume of spill, remedial action taken, comparison of pre-exposure baseline data (previous pollution conditions survey results) with post remediation data (e.g. soil/groundwater hydrocarbon concentrations).

11.2.10 Visual Impact

This is an impact that not only affects the aesthetic appearance, but also the integrity of the facility. As the facility is located in an industrial area, the visual impact is relatively low.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Without Preventative / Mitigation Measures									
Construction	Poor housekeeping and a disorganised construction site	2	1	2	2	1	-10	-2	Probable
Daily Operations	Poor housekeeping and maintenance	2	1	3	2	1	-12	-2	Probable
After Preventative / Mitigation Measures									
Construction	Poor housekeeping and a disorganised construction site	2	1	2	2	1	-10	-2	Improbable
Daily Operations	Poor housekeeping and maintenance	2	1	3	2	1	-12	-2	Improbable

Desired Outcome: To minimise aesthetic impacts associated with the facility.

Actions
Mitigation:

- Regular waste disposal, good housekeeping and routine maintenance on infrastructure will ensure that the longevity of structures are maximised and a low visual impact is maintained.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- A report should be compiled every six months of all complaints received and actions taken.

11.3 DECOMMISSIONING AND REHABILITATION

Decommissioning is not foreseen during the validity of the environmental clearance certificate. Decommissioning was however assessed as construction activities include modification and decommissioning. Should decommissioning occur at any stage, rehabilitation of the area may be required. Decommissioning will entail the complete removal of non-permanent infrastructure. Any pollution present on the site must be remediated. Radioactive material is not supposed to be present on site at this stage as all leaks should be cleaned as soon as it is detected. The impacts associated with this phase include noise and waste production as structures are dismantled. Noise must be kept within Health and Safety Regulations of the Labour Act limits and WHO guidelines for community noise and waste should be contained and disposed of at an appropriately classified and approved waste facility and not dumped in the surrounding areas. All radioactive sources will have to be returned to their manufacturers in their country of origin. Future land use after decommissioning should be assessed prior to decommissioning and rehabilitation initiated if the land would not be used for future purposes. The ERMP for the facility will have to be reviewed at the time of decommissioning to cater for changes made to the site and implement guidelines and mitigation measures.

11.4 ENVIRONMENTAL MANAGEMENT SYSTEM

The Proponent could implement an Environmental Management System (EMS) for their operations. An EMS is an internationally recognized and certified management system that will ensure ongoing incorporation of environmental constraints. At the heart of an EMS is the concept of continual improvement of environmental performance with resulting increases in operational efficiency, financial savings and reduction in environmental, health and safety risks. An effective EMS would need to include the following elements:

- A stated environmental policy which sets the desired level of environmental performance;
- An environmental legal register;
- An institutional structure which sets out the responsibility, authority, lines of communication and resources needed to implement the EMS;
- Identification of environmental, safety and health training needs;
- An environmental program(s) stipulating environmental objectives and targets to be met, and work instructions and controls to be applied in order to achieve compliance with the environmental policy;
- Periodic (internal and external) audits and reviews of environmental performance and the effectiveness of the EMS; and
- The ERMP.

12 CONCLUSION

Namaquanum Investment Two CC intends to develop a facility for the storage of sealed radioactive sources, and the use of these sources for the calibration and testing of logging while drilling equipment used in oil and gas exploratory drilling. This facility will be the first of its kind in Namibia. Storage and handling of radioactive material is strictly controlled with stringent safety and security measures prescribed in local and international legislation and codes of conduct. Therefore, from the onset, the Proponent planned the facility to meet the requirements for its safe storage and handling. This includes storage inside containers (pigs) designed to shield radiation emitted by the sources, and in turn storage of the pigs in lead and concrete lined metal containers with very strict security measures and access control. Areas where the sources will be used will also have concrete walls, strict security and access for authorised personnel only.

Responsible operations of the facility will play an important role in provision of essential services for the oil and gas exploration industry and will thus have a positive impact on Namibia as a whole. The business sector operational in Swakopmund and Namibia can benefit from the provision of services and goods to the Proponent during both construction and operations of the facility. It will also contribute locally to reduction in unemployment, skills transfer and training and technological development.

The major concern regarding the facility, highlighted by members of the public, is that of potential radioactivity harming workers on site, neighbours, residents of Swakopmund, and the environment in general. As a spinoff of this concerns were also raised that it will negatively affect the tourism industry, one of the main economic drivers of the town. It should be noted that many of these concerns were exacerbated by the spread of misinformation in social media, community platforms and the press, which branded the facility as a radioactive **waste** storage facility, which it clearly is **not**. Nevertheless, their concerns were noted and detailed radiation specialist risk assessment was commissioned to determine the actual risk the facility pose.

The radiation risk assessment highlighted two main findings: 1) that under normal operations of the facility there is no real risk to the public, including direct neighbours; and 2) that under normal operations and by implementing the necessary safety and security measures, the exposure of workers to radiation is within the prescribed limits of Namibia and the IAEA. That said, once operational, a radiation safety assessment should be repeated at the facility, using actual operational parameters, and optimisation of radiation protection should be investigated to reduce exposure doses as low as possible, while taking into consideration social and economic balances. The facility must be treated as an IAEA Category 2 facility which requires implementation of Security level B structures and procedures to ensure no unauthorised entry and / or theft of SRS.

It remains imperative that all personnel is suitably trained and authorised to work with radioactive sources, radiation exposure monitoring must be conducted, and an emergency response plan must be in place and all staff well versed on its contents. The ERMP as presented in this document should be adopted and the contents kept up to date as legislation, equipment and operational methods and conditions change. It is thus also suggested that the radiation safety assessment be updated once the facility comes into operation to address minor deviations in operational procedures or equipment.

For non-radiation related impacts, noise levels should at all times meet the prescribed Health and Safety Regulations of the Labour Act and WHO requirements to prevent hearing loss and not to cause a nuisance to nearby receptors. Fire prevention should be adequate and present throughout the facility, and health and safety regulations should be adhered to in accordance with the regulations pertaining to the Labour Act and relevant laws and internationally accepted standards of operation. Any waste produced must be removed from site and disposed of at an appropriate facility or re-used or recycled where possible. Hazardous waste must be disposed of at an approved hazardous waste disposal site.

The ERMP (Section 11) should be used as an on-site reference document for the operations of the facility. Parties responsible for transgressing of the ERMP should be held responsible for any rehabilitation that may need to be undertaken. The Proponent should use an in-house health, safety, security and environment management system and an emergency response plan in conjunction with the ERMP. All operational personnel must be taught the contents of these documents.

Should the NRPA and Directorate of Environmental Affairs (DEA) in the MEFT find that the impacts and related mitigation measures, which have been proposed in this report, are acceptable, the necessary authorisations and ECC may be granted to the Proponent. The ECC issued, based on this document, will render it a legally binding document which should be adhered to.

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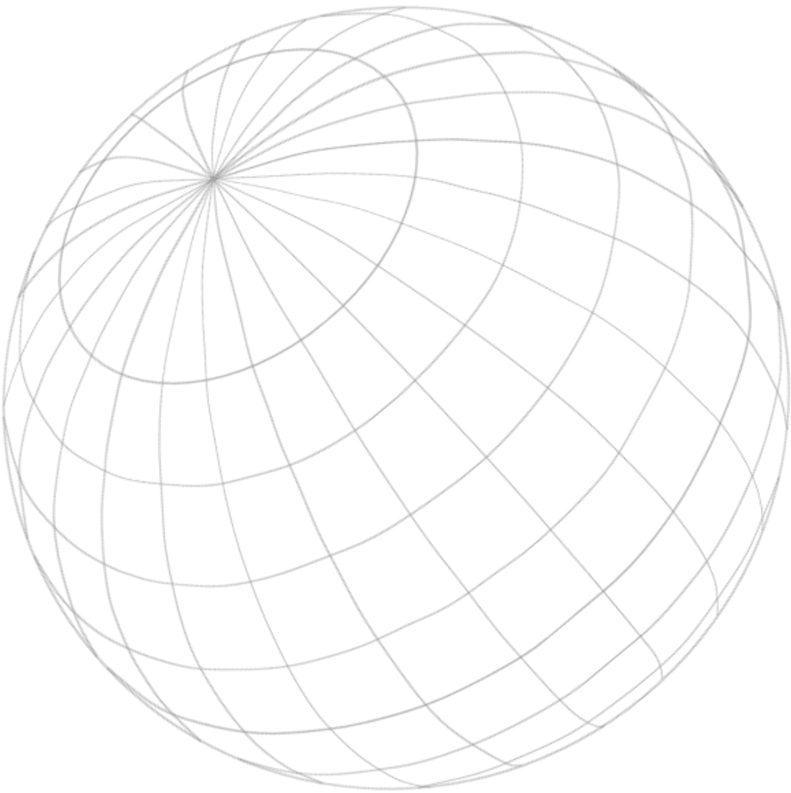
Van Blerk JJ. 2024. Proposed Sealed Radioactive Source Storage and Handling Facility, Erf 3954 Swakopmund: Potential Radiological Impact Report No. ASC-1070A.

Appendix A: Radiation Impact Assessment

Proposed Sealed Radioactive Source Storage and Handling Facility, Erf 3954 Swakopmund: Potential Radiological Impact



Report No. ASC-1070A

June 2024

Technical Report

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List of Acronyms

AERPA	Atomic Energy and Radiation Protection Act (Act No. 5 of 2005)
ALARA	As Low As Reasonably Achievable
DEA	Directorate of Environmental Affairs
ECC	Environmental Clearance Certificate
EMA	Environmental Management Act (Act No. 7 of 2007)
EMP	Environmental Management Plan
GPT	Geo Pollution Technologies (Pty) Ltd
GSR	IAEA General Safety Requirement
IAEA	International Atomic Energy Agency
ICR	International Congress of Radiology
ICRP	International Commission on Radiological Protection
ISO	International Organization for Standardization
mSv	milli Sievert
NRPA	National Radiation Protection Authority
PIE	Postulating Initiating Events
RDD	Radioactive Dispersal Device
RPS	Radiation Protection Specialist
SAH	South Atlantic High
SPR	Source-Pathway-Receptor
SRS	Sealed radioactive sources
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation

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1 Introduction

1.1 Background

Radioactive sources are used in a variety of essential and beneficial medical, industrial, research, and other commercial applications. These applications include cancer therapy, irradiation of blood for transplant patients and of laboratory animals for research, sterilization of medical devices, irradiation to reduce the transmission of foodborne illnesses and protect domestic crops from invasive species, non-destructive testing of structures and industrial equipment, exploration of geological formations to find oil and gas deposits, and instrument calibration (National Academies of Sciences and Medicine, 2021). As a result of this broad set of beneficial uses, radioactive sources are distributed worldwide in many countries, including countries that had no nuclear programmes in the past or at present. The total inventory of radioactive sources worldwide is estimated to be in the millions (IAEA, 2014a).

Although the vast majority of radioactive sources used around the world are managed safely and securely (IAEA, 2014a), the safety and security risks that these sources present - especially those that are unsuitable for their further intended use and that are uncontrolled - are matters of concern. This is one of the main reasons why the Code of Conduct on the Safety and Security of Sources was developed in 2004 (IAEA, 2004a). The objectives of the Code of Conduct are, through the development, harmonization and implementation of national policies, laws and regulations, and through the fostering of international cooperation, to (IAEA, 2014a):

- Achieve and maintain a high level of safety and security of radioactive sources;
- Prevent unauthorized access or damage to, and loss, theft, or unauthorized transfer of, radioactive sources, to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society, or the environment;
- Mitigate or minimize the radiological consequences of any accident or malicious act involving a radioactive source.

Furthermore, specific guidance on the security of radioactive material in storage, including radioactive sources, and the associated storage facilities is provided in the International Atomic Energy Agency (IAEA) Nuclear Security Series No. 11-G (Rev. 1) (IAEA, 2019a).

Namaquanum Investment Two CC (the Proponent) has an existing workshop on Erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund, located in the Erongo Region of Namibia (see Figure 1.1). The Proponent plans to refurbish the workshop and construct a dedicated radioactive source storage facility for those sources used to calibrate and test drilling equipment (well logging equipment) in the offshore oil exploration industry. Clients from the offshore exploration industry will use the workshop and radioactive source stored on Erf 3954, to perform the necessary calibrations and tests on their drilling equipment.

The Proponent has appointed Geo Pollution Technologies (Pty) Ltd (GPT) to apply for an environmental clearance certificate (ECC) for the proposed facilities and associated operations. The ECC is required as per the Environmental Management Act (Act No. 7 of 2007) (EMA). As part of the ECC application, an environmental assessment report and environmental management plan (EMP) will be submitted to the Ministry of Environment, Forestry and Tourism's Directorate of Environmental Affairs (DEA).

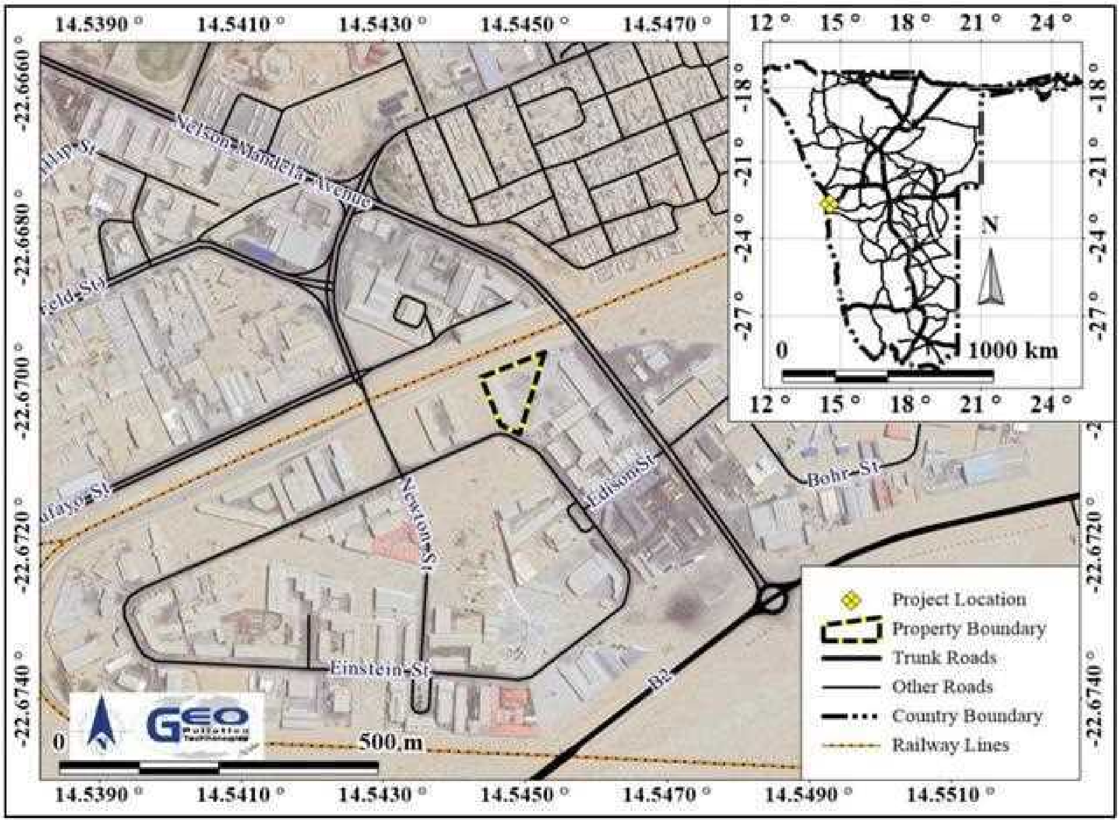

Figure 1.1 Location of the proposed radioactive source storage and handling facility on Erf 3954, located in the industrial area (Extension 10) of Swakopmund in the Erongo Region of Namibia.

GPT, in turn, appointed Dr Japie van Blerk of AquiSim Consulting (Pty) Ltd as Radiation Protection Specialist (RPS) to evaluate the potential radiological impact of the proposed facility and associated activity as part of the ECC application process and as required in terms of the Atomic Energy and Radiation Protection Act (Act No. 5 of 2005) (AERPA).

1.2 Objective of the Report

Given their inherent characteristics, radioactive sources emit ionising radiation and have the potential to lead to radiation exposure conditions. It is, therefore, important that the specific sources are used and managed under the intended use of the specific source and with consideration of the application of the appropriate radiation protection measures and principles.

The proposed radioactive source storage and handling facility will be designed, constructed and used to comply with the guidelines provided in the IAEA safety standards for the safety and security of storage facilities for radioactive material (IAEA, 2006a; 2019a). The purpose of these guidelines is to ensure compliance with the fundamental safety objective and associated principles as outlined in IAEA Safety Standard Series SF-1 (IAEA, 2006b).

The objective of this report is to evaluate the potential radiological impact of the proposed radioactive sources storage and handling facility on human health and the environment, as input into the ECC application process and associated EMP as required per the EMA and AERPA.

1.3 Scope and Structure of the Report

The scope of this report is limited to the proposed radioactive source storage and handling facility and associated activities. However, the scope excludes the transport activities associated with these sources to the facility or from the facility when the sources reach their useful end of life.

The report assumes a basic understanding of ionizing radiation and the effects of exposure to ionizing radiation on human health and the environment. If more information is needed on these subjects, the interested reader is referred to readily available literature resources, examples of which include documents entitled *Radiation, People and the Environment* published by the International Atomic Energy Agency (IAEA, 2004b) or "*Radiation Effects and Sources*" published by the United Nations Environmental Programme (UNEP, 2016).

The proposed facility will be used to store radioactive sources that will be used for the calibration of instruments containing radioactive sources used in the offshore oil exploration industry as well as the calibration process itself. However, the scope of the report excludes the activities, including the transport, of these instruments to and from the proposed facility.

To provide the necessary background information and facilitate the radiological impact assessment of the proposed radioactive sources storage and handling facility on human health and the environment, the report is structured as follows:

- Section 2 provides some background information on the properties of radioactive sources.
- Section 3 presents the regulatory framework from a national and international perspective.
- Section 4 provides a summary description of the site and facility characteristics that are of relevance to the purpose and objective of the report.
- Section 5 defines the radiological exposure conditions that are deemed appropriate to evaluate the radiological consequences of the proposed radioactive source storage and handling facility.
- Section 6 evaluates the radiological consequences of the proposed radioactive source storage and handling facility, to both workers and members of the public.
- Section 7 presents the conclusions and recommendations, as appropriate for the report and based on the radiological consequences of the proposed radioactive source storage and handling facility.

2 Properties of Sealed Radioactive Sources

2.1 General

Section 1.1 noted that radioactive sources are used in a variety of essential and beneficial medical, research and industrial applications. The characteristics of these sources are equally wide and exhibit a spectrum of radiological, physical, and chemical properties. The purpose of this section is to provide an overview of these properties to the extent that it is relevant to the purpose of this report.

The section is structured as follows. Section 2.2 provides relevant definitions of different components of radioactive sources and how they are referred to during their lifecycle. Section 2.3 summarises different radionuclides and associated activity concentrations associated with radioactive sources. Section 2.4 presents the IAEA source categorisation and security grouping schemes that are used to distinguish between different sources.

2.2 Definitions

In nearly all applications, radioactive sources are contained within a shielded holder that is associated with particular instrumentation or mechanical hardware. This shielded holder is generally known as a *device*. The nature of the device depends on the application. In many cases, the device is also used as a transport container for the radioactive source to a location for use. The device generally includes sufficient shielding to absorb radiation to a safe level for its intended use. Figure 2.1 is a photograph of an oil platform showing typical well-logging transport containers and source transfer tools. A *shutter* allows a beam of radiation from the source to be directed towards the subject when the shutter is opened (IAEA, 2014a). This allows the radiation emitted by the source in the device to be used in a controlled manner for its intended purpose.

Figure 2.1 Photograph of an oil platform showing typical well-logging transport containers and source transfer tools[1].

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1 *https://relir.cepn.asso.fr/en/reports/industrial/well-logging/243-loss-of-a-control-of-a-well-logging-source-being-transferred-from-a-transport-container.html*

Sealed radioactive sources (SRS) as *radioactive material* are permanently sealed in a capsule or closely bonded, in a solid form, and are not exempt from *regulatory control*. The capsule is designed to prevent the radioactive material from being released from encapsulation under normal usage and probable accident conditions. It is estimated that over 10 million sealed radioactive sources have been manufactured over the past century for a wide range of beneficial uses in agriculture, industry, medicine, education, various research areas, and some military applications (IAEA, 2014a). Figure 2.2 is a photograph of typical Am/Be-241 and Cs-137 well-logging SRS in their capsules.

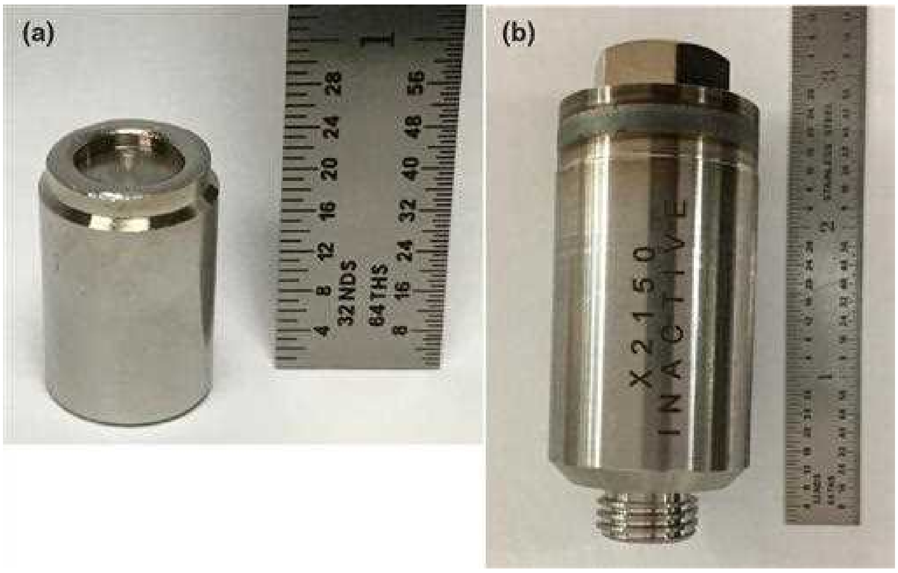


Figure 2.2 Photograph of typical (a) Cs-137 and (b) Am/Be-241 and well-logging sealed radiative sources in their capsules (National Academies of Sciences and Medicine, 2021).

SRS that are no longer in use or not intended to be used for the purpose that authorisation was granted are referred to as *disused*. SRS may become disused because the associated equipment becomes worn out or damaged, because of the availability of alternative technologies, or because of a change in priorities. Also, SRS may develop leaks and thus be no longer usable. If the source is no longer suitable for its intended purpose because of radioactive decay, it is considered as *spent*.

An *orphan source*, on the other hand, is a sealed radioactive source that is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorisation (IAEA, 2014a). Orphan sources or any other disused or spent sealed radioactive source may still be highly radioactive and potentially pose a hazard to human beings and the environment. A sealed radioactive source declared by one user as disused or spent may still be usable by another user.

2.3 Characteristics of Sealed Radioactive Sources

2.3.1 General

Depending on a particular application and the device used in practice, SRS may contain a spectrum of radionuclides. The source itself may have different forms and quantities of radioactive material, and as a result exhibit a wide range of physical, chemical, thermal, and radiological properties. The radiation risk posed by SRS depends on these factors. Despite their predominantly small physical size, examples of which are shown in Figure 2.2 and Figure 2.3, some SRS may contain very high activity concentrations.

Figure 2.3 Examples of sealed radioactive sources. It shows their different physical forms and relatively small sizes.

The radiation emitted from SRS is, therefore, potentially very high and as a result may require heavily shielded containers for their safe use, transportation, and storage. The capsule or material used as the radioactive source is manufactured to be durable and strong enough to maintain leak tightness under normal conditions of use and wear, for which the source is designed, as well as under foreseeable incidences or mishaps (IAEA, 2014a).

2.3.2 Radionuclides Used in SRS

Common radionuclides used in sealed radioactive sources include specific isotopes of radium (e.g., Ra-226), cobalt (e.g., Co-60, Co-57), caesium (e.g., Cs-134, Cs-137), strontium (e.g., Sr-90, Sr-89), iridium (Ir-192), americium (e.g., Am-241), californium (e.g., Cf-252), selenium (Se-79), iodine (I-131), polonium (e.g., Po-210), and plutonium (e.g., Pu-238, Pu-239). This means that the half-life of SRS may vary from a few seconds to tens of thousands of years. The SRS that will be stored and used at the proposed storage and handling facility is Cs-137, with a half-life of 30.2 years and Am/Be-241, with a half-life of 432.2 years. Table 2.1 lists example applications of Cs-137 and Am-241 SRS in medicine and industry (IAEA, 2012).

Table 2.1 Example applications of Cs-137 and Am-241 sealed radioactive sources in medicine and industry (IAEA, 2012).

Radionuclides	Half-Life	Application
Cs-137	30.2 years	Irradiators
		Teletherapy
		Brachytherapy (high/med dose rate)
		Well-logging/moisture gauges
		Industrial gauges
		Brachytherapy (low dose rate)
Am-241	432.2 years	Industrial gauges
		Bone densitometry
		Lightning conductors
		Static eliminators
Am/Be-241		Research
		Well-logging/moisture gauges

2.3.3 Physical and Chemical Form, Condition and Design

SRS are mostly in a solid form such as metals (e.g., stainless steel, titanium, platinum, or other inert metals), ceramic, and sometimes compressed powder. Soluble salts, liquids, and gases (e.g. Kr-85 and H-3) are seldom used. Powders, soluble materials, or liquids as radioactive material may give rise to contamination if the encapsulation leaks, while organic materials are combustible, or can produce radiolytic gases. Leaking sources are considered as disused and should be removed from service for safe management.

The geometrical configuration of some devices can be rather complicated since the radioactive source material is distributed on the surface of the structure. Depending on the applications and activity content, SRS can be found in a variety of shapes, forms, and dimensions. Most of these sources are small, but some are very large (e.g., static electricity eliminators, which are more than 1 m in length). Geometrical parameters are important in the selection of suitable methods for the conditioning, transport, storage, and disposal of DSRS.

2.4 Source Categorisation and Classification

2.4.1 General

Three categorisation or classification systems for radioactive sources are used in practice. The IAEA source categorisation system is the most widely used system from a safety perspective. The IAEA security grouping of sources was developed to be in harmony with the source categorisation system. The ISO source classification (ISO 2919:2012) is not presented here but provides an alternative classification system for SRS based on general requirements, performance tests, production tests, and marking and certification.

2.4.2 IAEA Source Categorisation System

The IAEA source categorisation system (IAEA, 2005) provides a logical system for ranking radioactive sources in terms of their potential to cause harm to human health, and group sources and the practices in which they are used, into discrete categories. In this way, it provides an internationally harmonised basis for risk-informed decision-making.

The system is based on the potential for radioactive sources to cause deterministic health effects. It uses the concept of *dangerous sources*, which are quantified in terms of *D values*. The *D* value is the radionuclide specific activity of a source that, if not under control, could cause severe deterministic effects for a range of scenarios creating external and/or internal exposures. The strength of a radioactive source (Activity, *A*) can vary over several orders of magnitude. The *D* values are used to normalise the range of activities for risk comparison.

IAEA (2005) presents the $\frac{A}{D}$ values for several commonly used sources. The ratio is used to provide an initial ranking of relative risk for sources and categorization taken into consideration factors such as the physical and chemical forms, the type of shielding or containment employed, the circumstances of use, and accident case histories. Table 2.2 shows that the source categorization system consists of five categories, with Category 1 considered to be extremely dangerous to a person, while Category 5 is unlikely to be dangerous.

The U.S. government developed a list of 16 radionuclides of greatest concern for use in a Radioactive Dispersal Device (RDD). Of these 16 radioisotopes, the 5 most common account for 99% of all sealed Category 1 and Category 2 sources in the United States. These five are Co-60, Cs-137, Ir-192, Am-241, and Se-75.

Table 2.2 The IAEA source categorisation system, and a description of the associated risk for each category (IAEA, 2005).

Category	Activity Ratio	Risk	Description
1	$\frac{A}{D} \geq 1000$	Extremely dangerous to the person	This source, if not safely managed or securely protected, would be likely to cause permanent injury to a person who handled it or who was otherwise in contact with it for more than a few minutes. It would probably be fatal to be close to this amount of unshielded radioactive material for a period in the range of a few minutes to an hour.
2	$1000 > \frac{A}{D} \geq 10$	Very dangerous to the person	This source, if not safely managed or securely protected, could cause permanent injury to a person who handled it or who was otherwise in contact with it for minutes to hours. It could possibly be fatal to be close to this amount of unshielded radioactive material for a period of hours to days.
3	$10 > \frac{A}{D} \geq 1$	Dangerous to the person	This source, if not safely managed or securely protected, could cause permanent injury to a person who handled it or who was otherwise in contact with it for some hours. It could possibly, although unlikely, be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks.
4	$1 > \frac{A}{D} \geq 0.01$	Unlikely to be dangerous to the person	It is very unlikely that anyone would be permanently injured by this source. However, this amount of unshielded radioactive material, if not safely managed or securely protected, could possibly, although unlikely, temporarily injure someone who handled it or who was otherwise in contact with it for many hours, or who was close to it for a period of many weeks.
5	$0.01 > \frac{A}{D}$ and A > exempt	Most unlikely to be dangerous to the person	No one could be permanently injured by this source.

2.4.3 The IAEA Security Grouping of Sources

The IAEA security grouping of sources (IAEA, 2019b) uses a graded approach to security based on a set of security levels, and the security functions of deterrence, detection, delay, response, and security management. For this purpose, three security levels (A, B and C) have been developed to allow specification of security system performance. Security level A requires the highest degree of security, while the other levels are progressively lower. Each security level has a corresponding goal, which defines the overall result that the security system should be capable of providing for a given security level. The following goals have been developed (IAEA, 2019b):

- Security level A: Provide a *high level* of protection of radioactive material against unauthorized removal;
- Security level B: Provide an *intermediate level* of protection of radioactive material against unauthorized removal; and
- Security level C: Provide a baseline level of protection of radioactive material against unauthorized removal.

IAEA (2019b) provide a summary of goals and sub-goals that apply to the detection, delay and response for each security level. A list of security management measures for radioactive material that apply to each security level is provided and includes (IAEA, 2019b):

- Establish a process for unescorted access to radioactive material and/or access to sensitive information;
- Ensure the trustworthiness and reliability of authorized individuals;
- Provide access controls that effectively restrict access to radioactive material to authorized persons only Identify and protect sensitive information;
- Provide a security plan;

- Ensure training and qualification of individuals with security responsibilities;
- Conduct accounting and inventory of radioactive material;
- Conduct evaluation for compliance and effectiveness of the security system, including performance testing; and
- Establish a capability to manage and report nuclear security events.

Malicious acts can involve either the unauthorised removal of a source or sabotage. While the security goals only address unauthorised removal, achievement of the goals will reduce the likelihood of a successful act of sabotage. Security systems that achieve the above goals will provide some (although limited) capability to detect and respond to an act of sabotage (IAEA, 2014a).

To ensure a harmonised approach, a security level should be assigned to each category in the IAEA Source Categorisation System. Category 1 sources should have security measures that meet the security objectives of Security Level A. Category 2 sources should have security measures that meet the security objectives of Security Level B. Category 3 sources should have security measures that meet the security objectives of Security Level C (IAEA, 2014a; 2019b).

2.4.4 The Interface between Safety and Security

Safety measures and security measures have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security (IAEA, 2014b).

This implies that security infrastructure and safety infrastructure need to be developed, as far as possible, in a well-coordinated manner. All the organizations involved need to be made aware of the commonalities and differences between safety and security to be able to factor both into development plans. The synergies between safety and security have to be developed so that safety and security complement and enhance one another (IAEA, 2014b).

3 Regulatory Framework

3.1 General

The purpose of this section is to provide an overview of the regulatory framework for the safety and security of sealed radiation sources. It is defined by national laws and regulations supplemented with principles, requirements and guidelines provided by international organisations concerned with radiation protection.

The section is structured as follows. Section 3.2 summarises the national regulatory framework that applies to the proposed SRS storage and handling facility, while Section 3.3 provides supplementary information from international organisations that contribute to the definition of the regulatory framework to protect human health and the environment.

3.2 National Regulatory Framework

3.2.1 Laws

The aim of the Atomic Energy and Radiation Protection Act, 2005 (Act No. 5 of 2005) (AERPA) promulgated in April 2005 includes amongst others, the provision for adequate protection of the environment and of current and future generations against the harmful effects of ionising radiation by controlling and regulating the production, processing, handling, use, holding, storage, transport and disposal of radiation sources and radioactive materials, and controlling and regulating prescribed non-ionising radiation sources. The Act also established an Atomic Energy Board and provision for its composition and functions, as well as the establishment of a National Radiation Protection Authority (NRPA).

Chapter 4 of the AERPA makes provisions for Authorisations, Licenses and Registrations. It includes several clearly defined provisions that are directly applicable to the proposed facility and associated activities. For example,

- Section 16 (1) (a) states that except when such activity is explicitly authorised by a license, no person may possess any radiation source or radioactive material
- Section 16 (2) (b) states that no person may without a licence operate or use any radiation source or instruct or permit any person in his or her employ or acting in any manner on his or her behalf or promoting his or her interests to operate or use any radiation source;
- Section 16 (4) states that no person may use or operate any radiation source, unless that source as well as the facilities in which such source is being operated, is registered as provided by this Act
- Section 18 states that unless any exemptions have been prescribed, any licence holder must register every radiation source, every facility used in respect of such source and the location where such source is used and the location where such source is stored.

Section 17 states the information to be included in a notification referred to in Section 16 (1), while Section 21 provides particulars of what an application for a license contemplated in Section 16 (2) must contain, in addition to the particulars stated in Section 17 (1). These include (Section 21 (1) (a) to (i)):

(a) particulars of any authorisations, registrations and licences which have been granted under this Act to the applicant as well as particulars of any applications for authorisations, registrations or licences that have been refused;

(b) the prescribed particulars of the applicant;

(c) a technical description of the practices for which the applicant requires a licence;

(d) the planned time of commencement and completion of all the facilities relating to the practice concerned;

(e) the name and qualifications of at least one person designated as a radiation safety officer;

(f) all relevant information relating to the impact of the practice concerned on public interests;

(g) the results of all assessments, including environmental impact assessments and studies that have been carried out in respect of the practice concerned as well as reports of those assessments and studies when the application is for disposal of radioactive waste or storage of radioactive sources for long periods;

(h) particulars of the impact of the practice concerned on private interests, including the interests of affected landowners and holders of other rights and interests in land;

(i) copies of consents and permits required under any other law or of the relevant applications if such consents or permits have not yet been granted.

3.2.2 Regulations

In 2011, the Radiation Protection and Waste Disposal Regulations under the AERPA were implemented. The Regulations, which came into operation on 16 January 2012, specify the minimum requirements for the protection of the people and environment against exposure to ionising radiation, for the safety of radiation sources, and for the security of radioactive and nuclear material. The Regulations do not relieve any person from the duty to take any additional actions as may be appropriate and reasonably necessary to protect any person or the environment from any damage resulting from radiation.

Chapters in the Regulations that are of particular importance for the proposed facility and associated activities include the following:

- Chapter 3 (*Radiation Protection Performance Requirements*), provides provisions for the justification of a practice, the application of the dose limit, the optimisation of protection and safety, and the application of a dose constraint.
- Chapter 4 (*Management Requirements*) provides for the following of a safety culture, quality assurance, human factors and the use and duties of radiation safety officers.
- Chapter 5 (*Verification of Protection and Safety*) provides for safety assessments, verification and compliance monitoring, record keeping, and the approval of dosimetry services.
- Chapter 6 (*Occupation Exposure Protection*) provides for responsibilities, conditions of services, the definition of controlled and supervised areas, rules and supervision, the use of personal protective equipment, exposure assessment, management of exposure monitoring of the workplace, health surveillance, and keeping of worker exposure record.
- Chapter 8 (*Public Exposure Protection*) provides for responsibilities, the control of visitors, radioactive contamination in enclosed spaces and monitoring of public exposure.
- Chapter 9 (*Requirements for the Safety and Security of Sources*) provides for responsibilities, accountability and security of sources, the design and safety of sources, storing and moving of sources, and record keeping.

3.2.3 Radiation Protection Criteria

In addition to the specific Regulations, dose limits for exposures incurred from practices are defined in Schedule 2 of the Regulations. For occupational exposure to workers, the following criteria apply:

- (1) Subject to subitem (2), the occupational exposure of any worker must be so controlled that the following limits are not exceeded –

  (a) an effective dose of 20 mSv per year averaged over five consecutive years;

  (b) an effective dose of 50 mSv in any single year;

  (c) an equivalent dose of to the lens of the eye of 150 mSv in a year; and

  (d) an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

- (2) For apprentices of 16 to 18 years of age who are training for employment involving exposure to radiation and for students of age 16 to 18 who are required to use sources in the course of their studies, the occupational exposure must be so controlled that the following limits are not exceeded –

  (a) an effective dose of 6 mSv in a year;

  (b) an equivalent dose to the lens of the eye of 50 mSv in a year; and

  (c) an equivalent dose to the extremities or the skin of 150 mSv in a year.

For public exposure to ionizing radiation, the following criteria apply:

- The estimated average doses to the relevant critical groups of members of the public that are attributable to practices may not exceed the following limits –

  (a) an effective dose of 1 mSv in a year: Provided that in special circumstances, an effective dose of up to 5 mSv in a single year may be approved: Provided further that the average dose over five consecutive years does not exceed 1 mSv: per year;

  (b) an equivalent dose to the lens of the eye of 15 mSv in a year; and

  (c) an equivalent dose to the skin of 50 mSv in a year.

3.3 International Framework for the Protection of Human Health and the Environment

3.3.1 General

The international framework for radiation protection in the nuclear, medical, and other industries is well-established and recognised. Organisations that play a key role in this regard include the *United Nations Scientific Committee on the Effects of Atomic Radiation* (UNSCEAR), the *International Commission on Radiological Protection* (ICRP), and the IAEA (IAEA, 2004b)

The UNSCEAR mandate, established by the General Assembly of the United Nations in 1955, is to assess and report the levels and effects of exposure to ionizing radiation. Governments and organizations throughout the world rely on the Committee's estimates as the scientific basis for evaluating radiation risk and for establishing protective measures. Consequently, UNSCEAR published many informative documents. Some of these publications and reports may not be directly applicable to the proposed storage facilities for SRS but contribute to the overall framework for the protection of human health and the environment from exposure to ionizing radiation.

3.3.2 The International Commission on Radiological Protection (ICRP) System of Radiological Protection

The ICRP is a non-governmental, independent, scientific organization founded in 1928, following recommendations at the first International Congress of Radiology (ICR) held in London in 1925 to establish international protection standards (ICRP, 2009). The ICRP has more than two hundred volunteer members from approximately thirty countries across six continents, who represent the world's leading scientists and policymakers in the field of radiological protection. The ICRP is a not-for-profit organisation registered as a charity in the United Kingdom and currently has its scientific secretariat in Ottawa, Canada. They publish recommendations for protection against ionizing radiation regularly (https://www.icrp.org/). The ICRP's authority derives from the scientific standing of its members and the merit of its recommendations.

Historically, the primary aim of the ICRP System of Radiological Protection is to provide an appropriate standard of protection for human beings without unduly limiting beneficial practices derived from radiological materials (ICRP, 1991). To achieve this objective, the ICRP system is intended to prevent the occurrence of deterministic effects by keeping doses below the relevant threshold. It also ensures that all reasonable steps are taken to reduce the induction of stochastic effects by keeping doses as low as reasonably achievable (ALARA) with economic and social factors being taken into account (ICRP, 2000). The ICRP System of Radiological Protection is based on three principles (ICRP, 1991):

- *The Principle of Justification*: Any decision that alters the radiation exposure situation should do more good than harm. This means that by introducing a new radiation source, coupled with reducing existing exposure and reducing the risk of potential exposure, one should achieve sufficient individual or societal benefit to offset the detriment it causes.
- *The Principle of Optimisation of Protection*: The likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable (ALARA), considering economic and societal factors.
- *The Principle of Application of Dose Limits*: The total dose to any individual from regulated sources in planned exposure situations (other than medical exposure of patients) should not exceed appropriate limits.

In its revised System of Protection, the ICRP recognises three types of exposure situations that are intended to cover the entire range of possible exposure situations (ICRP, 2007). These are:

- *Planned Exposure Situations*: Planned exposure situations involve the deliberate introduction and operation of sources. This may give rise to exposures that are anticipated to occur (normal exposures) and to exposures that are not anticipated to occur (potential exposures);
- *Emergency Exposure Situations*: Emergency exposure situations refer to unexpected situations that may occur during the operation of a planned situation, from a malicious act, or from any other unexpected situation that requires urgent action to avoid or reduce undesirable consequences.
- *Existing Exposure Situations*: Existing exposure situations refer to exposure situations that already exist when a decision on control must be taken, including prolonged exposure situations after emergencies or those caused by natural background radiation.

The principles of *justification* and *optimisation* apply to all three exposure situations, whereas the principle of *application of dose limits* applies only to doses expected to be incurred with certainty because of planned exposure situations. The principle of *justification* requires that the net benefit of any action involving radiation be positive.

Planned exposure situations are normally within the scope of regulatory requirements for radiological protection. The concepts of exclusion, exemption and clearance may, therefore, be used to justify and optimise regulatory control by avoiding the application of unamenable and unwarranted regulatory measures (ICRP, 2007).

3.3.3 International Atomic Energy Agency (IAEA) Safety Standard Series

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of human health and minimization of danger to life and property, and to provide for their application.

The IAEA safety standards provide a robust framework of fundamental principles, requirements, and guidance to ensure safety. The standards are developed through an open and transparent process of gathering, integrating, and sharing the knowledge and experience gained from the actual use of technologies, as well as from the application of the safety standards, including emerging trends and issues of regulatory importance. The standards contribute to the establishment of a harmonized high level of safety worldwide by serving as the global reference for protecting people and the environment from the harmful effects of ionizing radiation.

The safety standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material, and the management of radioactive waste. They are issued in the IAEA Safety Standards Series as Safety Fundamentals, Safety Requirements, and Safety Guides.

As the primary publication in the Safety Standards Series, the *Fundamental Safety Principles* establishes the fundamental safety objective and principles of protection and safety. The fundamental safety objective is *to protect people and the environment from the harmful effects of ionizing radiation*. This fundamental safety objective of protecting people, both individually and collectively, as well as the environment, has to be achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks (IAEA, 2006b).

The fundamental safety objective applies to all facilities and activities and all stages of the lifetime of a facility or radiation source including planning; siting; design; manufacturing; construction; commissioning and operation; transport of radioactive material and management of radioactive waste; decommissioning; and closure. Ten safety principles have been formulated, based on which safety requirements are developed and safety measures are to be implemented to achieve the fundamental safety objective (IAEA, 2006b).

An integrated and consistent set of *Safety Requirements* establishes the requirements that must be met to ensure the protection of people and the environment, both now, and in the future. The requirements are governed by the objectives and principles of the Safety Fundamentals. If they are not met, measures must be taken to reach or restore the required level of safety. The format and style of the *Safety Requirements* facilitate use by the Member States for the establishment, in a harmonized manner, of their respective national regulatory frameworks. Requirements, including several 'overarching' requirements, are expressed as 'shall' statements.

Safety Guides provide recommendations and guidance on how to comply with the requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly reflect best practices, to help users strive to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

3.3.4 Revised IAEA Basic Safety Standards (GSR Part 3) (IAEA, 2014b)

The Basic Safety Standards (BSS) published in 1996 were a cornerstone of the IAEA safety standards for many years (IAEA, 1996). However, "*Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*" (GSR Part 3) (IAEA, 2014b) in the General Safety Requirement series superseded the BSS. The overall objective of GSR Part 3 is to establish requirements (i.e., *shall* statements) for the protection of people and the environment from the harmful effects of ionizing radiation and the safety of radiation sources.

Section 1 of GSR Part 3 does not constitute requirements but explains the context, concepts and principles for the requirements presented in the remainder of the document. These include (amongst others) the following:

- The *System of Protection and Safety* that is based on the IAEA Fundamental Safety Principles outlined in IAEA (2006b);
- The *Types of Exposure Situations* that in their definition are consistent with the ICRP exposure situations (ICRP, 2007) introduced in Section 3.3.2;
- An explanation of the concepts of *Dose Constraints and Reference Levels*. Both concepts are used for the optimization of protection and safety, the intended outcome of which is that all exposures are controlled to levels that are as low as reasonably achievable (ALARA), with economic, societal, and environmental factors being considered;
- *Protection of the Environment* that recognised the protection of the environment as an issue necessitating assessment, while allowing for flexibility in incorporating into decision-making processes the results of environmental assessments that are commensurate with the radiation risks; and
- *The Interface between Safety and Security*, both of which have in common the aim of protecting human life and health and the environment. Also, safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

Requirements specified in Section 2 to Section 5 of GSR Part 3 make a distinction between the three types of exposure situations, with a further distinction between occupational exposure, public exposure, and medical exposure.

3.3.5 Safety Standards for the Protection of the Public and Workers

The ICRP recommends that any exposure caused by human activity above natural background radiation should be kept as low as reasonably achievable (ALARA) with economic and social factors being taken into account, but below the following individual dose limits (ICRP, 1991):

- The individual dose limit for public exposure in planned exposure situations is 1 mSv in a year.
- In special circumstances, an effective dose of up to 5 mSv in a single year provided that the average dose over five consecutive years does not exceed 1 mSv per year, can be applied.
- Also, the ICRP recommends equivalent dose limits of 15 mSv in a year to the lens of the eye and 50 mSv in a year to the skin.

The dose limits for public exposure presented in Schedule III of GSR Part 3 (IAEA, 2014b) are consistent with the limits defined in ICRP (1991):

- An effective dose of 1 mSv in a year;
- In special circumstances (e.g., in authorized, justified, and planned operational circumstances that lead to transitory increases in exposures), a higher value of effective dose in a single year could apply, provided that the average effective dose over five consecutive years does not exceed 1 mSv per year;
- An equivalent dose to the lens of the eye of 15 mSv in a year; and
- An equivalent dose to the skin of 50 mSv in a year.

The ICRP further recommends that consideration must be given to the presence of other sources that may cause simultaneous radiation exposure to the same group of the public. Allowance for future sources must be kept in mind so that the total dose received by an individual member of the public does not exceed the dose limit.

For this reason, *dose constraints* that are lower than the *dose limit* and typically around 0.1 to 0.3 mSv per year are proposed to ensure that 1 mSv per year is not exceeded. Dose constraints are thus set separately for each source under control, and they serve as boundary conditions in defining the range of options for optimization. Note that a *dose constraint is not a dose limit*; *exceeding a dose constraint does not represent non-compliance with regulatory requirements*, but could result in follow-up actions as required by the regulatory body (IAEA, 2014b).

For occupational exposure of workers over the age of 18 years, the dose limits presented in Schedule III of GSR Part 3 (IAEA, 2014b) are:

- An effective dose of 20 mSv per year averaged over five consecutive years (100 mSv in 5 years) and of 50 mSv in any single year;
- An equivalent dose to the lens of the eye of 20 mSv per year averaged over five consecutive years (100 mSv in 5 years) and of 50 mSv in any single year;
- An equivalent dose to the extremities (hands and feet) or to the skin of 500 mSv in a year.

Additional restrictions apply to occupational exposure for a female worker who has notified of pregnancy or is breast-feeding (para. 3.114).

For occupational exposure of apprentices of 16 to 18 years of age who are being trained for employment involving radiation and for exposure of students aged 16 to 18 who use sources in the course of their studies, the dose limits are:

- An effective dose of 6 mSv in a year;
- An equivalent dose to the lens of the eye of 20 mSv in a year;
- An equivalent dose to the extremities (hands and feet) or to the skin of 150 mSv in a year.

3.3.6 Application of The Graded Approach

The graded approach is a well-established concept, and it is an integral part of the broader radioactive waste management framework. According to the IAEA Safety Glossary (IAEA, 2019b),

> "*The use of the graded approach is intended to ensure that the necessary levels of analysis, documentation, and actions are commensurate with, for example, the magnitudes of any radiological hazards and non-radiological hazards, the nature and the particular characteristics of the facility, and the stage in the lifetime of a facility*."

In Principle 5 of the Safety Fundamentals SF-1 (IAEA, 2006b) it is stated that:

> *"The resources devoted to safety by the licensee, and the scope and stringency of regulations and their application, have to be commensurate with the magnitude of the radiation risks and their amenability to control. Regulatory control may not be needed where this is not warranted by the magnitude of the radiation risks."*

To apply this principle, a graded approach shall be taken in carrying out the safety assessments for the wide range of facilities and activities as established in Requirement 1 of GSR Part 4 (Rev. 1) (IAEA, 2016):

> *"A graded approach shall be used in determining the scope and level of detail of the safety assessment carried out at a particular stage for any particular facility or activity, consistent with the magnitude of the possible radiation risks arising from the facility or activity."*

4 Site, Facility and Source Description

4.1 General

It follows from Section 1.1 that the proposed SRS storage and handling facility is planned to be located in the industrial area of Swakopmund, in the Erongo Region of Namibia. The purpose of this section is to summarise the environmental site conditions that might be most relevant to the proposed SRS storage and handling facility, as well as to describe the design, construction, and operation of the facility itself. The facility description includes the description of the SRS that will be stored and handled at the proposed facility. Collectively, these aspects are key in the definition of exposure conditions (see Section 5) and in quantifying the potential radiological impact of the proposed SRS storage and handling facility on workers and members of the public (see Section 6).

The section is structured as follows. Section 4.2 describes the prevailing environmental site conditions, followed by an overview of the local human behavioural characteristics, in Section 4.2.8. This is followed by a description of the proposed SRS storage and handling facility as it is anticipated to be designed and constructed. Section 4.4 describes the characteristics of the SRS that will be stored at the proposed facility.

4.2 Environmental Site Conditions

4.2.1 General

The purpose of this section is to summarise the environmental site conditions observed near the proposed SRS storage and handling facility site and provide a statement on the potential environmental impact on each. Following a graded approach to the level of detail that is provided, this information provides insight into the potential environmental pathways that may be of importance in the case of the release of any radionuclides into the environment.

4.2.2 Locality and Surrounding Land Use

Figure 4.1 shows that the proposed SRS storage and handling facility is located on Erf 3954 on Einstein Street within the municipal area of Swakopmund (Coordinates 22°40'13.85"S, 14°32'41.53"E).

The property (Erf 3954) and the greater area around the property are currently zoned as a General Industrial area. Table 4.1 summarises the adjacent land users, which indicates that all are industrial land users. However, there is a residential area 120m to the northeast of the property across the railway reserve. There are no heritage or cultural sites located on, or close to the site. Access to the property is gained from the southwest *via* Einstein Street.

4.2.3 Climate Conditions

The climate in Namibia is dominated by dry conditions for most of the year, particularly in the west. The Intertropical Convergence Zone, Subtropical High-Pressure Zone and Temperate Zone are what determine the climate, with the Subtropical High-Pressure Zone being the major contributor to the dry conditions (Atlas of Namibia, 2002; Bryant, 2010) (see Figure 4.2). Table 4.2 summarises the main climate data for Swakopmund.

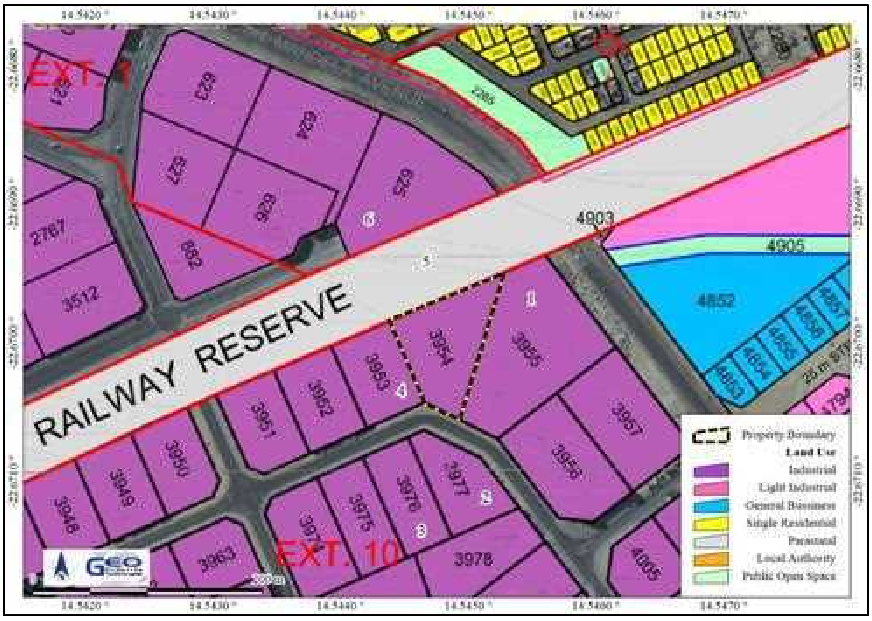


Figure 4.1 **locality map showing the proposed location on Erf 3964 on Einstein Street in Swakopmund.**

Table 4.1 **Summary of the surrounding land users in the study area.**

Direction	Land Use	Neighbour
North	Industrial	Railway Reserve
East	Industrial	QCrete Readymix Concrete
South	Industrial	Currently empty erf
West	Industrial	Currently empty erf

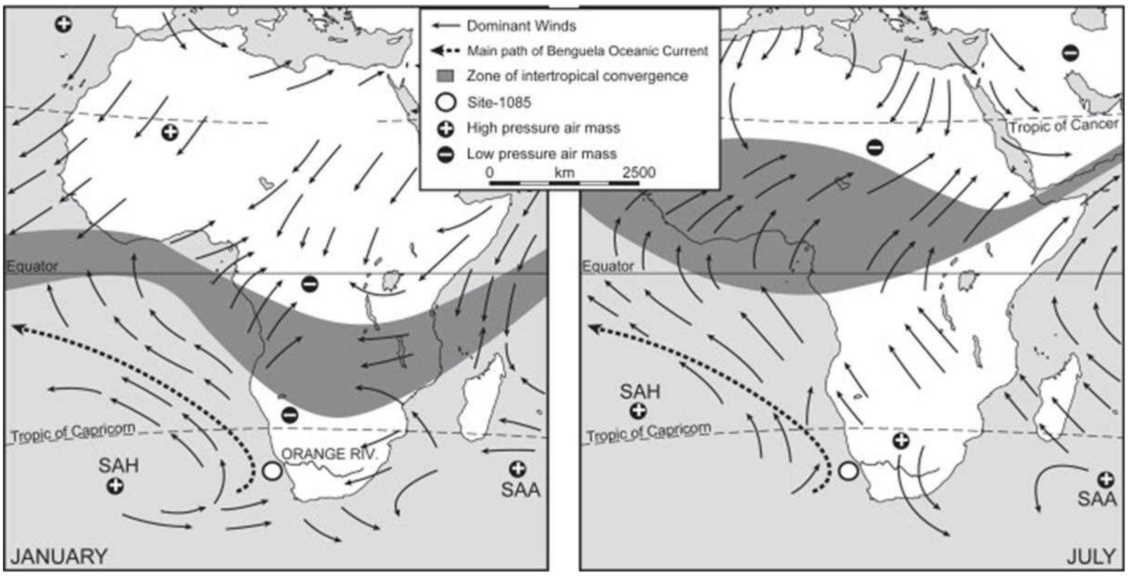


Figure 4.2 **Map indicating the Intertropical Convergence Zone, Subtropical High-Pressure Zone (SAH+), Benguela Current and Temperate Zone south of Tropic of Capricorn (not indicated) (from: http://www.meteoweb.eu).**

Precipitation over Namibia is mainly controlled by the South Atlantic High (SAH), a high-pressure cell (anticyclone) situated west of Namibia in the Subtropical High-Pressure Zone. The SAH shifts during the year and is at higher latitudes in winter and lower latitudes in summer. In winter, as a result of being situated more north, the high-pressure cell pushes any moisture originating from the Intertropical Convergence Zone northwards, preventing rain over Namibia. In summer, because the high-pressure cell moves further south and has less of an effect on the Intertropical Convergence Zone, moist air reaches Namibia, resulting in summer rains. Figure 4.3 summarises the Monthly average rainfall for Swakopmund.

Table 4.2 Summary of climate data for Swakopmund (Atlas of Namibia Project, 2002).

Parameter	Classification or Value
Classification of climate	Desert
Precipitation	0-50
Variation in annual rainfall (%)	> 100
Average annual evaporation (mm/a)	2,600-2,800
Water deficit (mm/a)	1,701–1,900
Temperature °C	<16

Average Monthly Rainfall (mm)											
Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
0.2	0.3	0.5	0.8	1.1	0.4	6.3	5.4	13.1	4.2	1.1	0.9

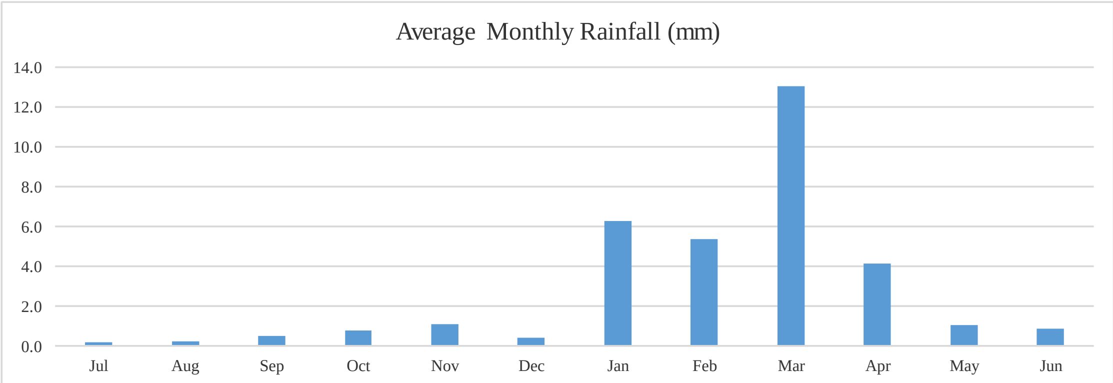


Figure 4.3 Monthly average rainfall (Atlas of Namibia Project, 2002).

On a more localised scale, the climatic conditions on the central Namibian coast, and inland thereof (coastal plains), are strongly influenced by the cold Benguela current, the SAH and the relatively flat coastal plains that are separated from the central highlands by a steep escarpment. The anticlockwise circulation of the high-pressure SAH and the action of the earth's Coriolis force results in strong southerly (longshore) winds blowing northwards up the coastline of Namibia (Bryant, 2010; Corbett, 2018). This longshore wind is responsible for the upwelling of the cold, deep waters of the Benguela Current. As a result of the temperature difference between the cold surface water of the Benguela Current and the warm coastal plains, the southerly wind is diverted to a south-south-westerly to south-westerly wind along the coast.

The winds are strongest in early to mid-summer (September to January) when the SAH is at its strongest and most persistent, and the temperature difference between the sea and the desert plains is at its greatest. Wind speeds then occasionally exceed 32 km.hour^{-1} and usually peak late morning to early afternoon. In winter, the SAH loses strength and the southerly to south-westerly winds are at their weakest. Winter winds do not have enough strength to reach far inland. Autumn to winter conditions do however promote the formation of east wind conditions (berg winds) that can reach speeds of more than 50 km.hour^{-1} and transport a lot of sand. East winds occur when the inland plateau is cold with a localised high-pressure cell, while a low-pressure system is present at the coast. The high-pressure cell forces air off the escarpment and as the air descends, it warms adiabatically as well as creates a low-pressure system due to the vertical expansion of the air column. The warm air flows toward the coastal low and as it passes over the Namib plains, it heats up even further. The wind manifests itself as strong, warm, and dry winds during the mornings to early afternoon but dissipates in the late afternoon.

Throughout the year the prevailing nighttime regional wind is a weak easterly wind. This results from the mainland cooling to below the temperature of the coastal water. This results in a coastal low versus an onshore high-pressure system with first no wind in the early evening, when temperatures between water and land are similar, and then weak easterly winds as the temperature difference increases (see Figure 4.4).

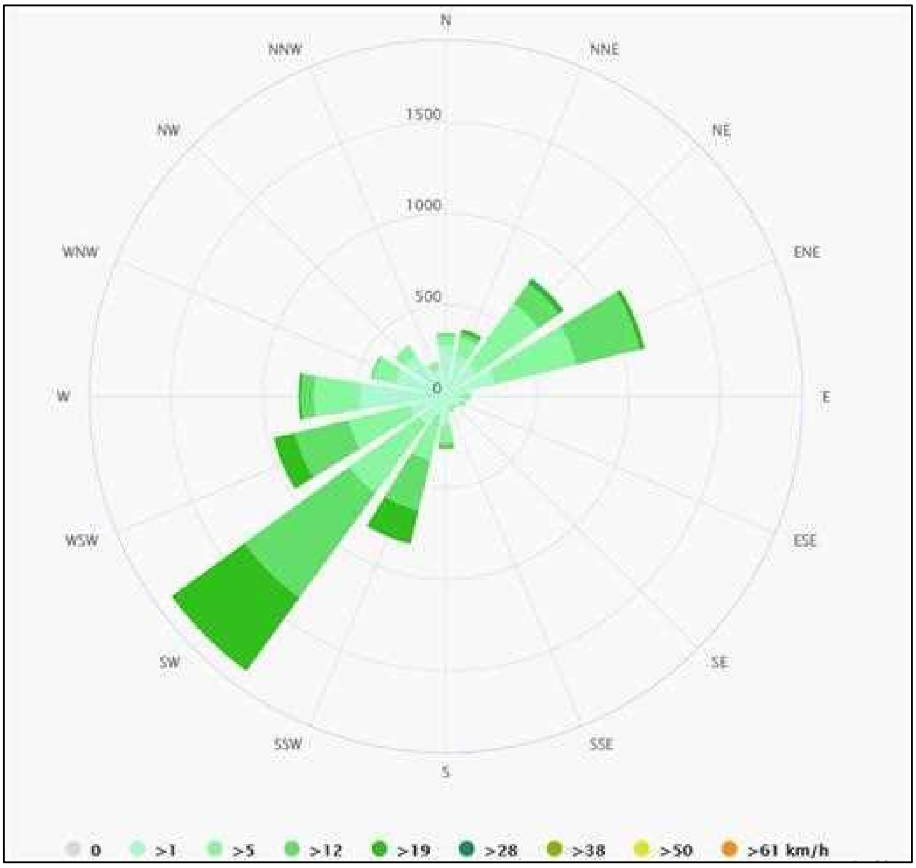


Figure 4.4 Wind rose of modelled wind direction and speeds (Meteoblue, 2024).

The temperature at Swakopmund is strongly regulated by the cold Benguela current. As a result, there is typically limited variation between diurnal and seasonal temperatures. The average annual temperatures are less than 16 °C with the maximum temperature seldom above 30 °C and minimums rarely below 5 °C. The only real temperature extremes are experienced during east wind conditions in the autumn to early winter months when temperatures can reach the upper thirties or even low forties. This results in these months having an average maximum temperature ranging from 30 °C to 35 °C. As one moves inland from Swakopmund, daytime temperatures increase rather quickly, while nighttime temperatures can get significantly colder in the desert environment.

As explained above, the SAH severely limits the amount of rainfall over Namibia, especially at the coast and over the Namib Desert. As such, the average annual rainfall in Swakopmund is below 50 mm, with more than 100% variation in annual rainfall. Infrequent, heavy rainfall does occur and typically results in rather chaotic conditions as Swakopmund has not been developed to cater for large volumes of stormwater. Fog plays a significant role as a source of water for many plants and animals along Namibia's coast and the Namib Desert. Swakopmund has more than 100 days of fog per year which results from the cold Benguela water cooling the humid air above it to such a temperature that the water vapour condenses to form fog and low-level clouds (Mendelsohn et al., 2002).

4.2.4 Corrosive Environment

The corrosive environment of Swakopmund can be closely related to that of Walvis Bay and may be attributed to the frequent salt-laden fog, periodic winds, and abundance of aggressive salts (dominantly NaCl and sulphates) in the soil. The periodic release of hydrogen sulphide (H_2S) from the ocean is expected to contribute to corrosion (see Table 4.3 for corrosion comparison data with other centres).

Table 4.3 Average annual corrosion rate for various metals in different locations in southern Africa (from Nickel Development Institute: Stainless Steels in Architecture, Building and Construction. http://www.nickelinstitute.org).

		Pretoria CSIR	Durban Bay	Cape Town Docks	Durban Bluff	Walvis Bay	Sasolburg
Environment							
Location Type		Rural, Very low pollution	Marine, Moderate Pollution	Marine, Moderate Pollution	Severe marine, moderate or low pollution	Severe marine, low pollution	Industrial high pollution
SO_2 Range µg/m3		6-20	10-55	19-39	10-47	NA	NA
Fog days/year		NA	NA	NA	NA	113.2	NA
Avg. rainfall (mm/year)		146	1,018	508	1,018	8	677
Relative humidity range %		26-76	54-84	52-90	54-84	69-96	49-74
Temp. Range °C		6-26	16-27	9-25	16-27	10-20	5-20
Unpainted galvanized steel life, years		5-15	3-5	3-7	3-5	0.6-2	5.-15
Annual Corrosion Rate (mm.year^{-1})							
Stainless Steel	Type 316	0.000025	0.000025	0.000025	0.000279	0.000102	NA
	Type 304	0.000025	0.000076	0.000127	0.000406	0.000102	NA
	Type 430	0.000025	0.000406	0.000381	0.001727	0.000559	0.000107
Aluminium Alloys	AA 93103	0.00028	0.00546	0.00424	0.01946	0.00457	0.00281
	AA 95251	0.00033	0.00353	0.00371	0.01676	0.00417	NA
	AA 96063	0.0028	0.00315	0.00366	0.020	0.00495	NA
	AA 96082	0.00033	0.00366	0.0034	0.02761	0.00587	NA
	AA 85151	NA	NA	NA	0.0246	0.00375	0.00317
Copper		0.00559	0.0094	0.00711	0.0246	0.0384	0.014
Zinc		0.0033	0.0231	0.029	0.111	NA	0.0152
Weathering Steel		0.0229	0.212	0.0914	0.810	1.150	0.107
Mild Steel		0.0432	0.371	0.257	2.190	0.846	0.150

The combination of high moisture and salt content of the surface soil can lead to rapid deterioration of subsurface metal (e.g. pipelines) and concrete structures. Chemical weathering of concrete structures due to the abundant salts in the soil is a concern.

4.2.5 Topography and Drainage

The landscape is classified as being in a flat western coastal plain composed of mobile dunes and gravel sandy plains, an area of dissection and erosional cutback. The local landscape is thus generally flat with poorly developed drainage systems. The site and surrounding areas themselves are also generally flat and levelled for township development. The site is not located within a river catchment and surface runoff would be in a north-westerly direction towards the Atlantic Ocean (see Figure 4.5). Erf 3954 has a small catchment area, and the entire surface drainage pattern of the larger area is significantly impacted by infrastructure development.

Figure 4.5 Map showing the surface drainage of the area.

The site is located about 11 m above the bed of the Swakop River at the river's narrowest point as dissected by lines A-B in Figure 4.6. An obstruction in the river at this point will have to be more than 10 m high and more than 300 m wide before water will start inundating the built areas on the riverbanks. Such flood waters will not reach the site as they will flood most of Swakopmund's lower-lying areas (all west of the site) and flow westwards into the ocean.

4.2.6 Geology and Hydrogeology

Figure 4.7 shows the local and regional geology of the area. The dominant surface soil cover in the area is petric Gypsisols. Local geology in the area consists of marble, schist, ortho-amphibolite, quartzite, dolerite sills and dykes of the Namibian Age – Karibib Formation of the Swakop Group. Surface geology at the site consists of coarse brown sand. Groundwater flow would be mainly through primary porosity in the topsoil cover and along fractures, faults, and other geological structures (secondary porosity) present within the underlying hard rock formations.

Groundwater flow from the site can be expected in a westerly direction towards the Atlantic Ocean. Local flow patterns may vary due to groundwater abstraction. No known boreholes are located within a 5 km radius of the site.

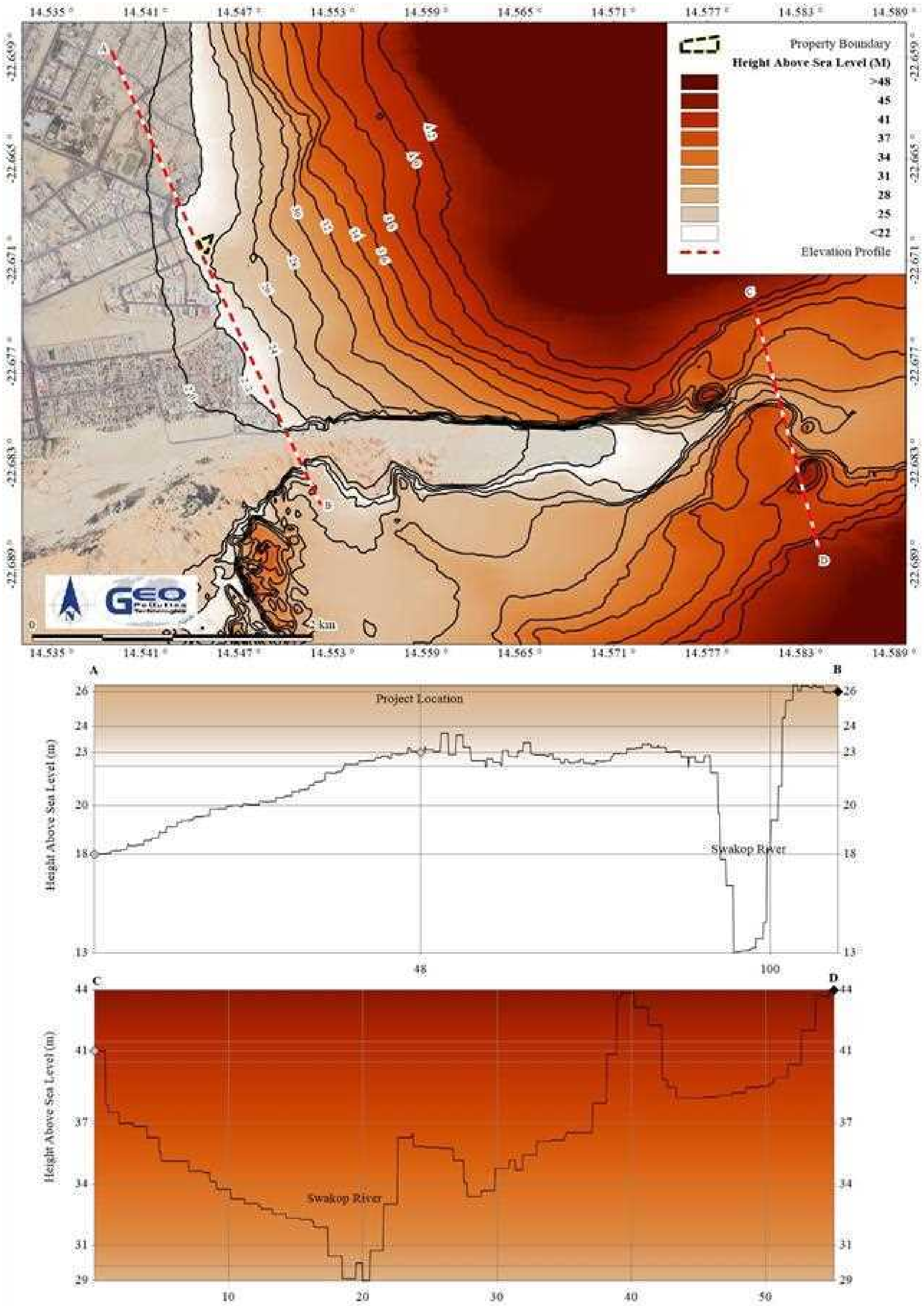
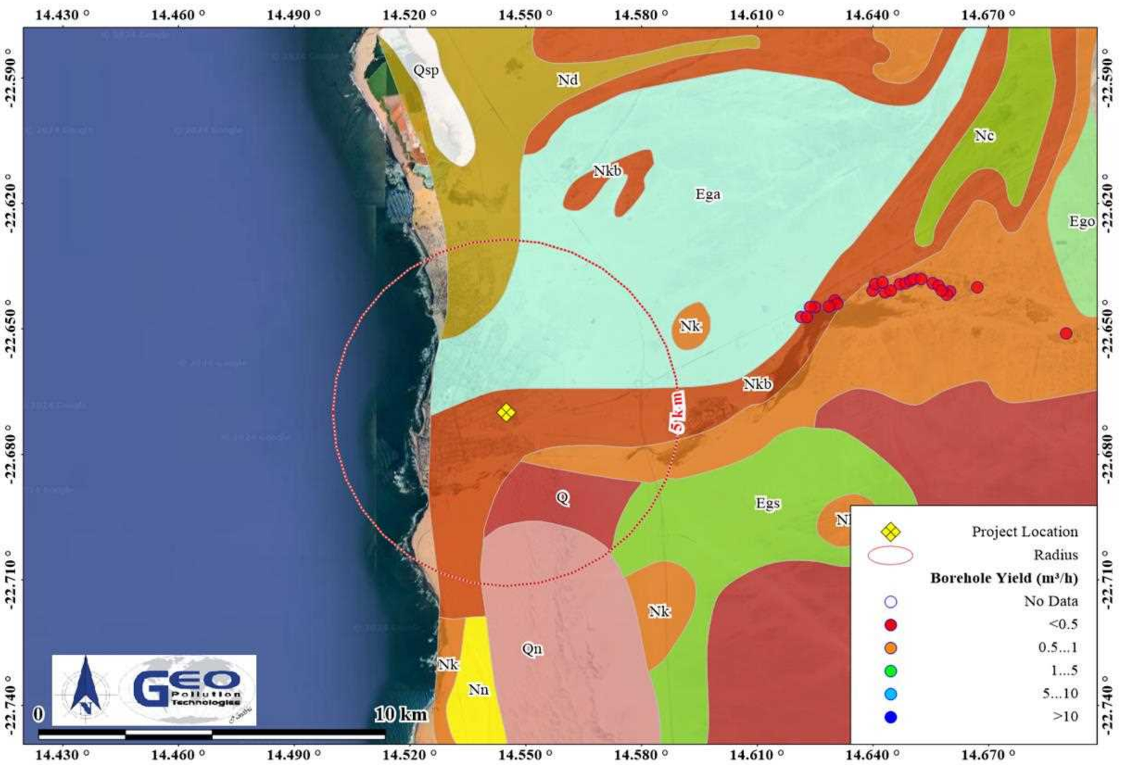


Figure 4.6 Topography and elevation above the Swakop Riverbed.



LITHCODE	AGE	FORMATION	SEQUENCE	GROUP	SUBGROUP	SUITE	INTRUSIVE_UNIT	ROCKTYPES	REMARKS
Ega	Cambrian					Red Granite		Syn- to post-tectonic gneissic red granite	
Ego	Cambrian					Red Granite	Ozombanda Granite	Post-tectonic homogeneous red granite	
Egs	Cambrian					Salem		Syn- to post-tectonic granite, granodiorite, monzonite, diorite	
Nc	Namibian	Chuos	Damara	Swakop/Otavi	Khomas/Tsumeb			Mixtite, minor schist, shale, quartzite, iron-formation, ortho-amphibolite, graphitic schist	
Nd	Namibian		Damara			SALEM		Schist, marble, quartzite, conglomerate, graphitic schist	Undifferentiated Swakop and Nosib Groups
Nk	Namibian	Kuiseb	Damara	Swakop	Khomas			Mica schist, minor quartzite, graphitic schist, marble	
Nkb	Namibian	Karibib	Damara	Swakop	Khomas			Marble, schist, ortho-amphibolite, quartzite	
Nn	Namibian		Damara	Nosib				Quartzite, conglomerate, schist, marble	
Q	Quaternary							Alluvium, sand, gravel, calcrete	
Qn	Quaternary			Namib				Sand sea of the Namib Desert	
Qsp	Quaternary							Coastal salt pan	

Figure 4.7 Map showing the local and regional geology of the area.

4.2.7 Ecology

The location for the proposed SRS storage and handling facility lies on the western edge of the Namib Desert Biome (Giess 1971), with the cold Atlantic Ocean to the west. The dry Namib Desert and the cold Atlantic Ocean largely determine water availability and vegetation, and thus also animal biodiversity. The site is situated in the transitional area between the Southern Desert and Central Desert vegetation types (Mendelsohn 2002) but is within a serviced and developed urban area. As such, the biodiversity near the project area is significantly altered by anthropogenic activities.

The Namib Desert characterises the west of Namibia and stretches from north-western South Africa, along the entire Namibian coast, and into the southwest of Angola. The desert area around Swakopmund can broadly be divided into the Walvis Bay – Swakopmund dune belt, the Gravel Plains of the Central Namib, and the ephemeral Swakop River forming a boundary between the two. A narrow beach zone (the coastal plain), associated with a hummock dune belt and small isolated salt flats, is found south and north of Swakopmund. The coastline, forming the western boundary of Swakopmund, is mostly a sandy shoreline south of Patrysberg some 7 km away, with a rocky shoreline interspersed with sandy beaches from Patrysberg to the north of Swakopmund.

The ecology of the area is largely influenced by the climatic conditions characterised by low and unpredictable rainfall with regular occurrences of fog. Many living organisms have thus largely evolved to survive with limited surface water by harvesting fog, or by obtaining water from food, as the main source of water. As a result, species richness and abundance are relatively low with a high level of endemism. Many species have also evolved to survive in areas with specific conditions (micro-habitats) and are thus often range-restricted.

While vertebrates are relatively well documented throughout Namibia, inventories of invertebrates are relatively patchy, and often associated with specific project areas (e.g. mines that conducted impact assessments). The desert conditions are more favourable to arthropods and reptiles while mammals are limited to relatively few desert-adapted species. Birds are also largely associated with the coastline and river courses. The dunes of the Namib Sand Sea are relatively uninhabited while the gravel plains have increased diversity on rocky outcrops and in drainage lines with increased vegetation. Rocky outcrops include inselbergs and dolerite ridges where habitat differentiation is more pronounced.

4.2.8 Public Water Supply

Water to Swakopmund town is supplied by NamWater and is sourced from the Omdel Dam and Erongo Desalination Plant. The Omdel Dam (Omaruru Delta Water Scheme) is situated in the Omaruru River, about 30 km northeast of Henties Bay, on the C35 to Uis. The Erongo Desalination Plant is located 35 km north of Swakopmund near Wlotzkasbaken. No groundwater is abstracted for potable use in Swakopmund. The area does not fall within a Groundwater Control Area. However, groundwater remains the property of the Government of Namibia.

4.3 Human Behavioural Conditions

4.3.1 Demographic and Economic Characteristics

Table 4.4 summarises the national, Erongo Region and Swakopmund demographic characteristics, as per the Namibian Statistics Agency (2024). According to the preliminary results of the 2023 Population and Housing Census (National Planning Commission, 2024), the Erongo region has 240,206 people, of which 44,725 reside in Swakopmund. Economic activities relate mostly to tourism and businesses within the area and around the site. The town is known as a tourist and commercial area.

Table 4.4 Demographic characteristics of Swakopmund, the Erongo Region and Nationally (Namibia Statistics Agency, 2024).

	Swakopmund	Erongo Region	Namibia
Population (Males)	37,950	122,322	1,474,224
Population (Females)	37,971	117,884	1,548177
Population (Total)	75,921	240,206	3,022401
Labour Force Participation Rate (2014) (15+ years)	Not available	79.7%	69.1
Literacy (2015) (15+ years)	Not available	94.4%	87.4%
Households considered poor (2015)	N/A	Not available	17.4%

4.3.2 Cultural, Heritage and Archaeological Aspects

There are no churches, mosques or related buildings close to the site. No known archaeological resources have been noted in the vicinity since the urbanisation of the area. No other structures, sites, or spheres of the heritage of cultural significance were determined to be near the site.

4.4 Facility Description

4.4.1 General

Presented here is a description of the proposed SRS storage and handling facility, which will only be constructed on Erf 3954 once the necessary regulatory approvals have been obtained. Therefore, the facility description information presented here is what is currently available. Some optimisation changes may be introduced as the process goes through the regulatory approval process.

4.4.2 Facility Layout

Figure 4.9 presents the layout of the infrastructure associated with the proposed SRS storage and handling facility. As mentioned in Section 4.2.2, the entrance to the site is from the south side, with the workshop and offices to the left. The yellow-shaded area is where the instruments will be calibrated with the workshop area. The green-shaded area is the position of the proposed SRS storage facility. The design details of the facility are presented in Section 4.4.3. This means that the SRS used for the calibration of the instruments will only move between the storage area and the calibration facility. The drilling tools will be calibrated in the magnetic calibration shack blue-shaded area.

Figure 4.8 View of the proposed workshop area that is planned for the workshop at Erf 3954 (Halliburton, 2023).

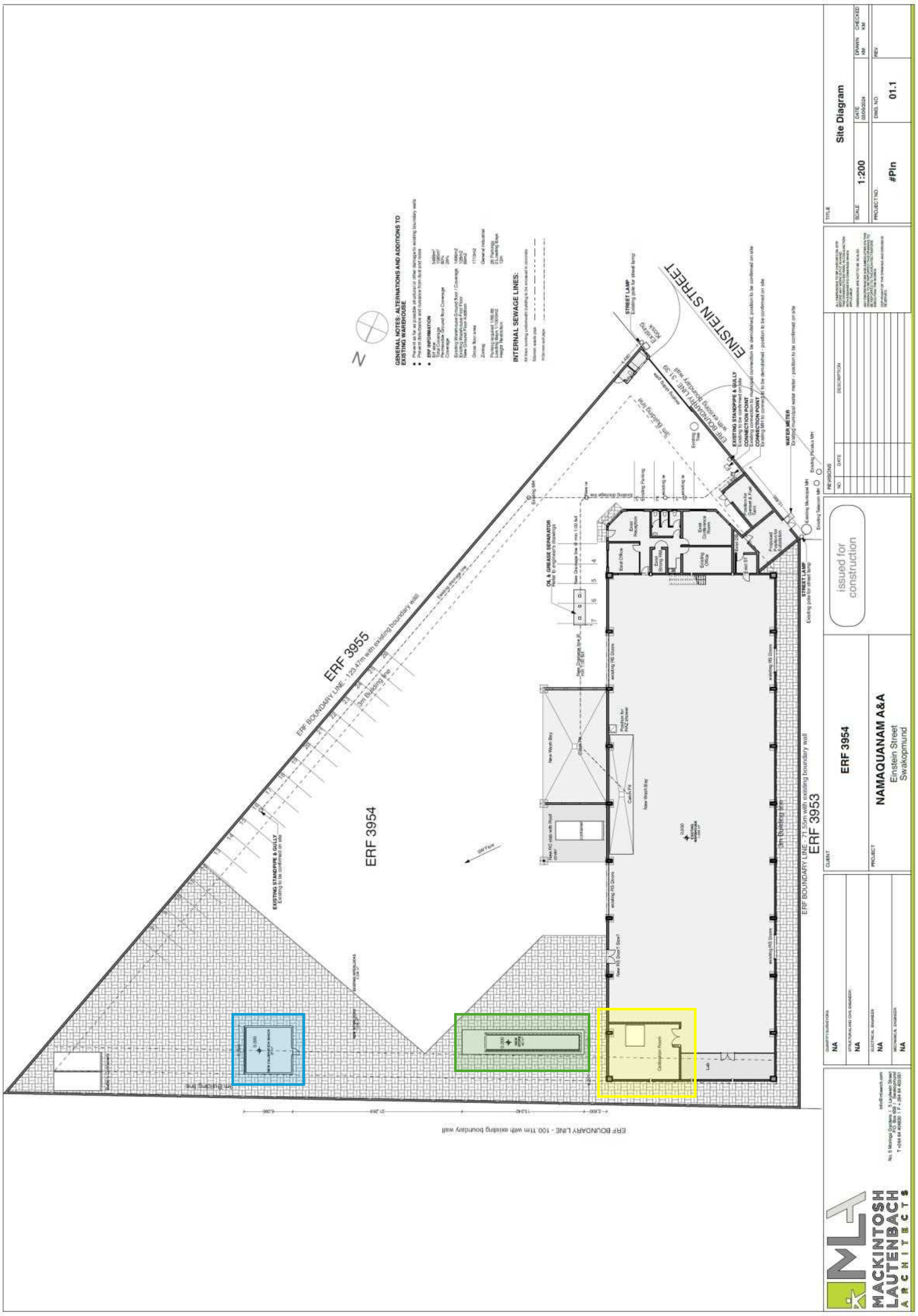


Figure 4.9 **Schematic diagram showing the layout and location of the infrastructure, including the proposed sealed radioactive source storage facility. The yellow-shaded area is where the instruments will be calibrated. The green-shaded area is the position of the proposed SRS storage facility. The drilling tools will be calibrated in the magnetic calibration shack blue-shaded area.**

4.4.3 Facility Design

4.4.3.1 Workshop

The yellow-shaded workshop area in Figure 4.9 will be transformed into a state-of-the-art workshop for the calibration and testing of drilling equipment. The floor of the workshop will be covered with a new 15 cm thick, reinforced and sealed concrete floor. Various workspaces will be created for the various tests and calibrations to be performed. Utilities like telecommunications, electricity and earthing, water, drainage, ventilation, and compressed air will be upgraded or newly installed. An equipment wash bay will be constructed and this, together with various drains, will be connected to an oil water separator. Additional emergency infrastructure and equipment will include a fire detection system, firefighting equipment, emergency eye wash stations, radiation detectors with audible and/or visual alarms, etc. A standby generator of 350 kVA will also be installed.

4.4.3.2 Storage Facility

Two design options are under consideration for the proposed SRS storage facility, both of which could be constructed in the green-shaded area in Figure 4.9. The preferred option shown in Figure 4.10 is a 12.2 m steel shipping container, placed on a concrete or paved surface. The four interior sides of the container will be lined by an approximately 150 mm thick, high-density concrete layer. A prefabricated concrete slab will be placed on top of the container. The container will also be lined with lead lining, with a proposed thickness of 6 mm. A 500 kg chain hoist on a monorail bean running under and parallel to the roof ridge will be installed. State-of-the-art security systems will be implemented to safeguard the storage facility (see Section 4.4.4).

As an alternative option, the facility to store radioactive source material can also be partially underground (see Figure 4.11). This will entail constructing a small building above ground, with a bunker pit below ground. The radioactive source material will be stored in this pit. The pit will be lined by concrete and covered with a sliding lockable pit cover. A 500 kg chain hoist on a monorail bean running under and parallel to the roof ridge will be installed. The facility will be fitted with a stairway to provide access to the bunker area. The same safety and security measures will be installed as the preferred option (see Section 4.4.4).

4.4.4 Security Arrangements

Notwithstanding their beneficial uses in industry, SRS security is of utmost importance, as highlighted in Section 2. This applies, in particular, to SRS that are in storage, which makes the security arrangements to be implemented at the proposed SRS storage and handling facility important. Independent of which storage facility options will be implemented, the container and the underground bunker will comply with the following radiation storage facility risk mitigation methodology (Halliburton, 2009) (see also Section 2.4.3 and Section 4.5.4):

- Radiological storage facilities must have Access Control that includes a physical barrier around the Security Zone, e.g., chain link fencing or concrete walls. The perimeter barrier for each Security Zone must be a minimum of six feet (1.83 m) in height and fencing, made of no less than 9-gauge wire and secured at the bottom.
- Perimeter fencing must have two feet (0.61 m) of top guard made of spiral barbed tape wire or two strands of barbed wire for a total fence height of no less than eight feet (2.44 m). Fully enclosed Security Zones do not need this top-guard.
- A 10-foot (3.05 m) cleared easement must be established around the barrier, building, or Security Zone.

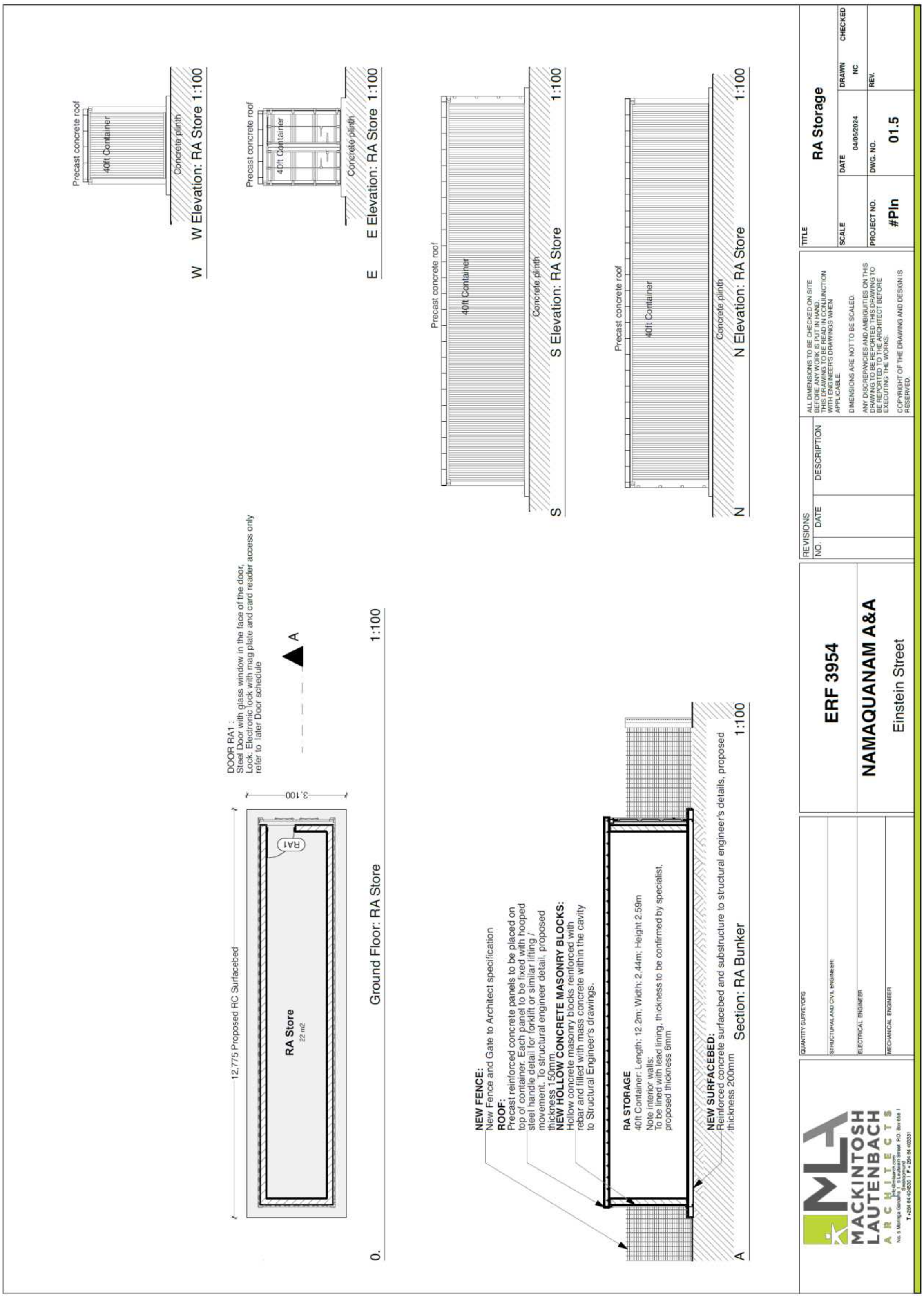


Figure 4.10 **Architectural drawing of the above-ground storage facility option, consisting of a reinforced 12.2 m shipping container.**

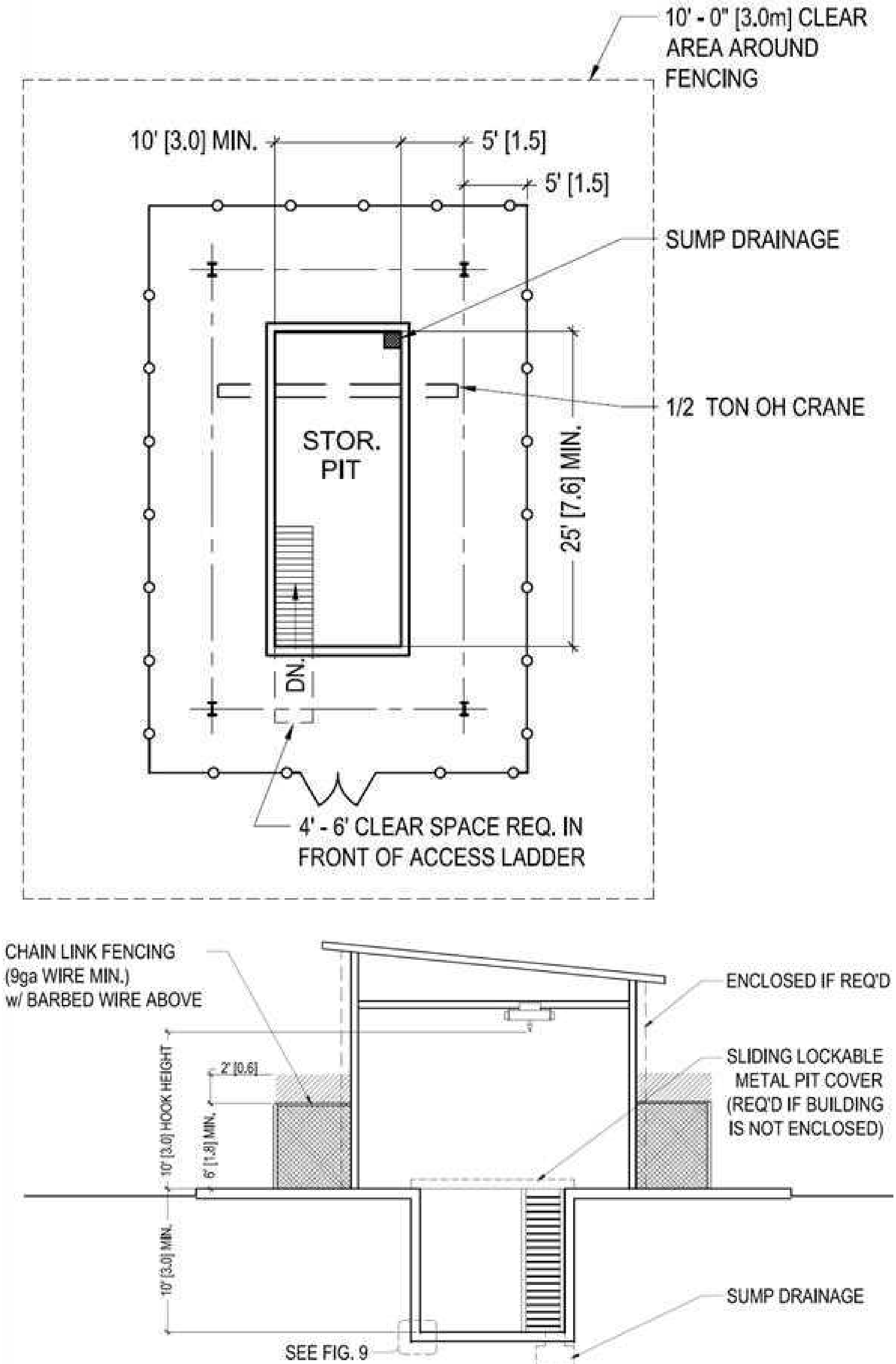


Figure 4.11 Schematic diagrams of the below-ground storage facility option, with a 3 m deep bunker that will serve as the storage area.

- Continuously monitored video surveillance of the Security Zone must capture 360 degrees around source pits 24/7, which meets the requirements for immediate detection of attempted unauthorized removal of Category 1 quantities of radioactive material and exceeds the requirement for weekly verification for Category 2 quantities of radioactive material.
- At a minimum, the entry point into the source storage area shall have Access Control readers that are alarmed for doors held open or forced entry and fail secure electric strike (or striking) devices with key override for safety, avoiding the use of a magnetic lock (or locking system). If magnetic locks are required by local regulation, then a secondary lock system, using security padlocks and controlled keys, shall also be installed for backup. All other entry points shall remain locked.
- Unescorted access to the security area will only be approved for those individuals who have taken the proper training and successfully completed a background and criminal history check as described in USNRC 10 CFR Part 37 Subpart B or other prevailing country regulations. All other employees shall be escorted by an approved individual for access into the Security Zone.
- All radiological storage zones must be actively alarm-monitored 24/7 by the Global Security Operations Center with a security system that meets all Corporate Security system standards.
- Intrusion detection alarms shall be configured to capture any unauthorized entry into the source area and provide 100% detection capability of the interior perimeter area.
- Standard operating procedures shall mandate a response to any intrusion alarm indicating unauthorized access within 10 minutes by a Company employee and within 30 minutes by a local law enforcement agency (where required by regulation). A letter or memorandum of agreement with the local law enforcement agency must be on file stating the required response times. A copy of the written agreement with the local law enforcement agency shall be provided to the Global Facilities Security Office in Houston, Texas.
- Control cabinets shall have tamper alarms and be located in a secured area.
- Any keys to the source storage area or security system components must be kept in a secured location accessible by Authorized Individuals only.
- Documentation containing details of the physical security measures and procedures shall be protected from disclosure to unauthorized employees. Such documentation shall be appropriately marked as sensitive security-related information, updated as necessary, and only accessible on the secured SharePoint site by authorized employees with a “need-to-know”
- Signage shall be posted on the perimeter fence or wall of the radioactive source storage building that reads: “IN CASE OF EMERGENCY CONTACT HALLIBURTON GLOBAL SECURITY CONTROL CENTER 281-575-5000”.
- A digital video recorder shall be installed in a secured location and set up for archiving video for no less than 15 days.
- Lighting shall be installed and consist of a minimum of 2-foot candlepower (21.5 lx) that provides adequate illumination of the entire storage facility, including the perimeter.
- All electronic components shall have uninterrupted power sources installed, which can operate for a minimum of two hours uninterrupted. For extended power outages, the radiation bunker shall be immediately secured with chain and padlocks by the Local Radiation Safety Officer or site security officers, and the Global Security Operations Center shall be informed.
- A steel cable shall be woven through the bottom of the chain link mesh around the perimeter, with secure clips over the steel cable into the concrete pad every 12 inches (31 cm) using a nail anchor.

After the aforementioned security measures, radioactive materials that are housed/stored differently (in dedicated buildings, inside other structures, etc.) shall consist of the following minimal measures:

- In addition to standards 1 through 17 above, any radioactive sources stored within a building must have 360-degree camera coverage of the exterior of the building.
- If the radioactive storage source is attached to a building wall, that wall must have camera coverage on the outside wall of the source area.

In addition to the security and risk mitigation measures listed above and as presented in Halliburton (2009), safety and security measures are also included in the Radiation Management Plan for Halliburton sites and facilities that address the following (Halliburton, 2022):

- Measures that will be employed to ensure the safety and security of sources.
- Description of the scenarios relating to potential breach of security involving radioactive materials
- Means of preventing the scenario.
- Response in case the scenario occurs.
- Description of how account will be kept of the inventories of the radiation sources as well as how the integrity of the radiation source will be maintained to promote safety.

4.5 Description of the Sealed Radioactive Sources

4.5.1 General

This section summarises the main radiological, physical and, where appropriate, the chemical properties of the SRS that will be stored and used at the facility. The potential radiological impact is directly associated with the properties of these sources. If there are no sources, then there is no radiological impact. Figure 4.12 is a schematic illustration of the most common types of radiation and their interaction with material types to shield alpha, beta, gamma, and neutron rays.

The SRS that will be used contains the isotopes Cs-137 and Am/Be-241. As mentioned, the primary purpose of the SRS is for the calibration of offshore oil exploration instruments of clients. Table 4.5 summarises the inventory of SRS that is earmarked for use and storage at the facility.

Note that the activity per source is the maximum since the activity of some of the sources may be less. Furthermore, the activity per source is the initial activity and does not take account of the decay to date. The current activity would, therefore, be less, especially for the Cs-137 sources.

Table 4.5 Summary of the sources that will be stored and used at the facility for the calibration of offshore oil exploration instruments.

Source	No. of Sources	Half-life	Activity per Source	Total Activity	D Values	A/D Ratio		Source Category	
		Years	GBq			Individual	Aggregated	Individual	Aggregated
Cs-137	15	30.17	74	1,110	100	0.74	11.10	4	2
Am/Be-241	5	432.20	555	2,775	60	9.25	46.25	3	2

If not in use, the SRS will be stored safely and securely using specially designed containers inside the proposed SRS storage facility. Figure 4.13 is an engineering drawing of a lead pig container used for the storage and transport of Cs-137 SRS. Figure 4.13 shows that the SRS is stored inside a container with a diameter of about 150 mm filled with lead as shielding material. Figure 4.14 is a schematic diagram of the container used for the storage and transport of Am/Be-241 SRS. Since Am/Be-241 SRS also emit neutron rays, lead alone is not sufficient and for this reason the contain is filled with polyethene as moderator for the neutron rays (see Figure 4.12). Figure 4.14 shows that the SRS is stored inside a container with a diameter of about 325 mm.

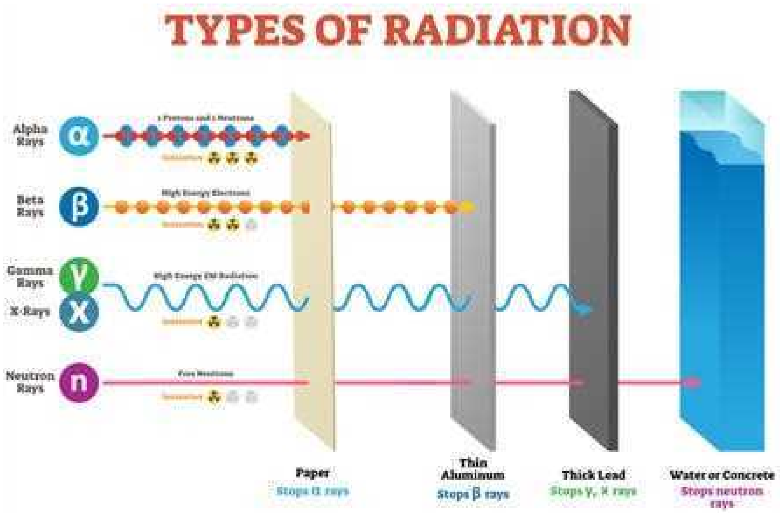


Figure 4.12 Schematic illustration of the most common types of radiation and their interaction with material types to shield alpha, beta, gamma and neutron rays[2].

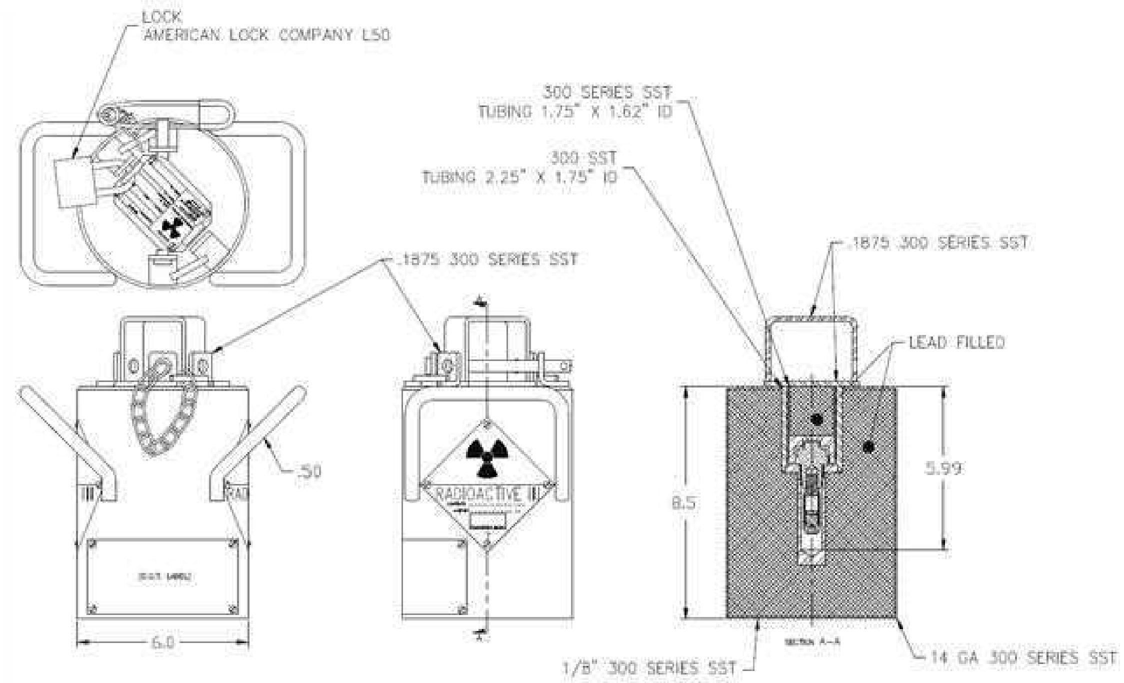


Figure 4.13 Engineering drawing of a typical lead pig used for the storage and transport of Cs-137 sealed radioactive sources.

[2] *https://www.ans.org/nuclear/radiation/exposure/*

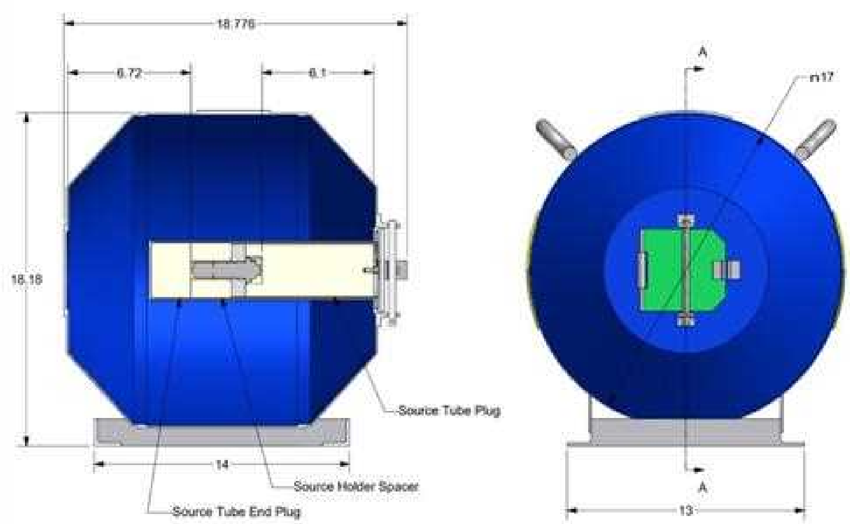


Figure 4.14 Schematic diagram of the container used for the storage and transport of Am/Be-241 sealed radioactive sources.

4.5.2 Cs-137 Sealed Radioactive Sources

The safety data sheets of the manufacturer for Cs-137 are included in Appendix B of this report, together with additional information on the physical, chemical, and radiological properties of Cs-137. Using the listed D-value for Cs-137 listed in IAEA (2005) and the calculated activities, an individual SRS is Category 4, while the aggregated category for the 15 Cs-137 SRS is Category 2 (see Table 2.2).

The Cs-137 SRS itself is in a cylindrical single encapsulation made of MP35N with a stainless-steel insert and tungsten inert gas or laser seal welded. The approximate exterior dimensions are 7.95 mm in diameter and 8.13 mm in length. The minimum wall thickness is 0.56 mm. Physically, the Cs-137 is in the form of a caesium silicate in a glass matrix or the form of sulphate as ceramic ion exchange pellets. The half-life of 30.2 years means that the sources will decrease in activity only in about 30 years. Cs-137 is a Beta and Gamma emitter with a Beta energy of 511 KeV and a Gamma energy of 663 KeV.

4.5.3 Am/Be-241 Sealed Radioactive Sources

The safety data sheets of the manufacturer for Am-241 are included in Appendix C of this report, together with additional information on the physical, chemical, and radiological properties of Am-241. Table 4.5 summarises the inventory of SRS that is earmarked for use and storage at the facility. Using the listed D-value for Am-241 listed in IAEA (2005) and the calculated activities, an individual SRS is Category 3, while the aggregated SRS category for the Am/Be-241 is Category 2 (see Table 2.2).

The Am/Be-241 SRS itself is in a cylindrical single encapsulation made of MP35N and tungsten inert gas or laser seal welded. The approximate outer dimensions are 16.5 mm in diameter and 44.5 mm in length. The minimum wall thickness is 0.5 mm. Physically, the Am-241 is in the form of an oxide mixed with a beryllium powder and pressed into a solid pellet. The half-life of 432.2 years means that the sources will decrease in activity only in about 432 years. Am/Be-241 is a Gamma and a Neutron emitter, with a relatively low Gamma energy of 59.5 KeV. This means that Am/Be-241 is predominantly a neutron source with a broad energy spectrum of 3.5 and 5 MeV and extends up to 11.5 MeV.

4.5.4 The Security of Sources

In Section 2.4.3 the IAEA security grouping of sources was introduced, with three levels of security measures to apply that link up with the IAEA source categorisation system. While individually, the Cs-137 and Am/Be-241 SRS fall within Category 4 and Category 3, respectively, what is of relevance here is the aggregated category since the SRS is stored in a single facility. The aggregated Category 2 classification means that a Security Level B would be required for the proposed SRS storage and handling facility as a minimum *that provides an intermediate level of protection of radioactive material against unauthorized removal*. Table 4.6 summarises the sub-goals for security level B measures to apply in terms of detection, delay and response. Security management measures for security level B were presented in Section 2.4.3.

Table 4.6 Security sub-goals for security level B in terms of detection, delay and response (IAEA, 2019b).

The Goal for Security Level B	Sub-goals		
	Detection	Delay	Response
Provide an intermediate level of protection of radioactive material against unauthorized removal	Provide immediate detection of any unauthorized access to locations where radioactive material is present	Furnish sufficient delay to provide an intermediate level of protection against unauthorized removal of radioactive material	Provide immediate communication to response personnel
	Provide detection of any attempted unauthorized removal of radioactive material		Provide immediate initiation of response to interrupt unauthorized removal of radioactive material
	Provide immediate assessment of detection		
	Provide a means to detect loss of radioactive material through verification		

5 Exposure Conditions

5.1 General

The purpose of this section is to define public and occupational radiation exposure conditions that form the basis for the potential radiological impact assessment of the proposed SRS storage and handling facility presented in Section 6. These exposure conditions are based on the site, facility and SRS description presented in Section 4 and relate to both normal operating and potential accident conditions that might occur during the operational period of the facility.

The section is structured as follows. It starts with an introduction of the Source-Pathway-Receptor analysis approach in Section 5.2, as a way of defining the exposure conditions. The focus of the report is on the operational period of the proposed SRS storage and handling facility. However, for completeness, Section 5.3 discusses the conditions that may apply during the construction (pre-operational) period, while the conditions that apply during the decommissioning and closure (post-operational) period are discussed in Section 5.4. The focus shifts then to the operational period. Section 5.5 defines the occupational exposure conditions during the operational period and Section 5.6 defines the public exposure conditions during the operational period.

5.2 Source Pathway Receptor Analysis

For the definition of representative exposure conditions for the proposed SRS storage and handling facility, a Source-Pathway-Receptor analysis approach was applied. This approach is inherently systematic, traceable, and transparent. Source-Pathway-Receptor analysis as a modelling approach is well-known and applied extensively in environmental and radiological risk assessment (Till and Grogan, 2008).

The approach requires first the identification and definition of all potential *sources* of radiation exposure, with the *sources* referring to any feature that contains or has the potential to release radioactivity into the environment in concentrations significant enough to pose a potential radiological risk to humans. The sources are characterised in terms of their unique composition (i.e., specific radioactive substances present or emitted) and their characteristics, which determine how radionuclides may be released and distributed in the environment.

Next, all relevant pathways and routes of radiation exposure that relate to the sources are identified. In this context, *exposure pathways* refer to the means, by which radionuclides may be dispersed or transferred within or between media of the total environmental system, to a point where humans interact with the media. An *exposure route,* on the other hand, refers to the route of entry into the human body to poses a radiation risk, such as through ingestion, inhalation, or external exposure.

Finally, *Receptors* are defined and characterised, where receptors as used here refer to human beings that may potentially be subject to radiation exposure (i.e., a radiation dose) from the applicable sources and through the exposure pathways and exposure routes of concern.

5.3 Conditions During the Construction Period

During the pre-operational or construction period, no radioactive material will be present or will be handled at the proposed SRS storage and handling facility that could serve as a source of radiation exposure and that could have any potential radiological impact on workers or members of the public. This is only possible once the facility is commissioned, and the SRS is brought into the boundaries of Erf 3954.

5.4 Conditions During the Decommissioning and Closure Period

The timeline for how long the proposed SRS storage and handling facility will be operational is undefined at present but it can be assumed that it will continue to be operational as long as there is a need to calibrate offshore well logging instruments along the Namibian coast.

At the end of its operational life, the proposed SRS storage and handling facility will have to go through a decommissioning phase before it can be closed. The decommissioning plan and specific activities that will be performed are not defined yet but it can be assumed that the SRS will be removed from storage and returned to the supplier or transferred to another user. This will remove the main source of any potential radiation exposure to workers and members of the public from the facility.

It can be assumed that the decommissioning plan would make provision for the decontamination of the storage facility itself, as well as the area within the workshop area where the calibration activities were performed. Confirmation surveys will be performed to ensure that all potentially contaminated components and structures are identified and that appropriate decontamination activities are performed. Any remaining contaminated solids and liquids (e.g., generated during the decontamination activities) that are above the clearance levels for Cs-137 and Am-241, will be managed as radioactive waste.

5.5 Occupational Exposure Conditions

5.5.1 General

Occupational workers (also referred to as *radiation workers*) are considered to be those who work in an environment where their work-related activities may lead to higher radiation exposure levels than what is allowable for public exposure. These workers should be medically fit for the activities that they have to perform, which may include higher levels of exposure to radiation sources. For this reason, these workers are monitored regularly for any side effects due to radiation exposure and the occupation exposure limits for occupational workers are higher than for public exposure (see Section 3.2.3). Similar to public exposure conditions, occupational exposure of workers may occur during both normal operating and accident conditions.

5.5.2 Normal Operating Conditions

The occupational exposure during normal operating conditions is due to activities that have to be performed as part of the management of the SRS (e.g., storing in containers inside the storage facility) and the calibration of the offshore well-logging instruments of clients in the calibration facility. These activities take place according to approved processes and procedures in a controlled and monitored environment. For normal operating conditions, it is assumed that the SRS is undamaged and able to perform the calibration activities as per their intended use. These activities may include the following:

- Perform radiation surveys in the storage facility before and after performing calibration activities.
  The 20 SRS is stored in containers inside the storage facility, which will reduce any potential gamma and neutron radiation exposure significantly. It can be assumed that due to the size of the storage area, a survey will not last more than 10 minutes, which equates to 20 minutes for a calibration session if the survey is performed before and after the calibration.

- Handling the SRS in the storage facility and between the storage facility and the workshop area where calibration is performed.

To prepare for the calibration process, the containers (20 in total) with the Cs-137 or Am-241 SRS are collected from the storage room and carried to the calibration area inside the workshop area. This is a distance of about 50 m. Assuming that only one worker is responsible for the collection of the SRS, that one container with an SRS can be carried at a time, and that it will take about 1 minute to cover the distance, then it will take 20 minutes to transfer all the containers from the storage room to the calibration facility. When the calibration is completed, the containers are returned to the storage room again, which will also take about 20 minutes. The total handling time is, therefore, 40 minutes for a calibration session.

- Transfer the SRS between the container and the calibration instrument, before and after the calibration process.
  To perform the calibration, it is necessary to transfer the SRS to the position where the calibration is performed. The calibration process of an instrument involves only one of the Cs-137 or Am/Be-241 SRS at a time, which means that during the calibration process, all the remaining SRS remain in their containers. The SRS is removed from the container using a handling tool that is about 1.5 m long. It is assumed that it takes about 15 seconds to transfer the SRS from the container to the calibration instrument. Since this has to be done before and after the calibration process, the total exposure period equates to 90 minutes or 1.5 hours per year for the Cs-137 SRS and 30 minutes or 0.5 hours per year for the Am/Be-241 SRS.
- Performed the calibration of the offshore well logging instruments with the SRS in position.
  It is assumed that it takes about 1 minute to perform the calibration of an instrument with an SRS. Since this will happen for each calibration session, the total exposure period equates to 180 minutes or 3 hours per year for the Cs-137 SRS and 60 minutes or 1 hour per year for the Am/Be-241 SRS.

In addition to the characteristics of the SRS itself, the time exposed to the SRS and the distance from the SRS would determine the occupational worker's radiation risk. This can be controlled by providing additional shielding or reducing the exposure period.

5.5.3 Accident Conditions

As with public exposure, accident conditions for occupational workers refer to those events and processes that lead to conditions outside the parameters of normal operation conditions at the proposed SRS storage and handling facility. While some accidents may occur that lead primarily to physical injuries, the focus here is still on accident conditions that may lead to additional radiation exposure.

Using the same arguments as for public accident conditions presented in Section 5.6.3 to screen out relevant PIE, the only PIE that is of concern from an occupation exposure perspective is the dropping of the SRS during the calibration process. However, the conditions that apply to this scenario would not differ significantly from the conditions and activities that have to be performed during the calibration process itself. The dropped SRS will have to be collected again using the handling tool and returned to the container. The exposure period could be longer since the SRS may not immediately be found. For this purpose, it is assumed that the SRS is outside the container and that it takes about 15 minutes or 0.25 hours for the worker to recover the dropped SRS and return it to the container. A distance of 1 m is assumed between the SRS and the worker, under the assumption that the worker is not aware of where the SRS is. Naturally, this SRS will then have to be leak-tested to verify it is not damaged.

5.6 Public Exposure Conditions

5.6.1 General

The Source-Pathway-Receptor analysis approach introduced in Section 5.2 was applied to define the potential public radiation exposure condition for the proposed SRS storage and handling facility. For an exposure condition to be credible, a complete Source-Pathway-Receptor linkage should be possible. If no reasonable linkage can be defined or justified, then it is unlikely that an exposure condition exists.

Within the Source-Pathway-Receptor analysis approach, the *source* is the Cs-137 and Am/Be-241 SRS stored and used for the calibration of offshore well logging instruments. Generally, the *pathways* of concern for public exposure are the atmospheric pathway, the groundwater pathway, and the surface water pathway, while the potential exposure routes of concern are ingestion, inhalation, or external exposure. For the proposed SRS storage and handling facility, receptors are members of the public outside the designated areas for authorised access. This means that receptors include those working or residing outside the boundaries of Erf 3954 but also those working outside the designated authorised areas on Erf 3954 (e.g., the offices).

5.6.2 Normal Operating Conditions

If not physically in use (i.e., for the calibration of the offshore well logging instruments), the Cs-137 and Am/Be-241 SRS are contained and secured inside the proposed SRS storage and handling facility (see Section 4.4). The SRS itself is in a solid form consisting of a source capsule (e.g., stainless steel – see Figure 2.2), with the radioactive material contained in the source capsule. Data from Table 4.3 suggests that even along the coastal areas the corrosion rates are slow, and the source capsule will not lose its integrity within the suggested service life of 15 years of an SRS.

Furthermore, the SRS itself (i.e., the capsules) is stored in containers inside the storage facility if not in use. To use the SRS for calibration purposes, a container with the SRS will be carried from the storage facility to the workshop area where the calibration will be performed. In other words, during this process, the SRS will be either in the containers or used within the process to perform the calibration.

While the SRS is not damaged and leaking, something that is not expected under normal operating conditions, the radioactivity (i.e., the Cs-137 and Am/Be-241 contained in the source capsule) cannot be released or dispersed from the capsule into the environmental pathways of concern (i.e., atmospheric, groundwater or surface water).

It follows from Section 4.5 that both Cs-137 and Am/Be-241 would emit gamma rays, while Am/Be-241 would also emit neutron rays, which if exposed to these rays, will result in external radiation exposure. Any shielding provided in the form of lead or concrete would reduce the external radiation from these sources. The radiation levels would be the highest close to the SRS and decrease by a factor of the square of the distance (i.e., inversely proportional to the square of the distance) away from the source (Martin, 2006). Maintaining a greater distance from the SRS is, therefore, a very effective method to increase radiation safety. The third principle to reduce external radiation exposure is to reduce the external exposure time to the SRS.

To derive public exposure conditions during normal operating conditions, assumptions are necessary in terms of the potential receptors, their distance from the SRS, potential exposure time, and the shielding available that would reduce the external exposure. For normal operating conditions, it is assumed that the

SRS is undamaged. The following public exposure conditions were defined to evaluate the radiological impact on members of the public under normal operating conditions:

- Residential area: The nearest residential area is about 100 m northwest of Erf 3954. Residents in this area are the furthest away from the facilities but with potentially the longest exposure period. For the assessment, it is assumed that the residents are subject to external exposure for 2,922 hours per year (8 hours per day for 365.25 days per year). For the remainder of the year, it is assumed that the residents are indoors (with additional shielding) or not in the residential area. A minimum of 100 m is assumed as the exposure distance.
- Industrial area: There are several industries near Erf 3954 towards the northeast, southeast, southwest and south. The distances vary from 30 to 50 m from Erf 3954. For the assessment, it is assumed that the industrial workers are subject to external exposure for 2,000 hours per year, which equates to 8 hours for 250 days per year. It is conservatively assumed that the 2,000 hours are spent outdoors. An exposure distance of 50 m is assumed.
- Pedestrian: It can be assumed that during a 24-hour period, pedestrians may pass Erf 3954 on foot. The closest distance to the boundary wall where the storage and calibration facilities will be located is about 6 m. It is assumed that a person passes the site twice a day for 3 minutes each, which equates to about 36 hours per year.
- Non-radiation worker: There is a 3 m perimeter fence around the storage facility that prevents staff that are non-radiation workers from entering the storage facility. A similar fenced-in area for the calibration facility is not obvious from the facility description presented in Section 4.4. However, since the calibration of offshore instruments is performed periodically, a restricted area of 3 m around the calibration facility can be defined for the duration of the calibration process.

  During a normal 2,000 hours per normal working year, one has to assume that non-radiation workers will pass the storage and calibration facility. How often and how long it takes for a person to pass the facilities is highly speculative. The approach followed for the assessment, is to assume different exposure times at 3 m from the facilities for a non-radiation worker. The exposure times vary from 8 hours per year to 250 hours per year, which equates to about 2 to 60 minutes per day, for an 8-hour working day.

5.6.3 Accident Conditions

Accident conditions refer to those events and processes that lead to conditions outside the normal operation conditions at the proposed SRS storage and handling facility. The nature of an accident at the facility that might lead to a public exposure condition should be such that the SRS is damaged, leakage occurs, and that activity is released to the environment outside the facility (e.g., to the atmosphere), where members of the public can get in contact with the released and dispersed activity.

Postulating Initiating Events (PIE) for accident conditions include events such as lighting, extreme snowing, rain, drought or temperatures, strong winds, hydrology and hydrogeology events, geological changes such as seismic events, flooding and the potential for natural fires (AFRY, 2021). These can be considered catastrophic events that could potentially lead to public exposure conditions. Naturally, there is a likelihood or probability attached to these catastrophic events occurring that would decrease the potential risk to members of the public.

Given the SRS storage condition in containers inside the storage facility (i.e., ISO container or bunker) that is surrounded by concrete, in an area that is very flat with very low annual precipitation with stable geology, the probability of any of these PIE occurring to the extent that radioactivity is released from the SRS into the environment is very low. The absence of any combustible material that may lead to a fire means that even the probability of a natural fire occurring is insignificantly small, especially since the storage room is within a concrete structure. Most of these conditions also apply to the calibration facility, which means that the probability of PIE that may lead to public exposure conditions is insignificantly low.

PIE that may lead to public exposure that cannot be ruled out for the proposed SRS storage and handling facility, include the following:

- Dropping of SRS during calibration (see also Section 5.5.3): It is assumed that during the calibration process, the radiation worker accidentally dropped the SRS. The dropped SRS will have to be collected again using the handling tool and returned to the container. The SRS may not be immediately found. For this purpose, it is assumed that the SRS is outside the container and that it takes about 15 minutes or 0.25 hours for the worker to recover the dropped SRS and return it to the container. To evaluate the exposure to the non-radiation worker, a 3 m distance outside the calibration room is assumed.
- Entering a restricted area: While the necessary signage will be displayed to indicate that an area is restricted due to the presence of radioactive material, it is possible that a person enters such an area by accident. This could be either within the 3 m perimeter fence at the storage facility or the calibration facility. In such an event, it is expected that it would be a short period (e.g., a few minutes) and not something that would happen often for the same person. For the assessment, it is assumed that the exposure period is 1 hour per year.

6 Radiological Consequences

6.1 General

The purpose of this section is to evaluate the radiological consequences of the occupational and public exposure conditions that were defined in Section 5. For this purpose, the IAEA-developed SAFRAN software code was used. The SAFRAN code is a user-friendly software application that incorporates the methodology developed within the IAEA SADRWMS Project (IAEA, 2015), which became the basis for the development of the IAEA safety guide on the safety assessment and safety case for the pre-disposal management of radioactive waste in GSG-3 (IAEA, 2013). The details of the SADRWMS methodology and all the mathematical models and equations are presented in IAEA TecDoc-1777 (IAEA, 2015), while the tutorials for SAFRAN are presented in (AFRY, 2021). The SAFRAN code is freely downloadable.[3]

The section is structured as follows. Section 6.2 presents the consequence analysis results and radiation protection measures for occupational exposure conditions, while the consequence analysis results and radiation protection measures for public exposure conditions are presented in Section 6.3.

6.2 Occupational Exposure Conditions

6.2.1 General

It follows from Section 5.5 that due to the nature of the activities that have to be performed at the proposed SRS storage and handling facility, occupational radiation exposure is possible during normal operating conditions and during accident conditions. Presented here are the consequence analysis results and the radiation control measures that can be implemented at the site for the occupational worker. The calculations were performed using the SAFRAN code. The file for the assessment will be made available to the Proponent. Details of the mathematical model for a points source used for the dose rate calculations as presented in IAEA TecDoc-1777 (IAEA, 2015), are included in Appendix D of this report.

6.2.2 Normal Operating Conditions

6.2.2.1 General

The following were assumed and defined in SAFRAN to evaluate the radiological impact of the proposed SRS storage and handling to workers under normal operating conditions:

- The facilities were defined: the storage room and the calibration facility.
- Two workers as receptors were defined. It was assumed that the Radiation Safety Officer would perform the surveys in the storage room, while the Calibration Worker would be responsible for using the SRS and performing the calibration activities.
- The survey of the storage room was considered a separate and only activity performed by the Radiation Safety Officer.
- Provision was made for the following activities performed by the Calibration Worker:

[3] *http://safran.facilia.se/safran/show/HomePage*

- Collection and transfer of SRS from the storage room to the calibration facility.
- Remove the SRS from the container and position the SRS to perform the calibration.
- Perform the calibration.
- Collect and transfer the SRS back into the container.
- Transfer the SRS from the calibration facility to the storage room.

- Provision was made for radiation exposure while the SRS is inside the containers (e.g., during transfer or during the survey) and outside the containers (e.g., during the calibration process).
- Given the nature of the occupational exposure conditions during normal operating conditions, only gamma radiation exposure was assumed from the Cs-137 SRS, while a contribution from both gamma radiation and neutron radiation was assumed for the Am/Be-241 SRS.
- It was assumed that the calibration of the offshore well instruments would be done once a month (i.e., 12 times per year), which means that the survey of the storage room would be done 24 times per year (i.e., twice for each calibration session).

6.2.2.2 Survey of the Storage Facility

Assuming the survey takes about 10 minutes to do, then the total exposure period inside the storage room with the 15 Cs-137 and 5 Am/Be-241 SRS in 20 containers equates to 240 minutes of 4 hours per year. The lead shielding was assumed to be 0.06 m (6 cm) and a distance of 1 m between the worker and the containers was assumed. Using the activity concentrations listed in Table 4.5, Table 6.1 summarises the parameters and dose calculation results for workers performing the surveys in the storage facility. The total dose equates to 3.784E-01 mSv per year.

Table 6.1 Summary of the parameters and dose calculation results for workers performing the surveys in the storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	1.000E+00	
Shielding Thickness	m	6.000E-02	
Exposure Period	Hours per year	4.000E+00	
Gamma Dose Rate	Sv per hour	9.460E-05	3.270E-09
Neutron Dose Rate	Sv per hour	-	3.270E-09
Gamma Radiation Dose	Sv per year	3.784E-04	1.308E-08
Neutron Radiation Dose	Sv per year	-	1.308E-08
Total Dose	mSv per year	3.784E-01	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are similar[4].

6.2.2.3 Transfer of SRS Between the Storage Facility and the Calibration Facility

Assuming that it takes about 1 minute to transfer a container between the storage facility and the calibration facility, then it will take 15 minutes to transfer the 15 containers with Cs-137 SRS and 5 minutes to transfer the 5 Am/Be-241 SRS. This will happen twice for each calibration session. The exposure period equates to 360 minutes or 6 hours per year for the Cs-137 SRS and 120 minutes or 2 hours per year for the Am/Be-241 SRS. The lead shielding was assumed to be 0.06 m (6 cm) and a distance of 1 m between the

[4] *https://www.qsa-global.com/ambe-neutron-sources-owl*

worker and the containers was assumed. Using the activity concentrations listed in Table 4.5, Table 6.2 summarises the parameters and dose calculation results for workers responsible for the transfer of the SRS between the storage facility and the calibration facility. The total dose equates to 3.786E-02 mSv per year.

Table 6.2 Summary of the parameters and dose calculation results for workers responsible for the transfer of the SRS between the storage facility and the calibration facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Shielding Thickness	m	6.000E-02	
Exposure Period	Hours per year	6.000E+00	2.000E+00
Gamma Dose Rate	Sv per hour	6.310E-06	6.540E-10
Neutron Dose Rate	Sv per hour	-	6.540E-10
Gamma Radiation Dose	Sv per year	3.786E-05	1.308E-09
Neutron Radiation Dose	Sv per year	-	1.308E-09
Total Dose	mSv per year	3.786E-02	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

6.2.2.4 Transfer of SRS Between the Container and the Calibration Instrument

Assuming that it takes about 15 seconds to transfer the SRS from the container to the calibration instrument, then it will take 3.75 minutes to transfer the 15 Cs-137 SRS and 1.25 minutes to transfer the 5 Am/Be-241 SRS. Since this will happen twice for each calibration session, the total exposure period equates to 90 minutes or 1.5 hours per year for the Cs-137 SRS and 30 minutes or 0.5 hours per year for the Am/Be-241 SRS. No shielding was assumed and a distance of 1.5 m between the worker and the SRS was assumed. Using the activity concentrations listed in Table 4.5, Table 6.3 summarises the parameters and dose calculation results for workers responsible for the transfer of the SRS between the container and the calibration instrument. The total dose equates to 4.934E+00 mSv per year.

Table 6.3 Summary of the parameters and dose calculation results for workers responsible for the transfer of the SRS between the container and the calibration instrument.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Shielding Thickness	m	No Shielding	
Exposure Period	Hours per year	1.500E+00	5.000E-01
Gamma Dose Rate	Sv per hour	2.770E-03	7.790E-04
Neutron Dose Rate	Sv per hour	-	7.790E-04
Gamma Radiation Dose	Sv per year	4.155E-03	3.895E-04
Neutron Radiation Dose	Sv per year	-	3.895E-04
Total Dose	mSv per year	4.934E+00	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

6.2.2.5 Calibration of the Instruments

Assuming that it takes about 1 minute to perform the calibration of an instrument with an SRS, then it will take 15 minutes using the 15 Cs-137 SRS and 5 minutes using the 5 Am/Be-241 SRS. Since this will happen for each calibration session, the total exposure period equates to 180 minutes or 3 hours per year for the Cs-137 SRS and 60 minutes or 1 hour per year for the Am/Be-241 SRS. No shielding was assumed and a distance of 3 m between the worker and the SRS was assumed during calibration. Using the activity concentrations listed in Table 4.5, Table 6.4 summarises the parameters and dose calculation results for workers responsible for the calibration of the instruments. The total dose equates to 2.469E+00 mSv per year.

Table 6.4 Summary of the parameters and dose calculation results for workers responsible for the calibration of the instruments.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Shielding Thickness	m	No Shielding	
Exposure Period	Hours per year	3.000E+00	1.000E+00
Gamma Dose Rate	Sv per hour	6.930E-04	1.950E-04
Neutron Dose Rate	Sv per hour	-	1.950E-04
Gamma Radiation Dose	Sv per year	2.079E-03	1.950E-04
Neutron Radiation Dose	Sv per year	-	1.950E-04
Total Dose	mSv per year	2.469E+00	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

6.2.2.6 Discussion

The consequence analysis results for occupational exposure during normal operating conditions are based on assumptions about the shielding of the SRS, the distance between the workers and the SRS, and exposure periods to the SRS. The exposure periods listed in Table 6.1 to Table 6.4 required additional assumptions in terms of time to perform some of the activities and how many of the SRS are involved in these activities. Collectively, these assumptions influence the results presented here.

Table 6.5 summarises the occupational worker doses calculated for the activities associated with the normal operating conditions of the proposed SRS storage and handling facility, which shows that the higher doses are associated with the physical calibration process (i.e., the transfer of the SRS between the container and the calibration instrument and the calibration of the instruments).

Table 6.5 Summary of the occupational worker doses calculated for the activities associated with the normal operating conditions of the proposed SRS storage and handling facility.

Activity	Dose mSv per year
Survey of the Storage Facility	3.784E-01
Transfer of SRS Between the Storage Facility and the Calibration Facility	3.786E-02
Transfer of SRS Between the Container and the Calibration Instrument	4.934E+00
Calibration of the Instruments	2.469E+00
Total Dose (mSv per year)	**7.819E+00**

For the conditions and assumptions used in the dose calculations, the individual doses are less than the dose constraint of 5 mSv per year for occupational exposure. The total dose is in the order of 8 mSv per year, which is still significantly less than the dose limit for occupational exposure of 20 mSv per year. This means that optimisation of occupational exposure is possible to reduce the annual occupational exposure to workers. These optimisation measures may include reducing the exposure period for the activities or distributing the activities between more than one person.

Estimates were used for the potential exposure periods for the different Normal Operating Conditions. Any increase (or decrease) in the exposure period will result in an increase (or decrease) in the estimated exposure dose to the workers. For example, to survey the storage room, an exposure period of 10 minutes per survey was assumed, which equates to 240 minutes of 4 hours per year. If the exposure period is increased to 30 minutes per survey, the total exposure period would be 12 hours per year, resulting in a total dose of 1.135E+00 mSv per year. An exposure period of 24 hours per year (i.e., 60 minutes per survey) will result in a total dose of 2.270E+00 mSv per year.

6.2.3 Accident Conditions

The only accident condition that was defined was due to the dropping of an SRS during the calibration process. For this purpose, it was assumed that the SRS is outside the container and that it takes about 15 minutes or 0.25 hours for the worker to recover the dropped SRS and return it to the container. A distance of 1 m is assumed between the SRS and the worker, under the assumption that the worker is not aware of where the SRS is.

Using the activity concentrations listed in Table 4.5, Table 6.6 summarises the parameters and dose calculation results for the worker responsible for retrieving the SRS after accidentally dropping it during the calibration of the instruments. The total dose equates to 1.560E+00 mSv per year and 4.813E-01 for the Cs-137 SRS and Am/Be-241 SRS, respectively.

The total dose calculated for the accident conditions is below 2 mSv per year but is directly dependent on the assumed exposure period. Any period more or less will influence the doses accordingly. The same applies to the distance of 1 m assumed between the SRS and the worker. A distance more or less will influence the dose rate and the total dose accordingly. Note that the sum of the Cs-137 and Am/Be-241 SRS is not necessary since the accident condition will not occur simultaneously for the two SRS.

Table 6.6 Summary of the parameters and dose calculation results for the worker responsible for retrieving the SRS after accidentally dropping it during the calibration process.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Shielding Thickness	m	No Shielding	
Exposure Period	Hours per year	2.500E-01	
Gamma Dose Rate	Sv per hour	6.240E-03	1.750E-03
Neutron Dose Rate	Sv per hour	-	1.750E-04
Gamma Radiation Dose	Sv per year	1.560E-03	4.375E-04
Neutron Radiation Dose	Sv per year	-	4.375E-05
Total Dose	mSv per year	1.560E+00	4.813E-01

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

6.2.4 Radiation Protection Measures

Control measures that can be implemented to ensure that occupational workers are protected from potential exposure to radiation at the proposed SRS storage and handling facility include the following:

- Delineation of working areas as controlled, uncontrolled, and supervised areas based on the potential and magnitude of radiation exposure, with the implementation of appropriate radiation protection measures for each area.
- Implementation of an appropriate education and training programme for all occupational workers about radiation, radiation management, the effect of radiation exposure on the human body and the details of the emergency plan of the site (applying the graded approach).

- Wear appropriate personnel protective clothing and equipment to limit exposure to hands, eyes, and body (e.g., gloves and eye protection, the use of shielding and handling tools).
- Continuous radiation monitoring of occupational workers while working in areas where radioactive material is stored or while handling radioactive material (e.g., gamma radiation badges).
- Maintaining a health surveillance programme for the occupational workers to identify possible health risk hazards and that early signs of work-related illness are detected. Employers should take action to prevent further harm and protect employees.
- Doses to the occupational workers should be managed to ensure that the annual dose limit is not exceeded. For this purpose, dose records should be kept of each worker.

Note that these measures are broadly consistent with the measures included in the Halliburton radiation management plan for occupational exposure (Halliburton, 2022). These measures are complementary to measures already implemented as part of the Haliburton operations and do not replace existing programmes and procedures.

6.3 Public Exposure Conditions

6.3.1 General

In Section 5.6, some public exposure conditions were defined under normal operating and accident conditions. Presented here are the consequence analysis results and the radiation control measures that can be implemented at the site for the public. The calculations were performed using the SAFRAN code. The file for the assessment will be made available to the Proponent. Details of the mathematical model for a points source used for the dose rate calculations as presented in IAEA TecDoc-1777 (IAEA, 2015), are included in Appendix D of this report.

6.3.2 Normal Operating Conditions

6.3.2.1 General

The public exposure conditions under normal operating conditions are related to members of the public outside Erf 3954 and those who are staff (non-radiation workers) at the proposed SRS storage and handling facility. It includes the following:

- Residential area;
- Industrial areas;
- Pedestrians; and
- Non-radiation workers at the proposed SRS storage and handling facility.

For the exposure to the proposed SRS storage room, it is assumed that the 15 Cs-137 and 5 Am/Be-241 SRS are in their 20 containers, with a lead shielding of 0.06 m (6 cm). The storage room itself is fitted with a 0.6 cm lead sheet as well as inner concrete walls of 15 cm, both of which provide additional shielding to the gamma and neutron rays. Safran calculations performed with and without the shielding provided by the 15 cm concrete walls showed that the dose rate from the Cs-137 SRS is reduced by a factor of almost 3 (2.93), while the gamma radiation from the Am/Be-241 is reduced by almost a factor 300 (298).

For the exposure during the calibration of the offshore instruments, it is assumed that the calibration room is fitted with inner walls of 15 cm, which provide additional shielding to the gamma and neutron rays. No lead shielding is assumed since the SRS would be out of the containers during the calibration process.

To account for the exposure time to be consistent with the exposure time for the radiation workers, it is assumed that the total exposure time is the sum of the time to transfer the SRS between the container and the calibration instrument and to perform the calibration. This equates to 3.5 hours per year for the Cs-137 SRS and 1.5 hours per year for the Am/Be-241 SRS.

6.3.2.2 Residential Areas

It follows from Section 5.6.2 that the residential area is 100 m away from the facilities and that the external gamma radiation exposure period is 2,922 hours per year. Using the activity concentrations listed in Table 4.5, Table 6.7 summarises the parameters and dose calculation results for members of the public in residential areas 100 m from the proposed SRS storage facility. The total dose equates to 4.508E-03 mSv per year. The total dose for the assumed set of conditions and parameter values is low compared to the public dose limit of 1 mSv. Even if the exposure time to the resident is increased significantly, the total annual dose will remain a fraction of the public dose limit. In addition, note that no credit was given for the potential shielding provided by a concrete or brick boundary wall, or any other wall in the residential area. This means that the 2,922-hour per year exposure period is for a member of the public that spent outdoors, which is conservative.

Table 6.7 Summary of the parameters and dose calculation results for members of the public in residential areas 100 m from the proposed SRS storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	1.000E+02	
Lead Shielding Thickness	m	6.600E-02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	2.922E+03	
Gamma Dose Rate	Sv per hour	1.543E-09	1.789E-16
Neutron Dose Rate	Sv per hour	-	1.789E-16
Gamma Radiation Dose	Sv per year	4.508E-06	5.227E-13
Neutron Radiation Dose	Sv per year	-	5.227E-13
Total Dose	mSv per year	4.508E-03	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

Using the activity concentrations listed in Table 4.5, Table 6.8 summarises the parameters and dose calculation results for members of the public in residential areas 100 m from the proposed SRS calibration facility, for exposure times of 3.5 and 1.5 hours per year for the Cs-137 and AM/Be-241 SRS, respectively.

Table 6.8 Summary of the parameters and dose calculation results for members of the public in residential areas 100 m from the proposed SRS calibration facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	3.500E+00	1.500E+00
Gamma Dose Rate	Sv per hour	2.130E-07	1.900E-10
Neutron Dose Rate	Sv per hour	-	1.900E-10
Gamma Radiation Dose	Sv per year	7.455E-07	6.650E-10
Neutron Radiation Dose	Sv per year	-	6.650E-10
Total Dose	mSv per year	7.468E-04	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose equates to 7.468E-04 mSv per year. The total dose for the assumed set of conditions and parameter values is low compared to the public dose limit of 1 mSv. Even if it is added to the contribution from the SRS storage room it is still significantly lower than the dose limit. In addition, note that no credit was given for the potential shielding provided by a concrete or brick boundary wall, or any other wall in the residential area.

6.3.2.3 Industrial Areas

It follows from Section 5.6.2 that several industrial facilities are located within 30 to 50 m from Erf 3954 towards the northeast, southeast, southwest and south of the proposed SRS storage and handling facility. An exposure distance of 50 m is assumed, with an exposure period of 2,000 hours per year. Using the activity concentrations listed in Table 4.5, Table 6.9 summarises the parameters and dose calculation results for members of the public in industrial areas 50 m from the proposed SRS storage facility. The total dose equates to 1.235E-02 mSv per year. The total dose for the assumed set of conditions and parameter values is low compared to the public dose limit of 1 mSv. Even if the exposure time to the industrial area is increased significantly, the total annual dose will remain a fraction of the public dose limit. In addition, note that no credit was given for the potential shielding provided by a concrete or brick boundary wall, or any of the buildings in the industrial area. This means that the 2,000-hour per year exposure period is for a member of the public that spent outdoors, which is conservative.

Table 6.9 Summary of the parameters and dose calculation results for members of the public in industrial areas 50 m from the proposed SRS storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	5.000E+01	
Lead Shielding Thickness	m	6.600E-02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	2.000E+03	
Gamma Dose Rate	Sv per hour	6.177E-09	7.155E-16
Neutron Dose Rate	Sv per hour	-	7.155E-16
Gamma Radiation Dose	Sv per year	1.235E-05	1.431E-12
Neutron Radiation Dose	Sv per year	-	1.431E-12
Total Dose	mSv per year	1.235E-02	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

Using the activity concentrations listed in Table 4.5, Table 6.10 summarises the parameters and dose calculation results for members of the public in industrial areas 50 m from the proposed SRS calibration facility, for exposure times of 3.5 and 1.5 hours per year for the Cs-137 and AM/Be-241 SRS, respectively.

Table 6.10 Summary of the parameters and dose calculation results for members of the public in industrial areas 50 m from the proposed SRS calibration facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	5.000E+01	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	3.500E+00	1.500E+00
Gamma Dose Rate	Sv per hour	8.520E-05	7.580E-08
Neutron Dose Rate	Sv per hour	-	7.580E-08
Gamma Radiation Dose	Sv per year	2.982E-04	1.137E-07
Neutron Radiation Dose	Sv per year	-	1.137E-07
Total Dose	mSv per year	2.984E-01	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose equates to 2.984E-01 mSv per year. The total dose for the assumed set of conditions and parameter values is less than the public dose limit of 1 mSv but suggests that optimisation of protection would be beneficial to reduce the potential radiation exposure to nearby industrial workers. Note that no credit was given for the potential shielding provided by a concrete or brick boundary wall, or any of the buildings in the industrial area.

6.3.2.4 Pedestrian

It follows from Section 5.6.2 that pedestrians may pass Erf 3954 on foot, with a minimum distance of 6 m to the boundary of the property. An exposure period of 36 hours per year was defined to evaluate the radiological consequence of the proposed SRS storage and handling facility to pedestrians passing by. Using the activity concentrations listed in Table 4.5, Table 6.11 summarises the parameters and dose calculation results for pedestrians passing by the proposed SRS storage facility. The total dose equates to 1.548E-02 mSv per year.

Table 6.11 Summary of the parameters and dose calculation results for pedestrians passing by the proposed SRS storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	6.000E+00	
Lead Shielding Thickness	m	6.600E-02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	3.600E+01	
Gamma Dose Rate	Sv per hour	4.300E-07	4.968E-14
Neutron Dose Rate	Sv per hour	-	4.968E-14
Gamma Radiation Dose	Sv per year	1.548E-05	1.788E-12
Neutron Radiation Dose	Sv per year	-	1.788E-12
Total Dose	mSv per year	1.548E-02	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose for the assumed set of conditions and parameter values is low compared to the public dose limit of 1 mSv. Even if the exposure time to the pedestrian is increased significantly, the total annual dose will remain a fraction of the public dose limit. In addition, note that no credit was given for the potential shielding provided by a concrete or brick boundary wall.

Using the activity concentrations listed in Table 4.5, Table 6.12 summarises the parameters and dose calculation results for pedestrians that may pass Erf 3954 on foot and more specifically the proposed SRS calibration facility, for exposure times of 3.5 and 1.5 hours per year for the Cs-137 and AM/Be-241 SRS, respectively. Note that a distance of only 3 m from the SRS is assumed.

Table 6.12 Summary of the parameters and dose calculation results for pedestrians that may pass the proposed SRS calibration facility on foot.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	3.000E+00	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	3.500E+00	1.500E+00
Gamma Dose Rate	Sv per hour	2.370E-04	2.110E-07
Neutron Dose Rate	Sv per hour	-	2.110E-07
Gamma Radiation Dose	Sv per year	8.295E-04	3.165E-07
Neutron Radiation Dose	Sv per year	-	3.165E-07
Total Dose	mSv per year	8.301E-01	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose equates to 8.301E-01 mSv per year. The total dose for the assumed set of conditions and parameter values is less than the public dose limit of 1 mSv but suggests that optimisation of protection would be beneficial to reduce the potential radiation exposure to pedestrians passing by the proposed calibration facility. However, the conditions assume that the 36 hours per year that the pedestrian passes Erf 3954 coincide with the specific time (more or less 5 hours per year) that calibration activities are performed, which is unlikely. Note that no credit was given for the potential shielding provided by a concrete or brick boundary wall.

6.3.2.5 Non-Radiation Worker

It follows from Section 5.6.2 that there is a 3 m perimeter fence around the proposed SRS storage facility but that non-radiation workers may pass the fence during a working day. How often and how long it takes for a person to pass the facilities is highly speculative but it was assumed that it could be anything from 2 to 60 minutes per day. Using the activity concentrations listed in Table 4.5, Table 6.13 summarises the parameters and dose calculation results for the non-radiation worker passing by the proposed SRS storage facility on average about 30 minutes per day for 250 days per year (i.e., 120 hours per year). The total dose equates to 2.060E-01 mSv per year.

Table 6.13 Summary of the parameters and dose calculation results for the non-radiation worker passing by the proposed SRS storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	3.000E+00	
Lead Shielding Thickness	m	6.600E-02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	1.200E+02	
Gamma Dose Rate	Sv per hour	1.717E-06	1.983E-13
Neutron Dose Rate	Sv per hour	-	1.983E-13
Gamma Radiation Dose	Sv per year	2.060E-04	2.379E-11
Neutron Radiation Dose	Sv per year	2.060E-01	2.060E-01
Total Dose	mSv per year	2.060E-01	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose for the assumed set of conditions and parameter values is less than the public dose limit of 1 mSv. Even if the exposure time to the non-radiation worker is increased significantly, the total annual dose will remain below the public dose limit. Figure 6.1 shows the total gamma radiation dose to a non-radiation worker passing the proposed SRS storage facility as a function of the exposure time (minutes per day). It shows that even for an exposure time of 70 minutes per day for 250 days per year, the total effective dose is still below the dose limit.

Using the activity concentrations listed in Table 4.5, Table 6.14 summarises the parameters and dose calculation results for non-radiation workers that may pass the proposed SRS calibration facility, while calibration of offshore instruments is being performed, for exposure times of 3.5 and 1.5 hours per year for the Cs-137 and AM/Be-241 SRS, respectively. Note that a distance of 3 m from the SRS is assumed.

The total dose equates to 8.301E-01 mSv per year. The total dose for the assumed set of conditions and parameter values is less than the public dose limit of 1 mSv but suggests that optimisation of protection would be beneficial to reduce the potential radiation exposure to non-radiation workers that may be within a distance of 3 m from the facility during calibration. Note that no credit was given for the potential shielding provided by a concrete or brick boundary wall. The conditions also assume that the same non-radiation workers are within a distance of 3 m every time calibration is performed on an annual basis.

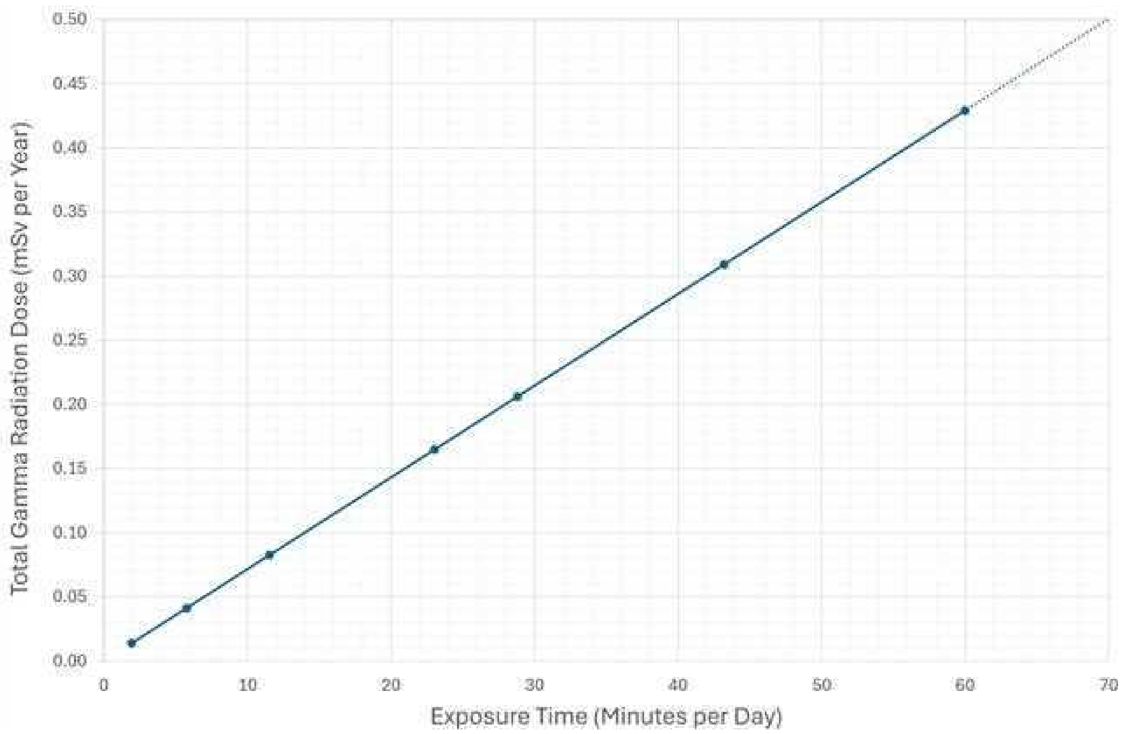


Figure 6.1 The total gamma radiation dose to a non-radiation worker passing the proposed SRS storage facility as a function of the exposure time (minutes per day).

Table 6.14 Summary of the parameters and dose calculation results for non-radiation workers that may pass the proposed SRS calibration facility while calibration of offshore instruments is being performed.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	3.000E+00	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	3.500E+00	1.500E+00
Gamma Dose Rate	Sv per hour	2.370E-04	2.110E-07
Neutron Dose Rate	Sv per hour	-	2.110E-07
Gamma Radiation Dose	Sv per year	8.295E-04	3.165E-07
Neutron Radiation Dose	Sv per year	-	3.165E-07
Total Dose	mSv per year	8.301E-01	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

6.3.2.6 Discussion

The potential radiation exposure to members of the public was evaluated for several potential receptors that include residents, workers at nearby industries, pedestrians passing by the proposed SRS storage and handling facility, or non-radiation workers at the facility. A distinction was made between exposure to the proposed SRS storage room and the SRS calibration facility.

Table 6.15 summarises the total doses calculated for the different cases, which shows that exposure to residence from either of the two facilities is at low risk of exceeding the dose limit of 1mSv per year. The distance to the proposed SRS storage and handling facility is a major factor in this regard.

Table 6.15 Summary of the total external dose to different public receptor groups from exposure to the proposed SRS storage room and calibration facility.

Receptor Group	Exposure to Storage Room	Exposure to Calibration Facility
	Dose (mSv per year)	
Residential areas	4.51E-03	7.46E-04
Industrial areas	1.24E-02	2.98E-01
Pedestrians passing by	1.55E-02	8.30E-01
Non-radiation workers	2.06E-01	8.30E-01

The same conclusion applies to the exposure of the industrial worker and the pedestrian, and a lesser extent the non-radiation worker, to the proposed SRS storage facility. However, the total dose for the non-radiation worker assumed that the person is 3 m from the storage room for 30 minutes every day for 250 days per year.

The total dose for the industrial worker, the pedestrian and the non-radiation worker due to exposure to the proposed SRS calibration facility is notably higher, which can be attributed to the fact that the only shielding provided is the 15 cm concrete walls and that members of the public may get 3 m from the facility. These potential total doses can be reduced by:

- Increase to minimum distance that any members of the public can get to the proposed SRS calibration facility during the calibration of the offshore instruments; and
- By increasing the shielding by increasing the concrete wall thicknesses and installing an additional lead sheet inside the facility, similar to the lead sheet proposed for the proposed SRS storage room.

For example, increasing the exposure distance for the pedestrian and non-radiation worker to 6 m would decrease the exposure dose to about 0.21 mSv per year, as opposed to 0.83 mSv per year. This should be possible even with the current dimensions of the calibration facility in Figure 4.9 if the calibration is performed in the middle of the facility.

6.3.3 Accident Conditions

6.3.3.1 General

It follows from Section 5.6.3 that two potential accident exposure conditions apply to members of the public. The first is the dropping of the SRS during the calibration of the offshore instruments and the second is if a non-radiation worker enters the 3 m restricted zone of the proposed SRS storage and handling facilities. The exposure period for the dropping of the SRS is the same as used in Section 6.2.3, namely 0.25 hours per year. The distance remains 3 m. For entering the restricted zone, an exposure time of 1 hour per year was defined in Section 5.6.3, within a distance of 1 m.

6.3.3.2 Dropping of SRS

The only difference between this accident condition and the conditions assumed for the non-radiation worker in Section 6.3.2.5 is the exposure time. Using the activity concentrations listed in Table 4.5, Table 6.16 summarises the parameters and dose calculation results for non-radiation workers that pass the proposed calibration facility, while the radiation worker retrieves the dropped SRS and returns it to the container. The total dose is 5.925E-02 and 4.380E-02 mSv per year for the Cs-137 and Am/Be-241 SRS, respectively. Due to the short exposure time, the total doses are low and significantly less than the annual dose limit of 1 mSv. Note that the sum of the Cs-137 and Am/Be-241 SRS is not necessary since the accident condition will not occur simultaneously for the two SRS.

6.3.3.3 Entering a Restricted Area

It is assumed that both the proposed SRS storage and calibration facilities have a 3 m restricted area around the facility to present unauthorised access by non-radiation workers. This accident exposure condition assumes that these workers enter these restricted areas accidentally.

Table 6.16 Summary of the parameters and dose calculation results for non-radiation workers that pass the proposed calibration facility, while the radiation worker retrieves the dropped SRS and returns it to the container.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	1.000E+00	
Gamma Dose Rate	Sv per hour	2.370E-04	2.110E-07
Neutron Dose Rate	Sv per hour	-	1.75E-04
Gamma Radiation Dose	Sv per year	5.925E-05	5.275E-08
Neutron Radiation Dose	Sv per year	-	4.375E-05
Total Dose	mSv per year	5.925E-02	4.380E-02

Using the activity concentrations listed in Table 4.5, Table 6.17 summarises the parameters and dose calculation results for non-radiation workers entering the restricted area around the proposed SRS storage facility.

Table 6.17 Summary of the parameters and dose calculation results for non-radiation workers entering the restricted area around the proposed SRS storage facility.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	1.100E+03	2.775E+03
Distance to SRS	m	1.000E+00	
Lead Shielding Thickness	m	6.600E-02	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	1.000E+00	
Gamma Dose Rate	Sv per hour	4.520E-05	1.660E-09
Neutron Dose Rate	Sv per hour	-	1.660E-09
Gamma Radiation Dose	Sv per year	4.520E-05	1.660E-09
Neutron Radiation Dose	Sv per year	-	1.660E-09
Total Dose	mSv per year	4.520E-02	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

The total dose is 4.520E-02 mSv per year. Due to the short exposure time, the total dose is low and significantly less than the annual public dose limit of 1 mSv. Even if the number of incidences where the same person enters the restricted zone around the proposed SRS is increased 10 times, then the total dose would still be well below the public dose limit.

Using the activity concentrations listed in Table 4.5, Table 6.18 summarises the parameters and dose calculation results for non-radiation workers entering the restricted area around the proposed SRS calibration facility, during the calibration of the offshore instruments. The total dose is 2.134E+00 mSv per year, which is more than double the annual public dose limit of 1 mSv.This emphasises the importance of preventing unauthorised access to the calibration facility during the calibration of the offshore instruments, even if the shielding of the facility is improved, as recommended in Section 6.3.2.6.

6.3.3.4 Discussion

Accident conditions refer to conditions outside the normal operating conditions and can be presented by applying appropriate radiation control and radiation management principles, even if it is not expected to lead to total exposure doses that exceed the public dose limit. The measures recommended in Section 6.3.2.6 to improve the radiation safety of the proposed SRS calibration facility would contribute but are not sufficient to ensure potential exposure to members of the public is below the dose limit if they enter the restricted area regularly, even as little as 1 hour per year.

Table 6.18 Summary of the parameters and dose calculation results for non-radiation workers entering the restricted area around the proposed SRS calibration facility, during the calibration of the offshore instruments.

Parameter	Unit	Cs-137	Am/Be-241
Total Activity	GBq	7.400E+01	5.550E+02
Distance to SRS	m	1.000E+00	
Concrete Shielding Thickness	m	1.500E-01	
Exposure Period	Hours per year	1.000E+00	
Gamma Dose Rate	Sv per hour	2.130E-03	1.900E-06
Neutron Dose Rate	Sv per hour	-	1.900E-06
Gamma Radiation Dose	Sv per year	2.130E-03	1.900E-06
Neutron Radiation Dose	Sv per year	-	1.900E-06
Total Dose	mSv per year	2.134E+00	

Note: The neutron dose rate was assumed to be the same as the gamma dose rate based on the fact that both dose rates for an unshielded Am/Be-241 SRS at 1 m per GBq are very similar[4].

If the calibration is performed in the middle of the facility, then the 1 m distance increases to 4 m and the resulting dose would decrease to 0.132 mSv per year.

6.3.4 Radiation Protection Measures

Control measures that can be implemented to ensure that members of the public are protected from potential exposure to radiation at the proposed SRS storage and handling facility include the following):

- Ensure that the necessary signage is displayed at the proposed SRS storage and calibration facility and that these are radiation areas with restricted access.
- Implement an appropriate training programme for all non-radiation workers about radiation, radiation management, the effect of radiation exposure on the human body and the details of the emergency plan of the site (applying the graded approach).
- Apply access control to Erf 3954, with an appropriate induction process to inform any visitors that they enter a site that stores and uses radiation sources and that restricted areas with the necessary signage are out of bounds.
- Keep records of any visitors to the site and the duration of the visit.

Note that these measures are broadly consistent with the measures included in the Halliburton radiation management plan for public exposure (Halliburton, 2022). These measures are complementary to measures already implemented as part of the Haliburton operations and do not replace existing programmes and procedures.

7 Conclusions and Recommendations

7.1 General

Namaquanum Investment Two CC has an existing workshop on Erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund. They plan to refurbish the workshop and construct a dedicated radioactive source storage facility for those sources used to calibrate and test drilling equipment (well logging equipment) in the offshore oil exploration industry.

Given their inherent characteristics, radioactive sources emit ionising radiation and have the potential to lead to radiation exposure conditions. It is, therefore, important that the specific sources are used and managed under the intended use of the specific source and with consideration of the application of the appropriate radiation protection measures and principles.

The objective of this report as defined in Section 1.2 is to evaluate the potential radiological impact of the proposed radioactive sources storage and handling facility on human health and the environment, as input into the ECC application process and associated EMP as required per the EMA and AERPA. The purpose of this section is to present some conclusions that can be drawn from the radiological impact assessment and to present some recommendations that may be necessary for the improvement of the radiological safety and security of the proposed radioactive sources storage and handling facility.

7.2 Conclusions

The characteristics of the SRS that will be stored and used at the facility were used together with the design of the proposed facilities and the prevailing environmental site conditions to evaluate the potential radiological impact on members of the public and the occupational exposure to workers.

Given the nature of the SRS and the extent of the activities that will be performed at the proposed SRS storage and handling facility, a graded approach as defined in Section 3.3.6 to evaluate the radiological safety is justified. The regulatory framework within which the safety of the proposed facility was evaluated as defined in Section 3 consists of national laws and regulations, supplemented with international principles and standards of organisations (e.g., IAEA, ICRP and UNSCEAR) that are concerned with radiation protection.

To evaluate the potential radiological impact on members of the public, a Source-Pathway-Receptor analysis approach was followed. The radioactive material associated with the SRS is contained in a durable source capsule (e.g., stainless steel), while the SRS is stored inside specially designed storage and transfer containers manufactured from specific materials to attenuate any alpha, beta, gamma, and neutron rays that may be emitted from the SRS (e.g., lead pigs). Furthermore, the storage containers are stored in a specially designed and secured storage facility, with concrete and lead walls, roof, and floor. These materials will further attenuate any radiation that may be released from the containers. The SRS are tested regularly for any leaks. The following was concluded:

- The potential receptors were divided into residents, industrial workers, pedestrians and non-radiation workers at the proposed SRS storage and handling facility.
- The exposure to residence from either of the two facilities is at low risk of exceeding the dose limit of 1mSv per year. The distance to the proposed SRS storage and handling facility is a major factor in this regard.

- The same conclusion applies to the exposure of the industrial worker and the pedestrian, and a lesser extent the non-radiation worker, to the proposed SRS storage facility. However, the total dose for the non-radiation worker assumed that the person is 3 m from the storage room for 30 min every day for 250 days per year, which is conservative.
- The total dose for the industrial worker, the pedestrian and the non-radiation worker due to exposure to the proposed SRS calibration facility is notably higher, which can be attributed to the fact that the only shielding provided is the 15 cm concrete walls and that members of the public may get 3 m from the facility. These potential total doses can be reduced by:
  - Increase to minimum distance that any members of the public can get to the proposed SRS calibration facility during the calibration of the offshore instruments; and
  - By increasing the shielding by increasing the concrete wall thicknesses and installing an additional lead sheet inside the facility, similar to the lead sheet proposed for the proposed SRS storage room.
- There is no combustible material in the facility that may lead to a fire and the dispersion of contaminants into the atmosphere, while the design of the facility is such that any fire would be contained inside the facility.
- The only credible accident conditions for the proposed SRS storage and handling facility are (i) if a worker drops the SRS during the calibration process or (ii) non-radiation workers enter the restricted area around the storage facility and calibration facility.
- While entering the area around the storage facility results in an insignificant dose for the assumed exposure time, this should be prevented at the calibration facility. This potential dose is higher than the public dose limit, which emphasises the importance of preventing unauthorised access to the calibration facility during the calibration of the offshore instruments, even if the shielding of the facility is improved.
- The bunker concept for the proposed SRS storage facility would provide additional shielding capabilities and, therefore, would improve the general safety of the facility from a public safety perspective.
- To ensure the safety of members of the public, the implementation of appropriate security measures is of utmost importance (see Section 2.4.3, Section 4.4.4 and Section 4.5.4). Control measures can be implemented to ensure that members of the public are protected from potential exposure to radiation at the proposed SRS storage and handling facility.

Occupational workers (also referred to as *radiation workers*) are considered to be those who work in an environment where their work-related activities may lead to higher radiation exposure levels than what is allowable for public exposure. To evaluate the potential radiological impact on occupational workers, activities that have to be performed as part of the management of the SRS (e.g., storing in containers inside the storage facility) and the calibration of the offshore well-logging instruments of clients in the calibration facility were considered. The following was concluded:

- The consequence analysis results for occupational exposure during normal operating conditions are based on assumptions about the shielding of the SRS, the distance between the workers and the SRS, and exposure periods to the SRS.
- The total dose is in the order of 8 mSv per year, which is still significantly less than the dose limit for occupational exposure of 20 mSv per year. This means that optimisation of occupational exposure is possible to reduce the annual occupational exposure to workers. These optimisation measures may

include reducing the exposure period for the activities or distributing the activities between more than one person.

- The total dose calculated for the accident conditions is below 2 mSv per year but is directly dependent on the assumed exposure period. Any period more or less will influence the doses accordingly. The same applies to the distance of 1 m assumed between the SRS and the worker. A distance more or less will influence the dose rate and the total dose accordingly.
- The bunker concept for the proposed SRS storage facility would provide additional shielding capabilities and, therefore, would improve the general safety of the facility from an occupational exposure perspective.
- To ensure the safety of workers, the implementation of appropriate security measures is of utmost importance (see Section 2.4.3, Section 4.4.4 and Section 4.5.4). Control measures can be implemented to ensure that members of the public are protected from potential exposure to radiation at the proposed SRS storage and handling facility

7.3 Recommendations

The radiological impact assessment presented here is based on the currently available information. However, the proposed SRS storage and handling facility is not yet constructed and operational, which means that the radiological impact assessment presented here is prospective. It is, therefore, recommended that once the facility becomes operational and a more detailed record of the different activities that will be performed becomes available, the prospective assessment should be updated with a site and operational-specific safety assessment.

For the site and operational-specific safety assessment, it is recommended that the following information be gathered for use in the assessment:

- A baseline radiation survey (e.g., gamma dose rate) inside and outside Erf 3954 before any activities or facilities are commissioned (i.e. before any SRS or off-shore instruments are brought onto the property).
- A detailed description of the activities that workers performed in the different areas of the SRS storage and handling facility, including during the calibration of the offshore well-logging instruments.
- A detailed record of the time to perform the activities in the different areas.
- Onsite radiation exposure (e.g., gamma dose rate) in the different areas and during the activities performed in the different areas of the SRS storage and handling facility.
- Offsite radiation exposure (e.g., gamma dose rate) outside Erf 3954 during the activities performed in the different areas of the SRS storage and handling facility.
- Reconsider the design of the proposed SRS calibration facility to ensure a restricted area of at least 3 m can be maintained at all times and that additional shielding capabilities are included, which may include thicker concrete walls and a lead sheet.

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APPENDIX A:
Background Information Document

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT PLAN FOR A RADIOACTIVE SOURCE MATERIAL STORAGE AND HANDLING FACILITY ON ERF 3954, SWAKOPMUND, ERONGO REGION

BACKGROUND INFORMATION DOCUMENT

Prepared by

Geo Pollution Technologies

Prepared for

Namaquanum Investment Two CC

January 2024

1 INTRODUCTION

Namaquanum Investment Two CC (the Proponent) has an existing workshop on erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund, Erongo Region (Figure 1). The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source material used to calibrate and test drilling equipment (well logging equipment) used in the offshore oil exploration industry. Clients from the offshore exploration industry will utilise the workshop and source materials on erf 3954, to perform the necessary calibrations and tests on their drilling equipment.

The Proponent has requested Geo Pollution Technologies (Pty) Ltd (GPT) to apply for an environmental clearance certificate (ECC) for the proposed facilities and operations. The ECC is required as per the Environmental Management Act No. 7 of 2007 (EMA). As part of the ECC application, an environmental assessment report and environmental management plan (EMP) will be submitted to the Ministry of Environment, Forestry and Tourism's Directorate of Environmental Affairs (DEA).

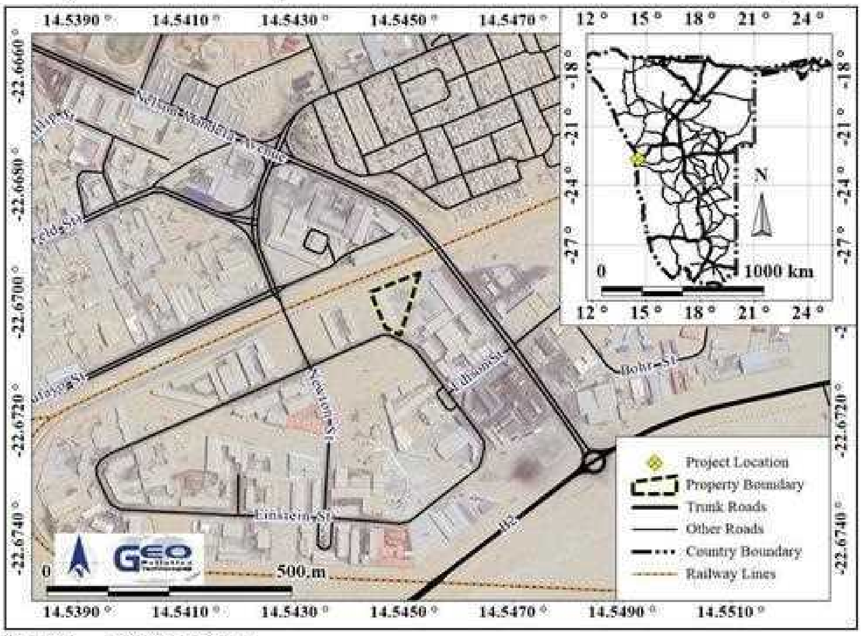


Figure 1 Project location

2 PURPOSE OF THE BID

With this background information document (BID), GPT aims to provide the DEA, authorities and interested and affected parties (IAPs) with information about the facility, and to register the ECC application with the Ministry of Health and Social Services' National Radiation Protection Authority and the DEA. IAPs are also invited to register with GPT in order to receive more information on the project, to provide comments, and to review all documents submitted to the DEA as part of the application for an ECC.

3 PROJECT DESCRIPTION

Activities considered for the assessment have been divided into the following phases: planning, construction and maintenance, operational and a decommissioning phases. A brief outline of expected activities for each phase is detailed below.

3.1 PLANNING PHASE

Continuously during construction and operations, and prior to possible future decommissioning activities of the project, it is the responsibility of the Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management and safety measures are in place prior to, and during all phases, to ensure potential risks and impacts are minimised. Typical planning activities include:

- Where not in place, obtain permits and approvals from local and national authorities including authorisation from the National Radiation Protection Authority and municipal consent.
- Make provisions to have a health, safety and environmental coordinator to implement the EMP.
- Ensure provisions for a fund to cater for restoration or rehabilitation activities in the event of environmental incidents or pollution.
- Ensure all appointed contractors and employees enter into an agreement with the Proponent which includes adherence to relevant sections of the EMP.
- Maintain a reporting system to report on aspects of construction and maintenance, operations and decommissioning as outlined in the EMP. This is a requirement of the DEA.

3.2 CONSTRUCTION AND MAINTENANCE

The Proponent plans to construct an aboveground storage facility for the storage of the radioactive source material. The facility will conform to stringent industry safety specifications. The preferred structure will be a six meter steel shipping container, placed on a concrete or paved surface. The four interior sides of the container will be lined by an approximately 50 cm thick, high density concrete layer. A prefabricated concrete slab will be placed on top of the container. The container will have intruder alarms and the area around it will be fenced and locked and entry strictly controlled. Warning signs will be placed, at minimum, at all entrances to the fenced area. The facility will be under 24 hour closed circuit television (CCTV) surveillance (outside and inside the container).

The existing workshop will be transformed into a state of the art workshop for the calibration and testing of drilling equipment. The floor of the workshop will be covered with a new 15 cm thick, reinforced and sealed concrete floor. Various workspaces will be created for the various tests and calibrations to be performed. Utilities like telecommunications, electricity and earthing, water, drainage, ventilation and compressed air will be upgraded or newly installed. An equipment wash bay will be constructed and this, together with various drains, will be connected to an oil water separator. Additional emergency infrastructure and equipment will include a fire detection system, firefighting equipment, emergency eye wash stations, radiation detectors with audible and/or visual alarms, etc. A standby generator of 350 kVA will also be installed.

As an alternative option, the facility to store radioactive source material can also be partially underground. This will entail constructing a small building above ground, with a bunker pit below ground. The radioactive source material will be stored in this pit. The pit will be line by concrete and covered with a sliding lockable pit cover. The same safety and security measures will be installed as for the container storage unit i.e. CCTV, alarms, fencing, etc.

Throughout the life of the facility, regular maintenance and refurbishments will be performed to ensure the facility's integrity does not become compromised and to ensure a low visual impact. This may include cleaning, painting and replacing of equipment and structures.

3.3 OPERATIONAL PHASE

Only suitably trained, qualified and authorised personnel will have access to the radioactive source material storage area, as well as handle and work with such material. Any movement of the radioactive source material must be logged (logged out and in). Continuous radiation exposure monitoring will be performed to ensure employees' exposure remains within the approved limits. Regular leak tests will be performed as per the individual sources' requirements, to ensure it remains within the threshold limits. All faulty radioactive source material that cannot be repaired as well as any obsolete materials will be returned to the supplier for safe disposal. The necessary security and emergency response plans will be implemented at all times to ensure safety and protection of the environment and local community.

3.4 Decommissioning Phase

Decommissioning of the facility is not foreseen during the validity of the ECC. Decommissioning will however be assessed. Decommissioning will entail partial or complete removal of all infrastructure. Where decommissioning occur, rehabilitation of the area may be required. After decommissioning, any pollution present on the site must be removed or remediated.

3.5 Preliminary Identified Impacts

During the preparation of the environmental assessment and EMP, all components of the environment will be considered. However, only those components which are, or may be, significantly impacted, or are deemed to be sensitive, will be assessed. These include the following:

- Human component (employee, visitor and community health and safety)
- Infrastructure (aesthetics, fire, integrity, damage to services, etc.)
- Neighbours (noise, aesthetics, waste, traffic)
- Groundwater, surface water and soil (radioactive pollution, hydrocarbon spills, waste)
- Ecosystem and biodiversity (habitat, pollutants, birds)
- Socio economic characteristics (service to the oil exploration industry, employment, training and skills development, revenue)

4 PUBLIC CONSULTATION

Public consultation is an integral part of all environmental assessments. Geo Pollution Technologies thus invites all interested and affected parties (IAPs) to provide in writing, any issues and suggestions regarding the project. This correspondence must include:

- Name and surname
- Organization represented or private interest
- Position in the organization
- Contact details
- Any direct business, financial, personal or other interest which you may have in the approval or refusal of the application.

All contributions become public knowledge and will be included in the environmental assessment report. The environmental assessment and EMP reports will be circulated to all registered IAPs for review as per the EMA requirements. The comments, inputs and suggestions will also be submitted to the DEA along with how any issues have been addressed in the environmental assessment.

The public participation process will remain ongoing during the environmental assessment. However, all comments and concerns should be provided to GPT timeously, to ensure incorporation into the final report. For any additional information the project team may be contacted at:

Geo Pollution Technologies (Pty) Ltd.
Telephone: (+264-61) 257411
Fax: (+264) 88626368
E-mail: ct@thenamib.com

APPENDIX B:
Data and Information for Cs-137 Sealed Radioactive Sources

QSA GLOBAL

Issue Date: September 5, 2019

Safety Data Sheet
Cesium-137 (Cs-137)

1.0 **Chemical Product and Company Identification**

1.1 **Material Identification:** Cesium-137 (Cs-137)

1.2 **Trade Names and Synonyms:**
Cesium-137 (Cs-137) Sealed sources (special form)

1.3 **Company Identification:**
Manufacturer:
QSA Global, Inc.
40 North Avenue
Burlington, MA 01803
Phone Number (781) 272-2000
Fax Number (781) 359-9191

2.0 **Hazard Identification:**
The ionizing radiation emitted from this material can only be detected by an appropriate beta/gamma detector. It cannot be experienced by human sensory systems. Acute exposure to ionizing radiation may result in acute radiation syndrome (ARS). Long term effects are increased risk for cancer and genetic effects.

3.0 **Composition, Information or Ingredients:**
Vitrified matrix of cesium in a stainless steel capsule.

4.0 **First Aid Measures:**
Remove from source of exposure or take other actions that minimize exposure. Acute exposure to ionizing radiation above applicable regulatory limits requires assessment by a medical professional familiar with radiation injuries.

5.0 **Fire-Fighting Measures:**

5.1 **Extinguishing Media:**
The capsules themselves are not flammable. Use media appropriate to surrounding fire.

5.2 **Special Firefighting Procedures:**
Fire fighters should wear positive pressure, self-contained breathing apparatus, full protective clothing, and alarming radiation monitoring devices. Survey for radioactive contamination in case of suspected capsule integrity failure.

6.0 **Accidental Release Measures:**
Do not approach spilled source(s) or material without appropriate radiation detection instruments. Secure the affected area from access except to save lives. Emergency operations should be conducted in accordance with site emergency plan and with responders spending the minimum possible time in the affected area.

7.0 **Handling and Storage:**
Possession of this material requires a radioisotope license both for the shipper and the consignee and handling must be performed as specified in the license.

7.1 **Handling:**
This material should never be handled directly, but through the use of remote handling tools. All appropriate radiation protection precautions should be utilized. Transport of this material must be in accordance with all applicable regulations.

7.2 **Storage:**
Store this material in an appropriate storage container made of a heavy dense metal such as lead or depleted uranium. Storage must be in accordance with applicable regulations.

8.0 **Exposure Control and Personnel Protection:**
Exposure to the radiation from this material may be mitigated by using remote handling tools, use of a shield, or by minimizing the time of exposure.

8.1 **Respiratory Protection:**
Respiratory protection is not necessary for normal operations with this material because the capsules are sealed. Should the integrity of the capsule be compromised, use an air-purifying respirator with P100 cartridge or equivalent.

8.2 **Protective Clothing:**
Protective clothing is used to prevent radioactive contamination of the skin and does not protect against ionizing radiation. Lead aprons or other lead impregnated materials may reduce exposure somewhat.

9.0 **Chemical and Physical Properties:**
Glass matrix containing Cesium.
Melting point: 2000°C.

Cs-137 is a beta and gamma emitter with the following main energies:

β	Energy KeV (% Yield)	γ	Energy KeV (% Yield)
	511 (94.6)		662 (89.9)

10.0 **Stability and Reactivity:**
Cs-137 decays with a half-life of 30.17 years.

11.0 **Toxicological Information:**
The radiation toxicity from this material exceeds the chemical toxicity of the material for the purpose of mitigating human effects.

12.0 **Ecological Information:**
The effects of this material are expected to be limited in area and scope.

13.0 **Disposal Considerations:**
Dispose of in accordance with all applicable regulations in a facility licensed for radioactive material.

14.0 **Transport Information:**
Transport of this material must be in accordance with all applicable regulations. It must be shipped in approved containers (usually Type B, UN2916 or UN2917).

15.0 **Regulatory Information:**
This MSDS is not required in the United States under the OSHA Hazard Communication Standard, but is produced for such jurisdictions where it is required.

16.0 **Other Information:**
Previous Version: September 17, 2014

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

East Building, PHH-23
1200 New Jersey Ave, SE
Washington, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS

CERTIFICATE USA/0650/S-96, REVISION 6

This certifies that the source described has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model X.1187 (Manufactured on or after March 27, 1991).

2. Source Description - Cylindrical single encapsulation made of MP35N with a stainless steel insert and tungsten inert gas or laser seal welded. Approximate exterior dimensions are 7.95 mm (0.313 in.) in diameter and 8.13 mm (0.32 in.) in length. Minimum wall thickness is 0.56 mm (0.022 in.). Construction shall be in accordance with attached AEA Technology QSA, Inc. Drawing No. RBA61858, Rev. A.

3. Radioactive Contents - No more than 93.0 GBq (2.5 Ci) of Cesium-137. The Cs-137 is in the form of a cesium silicate in a glass matrix or in the form of a sulfate as ceramic ion exchange pellets.

4. Management System Activities - Records of Management System activities required by Paragraph 306 of the IAEA regulations shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the requirements of Subpart H of 10 CFR 71.

5. Expiration Date - This certificate expires on July 31, 2027. Previous editions which have not reached their expiration date may continue to be used.

[1] "Regulations for the Safe Transport of Radioactive Material, 2012 Edition, No. SSR-6" published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

(- 2 -)

CERTIFICATE USA/0650/S-96, REVISION 6

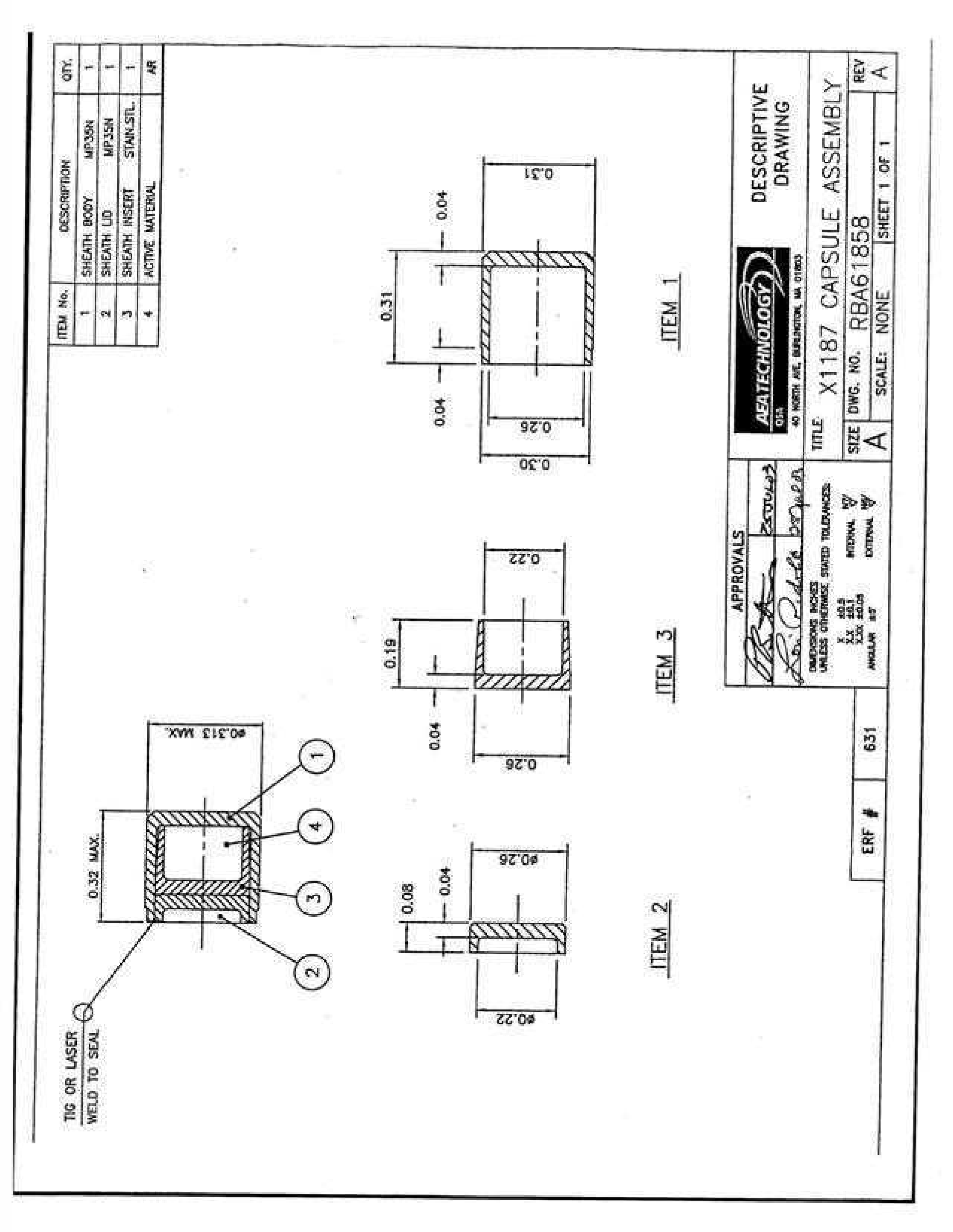
This certificate is issued in accordance with paragraph(s) 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the July 6, 2022 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified By:

William Schoonover
Associate Administrator for Hazardous
Materials Safety

July 25, 2022
(DATE)

Revision 6 - Issued to extend the expiration date.


ITEM No.
DESCRIPTION
QTY.
1 SHEATH BODY MP35N 1
2 SHEATH LID MP35N 1
3 SHEATH INSERT STAIN.STL. 1
4 ACTIVE MATERIAL AR
TIG OR LASER WELD TO SEAL
0.32 MAX.
ø0.313 MAX.
ITEM 1
ITEM 2
ITEM 3
APPROVALS
DESCRIPTIVE DRAWING
AEA TECHNOLOGY QSA
40 NORTH AVE, BURLINGTON, MA 01803
TITLE X1187 CAPSULE ASSEMBLY
SIZE A
DWG. NO. RBA61858
REV A
SCALE: NONE
SHEET 1 OF 1
ERF # 631

U.S. Department of
Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

East Building, PHH-23
1200 New Jersey Ave, SE
Washington, D.C. 20590

CERTIFICATE NUMBER: USA/0650/S-96

ORIGINAL REGISTRANT(S):

QSA Global, Inc.
40 North Avenue
Burlington, MA, 01803
USA

Halliburton
3000 North Sam Houston Parkway, East
Houston, TX, 77032
USA

Schlumberger
300 Schlumberger Drive
MD-121
Sugar Land, TX, 77478
USA

1

The information provided below on some characteristics of Cs-137 is an extract from IAEA Nuclear Energy Series No. Nw-T-1.3 (IAEA, 2014a).

Caesium-137

Caesium-137 is produced by fissioning uranium nuclei and then chemically separating the caesium from the irradiated nuclear fuel or targets. Most facilities that chemically process (reprocess) spent nuclear fuel to recover uranium and plutonium leave caesium in the waste stream. The caesium actually is made up of four isotopes: Cs-133 (stable), Cs-134 (half-life: 2 years), Cs-135 (half-life: 2.3 million years), and Cs-137 (half-life: 30 years). Caesium-137 is commonly regarded as a gamma emitter of medium energy, although the 662 keV energy gamma photons are produced by Ba-137m formed from Cs-137 by beta decay.

Caesium is a highly reactive alkali metal element, similar to potassium and sodium. Due to its high reactivity, it can only be used as a chemical compound in an SRS. Usually, Cs-137 is supplied as caesium chloride, a crystalline salt (it is chemically and structurally related to table salt, sodium chloride) that can be made in a range of particle sizes, from centimetre scale blocks to powder, as is used in the manufacture of radioactive caesium chloride sources. After cold-pressing to form a pellet inside a stainless steel, thimble-shaped receptacle, the receptacle is loaded in a protective stainless steel capsule that is welded to form the inner containment, and a second stainless steel jacket is welded over the first to form the actual sealed radioactive caesium chloride source. The production of radioactive caesium chloride sources is conducted at around 200°C because caesium chloride is hygroscopic.

Caesium chloride is soluble in water at room temperature. If it is intentionally or accidentally removed from its container, it can readily be dispersed. If a leak in the stainless steel container were to occur, it could dissolve in water and contaminate the nearby environment. It is highly reactive in the environment; binding to surfaces and even migrating into concrete. If it enters the body, it disperses wherever water goes and delivers a whole-body dose.

One approach to reducing the problems posed by the very high solubility of caesium chloride in water is to use another compound containing Cs-137 as a direct replacement for the caesium chloride powder. A suitable process includes evaporation and enamelling in sintered alumina cups, in sintered ‘pollucite’ pellets (caesium silica aluminate $Cs_20Al_20_34SiO_2$) or ceramic pellets and rods. These forms render the radionuclide virtually insoluble in water but in this case a drastic reduction of the specific activity results. An alternative approach to reducing solubility and dispersibility is to make cement incorporating the Cs-137 by the addition of cement paste and fillers. This approach has the advantage of low-temperature processing and, with judicious choice of the cement phase, low aqueous solubility. However, the dilution associated with making cement limits the attainable specific activity. Also, the product remains a brittle solid that could degrade due to radiation effects, so it does not lower the caesium’s potential dispersibility in an explosion. The cementitious approach has advantages for large-scale immobilization of waste containing Cs-137.

APPENDIX C:
Data and Information for Am/Be-241 Sealed Radioactive Sources

QSA GLOBAL.

Safety Data Sheet
Americium-241/Beryllium (AmBe)

Issue Date: September 5, 2019

1.0 Chemical Product and Company Identification

1.1 Material Identification: Americium-241/Beryllium (AmBe)

1.2 Trade Names and Synonyms:
Americium-241/Beryllium (AmBe) Sealed sources (special form)

1.3 Company Identification:
Manufacturer:
QSA Global, Inc.
40 North Avenue
Burlington, MA 01803
Phone Number (781) 272-2000
Fax Number (781) 359-9191

2.0 Hazard Identification:
The ionizing radiation emitted from this material is the most significant hazard. It can only be detected by an appropriate neutron and gamma detector. Acute exposure to ionizing radiation may result in acute radiation syndrome (ARS). Long term effects are increased risk for cancer and genetic effects.

3.0 Composition, Information or Ingredients:
Compressed pellets of americium and beryllium encased in stainless steel capsules.

4.0 First Aid Measures:
Remove from source of exposure or take other actions that minimize exposure. Acute exposure to ionizing radiation above applicable regulatory limits requires assessment by a medical professional familiar with radiation injuries.

5.0 Fire-Fighting Measures:

5.1 Extinguishing Media:
The capsules themselves are not flammable. Use media appropriate to surrounding fire.

5.2 Special Firefighting Procedures:
Fire fighters should wear positive pressure, self-contained breathing apparatus, full protective clothing, and alarming radiation monitoring devices. Survey for radioactive contamination in case of suspected capsule integrity failure.

6.0 Accidental Release Measures:
Do not approach spilled source(s) or material without appropriate radiation detection instruments. Secure the affected area from access except to save lives. Emergency operations should be conducted in accordance with site emergency plan and with responders spending the minimum possible time in the affected area.

7.0 Handling and Storage:
Possession of this material requires a radioisotope license both for the shipper and the consignee and handling must be performed as specified in the license.

7.1 Handling:
This material should never be handled directly, but through the use of remote handling tools. All appropriate radiation protection precautions should be utilized. Transport of this material must be in accordance with all applicable regulations.

7.2 Storage:
Store this material in an appropriate storage container made of hydrogenous material surrounded by a heavy dense metal such as lead. Storage must be in accordance with applicable regulations.

8.0 Exposure Control and Personnel Protection:
Exposure to the radiation from this material may be mitigated by using remote handling tools, use of a shield, or by minimizing the time of exposure.

8.1 Respiratory Protection:
Respiratory protection is not necessary for normal operations with this material because the capsules are sealed. Should the integrity of the capsule be compromised, use an air-purifying respirator with P100 cartridge or equivalent.

8.2 Protective Clothing:
Protective clothing is used to prevent radioactive contamination of the skin and does not protect against ionizing radiation. Lead aprons or other lead impregnated materials may reduce exposure somewhat.

9.0 Chemical and Physical Properties:
Americium:
Silver-white, crystalline metallic element solid under normal conditions.
Melting point: 1176°C. Boiling Point: 2607°C. Sp.Gr. 13.78

Beryllium:
Brittle, steel-grey metallic element.
Melting point: 1287°C. Boiling Point: 2469°C. Sp.Gr. 1.85

AmBe is a gamma emitter with the following main energies:

β	Energy KeV (% Yield)	γ	Energy KeV (% Yield)
	No significant β		59.5 (35.9)

AmBe is a neutron emitter.

10.0 Stability and Reactivity:
AmBe decays with a half-life of 432.7 years.

11.0 Toxicological Information:
The radiation toxicity from this material exceeds the chemical toxicity of the material for the purpose of mitigating human effects. The beryllium is not a hazard in this form.

12.0 Ecological Information:
The effects of this material are expected to be limited in area and scope.

13.0 Disposal Considerations:
Dispose of in accordance with all applicable regulations in a facility licensed for radioactive material.

14.0 Transport Information:
Transport of this material must be in accordance with all applicable regulations. It must be shipped in approved containers (usually Type A, UN2915 or UN3332).

15.0 Regulatory Information:
This MSDS is not required in the United States under the OSHA Hazard Communication Standard, but is produced for such jurisdictions where it is required.

16.0 Other Information:
Previous Version: September 17, 2014

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

East Building, PHH-23
1200 New Jersey Ave, SE
Washington, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY
SPECIAL FORM RADIOACTIVE MATERIALS

CERTIFICATE USA/0740/S-96, REVISION 4

This certifies that the source described has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] for the transport of radioactive material.

1. Source Identification - QSA Global, Inc. Model X1300 (Manufactured on or after February 10, 2000).
2. Source Description - Cylindrical single encapsulation made of MP35N and tungsten inert gas or laser seal welded. Approximate outer dimensions are 16.5 mm (0.65 in.) in diameter and 44.5 mm (1.75 in.) in length. Minimum wall thickness is 0.5 mm (0.02 in.). Construction shall be in accordance with attached QSA Global, Inc. Drawing No. RBA63121, Rev. A.
3. Radioactive Contents - No more than 740.0 GBq (20.0 Ci) of Americium-241. The Am-241 is in the form of an oxide mixed with a beryllium powder and pressed into a solid pellet.
4. Management System Activities - Records of Management System activities required by Paragraph 306 of the IAEA regulations shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the requirements of Subpart H of 10 CFR 71.
5. Expiration Date - This certificate expires on October 31, 2025. Previous editions which have not reached their expiration date may continue to be used.

[1] "Regulations for the Safe Transport of Radioactive Material, 2012 Edition, No. SSR-6" published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

(- 2 -)

CERTIFICATE USA/0740/S-96, REVISION 4

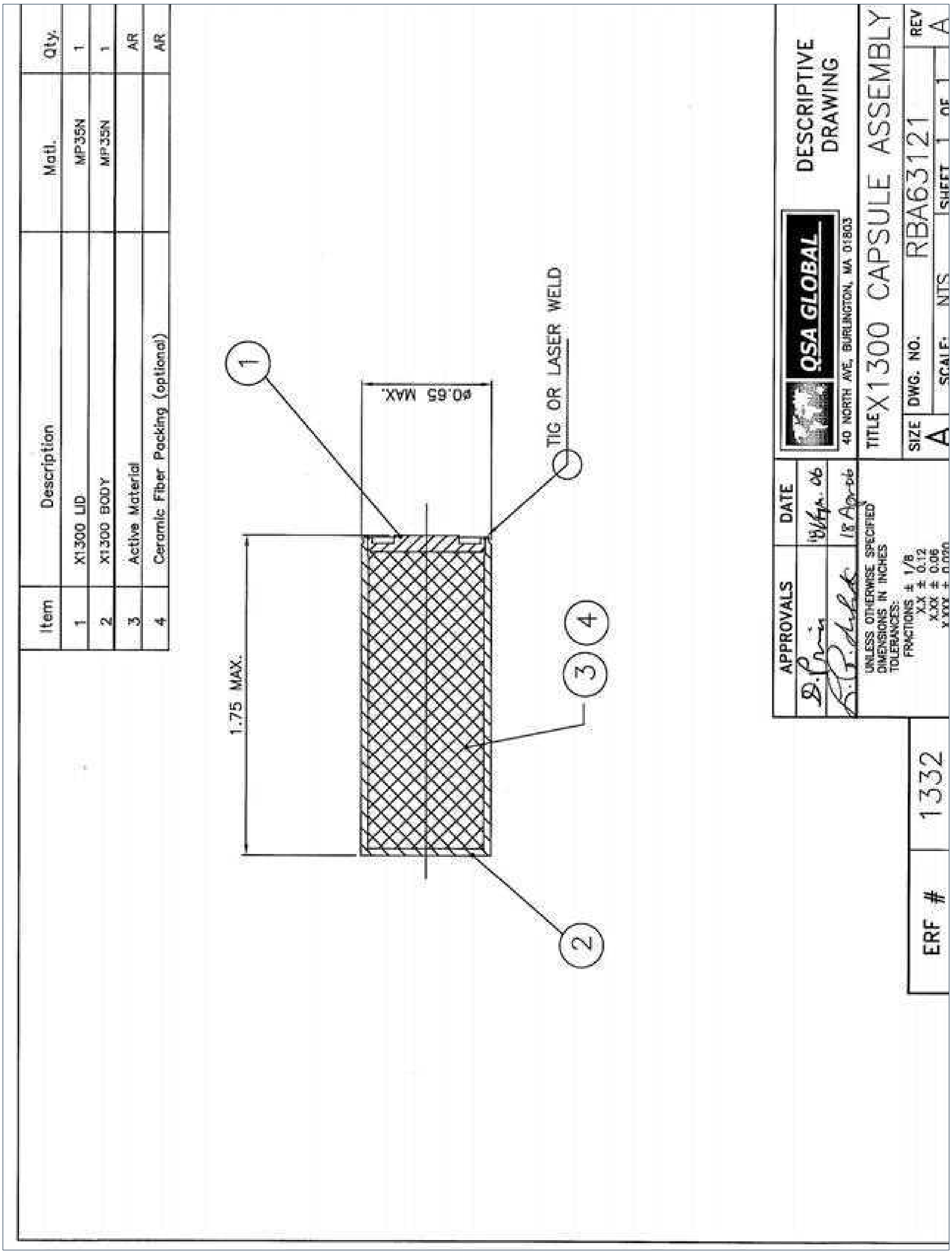
This certificate is issued in accordance with paragraph(s) 804 of the IAEA Regulations and Section 173.476 of Title 49 of the Code of Federal Regulations, in response to the October 1, 2020 petition by QSA Global, Inc., Burlington, MA, and in consideration of other information on file in this Office.

Certified By:

William Schoonover
Associate Administrator for Hazardous
Materials Safety

October 22, 2020
(DATE)

Revision 4 - Issued to extend the expiration date.


Item
Description
Matl.
Qty.
1 X1300 LID MP35N 1
2 X1300 BODY MP35N 1
3 Active Material AR
4 Ceramic Fiber Packing (optional) AR
ø0.65 MAX.
1.75 MAX.
TIG OR LASER WELD
1
2
3
4
APPROVALS
DATE
UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES:
FRACTIONS ± 1/8
X.X ± 0.12
X.XX ± 0.06
QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803
DESCRIPTIVE DRAWING
TITLE X1300 CAPSULE ASSEMBLY
SIZE A
DWG. NO. RBA63121
REV A
ERF # 1332

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

East Building, PHH-23
1200 New Jersey Ave, SE
Washington, D.C. 20590

CERTIFICATE NUMBER: USA/0740/S-96

ORIGINAL REGISTRANT(S):

QSA Global, Inc.
30 North Avenue
Burlington, MA, 01803
USA

Schlumberger
300 Schlumberger Drive
MD-121
Sugar Land, TX, 77478
USA

1

The information provided below on some characteristics of Am-241 is an extract from IAEA Nuclear Energy Series No. Nw-T-1.3 (IAEA, 2014a).

Amerisium-241

Americium is an actinide or transuranium element with no stable isotopes. Like the other actinides, americium oxidizes fairly readily. Americium is produced by successive neutron captures in U-238, its activation products and decay products, to produce Pu-241, which decays to Am-241 with a 14.4-year half-life.

Americium is recovered from ageing plutonium stocks, which it builds up through radioactive decay. Am-241 decays with a half-life of 432.7 years by emitting an alpha particle. The alpha particle has an average energy of 5.465 MeV and is accompanied by a 13.9 keV x-ray in 43% of decays, a 59.5 keV x-ray in 36% of decays, and no x-rays in the other decays. The decay product, Np-237, is also radioactive, with a 2 million-year half-life.

Americium-241 is used both as an alpha source and with beryllium as a neutron source (called americium–beryllium or Am–Be source). In an Am–Be source, some of the alpha particles from the decay of the americium are absorbed in the beryllium, which then emits a neutron with energy ranging from 0 to about 11 MeV, with the average energy at about 6 MeV. Am–Be produces about 1 neutron for 20,000 alpha decays.

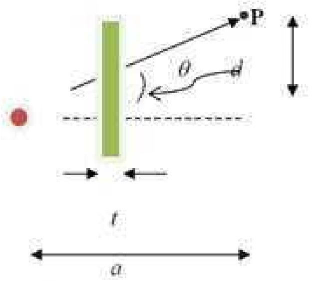
The ‘recommended working life’ of an Am–Be source is 15 years, after which the source manufacturers recommend that the sources be recertified (if it is in good condition), re-encapsulated (if the capsule is slightly damaged, but the design is still used), or recycled (if the design is no longer in use or the damage to the capsule is severe, then the raw Am–Be can be removed and manufactured into a new source).

Americium has chemical characteristics similar to rare earth metals. Normally, Am-241 is used in oxide form in sealed sources. For neutron sources, fine oxide powder is mixed with beryllium powder and sintered to a ceramic-like product, which is stable in air and from which the americium is not readily soluble in water. When used as a low-energy, gamma source, the stainless steel capsule contains a thin window to allow the gamma photons to be emitted without undue attenuation.

APPENDIX D:
Mathematical Model for Exposure to a Point Source as presented in IAEA TecDoc-1777 (IAEA, 2015)

III-2. DOSE RATES FOR DIFFERENT GEOMETRIES

III-2.1. Point source



Given a point source and a slab shield in between the source and the point P of interest, the dose rate, $\dot{D}$ [mSv h^{-1}]:

$$\dot{D} = 5{,}77x10^{-4}\sum_{\gamma}\mu_a(\varepsilon_\gamma)p_\gamma\varepsilon_\gamma B_D S\frac{e^{-b_1\sec\theta}}{4\pi(a\sec\theta)^2}, \quad \text{(III-7)}$$

where:

μ_a is mass absorption coefficient [cm^2 g^{-1}];

ε_γ is photon energy [MeV];

p_γ is photon yield [-];

For nuclide data on its photon energy and yield see nuclear textbooks.

B_D is dose buildup factor (GP) [-];

Geometric Progression parameters for iron, lead, water and concrete can be found in *DataForExternalDoseCalc.xls*.

S is source strength. In this case the radionuclide activity [Bq];

$a\sec\theta$ is distance from source to point P [cm];

$$\sec\theta = \frac{\sqrt{d^2 + a^2}}{a}$$

b_1 is shield attenuation [-].

$b_1 = \mu t$,

where:

μ is linear attenuation coefficient of shield [cm^{-1}];

t is thickness of shield [cm].

To get the linear attenuation coefficient μ (in cm^{-1}) just multiply the mass attenuation coefficients (in cm^2 g^{-1}) with density (g cm^{-3}). Values for iron, lead, water and concrete can be found in *DataForExternalDoseCalc.xls*.

Without shield $b_1 = 0$ and $B_D = 1$.

VAN BLERK, Jacobus Josia (PhD)

Nationality:	South African
Profession:	Geohydrologist, Radiation Protection Specialist (RPS)
Company:	AquiSim Consulting (Pty) Ltd
Position:	Owner (Director)
Speciality:	Radiological Public Impact and Safety Assessment of Mining and Mineral Processing Facilities Post-Closure Radiological Public Safety Assessment of Nuclear Radioactive Waste Disposal Systems Management of Radioactive Waste Saturated and Unsaturated Groundwater Flow and Mass Transport Modelling Mine Water Balance Modelling
Years of relevant experience:	31

Key Areas of Experience and Achievements:

- Perform radiological public impact and safety assessment of mining and mineral processing facilities and industries involving NORM (e.g., uranium, gold, rare earth, mineral sands, copper, phosphate, etc.) for regulatory and ESIA purposes under operational and post-operational conditions.
- Perform total system post-closure radiological public safety assessment analysis of near-surface radioactive waste disposal facilities.
- Radiological public impact and safety assessment of nuclear facilities other than disposal facilities.
- Develop disposal concepts for the near-surface disposal of radioactive waste (e.g., IAEA Borehole Disposal Concept).
- Provide radioactive waste management and radiological public safety assessment consultancy, review, training, and expert mission services to the International Atomic Energy Agency (IAEA).
- Develop and apply internationally accepted methodologies for the post-closure performance and safety assessment of radioactive waste disposal systems suitable for African and Southern African conditions.
- Perform prospective evaluation of groundwater and soil water movement, as well as radiological and non-radiological contaminant migration through saturated and unsaturated geological media.
- Perform mine water balance modelling using EcoBalance model libraries developed in Ecolego

- Served on the coordinating groups of the IAEA ISAM (Improvement of Safety Assessment Methodologies) Project as chairman of the Scenario Development and Justification Working Group (1997 – 2000) and the IAEA ASAM (Application of Safety Assessment Methodologies) Project as chairman of the Mining and Mineral Processing Waste Working Group (2002 -- 2007)
- Participated in the IAEA PRISM (Practical Illustration and Use of the Safety Case Concept in the Management of Near-surface Disposal) Project (2009 – 2012) and WG3 of the IAEA MODARIA (Modelling and Data for Radiological Impact Assessment) Project (2012 – 2016).
- Assisted the IAEA in defining a Coordinated Research Project on Nuclear Security Assessment Methodologies (NUSAM) in 2012.
- Served as an external moderator for honour and master's degree courses in geohydrology and served as an external examiner for geohydrology PhD and M.Sc. thesis.
- Presented a refresher course on Post-Closure Safety Assessment of Near-Surface Radioactive Waste Disposal Facilities at the IRPA13 Conference in Glasgow (UK) (May 2012).

Education and Professional Qualifications:

2000	PhD. – Geohydrology	University of the Free State
1991	M.Sc. (*Cum Laude*) – Geohydrology	University of the Free State
1989	B.Sc. (Hons. - *Cum Laude*) – Geohydrology	University of the Free State
1988	B.Sc. (Applied Math., Computer Science)	University of the Free State

- Member of the South African Council for Natural Scientific Professions (No. 400239/05)
- Member of the Southern African Radiation Protection Association (SARPA)
- Radiation Protection Specialist (RPS) Accredited by the Radiation Protection Accreditation Board

Languages	***Speaking***	***Reading***	***Writing***
Afrikaans	Native tongue	Fluent	Fluent
English	Fluent	Fluent	Fluent

Professional Career:

2000 to date — **Director, AquiSim Consulting (Pty) Ltd**

Perform and manage more than 80 radiological public impact and safety assessment studies of mining and mineral processing operations involving NORM (e.g., uranium, gold, rare earth, copper, mineral sands, phosphate, etc.) for regulatory and ESHIA purposes under operational and post-operational conditions. Define and manage radiological baseline site characterisation projects for new mining operations and facilities, as well as for areas that require characterisation for environmental remediation purposes.

Perform total system safety assessment analysis of near-surface facilities for the disposal and storage of radioactive waste nationally and internationally (e.g., in South Africa and Australia).

Contribute nationally and internationally to the development of long-term management solutions (disposal) for disused sealed radioactive sources (DSRS), particularly the IAEA Borehole Disposal System (e.g., South Africa, Ghana, Malaysia).

Perform IAEA expert missions and review services, and lecture at post-closure safety assessment and waste management courses and workshops in Austria, Argentina, Ghana, Brazil, Portugal, UK, Russian Federation, Spain, Indonesia, Kenia, Tanzania, Zambia, Malawi, Malaysia, and Namibia, South Africa, Japan and China.

Participating in various IAEA Coordinated Research Projects (CRP), e.g. ISAM (Improvement of safety assessment methodologies), ASAM (Application of safety assessment methodologies), PRISM (Practical implementation of safety assessment in the context of a safety case), and MODARIA (Modelling and Data for Radiological Impact Assessment).

Develop EcoBalance in Ecolego (https://www.ecolego.se/ecolego/) consisting of model libraries developed to perform dynamic mine water and mass balance modelling.

Perform saturated and unsaturated groundwater flow and contaminant migration analysis using Hydrus (unsaturated) and FeFlow (saturated) for tailings dam complexes, open-pit mines, radioactive waste disposal sites, waste disposal capping systems, distressed rock masses of underground mines, and industrial waste sites.

2000 — **PhD, University of the Free State (Institute for Groundwater Studies)**

The objective of radioactive waste management and its underlying principles is to ensure that human beings and the environment are protected at all times, without imposing an undue burden on future generations. This implies that, before any long-term management strategy for radioactive waste disposal can be implemented, the impact of the disposed of waste must be determined as a function of time - a procedure referred to as post-closure safety assessment. In the thesis, a methodology to perform a post-closure safety assessment of radioactive waste disposal systems in South Africa and other parts of Africa was described.

1990 – 2000 — **Scientist/Senior Scientist/Chief Scientist/Consulting Scientist, South African Nuclear Energy Corporation (Necsa), Nuclear Liabilities Management Division**

Simulate soil water and radionuclide movement through the unsaturated zone and the management of soil water measurements at Vaalputs using a neutron meter. Development of a safety assessment methodology for radioactive waste disposal facilities and the application of the methodology to radioactive waste disposal facilities in South Africa. Managing a multi-disciplinary team to perform total system safety assessments for Vaalputs.

Development of a disposal concept for the long-term management of disused sealed radioactive sources (DSRS), generally known as the IAEA Borehole Disposal System.

Performing radiological public impact and safety assessment of mining and mineral processing facilities.

Participating in IAEA Coordinated Research Projects to compare modelling results of radioactive waste disposal systems (NSARS) and to improve safety assessment methodologies (ISAM).

1988 – 1989 — **Student, University of the Free State (Institute for Groundwater Studies)**

1988 [B.Sc.(Hons) *(Cum Laude)*]: An honours course in theoretical geohydrology, focusing on the physics of groundwater flow in the saturated and unsaturated zone, and mathematical methods to solve groundwater problems.

1989 [M.Sc. *(Cum Laude)*]: Development of a finite element collocation method, using bi-cubic Hermite polynomials as basis functions, to solve differential equations defined over general non-rectangular domains. The method retains all the advantages when applied directly to a rectangular domain. A particular advantage of the method is its ability to yield continuous velocity fields, which is of considerable importance in the study of groundwater contamination problems.

1985 – 1987 **Student, University of the Free State (Faculty of Science)**
1985: Mathematics, Applied mathematics, Computer science, Mathematical statistics, Physics
1986: Applied mathematics, Computer science, Mathematics
1987: Applied mathematics, Computer science

Professional Experience: List of Selected Projects:

2022- 2023 **Specialist Radiological Public Safety Assessment Consultant**

In collaboration with Afry (Sweden), perform the Post-Closure Safety Assessment of the Sandy Ridge Facility for the containment and isolation of Disused Sealed Radioactive Sources (DSRS) and Naturally Occurring Radioactive Material (NORM) in Australia [*Client: Tellus Holdings Ltd (**Australia**)*].

Perform the prospective radiological public impact and safety assessment as part of the ESHIA process for the Sembehun Mineral Sand Operation for Sierra Rutile Limited in **Sierra Leone** [*Client: Digby Wells (**Jersey UK**)*]

Perform the prospective radiological public impact and safety assessment as part of the ESHIA process for the Pan African Resources (PAR) Operation in **South Africa** [*Client: Digby Wells (**South Africa**)*]

Perform a limited scope study to demonstrate compliance of the Koeberg Nuclear Power Station (KNPS) operational waste and Original Steam generators (OSGs) with the alternative definition of LILW (SL) or LLW in terms of the intrusion dose criterion as included in the National Radioactive Waste Management Policy and Strategy for the Republic of South Africa and the current Vaalputs WAC [*Client: Necsa (**South Africa**)*]

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator (NNR) licensing guide RG-002. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Kusasalethu Operation, Doornkop Operations, and Free State Mining Operation of Harmony Gold Mining Company [*Client: Harmony Gold (**South Africa**)*].
- The DRDGold ERGO Operations located in the Central and East Rand Basin of the Witwatersrand Basin to the east of Johannesburg in the Gauteng Province [*Client: DRDGold (**South Africa**)*].

2018 - 2021 **Specialist Radiological Public Safety Assessment Consultant**

Provide consultancy services to the IAEA to develop a report that outlines the application of a graded approach to the post-closure safety assessment of borehole disposal facilities for the long-term management of disused sealed radioactive sources [*Client: IAEA (**Vienna**)*].

Prepared a report to provide technical arguments in support of the Eskom reports dealing with the longevity of the Koeberg Nuclear Power Station (KNPS) metal drum and concrete waste containers containing LILW-SL and its influence on the post-closure safety of the Vaalputs radioactive waste disposal system [*Client: Necsa (**South Africa**)*].

In collaboration with Facilia AB (Sweden), perform the Post-Closure Safety Assessment of the Sandy Ridge Project for the Borehole Disposal of Disused Sealed Radioactive Sources (DSRS) in Australia [*Client: Tellus Holdings Ltd (**Australia**)*].

Perform the prospective radiological public impact and safety assessment as part of the ESHIA process for the Mkongo Rare Earth Mining Project in **Malawi** [*Client: Digby Wells (**Jersey UK**)*]

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator (NNR) licensing guide RG-002. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Moab Khotsong Operations of Harmony Gold Mining Company [*Client: Harmony Gold (**South Africa**)*].
- The Pilivili Titanium Minerals Project in **Mozambique** [*Client: EOH Coastal & Environmental Services (Pty) Ltd (**South Africa**)*].
- The Rappa Resources (Pty) Ltd Waste Treatment Facility [*Client: Rappa Resources (Pty) Ltd (**South Africa**)*].
- The Blyvoor Gold Mining Project located on the west rand near Carletonville[*Client: Digby Wells*

*Environmental (**South Africa**)*]

- The Foskor Operations located near Richards Bay in KwaZulu-Natal [*Client: Foskor (**South Africa**)*].
- The Hillendale and Fairbreeze Mines as part of the Tronox KZN Operations located near Empangeni in KwaZulu-Natal [*Client: Tronox KZN. (**South Africa**)*].
- The Central Processing Complex as part of the Tronox KZN Operations located near Empangeni in KwaZulu-Natal [*Client: Tronox KZN. (**South Africa**)*].
- The DRDGold ERGO Operations located in the Central and East Rand Basin of the Witwatersrand Basin to the east of Johannesburg in the Gauteng Province [*Client: DRDGold (**South Africa**)*].
- The South Deep Operation of Gold Fields [*Client: Gold Fields (**South Africa**)*].
- The Nufcor Operation of Harmony [*Client: Harmony Gold (**South Africa**)*].
- The Driefontein, Kloof and Rand Uranium Operations of Sibanye-Stillwater [*Client: Sibanye-Stillwater (**South Africa**)*].

2016 - 2017 **Specialist Radiological Public Safety Assessment Consultant**

Provide consultancy services to the IAEA to review the safety cases developed for the long-term management of disused sealed radioactive sources (DSRS) in Ghana and Malaysia [*Client: IAEA (**Vienna**)*].

Perform a radiological public and worker safety assessment for the Department of Water Affairs and Sanitation (DWS) Eastern Basin Water Treatment Plant and Sludge Management Operations as part of the Acid Mine Drainage (AMD) Project for the Witwatersrand Basin [*Client: TCTA (**South Africa**)*].

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator (NNR) licensing guide RG-002. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Kusasalethu Operation, Doornkop Operations, and Free State Mining Operation of Harmony Gold Mining Company [*Client: Harmony Gold (**South Africa**)*].
- The Burnstone Operations, Driefontein Operations, and Kloof Operations of Sibanye Gold [*Client: Sibanye Gold (**South Africa**)*].
- The Modder East Operation located in the East Rand of South Africa [*Client: Gold One International (**South Africa**)*].
- The South Deep Operation of Gold Fields [*Client: Gold Fields (**South Africa**)*].
- The Nufcor, Vaal River Operations and West Wits Operations of *AngloGold Ashanti*. [*Client: AngloGold Ashanti. (**South Africa**)*].
- The Richards Bay Minerals (RBM) Operations [*Client:* Richards Bay Minerals *(**South Africa**)*].
- The Tormin Mine [*Client:* Mineral Sands Resources Pty Ltd *(**South Africa**)*].

2014 - 2015 **Specialist Radiological Public Safety Assessment Consultant**

Perform an optimisation study to manage the NORM wastes and rejects generated at the Namakwa Sands Operations of Tronox Mineral Sands (Pty) Ltd [*Client: Namakwa Sands Operations of Tronox Mineral Sands (Pty) Ltd (**South Africa**)*]

Assisted Facilia AB with the radiological safety assessments for the remediation of the Zapadnoe Uranium Tailings Facility in the Pridneprovsky Chemical Plant Site in **Ukraine** as part of the ENSURE Project [*Client: Facilia AB (**Sweden**)*].

Performed radiological public impact and safety assessments as input into the EIA process for the various components of the West Rand Tailings Retreatment Project (WRTRP) of the Sibanye Gold Operations [*Client: Digby Wells (**South Africa**)*].

Performed a radiological baseline and scoping study for the Falea Uranium Mine in **Mali** [*Client: Digby Wells (**South Africa**)*].

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator licensing guide RG-002. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Bosveld Phosphate Operation near Phalaborwa in the Northern Province of South Africa [*Client:*

*Bosveld Phosphate (**South Africa**)*].

- The Mineral Separation Plant of the Namakwa Sands Operations of Tronox Mineral Sands (Pty) Ltd [*Client: Namakwa Sands Operations of Tronox Mineral Sands (Pty) Ltd (**South Africa**)*]
- The Sibanye Gold Randfontein Operation [*Client: Sibanye Gold (**South Africa**)*].
- The Steenkampskraal Monazite Mine located in the northwestern part of South Africa [*Client: Rareco (**South Africa**)*].
- A preliminary radiation impact assessment as input into the EIA process as part of the Kamieskroon heavy mineral sands project along the west coast of South Africa [*Client: ARCONSA (**South Africa**)*]
- A radiological safety assessment as part of a DFS for the Zandkopsdrift Rare Earth Element (REE) mine located in the northwestern part of South Africa [*Client: AGES Gauteng (**South Africa**)*].
- The Central Processing Plant (CPC) as part of the Tronox KZN Operations [*Client: Tronox KZN. (**South Africa**)*].
- A radiological safety assessment for the proposed RBM Zulti South Operations, as input into the Environmental Impact Assessment (EIA) process [*Client: Richards Bay Minerals (**South Africa**)*].

2012 - 2013 **Specialist Radiological Public Safety Assessment Consultant**

Draft a summary document on the Management of Radioactive Waste Generated at the Koeberg Nuclear Power Station as part of a broader assessment of the management of all waste at Koeberg [*Client: Golder Associated Africa (**South Africa**)*].

Perform a radiological public and worker safety assessment for the Sandpiper Marine Phosphate Project to develop an offshore phosphate dredge mining and land-based mineral processing operation situated near Walvis Bay on the **Namibia** coast [*Client: Enviro Dynamics (**Namibia**)*].

Perform a radiological worker and public safety assessment as input into the EIA process for the disposal of Tailings Treatment Plant residue (TTP tails) in the mine void at Richards Bay Minerals (RBM) [*Client: Golder Associates Africa (**South Africa**)*].

Reviewed the health risk assessment studies that were carried out for the Mahd Ad Dahab mining operation in **Saudi Arabia** from 2007 to 2011 [*Client: Facilia AB (**Sweden**)*].

Reviewed and provided a radiological interpretation of baseline data gathered for the OLTIN YO'L GTL" (OYGTL) Ltd project located in the Republic of Uzbekistan, in the territory of the Nishan District in the Kashkadarya Region of **Uzbekistan** [*Client: Golder Associates Africa (**South Africa**)*].

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator licensing guide LG-1032. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Wits Gold Operations in the Free State [*Client: With Gold (**South Africa**)*].
- A radiological public and worker safety assessment for the Mooifontein Uranium Mine proposed for development near Edenburg in the Southern Free State [*Client: Withers Environmental Consultants (**South Africa**)*].
- The Kusasalethu as well as the Free State Operations of Harmony Gold Mining Company Ltd. The Free State assessment was performed on a regional basis, taking into consideration the contribution of all 8 CoRs associated with the Free State Operations of Harmony [*Client: Harmony Gold Mining Company Ltd. (**South Africa**)*].
- A prospective assessment for the proposed Gold One Geluksdal Tailings Storage Facility [*Client: Digby Wells (**South Africa**)*].
- The Hillendale and Fairbreeze Mines as part of the Tronox KZN Operations located near Empangeni in KwaZulu-Natal [*Client: Tronox KZN. (**South Africa**)*].
- The Foskor Operations located near Richards Bay in KwaZulu-Natal [*Client: Foskor (**South Africa**)*].
- Radiological worker and public safety assessments of the proposed wet Gravity Scavenger Circuit at the Tronox Namakwa Sands Operations [*Client: Tronox Namakwa Sands (**South Africa**)*].
- The Ezulwini Gold Mine located near Westonaria [*Client: Gold 1 (**South Africa**)*].

2011 **Specialist Radiological Public Safety Assessment Consultant**

Perform various studies at the Steenkampskraal Monazite Mine to assess the radiological impact on workers during pre-operational activities, as well as the potential radiological impact of a Residue

Contamination Pond on members of the public [*Client: African Radiation Consultants (**South Africa**)*].

Perform a radiological public safety assessment of the Trekkopje Operations in Namibia to evaluate the potential impacts on members of the public induced through the release and dispersion of naturally occurring radionuclides in the form of airborne dust or gasses [*Client: Airshed Planning Professionals (**South Africa**)*].

Review and assess the radiological monitoring programmes for the Gold Fields Beatrix, South Deep, Kloof and Driefontein Operations [*Client: Golder Associates Africa (**South Africa**)*].

Perform various radiological public safety assessments for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator licensing guide LG-1032. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- The Rappa Resources (Pty) Ltd waste treatment facility located near Germiston, Gauteng [*Client: Rappa Resources (Pty) Ltd (South Africa)*].
- The Vaal River Operations and West Wits Operations of *AngloGold Ashanti* [*Client: AngloGold Ashanti. (**South Africa**)*].
- The Evander and Doornkop Operations of Harmony Gold Mining Company Ltd [*Client: Harmony Gold Mining Company Ltd. (**South Africa**)*].
- A preliminary radiological public impact assessment as part of a fatal flaw analysis for the Zandkopsdrift Rare Earth Project [*Client: AGES (**South Africa**)*].

2007 - 2010 **Specialist Radiological Public Safety Assessment Consultant**

Conduct specialist studies on radioactive waste management and radiological health and safety as part of the Environmental Impact Assessment (EIA) for the Pebble Bed Modular Reactor Demonstration Pilot Plant (PBMR DPP) [*Client: Argus Gibb* (***South Africa***)].

Perform a radiological baseline survey and dose assessment to international standards for the proposed Bakouma Uranium Mine located in the **Central African Republic** (CAR) for AREVA [*Client: Golder Associates Africa* (***South Africa***)].

Perform the 2008 Thabana Post-Closure Radiological Safety Assessment for the disposal of radioactive waste at Pelindaba [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

Perform a radiological public impact and safety assessment to evaluate the performance of the proposed Bannerman Uranium Mine operations located in the Erongo Region of **Namibia** [*Client: ERM (**South Africa**)*].

Perform the radiological public impact and safety assessment as part of the Strategic Environment Assessment (SEA) of the Uranium Industry in the Erongo area in **Namibia**. The study provided a broader Air Quality Study performed by Airshed Planning Professionals [*Client: Airshed Planning Professionals (**South Africa**)*].

Perform radiological public safety assessment for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator licensing guide LG-1032. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- A proposed Tailings Storage Facility for the Stilfontein operations of Mine Waste Solutions [*Client: Chemwes* (***South Africa***)].
- The proposed TPM uranium plant for the Welkom operations of Harmony Gold Mining Company Ltd [*Client: Harmony Gold Mining Company Ltd (**South Africa**)*].
- The re-mining of an existing Tailings Storage Facility, as well as the commissioning of a new Tailings Storage Facility for the Welkom operations of Harmony Gold Mining Company Ltd [*Client: Golder Associates Africa* (***South Africa***)].
- A new uranium processing plant near the Cooke gold plant and the interim disposal of tailings material at the Mill Site Tailings Storage Facility of Rand Uranium (Pty) Ltd. [*Client: Golder Associates Africa* (***South Africa***)].
- The potential radiological impact to members of the public from the land application of Sasol Nitro Gypsum [*Client: SRK (**South Africa**)*].
- The proposed Uranium processing plant at Driefonein No. 7 Shaft as well as the Centralized Tailings

Storage Facility located near the South Deep Operations of Gold Fields [*Client: Gold Fields South Africa (**South Africa**)*].

2007 **Specialist Groundwater Modeller**

Develop a groundwater flow and contaminant transport model using **FEFLOW** to evaluate the performance of the kiberlitic tailings dam complex at the Kao diamond mine in **Lesotho** [*Client: Golder Associates Africa* (***South Africa***)].

2005 - 2007 **Specialist Radiological Public Safety Assessment Consultant**

Perform the total system **2007 Vaalputs Post-Closure Radiological Safety Assessment** for the disposal of the best estimated national inventory at the National Nuclear Radioactive Waste Disposal Facility at Vaalputs in the Northern Cape Province of South Africa [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

Perform a provisional radiological public impact assessment of the proposed Trekkopje Uranium Mine located in the Erongo Region of **Namibia** as part of the Environmental Impact Assessment (EIA) [Client: *Ferret Mining* (***South Africa***)].

Conduct an Expert Mission to Kitwe (**Zambia**) to assess the radiological situation at the Amco settlement and propose remedial alternatives for the Amco tailings material [*Client*: *International Atomic Energy Agency (**Austria**)*].

Perform a screening level public dose assessment to assess the potential radiological impact on farmers located along the Swakop River near Swakopmund (**Namibia**) following the occurrence of elevated levels of uranium in the Swakop River [*Client: Rössing Uranium Limited (**Namibia**)*].

Perform a radiological similarity study between the TICOR Hillendale mining site and the proposed mining site at Fairbreeze [*Client: TICOR* (***South Africa***)].

Perform a radiological public safety assessment of the TICOR facilities at Hillendale (mining site) and the Central Processing Complex at Empangeni. This was done in accordance with the NNR licensing guide LG-1032. The objective of the study was to assess the radiological impact of releases from the TICOR Operations on members of the public [*Client: TICOR* (***South Africa***)].

2005 – 2006 **Specialist Groundwater Modeller**

Develop a groundwater flow model using **FEFLOW** to evaluate the dewatering of the Morila open-pit gold mine in **Mali** on the underlying groundwater flow regime [*Client Golder Associates Africa* (***South Africa***)].

Develop a groundwater flow and contaminant transport model for the ISPAT ISCOR site at Vanderbijlpark using **FEFLOW**, to evaluate the migration of contaminants at and from the site with time [*Client: Golder Associates Africa* (***South Africa***)].

Develop a groundwater flow model using **FEFLOW** to evaluate quantitatively the ingress of surface water into the underground mine workings of the Central Rand Basin, South Africa [*Client: South African Council for Geoscience* (***South Africa***)].

2003 - 2004 **Specialist Radiological Public Safety Assessment Consultant**

Perform a radiological impact and safety assessment for Namakwa Sands to evaluate the impact of a proposed gypsum disposal option on groundwater at the mining site at Brand-se-Baai [*Client: Namakwa Sands* (***South Africa***)].

Assist MonitorSci with model development to evaluate the impact of an exposure group from an intrusive igneous event intruding into the Yucca Mountain high-level radioactive waste disposal facility [*Client: Monitor Scientific LLC (**USA**)*].

Evaluate the radiological risk to members of the public if phosphogypsum plaster products are used in the building industry. Various scenarios associated with workers constructing a house and house inhabitants were considered as part of the study [*Client: BPB Gypsum Limited* (***South Africa***)].

Developed a comprehensive list of Features, Events, and Processes (FEPs) for near-surface radioactive waste disposal facilities. The basis for the updated list was the FEPs list developed as part of the IAEA ISAM Project [*Client: International Atomic Energy Agency (**Austria**)*].

Performed a radiological public safety assessment of the Duvha fossil fuel power station. The purpose of this study was to assess the levels of possible radiological exposure to members of the public that can be expected at the various Eskom fossil fuel power stations. This was done in accordance with the National Nuclear Regulator licensing guide LG-1032 [*Client: Eskom and Technical Services International (TSI)* (***South Africa***)].

2003 — **Specialist Groundwater Modeller**

Develop an unsaturated flow model using **HYDRUS 2D** of a proposed tailings dam complex. The purpose was to evaluate the behaviour of the tailings dam under design conditions [*Client: Groundwater Consulting Services (**South Africa**)*].

Develop an unsaturated flow model using **HYDRUS 2D** for the distressed rock mass area beneath the open pit at Palabora Mining Company. The purpose of the model was to simulate the infiltration of a high rainfall event through the cave mining area beneath the pit [*Client: Golder Associates Africa (**South Africa**)*].

2002 - 2003 — **Specialist Radiological Public Safety Assessment Consultant**

Compile a summary description of waste rock management practices as applied in South Africa during the planning, operational and post-operational phases [*Client: Stantec (**Canada**)*].

Contribute to the development of a generic safety assessment of the borehole disposal concept for the disposal of disused radioactive sealed sources in African countries (BOSS Concept). Specific contributions include the assessment context, system description and scenario development and justification [*Client: Quintessa Limited (**UK**)*].

Derive quantitative and nuclide-specific reference levels (waste acceptance criteria) for the disposal of low- and intermediate-level waste at the National Nuclear Radioactive Waste Disposal Facility at Vaalputs in the Northern Cape Province of South Africa [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

Perform radiological public safety assessment for mining and mineral processing operations involving NORM in accordance with the National Nuclear Regulator licensing guide LG-1032. The objective was to assess the radiological impact of releases from the operations on members of the public. This was done by integrating the contribution of the atmospheric and aquatic pathways, as well as the human behavioural study conducted for this purpose, into a *Safety Case*.

Some of the major assessments include:

- TICOR Operations at Hillendale (mining site) and the Central Processing Complex are both located near Empangeni [*Client: TICOR* (***South Africa***)].
- Proposed tailings storage facility (TSF) at the Placer Dome Western Areas Joint Venture South Deep operations [*Client: Placer Dome Western Area Joint Venture* (***South Africa***)].

2002 — **Specialist Radioactive Waste Management Consultant**

Perform a technical review of the issues that would influence the design of the borehole disposal of disused radioactive sources (BOSS) concept. Specify the design requirement for the development and evaluation of the concept. This was done as part of Phase III of a project to develop a long-term management solution for disused sealed radioactive sources in African countries [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

2001 — **Specialist Radiological Public Safety Assessment Consultant**

Perform a radiological public safety assessment of the Duvha fossil fuel power station. The purpose of this study was to assess the levels of possible radiological exposure to the workers and members of the public that can be expected at the various ESKOM fossil fuel power stations. This was done in accordance with the National Nuclear Regulator licensing guide LG-1032 [*Client: ESKOM* (***South Africa***)].

Compile a first iteration total system safety assessment of the National Nuclear Radioactive Waste Disposal Facility at Vaalputs in the Northern Cape Province of South Africa. The focus of this assessment was only on the waste that will be received from the Koeberg Nuclear Power Station. Specific aspects that were covered are drafting the assessment context, the generation and justification of exposure scenarios, the performance of the near-field, the prospective evaluation of the unsaturated zone and the compilation of the safety case [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

Compile a total system public safety assessment of the long-term radioactive waste storage facility at Thabana (Pelindaba). The facilities, which came into operation in the late 1960s, contain mainly uranium-contaminated waste. The focus of the assessment was to evaluate the influence of the facility on human beings and the environment over 30 years, after which the intention was that the site would be remediated [*Client: South African Nuclear Energy Corporation* (***South Africa***)]

2000 — **Specialist Groundwater Modeller**

Construct a single-layered finite element aquifer model for the Marsfontein mine in the Northern Province using **FEFLOW.** The objective of this investigation was to assess the influence of mine dewatering on the regional hydrological and geohydrological system and to determine inflow rates into the open-pit mine

workings [*Client: Southern Africa Geoconsultants* (***South Africa***)]

Conduct performance assessment studies (using **FEFLOW**) to evaluate the moisture movement through the unsaturated engineered clay caps of Trench B01 and Trans A01 at the National Nuclear Radioactive Waste Disposal Facility at Vaalputs in the Northern Cape Province of South Africa [*Client: South African Nuclear Energy Corporation* (***South Africa***)].

1999 - 2000 **Specialist Radiological Safety Assessment and Radioactive Waste Management Consultant (Employed by the South African Nuclear Energy Corporation)**

Phase II of the IAEA project to develop a long-term management solution for disused sealed radioactive sources in African countries entails the development and evaluation of the BOSS concept in terms of its technical feasibility and economic viability as a disposal concept. This included a preliminary safety assessment of the concept at two sites in South Africa, performed in collaboration with co-workers in the USA.

1998 - 1999 **Specialist Radiological Safety Assessment Consultant (Employed by the South African Nuclear Energy Corporation)**

Perform radiological public safety assessments of the mining and mineral processing facilities at the Palabora Mining Company and Foskor Ltd. This was done in accordance with the National Nuclear Regulator licensing guide LG-1032. The objective of the two studies was to assess the radiological impact of releases from the Palabora Mining Company and Foskor Operations on members of the public.

992 - 1997 **Safety Assessment Analyst (Employed by the South African Nuclear Energy Corporation)**

Evaluate the moisture movement in and around the radioactive waste disposal trenches at the National Nuclear Radioactive Waste Disposal Facility at Vaalputs in the Northern Cape Province of South Africa using **SUFF**. This served as a basis for performing a geohydrological performance assessment (using **HYDRUS-2D**) of Trench BO1. The objective of the investigation was to assess the performance of the unsaturated geosphere following the release of radioactive material from the trench into the environment.

Perform a geohydrological performance assessment of Thabana at Pelindaba. The objective of the investigation was to determine the radiological consequences of the storage facilities, guide remedial actions in cases where safety criteria have been exceeded, and demonstrate adequate safety to obtain a licence for Thabana as an interim radioactive waste storage facility.

Perform moisture and radionuclide movement studies for the IAEA coordinated research programme on the safety assessment of near-surface radioactive waste disposal facilities (NSARS) for Test Case 2a (presented results at an IAEA meeting in 1992 in Augusta, USA) and Test Case 2b (presented results at an IAEA meeting in 1994 Seville, Spain).

Major Research Conducted:

1988 – 1989 **Master degree, University of the Orange Free State (Institute for Groundwater Studies)**

Development of a finite element collocation method, using bi-cubic Hermite polynomials as basis functions, to solve differential equations defined over general non-rectangular domains. The method retains all the advantages when applied directly to a rectangular domain.

A particular advantage of the method is its ability to yield continuous velocity fields, which is of considerable importance in the study of groundwater contamination problems.

2000 **PhD, University of the Orange Free State (Institute for Groundwater Studies)**

The objective of radioactive waste management is to ensure that human beings and the environment are protected at all times, without imposing an undue burden on future generations. This implies that, before any long-term management strategy for radioactive waste disposal can be implemented, the impact of the disposed waste must be determined as a function of time - a procedure referred to as post-closure safety assessment.

In the thesis, a methodology to perform a post-closure safety assessment of radioactive waste disposal systems in South Africa and other parts of Africa was described.

List of Publications:

VAN BLERK, Jacobus Josia (PhD)

Van Blerk, J.J., and J.F. Botha, "*Numerical solution of partial differential equations on curved domains by collocation.* ", Numerical Methods for Partial Differential Equations (9) pp 357-371, 1993.

Van Blerk, J.J., and M.W. Kozak, "*Borehole Disposal of Spent Radiation Sources: 1. Principles,*" IAEA-CN-78, pp. 194-187, Proc. International Conference of the Safety of Radioactive Waste Management, Cordoba, Spain, 13-17 March 2000.

Kozak, M.W., and J.J. van Blerk, "*Borehole Disposal of Spent Radiation Sources: 2. Initial Safety Assessment*," IAEA-CN-78, pp. 48-51, Proc. International Conference of the Safety of Radioactive Waste Management, Cordoba, Spain, 13-17 March 2000.

Kozak, M.W., J.J. van Blerk, and J.P. Vivier, "*Borehole Disposal of Spent Radiation Sources*," Proc. International Symposium on Radiation Safety Management, November 5-7, Daejeon, Korea, pp 407-416, 2001.

Seitz, R.R., J Van Blerk, C. Gelles, and G. Bruno, "*Managing Uncertainties Associated with Radioactive Waste Disposal: Task Group 4 of the IAEA PRISM Project – 11190*". Waste Management 2011 Conference, February 27 – March 3, 2011, Phoenix, Arizona

Bugai, D, O. Voitsekhovich, T. Lavrova, S. Todosienko, R. Avila, M. Kozak, J. van Blerk, and I. Kovalets. "*Overview of Remedial Activities at Pridneprovsky Chemical Plant Site, Dneprodzerginsk, Ukraine*". Technical meeting of the Uranium Mining Remediation Exchange group (UMREG-2014), Freiberg, Germany, 2014.

Cochran, J., Bennett, D.G., Degnan, P., Grout, C., Liebenberg, G., Little, R., Ramsey, J., Van Blerk, J.J., and Van Marcke, P. "*International Implementation of IAEA's Borehole Disposal Concept for Sealed Radioactive Sources – 18545".* Waste Management 2018 Conference, March 18 - 22, 2018, Phoenix, Arizona, USA

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, the above information contained in the CV is an accurate description of my experience and qualifications, and me.

Jacobus Josia van Blerk (PhD)
Director: AquiSim Consulting (Pty) Ltd

Appendix B: Proof of Public Consultation

- Notified and Registered Parties
- Proof of Notifications
- Letter from the National Radiation Protection Authority
- Comments and Responses Table
- Correspondence with IAPs
- Press Notices
- Site Notice

Neighbours Notified by Hand Delivered Letter

Public Participation Notification: Environmental Assessment

Radioactive Source Material Storage and Handling Facility on Erf 3954, Swakopmund, Erongo Region

Name & Surname	Organisation/Address	Tel / Mobile	Email	Signature
Chandre Julius	Swakop Sign World CC	Privacy Block		
Anna Severus	I-Care Health Training Ins.			

Geo Pollution Technologies
Radioactive Source Material Storage and Handling Facility on Erf 3954, Swakopmund, Erongo Region
February 2024

Proof of Notification: NRPA

Geo Pollution Technologies

TEL.: (+264-61) 257411 ♦ FAX.: (+264) 88626368
CELL.: (+264-81) 1220082
PO BOX 11073 ♦ WINDHOEK ♦ NAMIBIA
E-MAIL: gpt@thenamib.com

To: **The Director**
Atomic Energy & Radiation Protection Authority
Ministry of Health and Social Services
Private Bag 13198
Windhoek

12 February 2024

Dear Mr. Tibinyanye

Re: **Environmental Assessment and Management Plan for a Radioactive Source Material Storage and Handling Facility on Erf 3954, Swakopmund, Erongo Region**

In terms of the Environmental Management Act (No 7 of 2007) and the Environmental Impact Assessment Regulations (Government Notice No 30 of 2012), notice is hereby given that an application will be made with the Environmental Commissioner for the construction and operations of a radioactive source material storage and handling facility on erf 3954, Swakopmund, Erongo Region. The Proponent for the project is Namaquanum Investments Two CC who has an existing workshop on erf 3954, Einstein Street, in the industrial area (Extension 10) of Swakopmund. The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source material used to calibrate and test drilling equipment (well logging equipment) used in the offshore oil exploration industry. Clients from the offshore exploration industry will utilise the workshop and source materials to perform the necessary calibrations and tests on their drilling equipment.

The facility will conform to stringent industry safety specifications. The preferred structure will be a six meter steel shipping container, placed on a concrete or paved surface. The four interior sides of the container will be lined by an approximately 50 cm thick, high density concrete layer. A prefabricated concrete slab will be placed on top of the container. The container will have intruder alarms and the area around it will be fenced and locked and entry strictly controlled. Warning signs will be placed, at minimum, at all entrances to the fenced area. The facility will be under 24 hour closed circuit television (CCTV) surveillance (outside and inside the container).

The existing workshop will be transformed into a state of the art workshop for the calibration and testing of drilling equipment. The floor of the workshop will be covered with a new 15 cm thick, reinforced and sealed concrete floor. Various workspaces will be created for the various tests and calibrations to be performed. Utilities like telecommunications, electricity and earthing, water, drainage, ventilation and compressed air will be upgraded or newly installed. An equipment wash bay will be constructed and this, together with various drains, will be connected to an oil water separator. Additional emergency infrastructure and equipment will include a fire detection system, firefighting equipment, emergency eye wash stations, radiation detectors with audible and/or visual alarms, etc.

Geo Pollution Technologies (Pty) Ltd was appointed by the Proponent to conduct an environmental assessment for the proposed project. As part of the assessment we notify interested and / or affected parties. You are hereby invited to share with Geo Pollution Technologies, any comments, issues or concerns related to the proposed project, for consideration in the environmental assessment.

Please forward your inputs to:

E-mail: ct@thenamib.com
Fax: 088-62-6368.

Comments and registrations should reach us by 21 February 2024.

Page 1 of 2

Directors: P. Botha (B.Sc. Hons. Hydrogeology) (Managing)

12/02/2024

Proof of Notification: Swakopmund Municipality

Geo Pollution Technologies
TEL.: (+264-61) 257411 ♦ FAX.: (+264) 88626368
CELL.: (+264-81) 1220082
PO BOX 11073 ♦ WINDHOEK ♦ NAMIBIA
E-MAIL: gpt@thenamib.com

To: **Interested and / or Affected Party** **30 January 2024**

Re: **Environmental Assessment and Management Plan for a Radioactive Source Material Storage and Handling Facility on Erf 3954, Swakopmund, Erongo Region**

Dear Sir / Madam

In terms of the Environmental Management Act (No 7 of 2007) and the Environmental Impact Assessment Regulations (Government Notice No 30 of 2012), notice is hereby given that an application will be made with the Environmental Commissioner for the construction and operations of a radioactive source material storage and handling facility on erf 3954, Swakopmund, Erongo Region. The Proponent for the project is Namaquanum Investments Two CC who has an existing workshop on erf 3945, Einstein Street, in the industrial area (Extension 10) of Swakopmund. The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source material used to calibrate and test drilling equipment (well logging equipment) used in the offshore oil exploration industry. Clients from the offshore exploration industry will utilise the workshop and source materials to perform the necessary calibrations and tests on their drilling equipment.

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Please forward your inputs to:
E-mail: et@thenamib.com
Fax: 088-62-6368.

Should you require any additional information please contact Geo Pollution Technologies at telephone 061-257411.

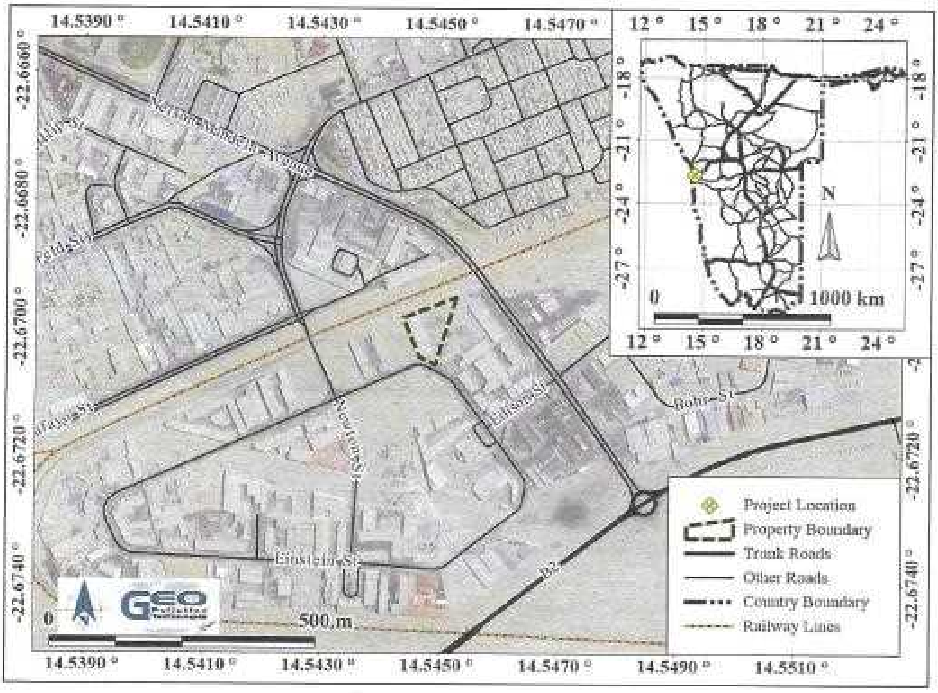
Thank you in advance.

André Faul
Environmental Impact Assessment Practitioner

Swakopmund Municipality
2024-02-08
General Manager
Engineering & Planning Services

Received

Directors: P. Botha (B.Sc. Hons. Hydrogeology) (Managing) Page 1 of 2



Swakopmund Municipality

2024 -02- 08

General Manager
Engineering & Planning Services

Page 2 of 2

Geo Pollution Technologies (Pty) Ltd

Interested and Affected Parties Notified by E-Mail

Name	Organisation
Vera Schatz	Namibia Breweries Ltd (Erven 3976 and 3977)
Quintus Erasmus	QE Construction
Bernadette Weimann	Body Corporate Investment 625
Mberipura Hifitikeko	TransNamib
Bertus Eksteen	TransNamib
Alynsia Platt	TransNamib
Kristian H. Woker	Woker's Trust (Pty) Ltd (Erf 3953)

Registered Parties

Title	Name	Organisation	Date Registered
Mr	Alfeus Benjamin	Chief Executive Officer, Municipality of Swakopmund	2024-02-27
Ms	Alma Wallis	Private	2024-03-08
Ms	Annete Erbslöh	Private	2024-03-08
Ms	Berchen Kohrs	Earthlife Namibia	2024-02-29
Ms	Bernadette Weimann	Industrial Investment 625 Body Corporate	2024-03-11
Dr	Detlof Von Oertzen	VO Consulting	2024-02-27
Mr	Faried Abu-Salih	Private	2024-03-07
Mr	Gerhard Byleveld	Advertising Displays	2024-03-08
Mr	J.C Brandt	Private	2024-03-09
Mr	Jens Porthmann	Private	2024-03-04
Mr	John Hopkins	Chairman, Swakopmund Residents Association	2024-03-18
Ms	Julika Becker	Private	2024-03-07
Ms	Katharina Geier	Private	2024-03-06
Mr	Kristian H Woker	Woker's Trust (Pty) Ltd	2024-03-06
Ms	Margo Bassingthwaighte	Private	2024-03-10
Ms	Michelle Pfaffenthaler	Private	2024-03-25
Mr & Mrs	Nicholas Preller	Private	2024-03-04
Mr	Olof Nederlof	Private	2024-02-29
Ms	Paulina Engelbrecht	Environmental Officer, Municipality of Swakopmund	2024-02-27
Mr	Pieter Hamman	Pieter Hamman Legal Practitioners	2024-03-04
Mr & Mrs	Ralf and Birgit Linow	Private	2024-03-12
Mrs	Riana Brandt	Private	2024-03-09
Ms	Talita Nel	Capricorn Estate Agency	2024-03-07
Mnr	Thimo Martens	Private	2024-03-08
Ms	Virginia Tsele	Interwaste Environmental Solutions	2024-02-28
Mr	Wiebke Frey	Private	2024-03-08
Ms	Wiltrud Patzner	Private	2024-03-07

Comments Responses Table – Comments are presented as received with no changes or corrections made to text

IAP Details	Comment / Concern	Response
Detlof Von Oertzen Email: 27/02/2024	*<u>Initial Query:</u>* Kindly register me as an interested and affected party for the planned Industrial Hazardous Waste Storage Site at Swakopmund.	*<u>Initial Response:</u>* Thank you for your mail. I assume you are referring to the Radioactive Source Material storage facility in Swakopmund as per attached BID? Note that it is not hazardous waste that will be stored, but radioactive sources that will be used to calibrate and test drilling equipment for the offshore oil industry. I have registered to you for the project and will share the EIA/EMP with you for comment. You are also welcome to send me your initial comments/questions to be included/considered in the EIA. Do not hesitate to contact me for any additional information.
	<u>Subsequent Query:</u> The document was well received, and yes, it is the project for which you've sent the BID for which I requested to be registered as an I&A party. As I also mentioned to Johann Otto, the BID suggests that its purpose will be "…to register the ECC application with the Ministry of Health and Social Services' National Radiation Protection Authority…". Please note that it is not merely a matter of registering the project, but also submitting a Radiation Management Plan (RMP) for such a facility, prior to the commencement of operations. As my company is providing a broad range of radiation protection services, we could develop a fit-for-purpose RMP, if of interest. Also, I'd be keen to see the EIA/EMP, where my interest is particularly focused on the radiation-related impacts – has a radiation impact assessment (RIA) been done for the EIA? In my view, a RIA is essential, as there are many (often baseless) fears about the use of radioactive materials. Again, we could do a RIA for inclusion in the EIA/EMP, if of interest. Thanks for establishing contact, please do not hesitate to approach us if we can be of assistance!	*<u>Subsequent Response:</u>* I take note of your comments and will also forward your mail to the client.

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Virginia Tsele Email: 28/02/2024	*Initial Query:* I would like to register as an Interested and Affected Party on the subjected project. Would you kindly share registration forms and any available documentations/reports regarding the subjected application.	*Initial Response:* The email is sufficient for registration and I have now registered you. Attached is the BID for the project in case you have not received it yet. I will forward you the EIA/EMP for review once complete. In the meantime please send any comments or questions you may have for consideration in the EIA to me. Do not hesitate to contact me for any additional information.
Berchen Kohrs Email: 29/02/2024	*Initial Query* I kindly ask you to register Earthlife Namibia as I&AP for the Storage Facility for Radioactive Source Material in Einstein Street in Swakopmund. Contact: Bertchen Kohrs Chair of Earthlife Namibia Earthlife Namibia is a NGO concerned about environmental and social justice and looks back on 33 years of experience on the nuclear field. We are interested in the above mentioned project. I would highly appreciate if you send a confirmation of registration.	*Initial Response:* Thank you for your mail and registration. I have added you on behalf of Earthlife on the stakeholders list. In case you have not seen the BID yet, please find it attached. We will forward all documentation to you for review prior to submission to MEFT.
	Letter Received from Earthlife Namibia : Earthlife Namibia is an NGO concerned about social and environmental justice and as such looks back on 34 years of experience on the nuclear field. Thanks to Geo Pollution Technologies for the opportunity to ask questions and raise concerns. There are plenty of both. When it comes to radioactive material, all the alarm bells are ringing. Many nuclear accidents happen around the world where radioactive material is released, with devastating consequences for the people and the environment. Both, human and technical errors are usually the cause of industrial accidents. There are no	*Responses to Letter* Calibration and testing LWD tools is highly specialised and require highly specialised equipment. It is GPT's understanding that there is no facility in Namibia with this type of technology. If there is, we are not aware of it.

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	accident-free guarantees in any business. Many of these accidents are being swept under the carpet. The fact that the calibration of test drilling equipment and the physical characterisation of borehole profiles with radioactive material is a known and accepted method worldwide should not obscure the fact that it is associated with dangers and must therefore be handled with greatest expertise and utmost care. Unfortunately, in the BID of Geo Pollution Technologies the isotopes to be used in the off-shore oil exploration are not mentioned. It is extremely important to distinguish between alpha, beta, and gamma radiation of the isotopes and to handle and store them accordingly. Even though the EIA is dealing with the storage of radioactive material, it seems necessary to educate the population about the use of this material. Interested and concerned Namibian residents are invited to direct their objections and questions to Geo Pollution Technologies, although it can be assumed that only insiders understand the principle of the process. The method intended for the project under discussion is applied in mining, mineral exploration, oil and gas well-drilling, in fracking (which is fortunately not done in Namibia) and even in water-well drilling. • Can one therefore assume that this method has already been used in Namibia without the awareness of the Namibian citizens?	
	What isotopes are we talking about? In order to make comments, it is necessary to know which isotopes are to be stored on the Einstein Street premise in the Swakopmund industrial area. Judging by the equipment of the shipping steel container with a coating of approximately 50 cm high density concrete layer, one can assume that this structure is for the storage of a gamma emitter. Generally, small quantities of caesium-137 are used for the calibration of radiation detectors. • Can we assume that indeed Caesium-137 is the isotope we are talking about?	The isotopes are Caesium-137 and Americium-241 Beryllium. Yes, gamma rays will be emitted The SRS will be supplied by an international supplier, QSA Global. See the RIA for MSDS and supporting documentation Decommissioned SRS will be returned to the supplier. Decontamination will only be required if a leak from one or more of the SRS occurred. Decontamination procedures will thus occur during operations if such a leak is detected. Decontamination will comprise of washing

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	• Where will the material come from? Will it be obtained from an accredited source? • Where does the radioactive material go to after decommissioning of the plant? • How will the bunker and indeed the entire effected area be decontaminated after the plant is closed?	the contaminated area with tepid water and soap and disposable cloths. All cleaning material and water will be placed in an airtight container for storage in a secure location.
	Location of the storage facility It seems that Walvis Bay was the first choice when looking for a storage site. • Why did Walvis Bay refuse to build the plant? • What tipped the balance in favour of the industrial area in Swakopmund? Considering that the oil rigs are much closer to Walvis Bay, it seems to be the better choice.	Walvis Bay did not refuse as the Proponent never approached them. The Proponent has an existing property in Swakopmund which they wish to develop.
	Building the bunker to store highly radioactive substances is a decision with long-term consequences and needs to be well thought through, taking all factors into account, not just the location but the impact of the entire project. Residents of Kramersdorf and indeed the whole of Swakopmund are understandably very concerned about their safety. Even the people working in an industrial area should not be exposed to the risk of exposure and or a nuclear accident. • Is there a chance that another location outside of any dwelling and human activity can be chosen?	The RIA indicates that the public will not be exposed to radiation under normal operating conditions.
	A photo taken at Einstein Street 111 shows shipping containers, apparently to be used for the storage of radioactive materials. • Can we conclude from this that the project is already underway before an Environmental Clearance Certificate has been issued by government? That would be illegal and would undermine any confidence in the entire project.	No. The containers served other purposes.

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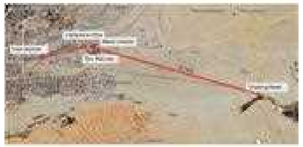
	 Einstein Street 111	
	• How is the proposed site protected against flash floods?  Although flash floods are rare in Namibia, they will inevitably come. The proposed site is in the lower reach of the Swakopmund river and sits at an estimated elevation of 28 m above normal sea level. The critical choking point of the Swakopmund river is the section where the C28 and the railway lines cross the river, some 3.7 km upstream at a normal river elevation of 35 meters above sea level. If that choking point would be clogged from debris like trees as flash floods regularly carry, there would be a major flooding risks of the proposed site. The major risk of flooding such installations are electrical faults in safety equipment and the buoyance of any equipment like containers. There is then also the risk of radioactive material leaking and catastrophic spreading of the contamination in a flash flood environment. • What kind of emergency measures will there be in place for such an event? • How will the site be protected against such flooding? Flash floods do not occur regularly, but they do occur.	Refer to section 8.4. It is extremely unlikely that a flash flood will impact the facility. There is a clear watershed between the site and the river. Two elevation profiles for two potential choke points were created. For both scenarios the water will flow around the obstruction and back to the river. Heavy rainfall in Swakopmund and on the site itself may cause localised pooling. The catchment of erf 3954 is extremely small as indicated in Figure 8-4. As such significant flood damage that will result in the scenarios mentioned is highly unlikely.

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	• Are the Swakopmund emergency services equipped and trained to deal with a flooded nuclear facility? We doubt that.	
	Transport The transport of highly radioactive material is one of the major safety factors. The transport vehicles must be equipped appropriately, the drivers must be qualified and informed. In the event of an accident involving the transport vehicle, the driver must know what emergency measures need to be taken immediately. Namibia is a country with nuclear experience and as such should be equipped for the safe transport of radioactive materials, although accidents happen. The radioactive substance is normally stored in specially equipped metal containers. The nuclear material is extremely expensive and therefore a target for thieves and criminals. However, if the perpetrators are not aware of the danger of the loot and open the cans, this is their death sentence and possibly that of many others. It is known that tins have been violently broken because they were thought to contain something very valuable. This ended fatally. Last year, a container of highly radioactive material fell off a pick-up truck in Australia. After a long search, it was recovered unscathed in the bush. It would have been catastrophic if it had fallen into the wrong hands. This event is evidence of greatest negligence. • What measures will be taken to prevent all forms of accidents (road accidents, handling and loading of the material, etc.). • What measures will be taken to prevent criminal action?	There is currently only one transport company in Namibia that is authorised by the NRPA to transport radioactive material. They have already been engaged and have indicated what steps need to be taken to obtain the necessary additional approvals for transport of the SRS, should the project realise.
	The legal issue • Is the necessary legislation, including regulations, in place for this business in Namibia? • What are the recommendations of the National Radiation Protection Authority? • What is the opinion of the Swakopmund City Council and other decision-makers in the city?	The EIA, RIA and ERMP is the first step in the obtaining all necessary permissions and approvals. The NRPA was notified of the EIA process and responded. They indicated that consent is required and that a final decision will be made pending the outcome of the EIA, RIA and issuance of an ECC. All concerns received from IAPs are included and addressed in this comments and responses table. The EIA, RIA and ERMP will be circulated to all registered parties for review and comment prior to submission.

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	• Are the concerns of Swakopmund residents being considered and properly reflected in the EIA?	
	Operational phase The BID states: Only suitably trained, qualified and authorised personnel will have access to the radioactive source material area, as well as handle and work with such material. • When is the start of construction expected (depending on when the ECC is issued, of course)? It is unlikely that there will be sufficient persons in Namibia with the required qualifications. • Will there be sufficient time to train a suitably qualified team of employees? • Or will foreigners be employed due to a lack of skilled local manpower?	The Proponent intends to start construction once and if the ECC is approved and the approvals from the NRPA and Swakopmund Municipality are obtained. Actual dates are not known. Due to the highly specialised nature of the work, skilled persons will have to be sourced from elsewhere. Unskilled and semi-skilled employees will be sourced locally (e.g security, administration, etc.)
	Safety Requirements The BID states: Regular leak tests will be performed as per individual sources' requirements, to ensure it remains within the threshold limits. • How will the tests be carried out? • What are the threshold limits for the individual sources? • What measures will be taken to prevent contamination of surface water, groundwater, soil and air?	Standardised wipe tests. Refer to section 11.2.2 and section 11.2.9 for procedures to prevent contamination.
	The BID states further: The existing workshop will be transformed into a state of the art for the calibration and testing of drilling equipment. In addition to the storage, this involves much more practical handling of highly radioactive material, more vulnerability to accidents and escape of radiation. The entire area must be shielded from the outside world like a high-security zone, similar to a nuclear reactor. • How can this be achieved? • Can you confirm that the Specific Safety Requirements No. SSR-1 of the IAEA ("SITE EVALUATION FOR NUCLEAR INSTALLATIONS", in	SSR-1 is not applicable to the proposed facility of the Proponent. SSR-1 states: *The requirements in this publication apply to all nuclear installations [10], as follows:* • *Nuclear power plants;* • *Research reactors (including subcritical and critical assemblies) and any adjoining radioisotope production facilities;* • *Storage facilities for spent fuel;*

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	particular Requirement 12: Potential effects of the nuclear installation on people and the environment") will be followed through with scientific and technical vigor?	• *Facilities for the enrichment of uranium;* • *Nuclear fuel fabrication facilities;* • *Conversion facilities;* • *Facilities for the reprocessing of spent fuel;* • *Facilities for the predisposal management of radioactive waste arising from* • *nuclear fuel cycle facilities;* • *Nuclear fuel cycle related research and development facilities.* However, despite it not being applicable, significant effort was made to ensure proper evaluation of the site and risks.
	Can you confirm that the IAEA rules contained in the Safety Report Series No. 16: CALIBRATION OF RADIATION PROTECTION MONITORING INSTRUMENTS of 2000, in particular the requirements for calibration facilities will be fully observed?	Safety Report Series No. 16: CALIBRATION OF RADIATION PROTECTION MONITORING INSTRUMENTS of 2000 is not applicable to the facility. Its scope is as follows: *This report is intended to serve those who are* ***establishing or operating calibration facilities for radiation monitoring instruments****. The sources of radiation and associated apparatus and calibration techniques presented are examples of what established calibration laboratories have deemed adequate.* It therefor serves facilities that calibrate the radiation monitoring equipment that will be used by the Proponent to, amongst others, monitor radiation exposure of workers on site (i.e. dosimeters or similar).
	Health of the employees • How regularly will the employees be medically examined? • Which medical check-ups are carried out regularly?	A health and safety policy in accordance with local laws, and regulated by IAEA, will be put in place and strictly followed. The objectives of which will be to protect the health of the general public and the employees, and to prevent debilitating accidents resulting from the use of

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	• Is the medical staff trained to evaluate the health status of exposed employees? • Are employees provided with adequate medical and financial care if their health is affected by occupational circumstances, keeping in mind that gamma radiation is dealt with? • Are employees informed about the risks of their work before they sign an employment contract? • What kind of personal protection will employees receive in the form of clothing, masks, etc.? • And finally, what is the expected lifetime of the entire project? • Who will monitor the plant from A to Z? • Who will take responsibility for any accidents? • Will any victims be provided with medical and financial care? • What is the plan for decommissioning? In view of the planned dangerous operation, Earthlife Namibia finds the many questions and comments justified. We trust that they will be taken into consideration when preparing the EIA and EMP.	radioactive materials. All employees will be informed of the risks involved with working with radioactive material.
Olof Nederlof Email: 29/02/2024	*<u>Initial Query:</u>* TO WHOM THIS MAY CONCERN Re: Consent for a Noxious Industry/Hazardous Storage (Radioactive Source Material Storage And Handling Facility) on Erf 3954 Swakopmund Extension 10 I am writing this letter in regards to the consent referenced above. I am writing this letter as a concerned and angry resident of Swakopmund. Swakopmund has been my home for over 30 years, I was basically raised here. I am so blessed to call Swakopmund my home. In all of those years, there has been no events that ever shocked me until recently. On the social media platform Facebook, I saw a post that horrified me to the core. The post in question was about a consent to build a storage and handling facility for hazardous, radioactive source materials.	*<u>Initial Response:</u>* Thank you for your mail. I take note of your objection letter. Just to be clear, we are dealing with the environmental impact assessment process for the proposed facility. Objections against consent should be directed towards Stewart Planning/the Municipality who deals with the consent application. Nevertheless, I will, based on your email, add you to the stakeholders list of the environmental assessment process and also include your letter in the environmental assessment report which will be submitted to the National Radiation Authority and the Ministry of Environment, Forestry and Tourism for review. Prior to submission of the reports we will circulate it to all registered stakeholders, such as yourself, for

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	I am totally against the idea of a facility holding hazardous and radioactive materials in a populated town. I have read through the background information document (which was attached to the Facebook post) and even though it mentions about safety of the structure and storage of the radioactive materials, I am not convinced. This is a huge risk to the health of every citizen and animals in Swakopmund and to the environment. It doesn't matter how well the structure is built or how safe and secure the radioactive materials are stored, there will always be a chance of an accident happening with perhaps deadly consequences. But what if there was an accident? What impact will it have on the health of every living person and animal living in Swakopmund? What impact will it have on the environment? With all due respect, but you are playing with fire with the lives of every living person and animal in Swakopmund. Swakopmund is a beautiful coastal town surrounded by the beauty of the Namib Desert and the mighty Atlantic Ocean. It is a very popular holiday destination for not only for Namibians but also for international visitors. You cannot build such facilities in such a popular town. I reiterate that you are playing with fire with not only the lives of every person living in Swakopmund, but also with the lives of persons from other countries as well. Facilities such as this, should be build where it will not harm people and animals and the environment. Even though it will be up to the Council to either approve or disapprove the consent for the building of the storage facility to store radioactive materials, but I strongly believe that the citizens in Swakopmund should have a vote to approve or disapprove, because this proposal is risking our health and lives and we should have a say in it as well. This will have an impact on the future generations to come. This letter is not a formal objection letter, but I will still OBJECT to the highest level to the consent for a noxious industry/hazardous storage (radioactive source material storage and handling facility) on ERF 3954 Swakopmund, Extension 10. If you could kindly note of my objection and receipt of this letter, I would be grateful.	review and comment. Please rest assured that we will conduct an in-depth scientific assessment of the proposed project and make our recommendations based on this assessment. Please do not hesitate to contact us for any additional information.
Jens Porthmann Email: 28/02/2024	*Initial Query: 28 February 2024 08:51 (addressed to CEO of the Swakopmund Municipality and to the town planners dealing with the consent application* Dear Mr. Benjamin, My family and I are residents of Swakopmund and are deeply concerned about the potential extreme danger of the above-mentioned planned facility, especially in view of the very close proximity to high-density DRC, as well as Mondesa and Kramersdorf.	*Initial Response:* *28 February 2024 at 13:10:31 by the town planner* Thanks for your email and written objection. In reading Article 95(I), I get the impression that you were made to believe that this facility will permit the dumping of foreign nuclear waste and toxic waste on Namibian territory which is not the case.

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	I shall not dwell on the obvious inherent noxiousness, hazardousness and danger of the planned facility, but suffice to point out that, in the letter and spirit of Article 95(l) of our Constitution, it is clearly outlawed by both the Environmental Management Act 7 of 2007 and the Atomic Energy and Protection Act 5 of 2005. Trusting in your and Swakopmund Municipal Council's due consideration and consequent outright rejection of ANY related application. Thanking you in advance. *Subsequent Response (addressed to the town planner):* 29 February 2024 06:55 Thank you for your response, advice and attached information. Concerns remain, however. For instance, why can the facility not be built more remotely where it is not populated? And, what about the harsh and corrosive conditions at the coast? Trusting in your due consideration. *Subsequent Response (addressed to the town planner and Geo Pollution Technologies)* 04 March 2024 13:30 Good day Mr. Otto, Thank you for your advice. It would be appreciated if my concerns/questions could be addressed in the Environmental Impact Assessment report. I am copying our correspondence to the e-mail address you provided. .	Instead, the radioactive substances will be used to calibrate and test drilling equipment for the oil exploration industry – nothing to do with any nuclear waste or the nuclear industry. Please find attached, for your information, the public background information document on the project. You are welcome to share the BID document with anyone for their information as well. More information will follow from the developer. In any case, your objection has been recorded with our office. *Subsequent response by the town planner:* 1 March 2024 at 16:52:12 Dear Mr Prothmann, Thank you for the questions and noting your remaining concerns. We hope your concerns and questions will be considered and addressed in the EIA report from Geo Pollution Technologies (GPT). GPT invites all interested and affected parties (IAPs) to provide in writing, any issues and suggestions regarding the project. Any comments, suggestions, concerns and/or objections will be considered by GPT in their EIA report: to register please email: ct@thenamib.com The results of the EIA will determine whether the project can be executed on this erf and will make recommendations to such an effect. The report will be submitted to all registered parties for review before final submission to the Ministry of Environment, Forestry and Tourism. The Ministry and the applicable competent authority, Ministry of Health and Social Services' National Radiation Protection Authority will review and decide on the issuance of an environmental clearance for the project.

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		Thank you for input and participation. *<u>Subsequent response by Geo Pollution Technologies:</u>* Mon 04/03/2024 2:24 pm I confirm receipt of your email and registration as an interested and affected party for the project. Your concerns as outlined below is noted and will be addressed in the EIA. I understand you have received the BID from Johann. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
Pieter Hamman via Marina Loubser Email: 04/03/2024	*<u>Initial Query:</u>* Good Day Enclosed hereto please find our letterhead, which is self-explanatory, for your further attention. Kind regards *Letter:* Dear Sir/Madam Subject: Formal Objection to Proposed Application for Consent Use for Noxious Industry and Hazardous Material Handling We are writing to you on behalf of various members of the business community in Swakopmund to express their deep concern and urgency regarding the proposed application for consent use of property situated in our industrial area for a noxious industry and the storage and handling of hazardous materials. Our clients, as residents and businesspersons in Swakopmund, are deeply invested in the well-being of the Swakopmund community and environment. Our clients strongly object to this proposal on numerous grounds, including but not limited to the significant risks of:	*<u>Initial Response:</u>* Your email of 4 March 2024 refers. I confirm receipt of your email with objection and have registered you as an interested and affected party on the environmental impact assessment (EIA) side of the project. We are busy with the environmental impact assessment (EIA) and will include and address your objection in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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	1. Environmental Concerns: Our clients are deeply concerned about the potential environmental risks posed by this proposed development. The storage and handling of hazardous materials on the property could lead to soil contamination, groundwater pollution, air quality degradation, and adverse impacts on local ecosystems. It is imperative to protect our natural resources and biodiversity. 2. Health and Safety Risks: The storage of hazardous materials presents severe health and safety risks to nearby residents, workers, and wildlife. Potential hazards such as toxic fumes, chemical spills, fires, explosions, and long-term health effects must be carefully considered and mitigated. 3. Public Health Impacts: Our clients are alarmed by the potential public health impacts associated with exposure to hazardous substances. Increased rates of respiratory illnesses, cancer, birth defects, and other health problems could result from proximity to the proposed facility. 4. Property Values: The presence of a hazardous waste storage facility could significantly diminish property values in the surrounding area. This would have adverse effects on homeowners, businesses, and local tax revenues, undermining the economic stability of the community. 5. Legal Compliance: Our clients urge you to thoroughly review whether the proposed development complies with zoning laws, land use regulations, environmental protection statutes, and other applicable laws and ordinances. Any violations or inconsistencies must be addressed before moving forward with the application. 6. Community Opposition: There is widespread opposition within the community to this proposed development. Our clients have gathered evidence of this opposition through petitions, letters of concern, public meetings, and statements from residents, businesses, and community organizations that can be made available on request. 7. Alternative Locations: Our clients recommend exploring alternative sites for hazardous waste storage that may be more suitable in terms of environmental, health, and safety considerations. Industrial zones, remote areas, or facilities with advanced safety measures should be considered viable alternatives. 8. Lack of Adequate Mitigation Measures: Our clients challenge the adequacy of proposed mitigation measures to address potential risks adequately. Evidence of emergency response plans, containment systems, monitoring protocols, and liability	

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	insurance coverage must be provided to ensure the protection of public health, safety, and the environment. 9. Precedent Setting: Approving this proposal could set a dangerous precedent for future development projects in the area, potentially leading to further industrialization or hazardous waste storage. Our clients express serious concerns about the long-term implications of such a decision. 10. Community Rights: Our clients assert the community's rights to participate in the decision-making process regarding land use and development projects that could impact their health, safety, and quality of life. Transparency, accountability, and meaningful public consultation are essential aspects of democratic governance. 11. The proposed consent use of this property does not align with the approved 2020/2040 structure plan. 12. Tourism: This application will hurt the Swakopmund Tourism industry in various ways: (a) Prosperous Tourism relies on the natural beauty and cleanliness of an area. Visitors will be deterred by the presence of industrial facilities and the associated pollution. (b) Concerns about exposure to hazardous chemicals could lead to decreased visitation and economic losses for tourism-dependent businesses. (c) Negative publicity surrounding the establishment of hazardous waste facilities can tarnish the reputation of Swakopmund as a tourist destination. Media coverage of environmental accidents, regulatory violations, or health concerns may deter potential visitors and impact the long-term viability of tourism-based economies. (d) Tourism is a significant source of revenue and employment in the Erongo and in particular the Swakopmund region. The presence of hazardous waste facilities may lead to decreased property values, loss of jobs in tourism-related industries, and reduced spending by tourists due to concerns about safety and environmental quality. (e) Tourism stakeholders often advocate for sustainable development practices that balance economic growth with environmental protection and social equity. Hazardous waste facilities may conflict with the principles of sustainable tourism by jeopardizing the natural and cultural resources that attract visitors in the first place.	

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	13.Insurance: This application will impact the insurance of surrounding properties to the following extent: (a) Risk Assessment: Insurance companies assess risks associated with properties when determining premiums. If a property in the immediate vicinity is rezoned to a designation that is deemed hazardous or noxious, insurance companies may perceive higher risks associated with the surrounding properties. This could be due to potential environmental hazards, increased crime rates, or other factors associated with the new zoning. (b) Premium Increases: Rezoning to a hazardous or noxious designation can lead to increased insurance premiums for surrounding property owners. Higher premiums can be a financial burden for property owners and may also affect property values. (c) Availability of Coverage: In some cases, insurance companies may be hesitant to provide coverage for properties located in areas with hazardous zoning due to the increased risks involved. This lack of insurance availability can make it difficult for property owners to protect their assets and may deter potential buyers or investors from acquiring property in the area. (d) Liability Concerns: Property owners will also for good reason become concerned about liability issues associated with owning property in a hazardous or noxious zoning area. If accidents or incidents occur on the property, liability claims could result in signific financial losses. Insurance coverage helps mitigate these risks, but if coverage is limited or unavailable, property owners may be more inclined to object to rezoning. (e) Impact on Businesses: Businesses operating in the rezoned area may face challenges obtaining insurance coverage for their operations. This can affect their ability to operate effectively and may lead to increased operating costs or even closure. 14. Structural damage to surrounding properties: The property in question is situated on granite rock. This will require extensive blasting in the construction of the "bunker". As council, you are well aware of the extensive damage that has been caused to other properties in town due to construction blasting operations. (a) The potential for structural damage to surrounding properties cannot be overstated. Given that the proposed site is situated on granite rock, any construction involving extensive blasting poses a significant risk to the stability and integrity of nearby structures. The force generated by such blasting activities can cause vibrations	

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	that may lead to cracks, subsidence, and other forms of structural damage to adjacent buildings. (b) As a council, you are undoubtedly familiar with the detrimental effects that construction blasting operations have had on properties in our town. Instances of cracked walls, damaged foundations, and compromised structural integrity have been reported in areas where blasting has been conducted for various construction projects. Allowing similar activities to take place in such proximity to residential and commercial properties would undoubtedly exacerbate these risks and could result in costly repairs and potential safety hazards for occupant's. (c) Furthermore, the potential for structural damage extends beyond immediate neighbouring properties. The ripple effects of blasting-induced damage could spread throughout the community, impacting property values, insurance premiums, and overall quality of life for residents. This is a risk that our community simply cannot afford to take. d) Therefore, our clients strongly urge the council to consider the threat of structural damage to surrounding properties as a compelling reason to reject the proposed application for consent use. The potential consequences of such activities far outweigh any perceived benefits, and the safety and well-being of our community must be prioritized above all else. In light of the serious risks and concerns outlined above, our clients urge you to reject the proposed application for consent to the use of property for a noxious industry and hazardous material handling facility. The potential consequences of this project are too great to ignore, and the health and safety of our community must be prioritized above all else. Instead, we implore you to promote sustainable development practices that minimize harm to human health and the environment and prioritize the well-being of current and future generations. Thank you for considering our objections to this proposed development. Our clients trust that you will give careful consideration to the concerns raised by them and other concerned residents and make the decision that is in the best interests of our community and the environment.	
Nicholas Preller Email: 04/03/2024	*Initial Query:* 1. Health and Safety Risks: Radioactive materials can pose significant health risks if improperly handled. We are concerned about the potential for accidents, leaks, or spills that could release radiation into the surrounding environment, leading to long-term health consequences for ourselves and future generations.	*Initial Response:* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party for the project. Your concerns as outlined below is noted and will be addressed in the EIA. In case you have not received the

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	2. Environmental Impact: Radioactive materials can have a detrimental impact on the environment. We are worried about the potential contamination of soil, groundwater, and water reservoirs, which could harm residents as well as local ecosystems and wildlife. 3. Property Values: The presence of a radioactive storage facility can lead to a decline in property values in the surrounding area. We as Homeowners are concerned about potential financial losses and difficulties in selling our properties if such a facility is established nearby. 4. Stigma and Perception: The presence of a radioactive storage facility will create negative perceptions about the town and its desirability as a place to live or visit. This could have adverse effects on tourism, economic development, and the overall reputation of the town. 5. Emergency Preparedness: As Residents, we have concerns about the town's preparedness to handle emergencies related to the storage facility, such as fires, natural disasters, or terrorist threats. We question whether local emergency services are adequately equipped and trained to respond to such incidents. 6. Lack of Public Input: As residents, we feel that the decision-making process regarding the facility's development has been opaque and lacking in public participation, and we hereby voice our dissatisfaction and demand a more transparent and inclusive approach to decision-making.	BID yet, please find it attached. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
Kristian H Woker Email: 06/03/2024	Thank you very much for your mail of 15 February 2024. Unfortunately we have to advise that we completely OBJECT to the establishment of a radioactive source material storage and handling facility on our neighboring Erf No. 3954 (Swakopmund), Einstein Street, Erongo Region. Besides all the usual concerns of having such an outright dangerous facility right next door, we are especially concerned about the future status of this facility. What happens, if this facility gets older and deteriorates ? What happens, if the Owners and / or Managers depart one day from Namibia or go into liquidation ? What happens, if the facility is damaged by outside factors or an accident happens, whilst the material is being handled on the premises ? We have seen too many bad examples in Namibia (for example many abandoned mines) and also worldwide (Chernobyl being the best example), where such dangerous facilities are simply left by the original operators and	*<u>Initial Communication:</u>* Please receive attached notification for an environmental impact assessment we are conducting for erf 3954, Ext 10, Swakopmund. Do not hesitate to contact us for more information. *<u>Subsequent Response:</u>* I have registered you on the environmental impact assessment side of the project which we are conducting. Your concerns as outlined below is noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me

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	the local population has to suffer the consequences. The suddenly no one is any more accountable or taking care of the aftermath. The storage of the material is dangerous enough (whilst in storage) but the handling thereof poses an even bigger risk for us. How will the bunker be accessed for use of the stored radioactive material, how long will it stay open for access, how will radioactive material be removed from the store, where will testing and calibration be done, how will the radioactive material be transported to and from the store & site ? Anything can / could go wrong during one of the above processes. Our biggest concern is also that this facility will instantly diminish the value of our own property (Erf 3953). Nobody would want to rent from us anymore. The stigma attached to this area will then always be negative. We realize that there is a need for such a facility but then this should be located well outside a municipal area like near the Rubbish dumps (in a large enough well fenced off area) or behind Dune 7 (Walvis Bay). The granite ground near Dune 7 would be especially ideal for the establishment of such a facility (underground). To locate such a potentially dangerous facility in the midst of a residential town in our view would be extremely reckless and irresponsible (towards the local inhabitants and visitors of this town). It simply does not make sense to us to locate such a facility in the midst of a Town, which specializes on Tourism and has Residential Areas nearby (Mondesa and Kramersdorf). To summarize: We absolutely OBJECT to this envisaged project and trust & hope that Council rejects it outright.	for any additional information pertaining to the EIA process or any other comments you may have.
Katharina Geier Email: 06/03/2024	*Initial Query:* To whom it may concern I herewith would like to hand in my objection against the storage and handling of radioactive material on ERF 3954 Swakopmund I am a resident of Swakopmund living in Kramersdorf. Transport and handling of radioactive material in the surrounding of a town is dangerous and for several reasons put the residents in risk. I would like to register for discussion and questions. Please send confirmation of this registration to me via email.	*Initial Response:* I have registered you on the environmental impact assessment side of the project which we are conducting. Your concerns as outlined below is noted and will be addressed in the EIA. In case you have not received the BID yet, please find it attached. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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Julika Becker Email: 07/03/2024	*<u>Initial Query:</u>* I would like to voice my concern regarding the plan to change the use of land in order to build a bunker for radioactive waste in Einstein Street, Swakopmund. Please register my name among those in opposition to the plan to build any kind of storage or bunker in or near Swakopmund for the long-term storage of radioactive waste, because: 1. I am a resident of Swakopmund and am concerned about the health risks involved for myself and future generations of residents of Swakopmund. The location is too close to residential areas, the risks posed to people and the environment is huge and unpredictable. 2. There is no guarantee for control of what happens at such a facility over time when people, governors, governments and companies (responsibilities) change. Radioactive waste will be life threatening and toxic for over thousands of years for people, ground water, soil and air. 3. The Municipality of Swakopmund and Stewart Planning have not taken adequate steps to inform, educate and involve all residents of Swakopmund as interested and affected parties about this vital and life changing plan. There should at least be a well-advertised public information meeting in the Town Hall and a public petition for all the residents to voice their opinion and/or opposition to such a dangerous, life threatening change in land use. Please inform me of all further steps in handling this matter.	*<u>Initial Response:</u>* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party on the environmental impact assessment side of the project. Please note that the facility is not planned for the storage of radioactive waste. In case you have not received the BID yet, please find it attached. Your concerns as outlined below is nevertheless noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
Talita Nel Email: 07/03/2024	*<u>Initial Query (addressed to the Town Planners and the Swakopund Municipality):</u>* <u>27 February 2024 4:17 PM</u> Please find attached hereto the letter being self-explanatory. *Letter:* Dear Sir/Madam, SUBJECT: OBJECTION T APPLICATION FOR CONSENT – NAMAQUANUM INVESTMENTS TWO CC (ERF 3954, EINSTEIN STREET, SWAKOPMUND) We write with earnest concern and formal objection to the proposed development submitted by Namaquanum Investments Two CC, seeking consent for the establishment of an above or underground bunker facility on Erf 3954 in Swakopmund Extension 10. The intended utilization of this facility, encompassing the storage and handling of hazardous radioactive substances, as well as calibration tests for offshore	*<u>Initial Response (by the Town Planner):</u>* Thank you for lodging your collective concern and/or objection to the proposed radioactive source material storage and handling facility on Erf 3954, Einstein Street, Swakopmund. Your concern/objection will be recorded in the consent use application. Note that the **Namaquanum Investments Two CC** has appointed **Geo Pollution Technologies** (GPT) to undertake an Environmental Impact Assessment (EIA). GPT invites all interested and affected parties (IAPs) to provide in writing, any issues and suggestions regarding the project. Any comments, suggestions, concerns and/or objections will be considered by GPT in

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	oil exploration drilling equipment, presents a multitude of intricate issues warranting meticulous consideration and scrutiny. Our objection is framed by several paramount considerations, which include, but are not limited to: Proximity to Residential and Industrial Areas: The proposed site's hazardous nature, located in close proximity to both residential and industrial zones, notably our Madison Business Park on Erf 3949, Einstein Street, Swakopmund, raises considerable apprehensions. This situation prompts grave concerns regarding potential adverse impacts on the safety, health, and well-being of the local community and surrounding businesses. Cumulative Hazards in the Industrial Area: The inherent risks associated with any industrial area are further compounded by the introduction of a facility designed for the storage of radioactive materials. This convergence amplifies risks exponentially, creating an unacceptable level of danger that may extend beyond the proposed facility's perimeters. Lack of Clarity in the Application: The application is deficient in crucial details pertaining to the nature of the hazardous materials, such as their physical state (liquid, gas, or solid). This lack of clarity undermines our ability to comprehensively assess potential risks and the adequacy of proposed safety measures. Need for Water Resources for Radiation Control: Inadequacies in addressing the water requirements for radiation control are apparent in the application. Given the nature of neutrons and their particles, which necessitate significant water use to decelerate radiation, clarity on this aspect is imperative to ensure the safe handling of radioactive materials. Inadequate Packaging Information: Insufficient information regarding the packaging of radioactive materials is a critical concern. The absence of clear identification and safety protocols for packaging raises serious apprehensions about the potential for mishandling, accidents, and the resultant impact on both human health and the environment.	their EIA report. Please find attached the background information document (BID) which explains how to register as an IAP and to submit further comments. The results of the EIA will determine whether the project can be executed on this erf and will make recommendations to such an effect. The report will be submitted to all registered parties for review before final submission to the Ministry of Environment, Forestry and Tourism. The Ministry and the applicable competent authority, Ministry of Health and Social Services' National Radiation Protection Authority will review and decide on the issuance of an environmental clearance for the project. *Subsequent Response: (by Geo Pollution technologies)* Thank you for your email. I confirm receipt of your email and registration on behalf of Madison Business Park as an interested and affected party on the environmental impact assessment side of the project. In case you have not received the BID yet, please find it attached. Your concerns as outlined in the letter are noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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	Additional Equipment and Costs: The proposed facility imposes an additional burden on the municipality, necessitating the acquisition of specialized equipment such as survey meters, contamination meters, and personal dosimeters for individuals in close proximity. The associated costs and resources required for the maintenance and operation of such equipment should be thoroughly considered. Inherent Risks of Radioactive Materials: Radioactive materials, being inherently hazardous and imperceptible to human senses, present a significant challenge in terms of containment, detection, and response in the event of mishandling or accidents. The potential consequences of such incidents are severe and could have lasting impacts on the health of the community and the integrity of the environment. Insufficient Public Communication and Engagement: The absence of a transparent and comprehensive communication strategy regarding the proposed development raises significant concerns. Adequate public engagement is paramount, and residents and businesses in the vicinity should be provided with detailed information and opportunities to voice their concerns. Health Risks: Exposure to hazardous materials poses severe health risks to both working individuals and residents in the surrounding area. Airborne pollutants, water contamination, and soil pollution can lead to respiratory issues, skin problems, and other health complications. Environmental Pollution: Accidental spills, leaks, or releases of hazardous substances can result in environmental pollution, affecting local ecosystems, water sources, and soil quality. The facility may contribute to long-term environmental degradation, impacting biodiversity and natural habitats. Safety Concerns: Proximity to train tracks increases the risk of accidents during transportation, such as derailments or spills, potentially leading to immediate dangers for nearby	

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	communities. The facility itself may be at risk of accidents, fires, or explosions, posing a threat to both property and lives. Property Values and Liveability: The presence of a hazardous facility can negatively impact property values in the surrounding area, making it less attractive for potential buyers or tenants. Reduced liveability due to concerns about safety and pollution can lead to a decline in the overall quality of life for residents as well as property value. Negative Impact on Tourism: Despite its location in a light industrial area, Swakopmund, being a tourist destination, may suffer from a decline in tourism if the perception of the area is associated with industrial hazards and environmental risks. Long-term Sustainability Impact: The long-term sustainability of the region may be compromised, affecting the ability of the community to thrive economically, socially, and environmentally. In light of the aforementioned concerns, we implore you to meticulously evaluate the potential risks and implications associated with the proposed development. The safety and well-being of the Swakopmund community should be paramount in the decision-making process. We respectfully request that you reject the application by Namaquanum Investments Two CC for the proposed noxious industry/hazardous storage facility on Erf 3954 Swakopmund Extension 10. Thank you for your attention to this matter. We trust that you will approach this issue with the seriousness it deserves and prioritize the long-term safety and prosperity of our community. *Subsequent Query (to Geo Pollution Technologies):* 07 March 2024 13:53 Our Trustees at Madison Business Park, situated in Swakopmund, requested that we should register with you as an interested and affected party with regards to the attached. Please advise if there is a process applicable in this regard, since it would be great if we could be informed of any information regarding this application/development in the future.	

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Wiltrud Patzner Email: 07/03/2024	*Initial Query:* To whom it may concern Dear Sir/ Madam Herewith I would like to hand in my objection against the storage and handling of radioactive material on Erf 3954 Swakopmund, Extension 10. I am a resident of Swakopmund, Kramersdorf. Transport and handling of radioactive material in the surrounding area of a town is dangerous, and for several reasons put the residents on risk I would like to register for discussion and questions.	*Initial Response:* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party on the environmental impact assessment (EIA) side of the project. In case you have not received the BID yet, please find it attached. Your concerns as outlined below are noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
Faried Abu-Salih Email: 07/03/2024	*Initial Query (addressed to the Town Planners and the Swakopund Municipality):* I would like to voice my concern regarding the plan to change the use of land in order to build a bunker for radioactive waste in Einstein Street, Swakopmund. Please register my name among those in opposition to the plan to build any kind of storage or bunker in or near Swakopmund for the long-term storage of radioactive waste, because: I am a resident of Swakopmund and am concerned about the health risks involved for myself and future generations of residents of Swakopmund. The location is too close to residential areas, the risks posed to people and the environment is huge and unpredictable There is no guarantee for control of what happens at such a facility over time when people, governors, governments and companies (responsibilities) change. Radioactive waste will be life threatening and toxic for over thousands of years for people, ground water, soil and air The Municipality of Swakopmund and Stewart Planning have not taken adequate steps to inform, educate and involve all residents of Swakopmund as interested and affected parties about this vital and life changing plan. There should at least be a well-advertised public information meeting in the Town Hall and a public petition for all the residents to voice their opinion and/or opposition to such a dangerous, life threatening change in land use. Please inform me of all further steps in handling this matter.	*Initial Response (by the Town Planner):* Your objection and concerns have been recorded with my office, thank you. Dear Geo Pollution Technologies, could you please register Faried Abu-Salih as an interested and affected party for the EIA process? *Subsequent Response (by Geo Polltion Technologies):* With reference to the below, please note that I have registered you for the EIA side of the project. Your concerns as outlined below is noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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Annette Erbslöh Email: 08/03/2024	*<u>Initial Query (addressed to the Town Planner)</u>* In this letter I would like to make it very clear that I am against this planned project in Swakopmund in every aspect. I have informed myself about this project in various announcements, statements and articles and also listened to the report on your project in the HITRADIO Namibia report by Ms. Brigitte Weidlich. If you compare the official statements and those of the journalist, I think there is a world of difference. Offshore drilling or not, Namibia staying on the ball etc. is absolutely irrelevant in my eyes, because such a storage, even if supposedly secured, does not belong in a residential area, in the statements called "industrial area" - it is also ridiculous. Lined containers 6 m long with 50 cm thick compacted concrete walls in the interior etc. may sound reassuring, but they are not, as they are clearly not stored underground. Where do you want to install airlocks? The interior of a container is certainly not sufficient for this. What happens when the containers are "full", supposedly not waste, which is obviously not correct. They must be stored and therefore presumably moved or the contents must be transported. Here we are talking about "hazardous goods transportation". Who ensures safety? Who supervises it? Where is the radioactive waste then stored? These must be very special storage facilities. Are they really secure or do they even exist? And from the sound of it, there is no experience in Namibia and "you have to specialize in it now" is the statement. In addition, Cesium 137 is to be used for this. That's all that needs to be said! (The accident occurred in Chernobyl in 1986. Even today, mushrooms and game meat in the Bavarian Forest are still highly contaminated with radiation). The very tools used at that time are probably particularly radioactive and therefore the protective clothing etc. will also be contaminated. And this "waste" must or should be temporarily stored in the containers in Swakop. There is allegedly a low risk .... In the description by GEO Pollution Technologies, the material is described as hazardous, in a statement by Mr. Otto only as minimally hazardous ... That is already far too much. There are reports in the press of "underground storage", but in the description by GEO Pollution Technologies this is just another possibility. With the safety measures described, above-ground storage is far too unsafe. Water is used, which will then be contaminated .... This also poses a high risk. Can we still allow ourselves to contaminate water in our country? NO!	*<u>Initial Response (by the Town Planner):</u>* Thank you for raising your objection to the radioactive facility which will be recorded. Your careful evaluation of available information, and valuable input on the project is much appreciated. Dear Geo Pollution Technologies team, Will you please consider and address the comments, concerns, and objections raised by Annette Erbslöh in your Environmental Impact Assessment? *<u>Subsequent Response (by Geo Pollution Technologies):</u>* I confirm receipt of your email sent to the Town Planners. I have taken the liberty of registering you as an interested and affected party on the environmental impact assessment side of the project. Your concerns as outlined below is noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. It is indeed unfortunate that in the modern technological age of smartphones and social media the sharing of information becomes muddled. I trust that ultimately the EIA/EMP will present the facts in a way that is clear to everyone, and make recommendations that is based on scientific data taking into consideration of the local environment. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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	If Namibia thinks it has to get involved here, ONLY under the supervision of companies from abroad that have been practicing this for years, but never in a residential area of any size. If you really think you need to implement such a project/process etc. in Namibia, then plan it at the Rössing Mine. You must remember that we are exposed to a high level of insecurity in our country due to the unfortunately existing high level of corruption, companies operating in this country for whom the environment, safety, etc. mean absolutely nothing, but only their profit or greed and we are therefore exposed to a much higher risk than in countries such as the USA, UK, Germany.	
Gerhard Byleveld Email: 08/03/2024	*Initial Query (addressed to the Town Planner):* Dear sirs With the sketchy information provided re "radioactive source material storage and handling" I wish to point out that the location of this facility is surrounded by other factories and with the Mondesa town around 200 m from there. In Swakopmund we have 80% of the time a SW wind which blows in the direction of Mondesa. The placement of such facility is therefore critical taking into account the content and radioactivity of the "CONTENT" of such bunker. Much more information re products/source materials etc should be made available for residents especially Mondesa and surrounding areas to actively participate and make a more informed contribution. I trust that the Municipality will delve deeper into this matter and as usual put the safety and livelihood of residents first.	*Initial Response (by the Town Planner):* Thank you for your written concern, input and objection to the radioactive facility. If you have not done so already, you can also register as an interested and affected party with Geo Pollution Technologies who have been appointed to undertake the Environmental Impact Assessment (EIA) process. The attached background information document explains how to register. There is no specific deadline but the sooner the better. Dear Geo Pollution Technologies, Please see below the comment on the southwesterly wind which I think is important to consider and address in your EIA. *Subsequent Response (by Geo Pollution Technologies):* I confirm receipt of your email sent to the Town Planners. I have taken the liberty of registering you as an interested and affected party on the environmental impact assessment side of the project. Your concerns as outlined are noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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		Radioactive material can only become airborne if it leaks from the capsule of the SRS. This is not likely to occur and the SRS will not be removed from the pig outside of the bunker or calibration room.
Thimo Martens Alma Wallis Email: 08/03/2024	*Initial Query (addressed to the Town Planner):* Thursday, 8 March 2024 4:24 pm Please find attached objection letter. *Letter:* To whom this may concern Re: Hazardous Storage Facility on Erf 3954 Swakopmund Extension 10 We would herewith like to hand in our objection to the Hazardous Storage Facility on Erf 3954 Swakopmund. Reasons for objection: The proposed facility is directly in Swakopmund, with high traffic volumes passing the storage facility daily. Radioactive waste can leak into our underground water channels or escape into the air – with the facility being so close to human population, this poses a high risk to human health and the environment. Would it not be better to create a storage facility outside of town? Radioactive waste only decays naturally over hundreds of years. How can the Municipality of Swakopmund guarantee the safe-guarding and proper upkeep of the storage facility for that duration of time? The proposal states that personnel will be monitored to make sure their radioactive exposure is within legal limits. What about the public or the personnel of business in close proximity? How will the health and safety of those individuals be guaranteed / monitored? In the proposal it is being stated that the concrete walls of the storage facility will only be 50cm thick. Overseas, similar radioactive storage facilities are being stored 500m underground. How can mere 50cm thick walls be thick enough? The proposed thickness of the walls does not correspond with the depth the canisters are be stored	*Initial Response (by the Town Planner):* I herewith confirm receipt of the objection letter from Thimo, thank you. Dear Geo Pollution Technologies, could you also consider the questions, comments, and objections raised by Thimo? *Subsequent Response by Geo Pollution Technologies):* I confirm receipt of your objection sent to the Town Planners. I have taken the liberty of registering you as an interested and affected party on the environmental impact assessment side of the project. Please note that the facility is not planned for the storage of radioactive waste. In case you have not received the BID yet, please find it attached. Your concerns as outlined below is nevertheless noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

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	overseas. Added to that, that the proposed facility will be above ground, instead of underground. It is not being said what kind of radioactive waste will be stored – is it high-level or low-level waste? This makes a huge difference in the correct disposal procedure. The exact disposal procedure and nature of the waste storage is not clearly explained in the proposal – ie. Sentences such as "as an alternative option, the facility to store radioactive source material can also be partially underground" make the proposal sound like only ideas are being shared. If something can also be done, it is not said that it will be done. Where is the guarantee that all correct procedures are being followed – and which procedures are being implemented, as per law, pertaining the level of waste? None of this is being indicated in the proposal, thus we find the proposal not very clear and transparent.	
Wiebke Frey Email: 08/03/2024	*Initial Query:* I herewith hand in my concern against handling and storage of any radioactive material on Erf 3954 Swakopmund. I am a Swakopmund resident in the City and feel nothing in connection with radioactive things should be handle in a town due to the fact it is dangerous. I d like to register for discussions and questions . Could you please confirm registration.	*Initial Response:* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party on the environmental impact assessment (EIA) side of the project. In case you have not received the BID yet, please find it attached. Your concerns as outlined below are noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
J.C Brandt Riana Brandt Email: 09/03/2024	*Initial Query:* Proposed Storage and handling facility for radioactive source material at Namaquanum Investments two CC, Erf 3954, Einstein Street, Swakopmund We are writing to register on behalf of myself and my wife, Riana Brandt, our objection to the applicants' application. While we understand the necessity of safe storage facilities for radioactive materials, we also have concerns about the safety of the inhabitants of Swakopmund, given the proximity of the proposed facility to residential areas. Radioactive materials, if mishandled or improperly stored, pose significant health and environmental risks.	*Initial Response:* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party on the environmental impact assessment (EIA) side of the project. In case you have not received the BID yet, please find it attached. We are busy with the environmental impact assessment (EIA) as per point four of your information request list and trust that your other questions will be answered in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me

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	Therefore, we believe it is essential for the community to be informed about the safety measures that will be implemented to mitigate these risks. Additionally, we would like to enquire whether the feasibility of locating such a facility in a more remote area, away from densely populated areas, has been considered. Building the facility in the desert, away from residential zones, could potentially reduce the risk to human health and the environment while still serving its intended purpose. We kindly request that you provide more detailed information regarding the proposed facility, including but not limited to: 1. The types and quantities of radioactive materials that will be stored at the facility. 2. The safety measures and protocols that will be in place to prevent accidents and mitigate risks. 3. The emergency response plans in case of incidents or accidents. 4. Any environmental impact assessments that have been conducted. 5. Consideration given to alternative locations for the facility and the rationale for selecting the current site. 6. Training of the staff taking care of the operations and monitoring thereof and where the training takes place (which institutions) and for whose expense. It baffles the mind of the public and every reasonable citizen that while Swakopmund is surrounded by hundreds of thousands of vacant land that the proponent elects to convert the property in question for purposes of storage and handling facility of radioactive source material. Thank you for your elaborate and eloquent assurance of how the proponent/the council/and all the other authoritarian institutions referred to by you will monitor the operation of the facility in order to protect the public at large. It is a well-known fact that our country is inundated with corruption and incompetence however these aspects are not addressed against the background of monitoring and safeguarding the public. Should the council approve the proponents' application will the council be prepared to indemnify affected persons against the risks of any negative potential risks/effects/losses/expenses by such person? Any such indemnification should be supported by appropriate guarantees/suretyships commensurate to potential losses. We are looking forward to hearing from you.	for any additional information pertaining to the EIA process or any other comments you may have.

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Margo Bassingthwaighte Email: 10/03/2024	*Initial Query:* As a resident of Swakopmund I totally OBJECT to the above mentioned being carried out in the town of Swakopmund, in the industrial area along Einstein Street on Erf 3954 Ext 10. It does not take into consideration the lives of innocent people should there be a leak or any such thing happening. It will impact on people's health when things go wrong and you cannot guarantee that it won't. Need I say anymore.	*Initial Response:* Thank you for your email. I confirm receipt of your email and registration as an interested and affected party on the environmental impact assessment (EIA) side of the project. In case you have not received the BID yet, please find it attached. Your concerns as outlined below are noted and will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime, please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.
Bernadette Weimann Email: 11/03/2024	*Initial Query:* Attached, please find a letter from the owners of Industrial Investment 625 Body Corporate. Letter: Reference: 3954S RE: Consent for a noxious industry/ hazardous storage (radioactive source material storage and handling facility) on Erf 3954 Swakopmund, Extension 10 This letter serves to inform you that the owners of Erf 625 Swakopmund, Extension 10, object to the above planning application for the following reasons: •Why must such facilities be operated inside town? Would it not be better accommodated at a mine or a more remote industrial site that would have the correct zoning? •What are the real dangers that might be imposed daily on humans operating and working within the relevant closer vicinity (inclusive of Erf 625)? •With the fact that this Erf is located directly at the railway, the derailment of a train, smashing into the relevant premises, and releasing "nuclear waste" is a big problem. •Such installations might impact the value of the surrounding Erfs and workshops. It might also make it difficult, if not impossible, to source future tenants or buyers for neighboring Erfs.	*Initial Response:* Your email and letter is well received. I have registered you on behalf of Investment 625 Body Corporate. Your concerns as outlined in the letter are noted and these together with your questions will be addressed in the EIA. We will forward the EIA and EMP documentation for your review and comment once complete. In the meantime please feel free to contact me for any additional information pertaining to the EIA process or any other comments you may have.

IAP Details	Comment / Concern	Response
	•We would like to get more information about the applicant: Namaquanum Investments Two CC. We couldn't find any webpages or any other information about this company. •Additionally, we would like to receive more information about the work that is planned to be done on Erf 3954. Will there be radioactive waste? If so, will all requirements for the management and removal of radioactive waste be met? What radioactive material and how much will be stored? •Toxic materials remain highly radioactive for tens of thousands of years, posing a threat to the land, soil, freshwater sources, underground water, and humans. •We think that the above-ground storage facility is more dangerous than the alternative option of storing the radioactive material underground. We oppose these plans and would like to receive further and more detailed information about the application. Please keep us updated on the situation.	
Ralf and Birgit Linow Email: 12/03/2024	*Initial Query:* We are residents of Swakopmund and have a few questions as to GPT´s project in Einstein street: 1. Kindly inform us as Swakopmund residents about the type of radioactive material you intend to store in Einstein street? 2. Where does the radioactive material come from? 3. How does it get transported to Swakopmund? 4. Why place such a unit in a fairly dense area instead of somewhere in the mining area near Rössing etc.? 5. How radioactive is the material and please give us a comparison if possible to the degree of radioactivity. 6. Will the company be paid for storing radioactive material? We have major concerns about this project as to handling faults, pollution during operation(and afterwards - we all know that radioactive radiation cannot be destroyed and damage done to any genetic material/soil/water is permanent with potential detrimental outcome.	*Initial Response:* Thank you for your email and interest in the project. Your questions and concerns are well noted and will be answered/addressed in the environmental impact assessment (EIA) we are conducting for our client. I have also now registered you as interested and affected parties for the project. Just to confirm, it is not our project, but we were appointed as independent environmental consultants to conduct the EIA. I am not sure if you have seen the background information document yet, I therefore attach it again. It will answer some of your questions. The rest will be answered in the EIA which will be shared with you for review once complete. You will then get another chance to provide comments or questions which will be included in the final report to be submitted to the Ministry of Environment, Forestry and Tourism and the National Radiation Protection Authority of Namibia for their consideration and review. In the mean time you are welcome to provide more input / questions.

IAP Details	Comment / Concern	Response
	We live in a tourist attraction area providing income to about 50 - 80% of the people. This should not be at risk by something serving such a small community which can potentially be so harmful and cause longstanding effects. We are not a rubbish dump for other country´s radioactive material - if this should be the case. Nobody is perfect and here no-one has experience in handling such material. The incidence rate would be quite high from human errors. Thus we generally don´t agree to storage of such hazardous material in our town.	
Gerhard Byleveld Email: 28/03/2024	*<u>Initial Query:</u>* With reference to our telephone conversation this morning and my written submission at the bottom of the email, I wish to state the following: 1. At present there appears to be a lot of confusion regarding the proposed “Radioactive Bunker” in Einstein Street, adjacent to Mondesa and other food related businesses. 2. Johan Otto requested inputs by 8 March 24 but many concerned citizens (e.g. residents from Mondesa and their Councillors) were not even aware of the time line. 3. Yesterday a meeting was advertised to be held at the Tamariskia Town Hall where around 50 persons were under the impression it was a formal session by either yourselves or Town Panning. Nobody took a lead in this fruitless gathering. Apparently a concerned citizen Mr Hertzberg wanted to encourage people to attend the “Municipal strategic briefing” to elevate these concerns (wrong place/wrong agenda”). As confirmed by you it was not arranged by either of you as leading parties. Be that as it may, this was is a clear indication that there are far more concerned citizens than the 21 registered which you received up to now. 4. Due to the vague description of “radioactive source material” I would suggest that a much wider and more in depth communique be put out (also via community leaders) so that citizens are well informed before making submissions. At present it might even include serious radioactive waste in a “bunker” adjacent to a town extension. What perception will this leave in the minds of potential Tourists once the “Greenies” get hold of it.	*<u>Initial Response:</u>* Thank you for the call and email. It is quite unfortunate that someone advertised a public meeting and that expectations were that we / the town planners are hosting the meeting. Thank you also for putting me into contact with the SRA chairman. I hope that through the SRA we can better disseminate information regarding the project and the way forward. I urge all concerned residents and parties to register with me in order to be included in the environmental assessment process. I am currently engaging with the client in order to address the current confusion and “panic” (if that is the correct word to use). I will write a short communication in which I will try and better explain the process we are following for the EIA, and hopefully this will put residents at ease in so far as the EIA process is concerned – i.e. that the correct processes will be followed and that all parties’ will get an opportunity to review and comment on the EIA prior to it being submitted. I will forward said communication to you, the SRA, all parties registered with us in due course.

IAP Details	Comment / Concern	Response
	This EIA has the potential to probably stir up a lot of emotions, whether true or false, yet the best way to combat negative perceptions is adequate detailed information to the wider community for their inputs. I trust that you see my concerns as pro-active and meant in a positive light.	
Michelle Pfaffenthaler Email 22/03/2024	*Initial Query* I have been doing a bit of research myself and would like to raise concerns that I would like to see addressed: 1) LIST OF MATERIALS. We need a comprehensive list of all the radioactive substances that will be used, e.e.radon, beryllium, plutonium. 2) APPROPRIATE ACTIVITY Whilst calibration of equipment is standard in the oil drilling industry, this kind of work really needs to be done by experts as they are working with a variety of radioactive materials and both safe storage, and working with the materials will be important. In addition, disposal of contaminated wastes (including water) will be an issue. We need to identify if Namaquanum Investment Two CC has the expertise to do this kind of work and if it is not better to send the equipment to existing labs. We also need to know more about this company.. I do not find any mention of them on the internet, other than in relation to their commissioning you to do the EIA. 3)ALTERNATIVE LOCATIONS. I do not think that it is appropriate for this facility to be in Swakopmund light industrialist are. I think that alternate locations should be investigated, more specifically in the heavy industrial sections of Luderitz and Walvis Bay.	*Initial Response:* Apologies, I was out of office end of last week. I hereby confirm you registration with Geo Pollution Technologies for the EIA side of the project. I also take note of your concerns as raised below and these are concerns that we will definitely look at and address in the EIA. I will later today circulate information that answers some of the questions you and the other stakeholders raised, for example pertaining to the types of radioactive isotopes to be stored on site.

Widely Distributed Clarification Letter

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25 March 2024

To: The Chairman of the Swakopmund Residents Association,
Registered Interested and Affected Parties,
Concerned Citizens of Swakopmund
Interested and Affected Parties

Dear Sir/Madam

Radioactive Source Material Storage and Handling Facility in Swakopmund

Geo Pollution Technologies, as appointed independent environmental assessment practitioner (EAP) for the above project, hereby acknowledges that there are currently concerns and confusion regarding the proposed project. Please allow us the opportunity to provide some clarifications regarding the project and the authorisation process for the project.

The Project

Firstly, let us consider the project itself. The proposed facility will under **no** circumstances receive, handle or store any radioactive waste. What will be stored, is commonly referred to as "radioactive sources". For this project, it will specifically be **sealed radioactive sources** where the radioactive material (radioisotope) is permanently sealed in a capsule or closely bonded and in a solid form. The capsules are often made of stainless steel and a search for "sealed radioactive sources" on the internet will show you what they look like, and how small they typically are.

The radioisotopes contained in the sealed sources planned to be stored and used on erf 3954, are indicated in the following table.

Radioisotope	Examples of where this radioisotope is commonly used
Americium-241/Beryllium*	Smoke detectors in homes and businesses
	Tool used to measure lead in paint samples
	Steel and paper production to measure and ensure uniform thickness of steel and paper sheets
	Industrial radiography, gauging applications, mineral analysis, and geological prospecting devices
	Soil moisture gauging (measurement)
Cesium-137	Radiology to treat cancerous tumours
	To measure and ensure the right fill level for packages of food, drugs, and other products
	Soil moisture-density gauges
	Flow meters

* The beryllium component is not radioactive

The sources that will be stored on erf 3954 will be used to calibrate and test drilling and well logging equipment used in the offshore oil exploration industry. Apart from their primary containment, i.e. the capsule, they will remain stored inside secondary containment (called a pig), in the proposed bunker. The pig is a container made of a material such as lead, which blocks radiation. The bunker thus being the third "layer" of containment and also acting as a security bunker to prevent theft. Some sources have

Directors: P. Botha (B.Sc. Hons. Hydrogeology) (Managing) such low radiation activity that there is no need to store them inside pigs. These sources are typically stored in a bunker only. The sources will be removed from the bunker for the duration of its use in calibration or testing of the drilling equipment which will occur on site. Upon decommissioning of the source, they will be returned to the manufacturer for safe disposal. More details on these aspects will be available in the environmental assessment report (see "The Authorisation Process" below).

The Authorisation Process

The Environmental Management Act of Namibia lists certain activities that may not be undertaken without environmental clearance. In order to apply for an environmental clearance certificate (ECC), an environmental impact assessment (EIA) must be conducted and an environmental management plan (EMP) prepared. These documents must be submitted to the competent authority and the Ministry of Environment, Forestry and Tourism (MEFT) for review and approval/rejection. For the current project, the reports, and an application for an ECC, will thus be submitted to the National Radiation Protection Authority (NRPA), as competent authority, and the MEFT. The NRPA will provide their recommendations to the MEFT regarding the project's approval/rejection.

The environmental assessment process has, in short, the following phases:

1. Notification Phase: EAP notifies direct neighbours, authorities and interested and affected parties of the proposed project and invites them to provide an initial round comments/concerns to be considered in the environmental assessment. In order to give input, comments, concerns, or receive any further information beyond the notification phase, all parties must register with the EAP.
2. Assessment Phase: The EAP prepares the EIA and EMP in which all the project details are clarified. The environment is also described, impacts identified and management measures proposed. All comments and concerns received to date, are included and responded to, in the report, specifically included the comments and responses report, which will become public, as is the EIA and EMP. Based on the outcome of the EIA, the EAP will recommend that the project may or may not go ahead.
3. IAP Document Review Phase: The EIA and EMP are shared with all registered interested and affected parties for review. Interested and affected parties are again invited to, based on the review of the documents, provide comments.
4. Submission Phase: The comments received after the public review period, are included and addressed in the final EIA and EMP, which is then submitted to the NRPA and MEFT. All registered interested and affected parties are notified of the submission, and the final documents as submitted, are made available to interested and affected parties.
5. Public Review Phase: The MEFT provides another opportunity for the public to review and comment on the EIAs, this time directly to them via their online EIA Portal system.
6. Record of Decision Phase: The MEFT will, after receipt of the NRPA's recommendations and their own review, reject or approve the ECC, or, if the reports are lacking information, request additional work to be conducted. Should an ECC be granted, the EAP will notify all registered IAP's about the decision, only once an approved certificate was issued.

Currently we are still busy with the first two phases of this process. We usually do not give a deadline for comments and registrations and will accept these up to preparation of the final reports for submission to MEFT. However, to prevent further confusion, we decided to set a deadline for the initial round of registration and comments (Phase 1 as indicated above). The deadline is 12 April 2024. Remember that you do not have to submit comments by the 5th, but you should at least register in order to ensure receipt of the EIA and EMP for review. At that stage, you can still submit your comments based on the contents of the EIA and EMP. The EIA will, in addition to the technical explanations and discussions, provide a non-technical explanation of the project, in order to make sure everybody has a reasonable understanding of the project and its potential impacts.

Please note the following in terms of the relationship between the environmental assessment process and the town planning process. These are two separate processes, each with its own registration and reporting requirements, conducted by separate consulting firms. Thus, if you registered for the town planning process, you are not automatically registered for the environmental assessment process, and *vice versa*. Thus, once again, please make sure you register with Geo Pollution Technologies for the environmental assessment process. Also note that the Municipality of Swakopmund's consent for the project (which is the town planning process) will be dependent on the outcome of the EIA and the issuance of an ECC.

We understand that someone advertised a public meeting addressed to "concerned citizens" in the Namib Times and on social media. It is also our understanding that the person(s) who advertised the meeting did not show up to chair the meeting. I can confirm that this meeting was not advertised or arranged by Geo Pollution Technologies, the town planners or the client. I am not sure if this was a deliberate, malicious attempt by someone to cause further turmoil, or whether it was somehow a simple misunderstanding. We understand the frustration this caused and wish to, for future reference, confirm that we will always have our company name, a contact person, our company logo, and contact details, on any advertisements for EIAs and public meetings we intend to host.

Lastly, it was also mentioned on some platforms that it is Geo Pollution Technologies who will lease the property for purposes of storing the radioactive sources. This is not the case and we remain an independent consultant tasked with conducting the environmental assessment for the project.

In summary:

- Please **register** with Geo Pollution Technologies, by 05 April 2024, to be included in the environmental assessment process.
- **All** registered parties **will** receive access to an electronic copy of the EIA and EMP documentation for review prior to submission to MEFT.
- Feel free to **share** this letter with any party or member of the community who may benefit from the explanations above, or who may still wish to register.
- The background information document (BID) for the project, which is only a very short introduction to the proposed plans, remains available for download at: **www.thenamib.com/projects/projects.html** under the heading - **BID: Namaquanum Radioactive Source Material Storage and Handling Facility, Swakopmund**.

Do not hesitate to contact us for any additional information.

Sincerely

Dr André Faul
Conservation Ecologist
PhD Medical Bioscience

REDFORCE COLLECTS OVER $33M FOR ONDANGWA

STAFF REPORTER
ENGOYI

RedForce Debt Management has recovered over N$33 million from Ondangwa stakeholders who had defaulted on their municipal accounts.

The figure, as at November last year, was revealed by Ondangwa town council spokesperson Petrina Shitalangaho-Mutikisha, who said the money was collected over a period of 10 months.

In September last year, Ondangwa was owed a cumulative N$85 million by institutions, businesses and residents.

When asked what the debt-collection company's monthly target is, Shitalangaho-Mutikisha said council cannot disclose such information.

She, however, added that the council is "happy with the work they are doing thus far. The figures are there to see".

When RedForce was enlisted by the Rundu town council, the company had a monthly target of N$5 million – one it failed to reach most months, leading to its contract being terminated at that town.

Different exercise

Meanwhile, the Ondangwa town council's incentive initiative, which has seen it writing off close to N$700 000 in interest charged on accounts, is ongoing.

When asked whether there is any conflict between the initiative and RedForce's collection attempts, Shitalangaho-Mutikisha said they have experienced no challenges.

"The incentive is an initiative to help people whose debt accounts are growing on a daily basis. The collection by a debt-management company is a different exercise," she said.

"We should remember that this relief was introduced by council after going through reports from the debt-management company and it does not in any way affect their collections. To date, close to N$700 000 has been written off already from the people who have settled their accounts. We encourage others to take advantage of this relief exercise," she said.

She further clarified that "all accounts handed over to RedForce are not charged interest for the period they are with RedForce - only collection fees".

HARD AT WORK: RedForce has collected millions owed to the Ondangwa town council by defaulting stakeholders.
PHOTO: KENYA KAMBOWE

• NEW RAILWAY TO BOOST TRADE

Landmark Namibia, Botswana Trans-Kalahari railway spotlighted

The rail authorities of the two countries have been **lauded for the work done so far in order to make the project a reality.**

STAFF REPORTER
SWAKOPMUND

TOGETHER: Namibia's transport minister John Mutorwa and his Botswana counterpart, minister Eric Molale. PHOTO: PRECIOUS NGHITAUNAPO

Works and transport minister John Mutorwa has officially signed an agreement for the Trans-Kalahari Railway Line Project during a joint ministerial committee meeting held on 2 February in Swakopmund, Namibia.

His Botswana counterpart, transport and public works minister Eric Molale, was present at the meeting to mark a crucial step towards the recognition of the cross-border railway initiative.

"After a series of discussions, we have concluded by signing an agreement with regard to investigating the possibility of constructing a railway line from the sovereign territory of Botswana, which, once it is visible and practically implemented, will link with the railway line in Namibia," Mutorwa confirmed.

In his statement, Molale said: "Botswana and Namibia are just facilitators and probably the owners of the railroad, but we are doing this in the interest of the Africa Continental Free Trade Area initiative as well as the SADC Regional Integration Plan, where both documents call on member states to improve and expand on their infrastructure."

"That should become a catalyst for speedy economic growth for Africa and for the southern nations."

Crucial discussions

The committee, led by the Namibian transport ministry's executive director Esther Kaapanda and her Botswana counterpart Kgakgamalo Ketshajwang, discussed crucial aspects of the project, including the proposed operational budget for the 2024–25 financial year.

In acknowledgment of the progress made, the ministers approved the reinforcement of the Trans-Kalahari Railway Project Management Office with the necessary expertise to expedite the drafting of comprehensive terms of reference for the request for proposals. These are expected to be issued to short-listed respondents by March, with the appointment of a successful respondent anticipated by May 2024, aligning with the project's roadmap.

Expressing satisfaction with the commitment and progress demonstrated by rail authorities and senior officials, the ministers emphasised the importance of adhering to timelines. They reaffirmed their dedication to deepening strategic cooperation and partnership in transport infrastructure while nurturing the warm bilateral relations between Botswana and Namibia.

Construction on the Trans-Kalahari Railway Line is expected to commence in 2025, marking a transformative moment for regional connectivity and economic integration.

New 'home' for advocates

STAFF REPORTER
WINDHOEK

"You provide a service to the public, and it's a lot of money to hire a lawyer. The least we can do is to deliver the best service at the best possible rate."

This is according to advocate Marius Boonzaier, who was elected chairman of the newly established Namibian Bar Association on 29 January.

"We are very excited. It's not every day that something like this happens," he said. Boonzaier's colleague and friend, advocate Abraham (Apie) Small, has been appointed as the secretary and treasurer, and advocate Herman Steyn wrote the association's constitution.

"I started the constitution with a clean slate. I saw an opportunity for a new beginning," Steyn explained. One of the constitution's provisions stipulates that the association should be a home for its members, where they can share knowledge, skills, information and experiences with each other. "People should feel comfortable and at home here."

NEW: Adv Herman Steyn (left) is the author of the Namibian Bar Association's constitution, Adv. Marius Boonzaaier (middle) is the chairman and Adv. Apie Small is the secretary and treasurer. Photo: Kristien Kruger

Modern and flexible

The Namibian Bar Association's constitution allows its members to practice from any location.

"The constitution has been modernised. It is very flexible and provides for different segments of society to practice because not everyone can necessarily afford chambers in the beginning," Boonzaier explained.

According to him, it can also be ideal in cases where parents would like to practice from home or retired lawyers no longer want to incur the expenses of having full-time chambers (as lawyers and judges prefer to call their offices).

"An individual can practice from home and can still be a member of our association. The person still has access to a boardroom and research software. The facilities are here – for a fraction of the cost," Boonzaier explained.

"It's not because we are angry; our needs are simply not being met, especially concerning chambers," said Steyn.

Referrals

Boonzaier also emphasised that the association does not compete with attorneys.

"We are still a referral profession. A member of the public cannot just come to us; they still need a referral from an attorney. It's like the difference between a general practitioner and a specialist. You can't go to the specialist without a referral," he explained.

According to Boonzaier, there were also other needs, aside from the issues regarding chambers, that the association identified and took into account to "keep up with life."

"Our constitution is drafted so that a person who has been a lawyer for 20 years automatically qualifies to become a senior lawyer," Steyn added that in such cases, the lawyer still has to apply for it.

Transparency

Another provision in the association's constitution – which differs from many others around the world – is that an individual may not be a member of the association if they are a member of a secret organisation.

"It's about objectivity. If you are representing a client, you should be able to lie in the trench with that person, walk a path together, and not be influenced by external factors," said Boonzaier.

"Openness and transparency are important to us," affirmed Steyn.

Ons Mense

irene@republikein.com.na

Vrou met 'n hart vir haar medemens

» Reeds 15 jaar by Huis Acacia

Maggie Kotze het vroeër jare skoolgehou en 'n koffiewinkel bestuur, maar sy het uiteindelik haar roeping by CAN se tussentydse tuiste vir kankerpasiënte gevind.

Irene-Mari van der Walt

"Mense is ingestel daarop – die oomblik as jy 'kanker' hoor hoor jy 'dood' en dis nie die waarheid nie. Daar is mense wat by ons kom kuier wat 20 of 25 jaar gelede met kanker gediagnoseer is wat nog steeds lewe. Ons probeer die 'dood' uit kanker haal," sê Maggie Kotze wat reeds die afgelope 15 jaar die matrone by die Kankervereniging van Namibië (CAN) se tussentydse tuiste vir kankerpasiënte, Huis Acacia, is.

Maggie was eers 'n onderwyseres voor sy 'n koffiewinkel bestuur het. Hiër het sy vir Reïnette Koeglenberg, die voormalige uitvoerende hoof van CAN, ontmoet.

"Gedurende dieselfde tyd het ek 'n paar familielede aan die dood afgestaan weens kanker. Ek het toe met Reïnette in verbinding getree en gevra as daar 'n pos by Huis Acacia oopgaan, moet sy my laat weet, want ek sal graag aansoek wil doen. Ek het 'n begeerte gehad om met kankerpasiënte te werk ná wat ek met my geliefdes deurgemaak het. Ek is passievol oor hierdie siek mense," sê Maggie.

Kort voor lank het CAN haar gekontak toe die vorige matrone by Huis Acacia afgetree het.

"Ek het daarna nooit weer gewerk nie, want ek lewe my passie uit. Vyftien jaar later, en hier is ek steeds by Acacia," sê sy.

Maggie sê die algemene vrees onder pasiënte is om dood te gaan.

"Baie kere wanneer die pasiënte hier aankom, vra hulle of hulle gaan doodgaan? Ek sê dan ja, en dan sien jy die geskokte uitdrukking op hulle gesigte. Dan verduidelik ek dat almal van ons gaan doodgaan, maar jy gaan nie noodwendig aan kanker doodgaan nie – jy kan van baie ander dinge doodgaan. Ek wat nie kanker het nie, kan byvoorbeeld oor die pad loop en 'n motor kan my raakry," sê sy.

"Dit is egter vir my die lekkerste wanneer pasiënte gesond word. Ek kan in Namibië enige plek gaan en iemand sal my herken en hulle arms om my kom sit. Om pasiënte weer raak te loop ná hulle van kanker genees is en hulle vou hulle arms om jou om dankie te sê, dan besef jy dat jy tog iets beteken," sê sy.

Maggie verduidelik Huis Acacia bied nie net verblyf aan kankerpasiënte wanneer hulle behandeling ontvang nie, dis ook 'n plek waar pasiënte deur mense omring word wat hulle verstaan en 'n plek waar hulle sonder vrees kan praat.

"Talle pasiënte voel hulle kan met ons praat en dan luister ek net. Wanneer hulle klaar gepraat het, sê hulle dankie, hulle voel beter, maar jy het eintlik niks gedoen nie. Hulle kan nie altyd oop gesprekke met hulle vriende en familie hê nie, want die geliefdes is bekommerd, maar met jou kan hulle openlik oor hul vrese praat," sê sy.

Diegene wat reeds in remissie is help ook uit by Huis Acacia om pasiënte moed in te praat.

"Hulle sê altyd hulle het gedink hulle is die siekste mens, maar dan kom hulle hier en besef daar is altyd iemand sieker as hulle," sê sy.

Sy sê ook dat Huis Acacia hoop aan pasiënte bied.

"Baie kere woon mense wat vir hul opvolgbesoeke kom ook hier. Dié mense is reeds genees en hulle praat dan met die pasiënte en dit gee hulle hoop. Ons kry baie ouer mense wat vrede in hul harte het en sê hulle is nie bang om dood te gaan nie, maar ons hardste vegters is ma's met jong kinders. Hulle wil veg en wil aanhou lewe vir hulle kinders," sê Maggie.

Maggie verkoop appels ten bate van die Bank Windhoek Kankerappelprojek. FOTO'S VERSKAF

"Dit is baie rustig hier – die pasiënt kan eet en slaap wanneer hulle wil – daar is nie 'n roetine nie. Dit is nie soos om by familie te kuier waar hulle 'n roetine moet volg nie," sê sy.

Haar grootste wens is dat pasiënte kankervry is.

"My wens is net kom, word gesond, gaan terug na jou mense toe en kom weer terug – hulle doen dit nie altyd nie. 'n Pasiënt moet in die jare ná die diagnose vir hul opvolgafsprake kom," sê Maggie.

Sy raai aan dat diegene wat reeds kanker gehad het en hul nabye familie vir gereelde doktersbesoeke gaan.

"Gaan elke jaar dokter toe. Die oomblik as jy vroeg gediagnoseer word, is jou kanse op herstel baie beter – moenie wag dat jy siek word nie," sê sy.

CAN het onlangs aangekondig dat Huis Acacia nou sewe dae per week oop sal wees, waar dit voorheen van Sondagmiddae tot Vrydagoggende oop was, en Maggie is vasbeslote om dié uitdaging aan te pak.

"Dis 'n groot stap, maar ons pasiënte neem geweldig toe. Die staatspasiënte raak nou so baie dat hulle op Saterdae en Sondae ook moet behandeling kry – so ons moet daarby inval. Dit is nuwe aanpassings en nuwe dinge, maar ek glo ons sal dit regkry," sê sy.

Maggie moedig die gemeenskap aan om betrokke te raak waar hulle kan.

Maggie en haar man in Barcelona.

"Nou dat ons meer pasiënte het, raak ons kostes ook meer. Jy dink dalk nie so nie, maar selfs 'n pakkie rys gaan help. Wanneer ons geldinsamelings hou, koop die appels, ondersteun ons projekte, koop die kolwyntjies. Tien dollar is dalk nie baie vir jou nie, maar 'n klomp tien dollars bymekaar kan ons help om 'n verskil te maak. As iemand hier verbyry en kom aanklop en sê hulle het vir ons 'n sakkie aartappels, is ons altyd so dankbaar," sê sy.

Diegene wat selfs net hul tyd kan afstaan om geselskap aan die pasiënte by Huis Acacia te bied, is ook welkom.

"Kom kuier vir ons mense – enigiemand kan kom aanklop en sê hulle het kolwyntjies gebring, kom ons maak koffie – dit is vir hulle so lekker om iemand van buite af te kry," sê sy.

"Baie pasiënte kom hier aan dan vra hulle wat is die besoektye, want hulle het so baie mense wat vir hulle wil kom kuier. Ons sê dan dat ons nie sulke dinge het nie – hierdie is nie 'n koshuis en 'n hospitaal nie – jou mense kan vir jou kom kuier. Dan gaan die tyd verby en niemand kom kuier nie," sê Maggie.

"Ek moes al talle kere hierdie mense se geliefdes vra hoekom hulle nie kom kuier nie, dan is hulle woorde: 'Wat moet ons vir hulle sê?' Daardie persoon het nie verander nie, dis presies dieselfde mens. Wat sou jy vir hulle sê as hulle nie kanker gehad het nie? Jy kan dit vir hulle sê. Kanker is nie aansteeklik nie – kom kuier vir hulle, kom ondersteun hulle. Al kan jy net een dag hier kom koffie drink en net vars geselskap bring, kom kuier vir hulle."

Maggie vertel van 'n pasiënt wat op sy 75ste verjaardag geen besoekers gekry het nie.

"Hier was 'n oom wat 75 geword het en ek kon sien die oom was dié dag nie lekker nie. Ek het my man gebel en gesê hy moet onmiddellik 'n koek koop en Acacia toe kom. Hy het toe so gemaak en almal het die oom se verjaardag saam met hom gevier. Hy het ure lank gesels en almal het saam koek geëet en gekuier," onthou sy.

Die CAN-span by die Hats and Roses-vroueontbyt in 2023. FOTO VERSKAF

Sun
WEDNESDAY 14 FEBRUARY 2024 NEWS 3

NEWS IN SHORT

Man wanted for assault

Police in the Kavango West Region are appealing for public assistance in tracing a suspect who allegedly assaulted a 29-year-old man with a bottle to his right eye, leaving him severely injured, at Nkurenkuru. Chief inspector Raimbert Muronga confirmed the incident, which took place at Sondorokeni shebeen.
The victim is from Sondorokeni village.
Anyone with information on the whereabouts of the suspect is urged to contact the nearest police station.
-NIKANOR NANGOLO

FlyNamibia celebrates first all-female crew

FlyNamibia yesterday celebrated its very first flight with an all-female crew. Captain Elsa Martin and co-pilot Li Rossouw flew with Yolanda Gawases as flight attendant. Martin is an experienced pilot and was named captain at FlyNamibia in October last year, becoming the airline's first female captain.
"I don't think your gender or skin colour matters. If you have a passion for flying, nothing will stop you. But it would be nice to see more girls in the industry," Martin said in an interview with Namibia Media Holdings last year. Meanwhile, outside her work as a pilot, Rossouw owns a swimwear business, Cheeky, with her friend and fellow pilot Belinda Hoebes.
Cheeky's exclusive, sustainable swimwear aims to make women of all shapes and sizes feel comfortable in their own skin.
Each piece is made from recycled plastic bottles, salvaged fishing nets and other ocean waste.
"It has always been important to us to be inclusive and to ensure that every woman can feel comfortable and beautiful," Rossouw said in an earlier interview. - STAFF REPORTER

GIRL POWER: FlyNamibia's Li Rossouw, Yolanda Gawases and Elsa Martin. PHOTO: FLYNAMIBIA

• WRONG RATES IN GOVERNMENT GAZETTE

Construction industry: Wage adjustments delayed

The process has to start all over again, the labour ministry's executive director said.

AUGETTO GRAIG
WINDHOEK

WAITING: Construction workers like Jonathan Geib will have to wait more than a month for adjustments to the minimum wage to take effect. PHOTO: TANJA BAUSE

While the Construction Industries Federation of Namibia (CIF) and the Metal and Allied Namibian Workers Union (Manwu) reached an agreement on adjustments to the minimum wage for workers in the construction industry last October, it has yet to take effect.

The CIF and the union have blamed the labour ministry for the delay, while the ministry has pointed fingers right back at the two bodies.

According to executive director Lydia Indombo, the delay is due to an incorrect version of the agreement being submitted electronically by the CIF.

The federation's CEO Bärbel Kirchner admitted that an incorrect version was sent to the ministry on 7 October 2023. However, it was sent after the correct, original agreement had already been submitted to the minister's office on 4 October 2023, she explained.

The ministry submitted the wrong document to its justice counterpart, which was subsequently published in the Government Gazette on 19 December 2023, Kirchner said.

"The version of the joint agreement the ministry received from the parties was wrong. This was the exact version that the ministry used throughout the process and was finally published in the Government Gazette," Indombo said.

After publication in the Government Gazette, 44 days must lapse for the recording of any objections and before the minimum wage comes into force.

Human error

According to Kirchner, an inquiry by a building contractor brought the error to the CIF's attention.

"Fortunately, we picked up the error shortly before the grace period ended. There was indeed an error in the soft copy emailed to the ministry. It was an honest, human error and there was nothing deliberate about it," she stressed.

According to Indombo, the process now has to start all over again. She said the labour ministry has already submitted the correct agreement to the justice ministry. However, it must be published again in the Government Gazette, while the period of 44 days will also apply again.

Indombo further denied that the ministry wants to delay the ratification of the new minimum wage.

"The ministry wants to make it clear that it has no reason to delay such an application or any other application," she said. She also distanced herself from allegations made by Manwu against the ministry.

Delay tactic

The union's secretary-general Justina Jonas said the ministry is simply shifting the blame. According to her, the ministry has been using this delay tactic for years.

"Every year, they delay things until we have to fight for them, then they wake up. Publication in the Government Gazette is always delayed - sometimes for six months, sometimes up to a year! This is the same thing they are doing now and now they want to blame us for it. The document is verified and usually they then come back to us but not this time."

Jonas added: "They only respond when you follow up. We contacted the executive director in January and only got a reply a week later. When asked whether the error would cause a delay, it took three weeks before they could answer us".

"Why don't they make sure from the beginning? Why don't they do their job from day one? The labour ministry delays the process year in and year out," she fumed.

augetto@republikein.com.na

GOVT CALLS ON CITIZENRY TO SUPPORT RADIO

OGONE TLHAGE
WINDHOEK

Deputy communications minister Modestus Amutse says radio is an important means of informing the masses and has had a profound impact on society.

He made the remarks in commemoration of World Radio Day yesterday.

"We celebrate the significant role radio continues to play in informing, educating and entertaining communities globally. As we mark 100 years since its inception, we reflect on radio's evolution, its profound impact on societies and its promising future," Amutse said.

He further called on the citizenry to continue supporting the medium through advertising.

"We urge both the public and private sectors to maintain their support for radio stations through advertising, enabling them to fulfil their mandate of informing, educating and entertaining while upholding fact-based, high-quality journalism sustainably," he said.

"Let us recognise and honour the enduring legacy of radio by appreciating its influence and looking forward with optimism to the future. Let us continue embracing the power of radio, allowing it to capture our imagination and keep us tuning in."

Woensdag 14 Februarie 2024 Republikein NUUS 3

>> Lubowski-familie hard getref

'Antwoorde sterf saam met Geingob'

Anton Lubowski se familie het gehoop president Hage Geingob kon lig werp oor sy laaste ontmoeting met hom die aand van sy sluipmoord.

Ogone Tlhage

Die weduwee van die vermoorde politikus Anton Lubowski, Gabrielle, sê die dood van president Hage Geingob het alle hoop laat verdwyn dat sy familie geregtigheid vir sy sluipmoord sal kry.

Lubowski wat 'n prominente regspraktisyn en Swapo-lid was, is die aand van 12 September 1989 vermoor. Die 37-jarige Lubowski is voor sy huis in Windhoek met 'n AK-47 outomatiese geweer doodgeskiet.

Sy familie het gehoop dat hulle Geingob vanjaar kan ontmoet om meer uit te vind oor die besonderhede van sy laaste ontmoeting met Lubowski die aand van sy sluipmoord.

"Ons was so seker dat ons hom in 2024 gaan ontmoet en dat hy uiteindelik met ons sou deel wat so belangrik was dat hy en Anton sonder lyfwagte in die destydse Kaiserstraat (nou Onafhanklikheidsrylaan) moes gaan stap sodat niemand die gesprek kon afluister nie," sê Gabrielle.

> **Gabrielle Lubowski**
> WYLE ANTON LUBOWSKI SE VROU
>
> "Die nuus van president Geingob se dood het ons hard getref. Dit was soos 'n hou in die maag, ons was diep ontsteld en tranerig."

Lubowski het Geingob die aand van sy dood vir ete ontmoet. In 'n ope brief aan die ontslape president in 2019 het sy aan hom gevra wat so sensitief was dat hulle nie eers in 'n veilige ruimte kon gaan sit nie.

"Jy was die laaste persoon met wie Anton gepraat het. Hy het inligting met jou gedeel wat so sensitief was dat die twee van julle nie eens kon gaan sit vir 'n koppie koffie nie. 'n Paar uur later was Anton dood," skryf sy in die brief.

Die ontslape president Hage Geingob saam met die Swapo-politikus Anton Lubowski wat in 'n sluipmoordaanval dood is. FOTO ARGIEF

Volgens Gabrielle het die nuus van Geingob se dood op 4 Februarie die familie hard getref.

"Die nuus van president Geingob se dood het ons hard getref. Dit was soos 'n hou in die maag, ons was diep ontsteld en tranerig."

Die langverwagte gesprek met Geingob sou 'n einde bring aan die geheimsinnigheid wat Anton se dood omhul, sê Gabrielle.

"Ons wou nie net die inhoud van daardie gesprek weet nie, maar het ook die begeerte gehad vir die aanvaarding en erkenning van al die pyn, trauma, teistering en verwerping wat ons moes verduur het. Net Geingob sou ons gemoedsrus kon gee en ons waardigheid herstel en die nalatenskap met trots dra."

Die familie moet nou egter aanvaar dat hulle ná Geingob se dood nooit die waarheid sal weet nie.

"Net God kan ons nou troos. Ons moet aanvaar dat 'n ontmoeting van vrede, vergifnis en versoening vir altyd buite bereik is," het sy gesê.

Geingob het oor die jare enige betrokkenheid by Lubowski se moord ontken. In 'n brief aan sy vrou het die ontslape staatshoof by monde van sy prokureur Sisa Namandje haar bewerings as absurd beskryf.

"Jou bewerings is absurd en vreemd. Ten spyte van die feit dat die koelbloedige moord van Anton Lubowski die fokus van 'n polisieondersoek (en waartydens vereis is dat almal, insluitend jy, die polisie met inligting help) en 'n openbare hoërhofondersoek was, maak jy eers byna 30 jaar later roekelose bewerings," het hy gesê.

Die Ierse burger Donald Acheson wat oorweldigende bewyse teen hom as die beweerde sluipmoordenaar gehad het, is ná agt maande in aanhouding in Suid-Afrika vrygelaat. Geen poging is ooit aangewend om Acheson aan Namibië uit te lewer om hier verhoor te word nie. Hy is in 1991 na Ierland gedeporteer.

- republikein@republikein.com.na

FlyNamibia maak geskiedenis

FlyNamibia het gister sy heel eerste vlug met 'n bemanning wat slegs uit vroue bestaan het, gevier.

Kaptein Elsa Martin en eerste offisier Li Rossouw, waaroor *Republikein* al voorheen berig het, het saam met Yolanda Gawases as kajuitbemanning gevlieg.

Elsa is 'n ervare vlieënier en is in Oktober verlede jaar as kaptein by FlyNamibia aangestel en het hul eerste vrouekaptein geword.

Li besit ook 'n besigheid wat sy saam met haar vriendin Belinda Hoebes bedryf. Hul besigheid, Cheeky, verkoop swemklere en het ten doel om vroue van verskillende groottes en liggaamstipes gemaklik in hul vel te laat voel.

Li Rossouw, Yolanda Gawases en Elsa Martin. FOTO FACEBOOK/FLYNAMIBIA AIRLINE

"Dit was nog altyd vir ons belangrik om inklusief te wees en te sorg dat elke vrou gemaklik en mooi kan voel. Ná ons die eerste keer ons produkte bekend gestel het, het iemand vir ons 'n boodskap gestuur wat ontevrede was omdat die grootste nommer 'n XL was," het Li verlede jaar in 'n onderhoud gesê.

PUBLIC PARTICIPATION NOTICE

ENVIRONMENTAL ASSESSMENT AND MANAGEMENT PLAN FOR A RADIOACTIVE SOURCE MATERIAL STORAGE AND HANDLING FACILITY ON ERF 3954, SWAKOPMUND, ERONGO REGION

Geo Pollution Technologies (Pty) Ltd was appointed by Namaquanum Investments Two CC Ltd to undertake an environmental assessment for construction and operations of a radioactive source material storage and handling facility on erf 3954, Swakopmund, Erongo Region. Additional and location information about the project can be obtained at:

http://www.thenamib.com/projects/projects.html

The environmental assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

The Proponent has an existing workshop on erf 3954, Einstein Street, in the industrial area of Swakopmund. The Proponent plans to refurbish the workshop and to construct a dedicated storage facility for radioactive source material used to calibrate and test drilling equipment (well logging equipment), used in the offshore oil exploration industry. Clients from the offshore exploration industry will utilise the workshop and source materials to perform calibrations and tests on their drilling equipment. The facility will conform to stringent industry safety and security specifications.

All interested and affected parties are invited to register before 21 February 2024 with the environmental consultant. By registering you are provided with the opportunity to share any comments, issues or concerns related to the project, for consideration in the environmental assessment. Additional information can be requested from:

André Faul
Geo Pollution Technologies
Tel: +264-61-257411
Fax: +264-88626368
E-Mail: df@thenamib.com

Site Notice

Appendix C: Comments and Responses: IAP Review of EIA/ERMP

IAP Details	Comment / Concern	Response
Detlof Von Oertzen Email: 19/06/2024	Thank you for your mail and sharing the EIA/RIA/ERMP doc. There are numerous issues in the document, some of which include the following:	
	The exposure dose levels provided in table 5-2 are not complying with Namibian regulatory requirements, and the units are spelled incorrectly. I cannot believe that these matters were vetted by Dr van Blerk, noting the contents of section 3.2.3? Basic quality assurance should have addressed such discrepancies.	The following is an exact copy of Government Notice No. 221 Radiation Protection and Waste Disposal Regulations: Atomic Energy and Radiation Protection Act, 2005 (Act No. 5 of 2005) *Occupational dose limits* *1. (1) Subject to subitem (2), the occupational exposure of any worker must be so controlled that the following limits are not exceeded –* *(a) an effective dose of 20 mSv per year averaged over five consecutive years;* *(b) an effective dose of 50 mSv in any single year;* *(c) an equivalent dose to the lens of the eye of 150 mSv in a year; and* *(d) an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.* *(2) For apprentices of 16 to 18 years of age who are training for employment involving exposure to radiation and for students of age 16 to 18 who are required to use sources in the course of their studies, the occupational exposure must be so controlled that the following limits are not exceeded –* *(a) an effective dose of 6 mSv in a year;* *(b) an equivalent dose to the lens of the eye of 50 mSv in a year; and* *(c) an equivalent dose to the extremities or the skin of 150 mSv in a year.* *Special circumstances* *2. When, in special circumstances, a temporary change in the dose limit requirements is approved under regulation 11 –* *(a) the dose averaging period referred to in paragraph (a) of subitem 1(1) may exceptionally be up to 10 consecutive years as specified by the Authority, and the effective dose for any worker may not exceed 20 mSv per year averaged over this period and may not exceed 50 mSv in any single year, and the circumstances must be reviewed*

IAP Details	Comment / Concern	Response
		when the dose accumulated by any worker since the start of the extended averaging period reaches 100 mSv; or *(b) the temporary change in dose limit must be as specified by the Authority, but may not exceed 50 mSv in any year and the period of the temporary change may not exceed 5 years.* *Dose limits for the public* *3. The estimated average doses to the relevant critical groups of members of the public that are attributable to practices may not exceed the following limits –* *(a) an effective dose of 1 mSv in a year: Provided that in special circumstances, an effective dose of up to 5 mSv in a single year may be approved: Provided further that the average dose over five consecutive years does not exceed 1 mSv: per year;* *(b) an equivalent dose to the lens of the eye of 15 mSv in a year; and (c) an equivalent dose to the skin of 50 mSv in a year.* Table 5-2 is consistent with the above. Dr van Blerk only prepared the RIA. mSV was changed to mSv in the table.
	Section 6.1 does not address whether a facility as envisaged is not better located elsewhere, for example in Lüderitz. This should have been assessed and discussed.	The Proponent has taken various factors in consideration, including the needs of potential future clients. These, together with the fact that the Proponent already owns the erf in question, do not warrant assessment of alternative locations, as the Proponent is not considering alternative locations.
	Chapter 7 should include a summary of the provisions under the Atomic Energy and Radiation Protection Act 5 of 2005, and the Regulations under the Act.	A detailed summary of the Act and its regulations is provided in the RIA.
	Chapter 9 completely misses the point that the facility was advertised as being a "noxious/industry storage site". It is not what members of the public construed, but is a direct consequence of the adverts places by the project proponent or their "consultants". In my view,	"Noxious/industry storage site" is the official wording that had to be used by the Town Planners in order to apply for consent from the Municipality. The EIA advertisements clearly indicated "radioactive source material". Regardless of this, "Noxious/industry storage site" still does not imply that radioactive **waste** will be stored. The general public however persisted with sharing the notion that it will be a storage site for radioactive

IAP Details	Comment / Concern	Response
	the statements in paragraph 3 in particular are neither helpful nor addressing the subject matter in a factual and balanced way.	waste. Paragraph 3 addresses the misinformation and also confirm that their concerns are understood, even though their concerns may be based on the wrong information. As such, it is helpful in providing the Environmental Commissioner’s office with background to the public consultation process that may ultimately assist them in reaching a decision on the ECC approval/rejection.
	Section 10.5 lacks a description on how radioactive contamination can potentially arise and spread from the proposed premises.	This is discussed in the RIA.
	Section 10.5 would benefit from some serious fact checking and corrections.	Added references to section 10.5.
	Section 11.1 and its subsections are qualitative and do not present objective indicators that can be used to rank the various risks that were identified.	A standard environmental assessment method was used for the impact assessment.
	Many of the statements in section 11.1 are irrelevant (example: “A common example is the radioactive isotopes used to treat cancer patients.”) and not related to the project under consideration, not sure for whose benefit they were included?	The opinion on this is noted.
	Page 103, section 5.5.2, lacks quantification and would benefit (and be more credible) if it were to include actual gamma dose rates during on-site calibration, as well as off-site gamma dose rates during calibration. In the absence of specific exposure scenarios, the qualitative description provided in section 5.5.2 is too simplistic to enable a balanced judgement on the actual on- and off-site risk of exposure associated with on-site calibrations.	The facility is not operational yet and, therefore, is considered prospective in nature. It is recommended in the report that gamma dose rate surveys be conducted before commissioning of the facility to establish baseline conditions at the facilities, at the site and around the site. Once commissioned, this should be repeated under actual operating conditions. The sections on potential exposure to the public were revised and now include several scenarios under normal operating conditions and exposure conditions. It is recommended that these scenarios be revisited once commissioned to ensure that they represent operational conditions. The prospective assessment should be updated with an operational safety assessment and incorporate any site and facility-specific changes.
	Page 104, section 5.5.3, a few exposure scenarios would assist in quantifying the potential risk of exposure – the qualitative argumentation used not not adequately convey the measure of actual and potential	The sections on potential exposure to the public were revised and now include several scenarios under normal operating conditions and exposure conditions. It is recommended that these scenarios be revisited once commissioned to ensure that they represent operational conditions. The prospective assessment should be updated with an operational safety assessment and incorporate any site and facility-specific changes.

IAP Details	Comment / Concern	Response
	risk of exposure of staff as well as members of the public.	
	Section 5.6 has the same deficiencies as identified in the previous bullets in that it lacks a measure for the actual risk of exposure.	The facility is not operational yet and, therefore, is considered prospective in nature. It is recommended that these scenarios be revisited once commissioned to ensure that they represent operational conditions. The prospective assessment should be updated with an operational safety assessment and incorporate any site and facility-specific changes.
	6.3.2.1 mentions Radiation Protection Officers (RPOs). In Namibia, RPOs are NRPA staff. What this section should refer to are the duties of the Radiation Safety Officer (RSO). Had you hired a competent Namibian specialist, such mistakes would not have happened!	This "error" does not change any of the findings of the study and the ultimate responsibility, regardless of what the position is called, remains the same. A local specialist was engaged, but, due to an excessively expensive quote by the specialist, could not be contracted. Nevertheless the comment is noted and it was changed to Radiation Safety Officers (RSO).
	Table 6.1 – the exposure periods assumed are most likely too short in an operational setting. This implies that the associated exposure dose estimate is likely too low.	Section 6.2.2.6 discusses the effect of the shorter or longer exposure period.
	Attention needs to be given to the number significant figures that is used to express the exposure dose estimates in the report, one cannot use an input of one significant figure and express a result using three significant figures – Maths 101.	Noted. The tables were revised to be consistent and the values quoted in the text are presented in a consistent manner.
	A Radiation Management Plan was not included in the document, although this is suggested in your email. The RMP forms the basis of radiation protection measures contained in the EMP.	A radiation management plan and overall operational overview is provided in the final submitted document.
Kristian Woker Email: 19/06/2024	Thank you very much for your mail of 18 June 2024 and the detailed Report. It certainly makes for interesting reading. We have full understanding that such a facility is necessary but not in the middle of a town. We have several residential area's nearby and Swakopmund is a well-known holiday destination.	*Initial Response* Your email and objection is noted and will be included in the EIA. You will also be notified upon final submission of the documentation, with the final document also shared with all registered parties. *Subsequent Response*

IAP Details	Comment / Concern	Response
	This facility will also devalue our property, as no one would like to rent next to such a facility (no matter how good the precautions are). It is just how human nature works. We thus still OBJECT to this facility. It needs to be located in a safer and more remote area like the Industrial properties near the airport of Walvis Bay.	The RIA as presented in Appendix A was reworked and expected exposure for nearby residents, neighbours and passers-by was calculated. Refer to section 6.3 in the RIA. As can be seen, exposure to nearby neighbours and passers-by is extremely low.

Appendix D: Operator Specific Operational Procedures and Radiation Management Plan

Radiation Management Plan

Halliburton Namibia, July 2024

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List of Tables

1 Halliburton Business Profile

Halliburton is an oilfield service company. The company serves the upstream oil and gas industry throughout the lifecycle of the reservoir, from identifying hydrocarbons and managing geological data, to drilling and formation evaluation, well construction and completion, and optimizing production. Halliburton offers drilling, cementing, stimulation, intervention, artificial lift, well-bore placement solutions, and completion services for the oil and gas upstream companies.

The company has manufacturing facilities in the US, Malaysia, Singapore, and the UK. Geographically, the company has a presence in North America, Europe, Africa, Latin America, Asia, and the Middle East. Halliburton is headquartered in Houston, Texas, the US.

As part of service delivery some of Halliburton's product service lines use radiation in well logging to assist in determining whether a drilled well has certain rocks or minerals, oil, gas, or other substances of consumer value. Well logging generally uses sealed sources containing radioactive materials that emit gamma ray or neutrons.

2 Pre-Operational Safety Assessment

Halliburton has internal Rules of Radiological Protection with respect to the storage, transport and use of radioactive sources, as implemented by general management, located in United States of America and are implemented in all facilities, onshore and offshore locations globally.

Halliburton's general policy is to keep radiation levels for personnel as LOW AS REASONABLY ACHIEVABLE (ALARA). The manipulation procedures designed to maintain the personnel exposure to radiation as low as reasonably achievable by limiting the time of exposure and providing all reasonable protection against radiation and use of remote handling devices.
These Rules were drafted as part of the Company's Health and Safety Guarantee Policy and in accordance Local Laws regulated by IAEA.
The objectives of these Rules are to protect the health of the public and the employees of this company and to prevent debilitating accidents resulting from the use of radioactive materials.

Compliance with these Rules will also prevent the violation of the law and consequently redress actions, including fines to the company and personnel and license suspension. If there is any doubt about these Local Rules or the safety conditions in the storage facilities listed in this document or at a remote workplace, contact the Local Radiation Safety Officer (LRSO)

Each employee involved in the handling of radioactive materials is responsible for having functional knowledge of these rules. Every employee will be required to read this document and acquire the appropriate training before being allowed to work with radioactive sources used under license by this company. Violations of the conditions and procedures established in these rules by any employee will be just cause for punitive action, including, through sufficient intentional violation, termination of employment.

This document will apply to the non-exempt use of radioactive sources in the premises specified as a storage location in the respective Radiation Licenses and when such sources are used for profiling in remote well locations (Offshore).

3 Organizational Contacts

3.1 Halliburton Emergency Contacts

Table 1: Emergency Contacts

Name	Function	Contact
Antoine Berel	VP Africa Other	+244 931574079
Mohamed Warraky	Sperry Drilling Manager	+20 1120030087
Gavin Clark	Sperry Drilling R&M Manager	+258 843025058
Irene Diatta	RSO	+221 778245020
Elkana Hanghome	HSE	+264 813087469
Silveiro Conde	RSO-HSE	+264 812054510
Luis Gimbi	RSO	+244 930256351

4 Radiation Safety Program

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines.

The company provides Standards (ST) and Work Methods (WM) that govern the work activities to ensure local, country and or customer requirements are complied with.

4.1 Radiation Safety Program

4.1.1 ST-GL-HAL-HSE-1201 – **Page 7**

4.1.2 WM-GL-HAL-HSE-1201A (Radiation Safety Training)

4.1.3 WM-GL-HAL-HSE-1201B (Well Logging Supervisors, Assistant RSO, On Job Training

4.1.4 WM-GL-HAL-HSE-1201D (Radiation Safety Emergency Procedures)

4.2 Public Exposure Monitoring Program

4.2.1 ST-GL-HAL-HSE-1202 – **Page 11**

4.2.2 WM-GL-HAL-HSE-1201A (Radiation Safety Training

5 Radiation Standards

5.1 **Definition:** A document, established by consensus and approved by a recognized body (or by Halliburton for an internal standard), that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Standards define the Company's minimum expectations for the control of an activity or system.

Title: Radiation Safety Program		HMS Document Number: ST-GL-HAL-HSE-1201		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 06-May-2024	Rev No: 9	Page: 1 of 5

1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines.

This standard concerns a Critical Focus Area or Life Rule. Improper attention to this standard may result in personal injury or death. Radiation is a Critical Focus Area for Halliburton and strict accountability shall be ensured.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide. Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Radiation Safety Program Requirements

4.1 General Requirements → 4.2 Plant Activation & Deactivation → 4.3 RSO Appointments → 4.4 Training Curricula & Competencies → 4.5 Documentation / Recordkeeping

4.1 General Requirements

4.1.1 Any incident, event, or act associated with radioactive materials or radiation producing machines that might endanger personnel, public health or the environment shall be immediately reported in accordance with ST-GL-HAL-HMS-804 – HSE and SQ Event Management.

4.1.2 A written Local Emergency Response Program (LERP) shall be developed for each Halliburton location or site to address Level 1 & 2 Events as outlined in ST-GL-HAL-HSE-0601 - Emergency Response and Crisis Management and WM-GL-HAL-HSE-1201D – Radiation Safety Emergency Procedures.

4.1.3 Prior to the procurement, possession, usage or operation of radioactive materials or radiation producing equipment, all locations shall first meet and adhere to the requirements outlined in the Global HSE Radiation Safety Program:

A. ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring

B. ST-GL-HAL-HSE-1203 - Radiation Source Control and Accountability

C. ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments

D. ST-GL-HAL-HSE-1206 - Transportation of Radioactive Materials

E. ST-GL-HAL-HSE-1208 – Radiation Producing Machines

4.1.4 Before implementing any changes (such as but not limited to the below) to the site operations that may differ from the approved license application, the location shall conduct a risk assessment, have a review with the Halliburton local legal representative and document the approval of change through a MOC.

A. Changes to operational procedures or techniques

B. Changes to facilities or storage areas

C. Changes in radioactive material inventory

4.1.5 Reference BSD-GL-HAL-HSE-1201A - Radiation Safety Program Calendar for a complete list of timely dates that require RSO and management completion.

4.2 Plant Activation & Deactivation

4.2.1 **Plant Activation (Radiation)**

A. As part of the Plant Activation, the Appian – GREX Plant Management module is used to create and manage all radiation plants. See the Appian tab in the Radiation Safety SharePoint for instructions on creating and managing the plant and PSL combination.

HALLIBURTON

Printed versions of this document are considered UNCONTROLLED.

This is the minimum Halliburton Company Standard. If local, country, or contractual requirements exceed this standard then those requirements must be followed.

Page **7** of **102**

HALLIBURTON

Title: Radiation Safety Program		HMS Document Number: ST-GL-HAL-HSE-1201		
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B. In addition to GREX Plant Management, all new locations shall create an MOC generated by the country or operations manager. The MOC shall contain evidence that the applicable Global HSE Standards have been implemented into the location. Considerations shall be made to the following:

I. A License/Registration authorizing the import, storage, and usage. If a country or regulatory body does not require specific radioactive material or radiation producing equipment to be on a license/registration due to activity or other exemption, then that material does not need to be on a license.

II. 2 RSOs appointed in the Appian – GREX Appointment Letter module for the PSL/Plant combination.

III. PSL Management assigned for the applicable program approvals.

IV. Radiation Safety Curricula assigned as outlined in this standard.

V. Area and Personnel Exposure Monitoring (as applicable)

VI. Background Surveys and/or NORM evaluation (as applicable)

VII. Facility Storage (equipment, signage, segregation etc.) and Security requirements

VIII. Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the more stringent local/country regulations shall be included.

4.2.2 **Plant Deactivation (Radiation)**

A. In case of an operations exit from a facility requiring all the inventory redeployment to other facilities or manufacturing, an MOC generated by the country or operations manager is required. The MOC will consider the following:

I. Comprehensive Risk Assessment and action plan to mitigate the risk.

II. Key personnel management including RSO. Designate key personnel that will drive the closure or exit plan through the end. If applicable hand over process between key personnel.

III. Communication plan to key personnel including RSO and GRSO.

IV. Federal, state, and local licenses and permits for disposition and reciprocity.

V. Support from Halliburton Legal & Licensing Department for guidance and communication.

VI. Record retention for regulatory purposes.

B. Follow GD-GL-HAL-HSE-1203B - Operations Exit and Facility Disposition Guideline when a facility disposition is required.

C. Complete the following (as applicable):

I. CL-GL-HAL-HSE-1205A - HSE RA Release of Property for Unrestricted Use and License Termination

II. FO-GL-HAL-HSE-1205D - Radioactive Materials Location Exit Report

III. Deactivate the Appointed RSO's for the plant/psl combination in the Appian - Appointment Letter Module.

4.3 RSO Appointments

4.3.1 Each Plant and PSL Combination that is set up for radiation (Plant Activation), that utilizes and/or stores Radioactive Material and/or Radiation Producing Machines shall have two RSO's appointed.

4.3.2 RSO Appointments shall be completed, submitted, and approved as outlined in WM-GL-HAL-HSE-1201C – Radiation Safety Officer Appointment.

4.3.3 RSO Appointments are reviewed as part of the Quarterly Compliance Assessment (QCA). If an Appointed RSO is no longer fulfilling the duties of a RSO, that appointment shall be Deactivated. Deactivations are completed in the RSO Appointment Letter located in the Appian - Appointment Letter Module.

4.4 Training Curricula & Competencies

4.4.1 WM-GL-HAL-HSE-1201A - Radiation Safety Training establishes the Curricula and Competencies that shall be assigned according to the risks associated with employee job duties for the roles that are authorized to access and work with radioactive material and radiation producing equipment.

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4.4.2 See WM-GL-HAL-HSE-1201B – Well Logging Supervisors / Assistant – Radiation and On the Job Training for information regarding the training criteria, radiation specific topics and On-the-Job-Training (OJT).

4.4.3 A passing grade of 80% or better is required. If a grade obtained is <80%, the course shall be retaken.

4.4.4 Refresher Training shall be completed when identified by WM-GL-HAL-HSE-1201A - Radiation Safety Training, regulation, observation of employee practices, inspections, audits, or incidents on an annual basis unless otherwise specified.

4.4.5 At a minimum, during the Quarterly Compliance Assessment, the RSO shall review the Learning Central curricula assignment and completion. Employees who are deficient, shall not access radioactive material or radiation producing equipment.

4.4.6 The RSO Role (curricula and competency) is automatically assigned by the RSO Appointment process.

A. RSO Competencies shall be assessed by a qualified rater within 6 months from the assignment date to the levels outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training.

4.5 Documentation & Recordkeeping

4.5.1 All locations that store/utilize radioactive material shall maintain and have readily available for review documents/records as required by the local/country regulations. Local/country regulations shall be reviewed to ensure proper document/record compliance. Table 1 contains a list of general documents/records required by local/country regulations.

Name of Document / Record	PSL/Plant	Well Site
Agreement with well operator, owner, drilling contractor or landowner		
Survey Instrument Calibration		Yes
Leak Test		Yes
Quarterly Inventory		
Utilization Records		
Certification Documents		
Inspection and Maintenance		
Training and Testing	Yes	
Current Operating, Safety and Emergency Procedures		Yes
Exposure Monitoring Records		
Radiation Survey Records		Yes
Current License, Certificate of Registration, Reciprocity, etc.		Yes
Receipt, Transfer and Disposal		
Shipping /Transportation Papers		Yes
Applicable Regulations		

Table 1

4.5.2 All HSE documents shall:

A. Be retained and maintained in accordance with (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance.

B. Records for certificates of training shall be maintained within Learning Central.

C. Only be considered complete if reviewed and signed by an Authorized Person.

D. Demonstrate complete accountability of all source inventories, receipts, transfers, and disposals.

E. Be maintained by electronic form, or external database shall only be considered valid if the record is a complete and accurate replica of the original copy.

F. Be secured in a conspicuous location within operational areas.

5.0 References

5.1 (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance

5.2 BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions

5.3 BSD-GL-HAL-HSE-1201A - Radiation Safety Program Calendar

5.4 ST-GL-HAL-HMS-715 - SWA and HSE/SQ Observations

5.5 ST-GL-HAL-HMS-804 – HSE and SQ Event Management.

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5.6 ST-GL-HAL-HSE-0601 - Emergency Response and Crisis Management

5.7 ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety

5.8 ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring

5.9 ST-GL-HAL-HSE-1203 - Radiation Source Control and Accountability

5.10 ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments

5.11 ST-GL-HAL-HSE-1206 - Transportation, Shipping & Receiving Radioactive Material

5.12 ST-GL-HAL-HSE-1208 - Radiography Safety Management

5.13 WM-GL-HAL-HSE-1201A - Radiation Safety Training

5.14 WM-GL-HAL-HSE-1201B – Well Logging Supervisors / Assistant – Radiation and On the Job Training

5.15 WM-GL-HAL-HSE-1201C – Radiation Safety Officer Appointment

5.16 WM-GL-HAL-HSE-1201D – Radiation Safety Emergency Procedures

6.0 Appendix

Personnel Type	Responsibility
HSE/SQ Personnel	Communicating requirements of this standard and any additional governmental HSE regulations to management in their area of responsibility.
	Ensuring training meets requirements of this standard and any related governmental regulations.
Management	Communicating requirements of this standard and coordinating employee training as applicable to this standard
	Identifying and ensuring that employees in their area of responsibility complete required training and adhere to the requirements of this standard
	Confirming, in their areas of responsibility, that only the employees who meet the requirements specified in this standard are involved in the activities described in this standard
	Ensuring, in their areas of responsibility, that any Contractors have complied with the requirements of ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety
	Ensuring that appropriately qualified personnel are appointed to fulfill the duties of the Radiation Safety Officer (RSO) for their area of responsibility.
	Filling vacancies immediately when personnel are transferred, change job duties or employment is terminated
	Monitoring and supervising the use of Radioactive Material and Radiation Producing Machines in their area of responsibility
	Ensuring that QCA's are performed, completed, and approved within 5 days of submission and QCA corrective actions, if applicable, are completed in a timely manner
	Ensure that each person under their supervision is knowledgeable in recognizing and responding to an emergency event involving radiation
Employees	Complying with requirements of this standard and all applicable local or country safety standards.
	Completing required training and complying with the requirements set forth in this standard and any additional site-specific standards, regulations, or work methods.
Contractors	Complying with requirements of this standard or equivalent and all applicable local or country safety standards, while working at Halliburton or customer properties or facilities.
GRSC	Reviewing and recommending improvements to company's radiation policies, practices, processes, and procedures.
	Reviewing the status of the company's radiation performance, including processes to ensure compliance with internal policies and goals, and applicable laws and regulations.
	Reviewing significant incidents, stop work authority and exposure monitoring for evaluation of risk and corrective measures for the prevention of future incidents.
	Reviewing internal assurance services audits, QCAs and regulatory inspections.
	Serving as the liaison to the Health, Safety and Environment and Sustainable Development Committee and providing pertinent information on radiation performance and risks.
	Reviewing regulatory agency inspections, internal audits, notices of violation of a significant nature, enforcement actions and corrective actions.
GRSO	Supporting operations with regulatory guidance, licensing, and compliance assistance, including specifying the requirements for training, performance evaluation, recordkeeping and HSE Standards.
	Describing requirements, developing procedures and processes for the Global Radiation Safety Program which includes any element of a comprehensive Global Radiation Safety Program necessary to ensure regulatory compliance and the safety of employees, public and the environment

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1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines.

This standard concerns a Critical Focus Area or Life Rule. Improper attention to this standard may result in personal injury or death.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide. Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Radiation Exposure Monitoring Requirements

Figure 1 Requirement Flow

4.1 General Requirements

4.1.1 Any person under 18 years of age shall not work with radioactive materials, radiation producing machines or enter any radiation restricted areas.

4.1.2 Exposure levels from radioactive materials or radiation producing machines shall not exceed:

A. 0.01mrem/hr. (0.1µSv/hr.) above background outside any Halliburton property boundary line.

B. 2mrem/hr. (.02 mSv/hr.) outside of any Radiation Restricted Area or Dose to Members of the Public

4.1.3 Table 1 Exposure Limits outlines the Regulatory and Halliburton Annual Dose Limits as well as the Investigation Actions Levels that shall be adhered to. All Halliburton locations shall review local/country specific regulations and establish more restrictive Annual Dose Limits and Action Levels as applicable.

A. Any Regulatory Annual Dose Limit exceeded, shall require notification to the regulatory body.

B. Any employee exceeding the Annual Occupational Dose Limit, shall cease all work with radioactive material and radiation producing machines for the remainder of the calendar year.

C. Any Investigation Action Level exceeded, shall be reported as outlined in this standard.

Personnel	Dose Type	Regulatory Annual Dose Limit	Halliburton Annual Dose Limit	Investigation Action Level
Radiation Worker	Whole Body Dose	5000 mRem (50 mSv)	4000 mRem (40 mSv)	500 mRem/qtr (5.0 mSv)
	Lens Dose	15000 mRem (150 mSv)	12000 mRem (120 mSv)	500 mRem/qtr (5.0 mSv)
	Shallow Dose	50000 mRem (500 mSv)	40000 mRem (400 mSv)	500 mRem/qtr (5.0 mSv)
	Extremity Dose	50000 mRem (500 mSv)	40000 mRem (400 mSv)	500 mRem/qtr (5.0 mSv)
Non-Radiation Worker	Whole Body Dose	500 mRem (5 mSv)	500 mRem (5 mSv)	100 mRem/yr. (1.0 mSv) *(From an Area Badge)*
Member of the Public	Whole Body Dose	100 mRem (1 mSv)	100 mRem (1 mSv)	
Embryo / Fetus	Whole Body Dose	500 mRem (5 mSv)	500 mRem (5 mSv)	50 mRem/month (0.5 mSv)

Table 1 Exposure Limits

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4.2 Dosimetry Services

4.2.1 Dosimetry Service Activation

A. For all new locations, prior to the procurement of radioactive material or radiation producing machines, the location shall make a request to the GRSO to activate dosimetry services through the selected service provider of Global Radiation Safety department.

B. As applicable, dosimetry activations include area and personnel dosimetry.

4.2.2 Dosimetry Service Termination

A. When terminating area or personnel dosimetry services, the RSO shall complete FO-GL-HAL-HSE-1202E - Radiation Dosimeter Termination and submit the form to FHOUDOSIMETRY@halliburton.com.

4.3 Dosimetry Types

4.3.1 Area Dosimetry

A. Reference WM-GL-HAL-HSE-1202A - Dosimetry Program Management for additional information regarding area dosimetry and BSD-GL-HAL-HSE-1203A - Storage Areas for additional information regarding Permanent and Temporary Storage Areas.

B. At a minimum, area dosimeters shall be placed at:

I. At each Full Scale Permanent Storage Area/s on the boundary (outer perimeter) of all vertical sides of a Radiation Restricted Area.

II. At each Limited Scale Permanent Storage Area/s, a single area dosimeter is sufficient.

III. At each Radiation-Producing Equipment Use (operated) Areas. This does not include handheld radiation-producing machine/s.

a. Machines in dedicated rooms and enclosed machines that require room shielding, shall have area dosimeters on the outside perimeter of all vertical walls of the room(s).

b. Desktop machines shall have a dosimeter placed where the operator stands during use.

C. Additional Dosimeters may be placed on other non-restricted occupied areas to demonstrate the dose limits are not exceeded.

D. Temporary Storage Areas are not subject to area dosimetry requirements unless otherwise required by local/county regulations.

E. The FO-GL-HAL-HSE-1202G - Dosimeter Area Monitoring form shall be completed and submitted to FHOUDOSIMETRY@Halliburton.com to activate dosimeters for area monitoring.

E. Area Dosimeters shall:

I. Be placed between 1 and 1.5 meters above the ground or other walking / working surfaces to demonstrate the employee or public dose limits are not exceeded.

II. Not be worn by individuals.

III. Have the Remove tab removed from the dosimeter prior to posting.

4.3.2 Personnel Dosimetry

A. Prior to personnel being issued personnel monitoring badge, the RSO shall use WM-GL-HAL-HSE-1202A - Dosimetry Program Management to make the determination if personal dosimetry is required.

I. If the determination is made that personnel dosimetry is required:

a. Personnel shall be provided with the Dosimetry Care information as outlined in this standard.

b. Complete the Radiation Dosimeter Request, submitted through the Radiation Safety SharePoint to activate personal dosimetry.

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c. If an employee requesting a Dosimeter was previously monitored at a former employer, they shall authorize Halliburton to obtain this information from their previous employer by completing FO-GL-HAL-HSE-1202C - Radiation Exposure Request. If after a reasonable effort Halliburton is unable to obtain the employee's Dose history for the current calendar year, the employee shall be assigned 25% of the annual regulatory limit for every quarter employed by their previous company during the current year and documentation shall be made in the Global Radiation Safety files

d. Remove the Remove tab from the dosimeter prior to issuing the dosimeter.

B. All operations using new types of Radioactive Material or handheld Radiation-Producing Machine(s) shall use personal monitoring for a minimum of four consecutive quarters. After four consecutive quarters of representative Radioactive Material or handheld Radiation-Producing Machine(s) utilization, the RSO and GRSO will review exposure data to determine if the new operation produced an allowable exposure ≥ 10% or <10% of the regulatory requirements. If local regulations allow and the determination confirms allowable exposure is <10% of the regulatory requirements, personal monitoring can be discontinued upon GRSO approval.

4.3.3 Visitor Dosimeters

A. A visitor dosimeter shall be assigned to any personnel that meets the requirements outlined in this standard that requires immediate personnel dosimetry.

B. Additionally, as outlined in this standard, visitor dosimeters are used to replace the lost or damaged dosimeter of a participant before the participant utilizes radioactive material, radiation producing machines or enters a Radiation Restricted Area.

C. A visitor dosimeter is assigned by completing a Radiation Dosimeter Request submitted through the Radiation Safety SharePoint.

D. Prior to issuing the visitor dosimeter, remove the Remove tab from the dosimeter.

E. If additional visitor dosimeters are needed, contact the GRSO.

4.3.4 Control Dosimeters

A. Control Dosimeters shall:

I. Be stored with all unused, unassigned, or collected dosimeters and stored in a low background area.

II. Be kept in each dosimeter storage area (a minimum of one)

III. Not be interchanged between groups or batches of personal dosimeters.

IV. Not be worn by individuals.

V. If additional control dosimeters are needed, contact the GRSO.

4.3.5 Real Time Dosimeter (Self-Reading)

A. Dosimeters that provide real-time exposure monitoring information, such as digital dosimeters, self-reading pocket dosimeters and neutron bubble detectors shall:

I. Not be acceptable alternatives for an individual's issued personal dosimeter.

II. Only be used as supplemental devices to provide individuals real-time dose information when performing activities where higher exposures may be possible.

III. Be calibrated per the manufacturer's recommendation.

4.3.6 Extremity Dosimetry

A. Extremity dosimetry shall be issued:

I. To handheld radiation producing machine operators prior to the machine being used (operated).

II. When performing activities with the hands where higher exposure may be possible. When in doubt, contact the GRSO.

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4.3.7 Fetal Dosimeters

A. A fetal dosimeter shall be:

I. Issued to any occupationally employee that has chosen to declare her pregnancy as outlined in this standard.

II. Be worn on the abdomen of the Declared Pregnant Woman and exchanged monthly.

4.3.8 Other (Internal (Physical) Monitoring)

A. Personnel involved in operations which utilize, at any one time, more than 100 mCi of Tritim in a non-contained form, other than metallic foil, shall have Bioassay performed within one week following a single operation and at monthly intervals for continuing operations.

B. Urinalysis shall be the method used for internal exposure monitoring.

C. The results of the urinalysis shall be made available to the affected employee and recorded on the employee's annual exposure report.

4.4 Dosimetry Care

4.4.1 Prior to personnel being issued a personnel monitoring badge, personnel shall read, acknowledge, and agree to the Dosimetry Care Instructions outlined below. The personnel dosimeter provides a record of the Halliburton occupational radiation exposure received and should be cared for accordingly. Personnel issued dosimeters shall:

A. Only be worn by the person to whom they are issued to.

B. Always be worn while on duty when performing work for Halliburton. Do not allow the dosimeter to be exposed to non-work-related sources of radiation. If you become aware that your dosimeter has been exposed to any non-work-related radiation sources, immediate notification shall be made to the RSO.

C. Be stored in a cool dry place away from sources of radiation when not in use.

D. Be positioned on the front torso between the neck and waist with the front or name side of the dosimeter facing outward. Ensure that the dosimeter is securely fastened to prevent loss. Ring/wrist dosimeters (if issued) shall be worn as directed by the RSO.

E. Be timely returned and exchanged for a new dosimeter as instructed by the RSO.

F. Immediately reported to the RSO by completing FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report if the personnel dosimeter is lost or damaged. No work with any sources of radiation will be permitted until a replacement dosimeter has been issued.

G. Shall not be worn during or after receiving diagnostic or therapeutic medical procedures involving radiation, such as nuclear medicine or radiation therapy. If the employee has or plans to have such treatment, the employee shall contact the RSO to advise they do not meet the medical requirement to wear the Halliburton issued dosimetry. The RSO shall direct the employee to contact the Halliburton medical group at FHOUMEDICAL@Halliburton.com for assistance in the completion of a medical eval. to resume work requiring the use of dosimetry.

4.4.2 Deliberate or intentional exposure of the personnel dosimeter to a source of radiation, either work-related or non-work-related, with the intent to provide inaccurate monitoring data is prohibited and may be considered a violation of the company's Code of Business Conduct.

4.4.3 When traveling, travelers shall leave dosimeters at their hme location and contact the RSO at the destination to obtain a visitor's badge. If destination location is not able to provide a visitor's badge the following measures shall be taken:

A. Employees shall carry dosimeters separate from luggage and request that transit security hand-check their dosimeters. Dosimeters shall never be placed in checked or carry-on baggage. If transit security insists on checking Dosimeters using carry-on baggage scanners, employees shall comply with the requests.

B. If employees work in locations that require dual monitoring by both global vendor and local government, both dosimeters shall be taken when traveling to jobsites, service centers, or training facilities.

4.5 Dosimetry Processing

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4.5.1 Dosimetry processing includes completing the following actions (as applicable). Refer to WM-GL-HAL-HSE-1202A - Dosimetry Program Management for details.

A. Dosimetry Exchanges:

I. Collect all used and un-used dosimeters. Used dosimeters are allowed to be collected prior to the exact end of the wear period.

II. A new dosimeter shall be issued / posted at the time of collection.

a. Ensure the Remove tab on the dosimeter has been removed.

III. Complete a Floor to Book process to account for all dosimetry badges.

a. For dosimetry that is Lost, submit a FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

b. For dosimetry that is Late, create a OneView Action Plan.

B. Dosimetry Returns:

I. For any damaged dosimeters, complete FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

II. Dosimeters returned shall include a Control Dosimeter that is designated for the monitoring badges being returned.

III. Dosimetry shall be postmarked (date of return) to the vendor by the 20th of the month following the end of the Wear Period. The site shall maintain documentation demonstrating the postmarked date (date of return) to the vendor.

4.6 Dosimetry Documentation

4.6.1 Dosimetry Investigations

A. Dosimeters above the Investigation Action Level described in Table 1: Exposure Limits, Lost or Damaged Dosimeters or for an Inaccurate Dose assigned shall be reported as per this standard.

I. Action Level Exceeded for a Radiation Worker or an Employee's Pregnancy shall be reported by completing FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

a. The GRSO will make the determination if the reported exceeded dose will be classified as a Significant Incident, and require a Taproot investigation with a SIR in accordance with ST-GL-HAL-HMS-0804 - HSE & SQ Event Management to be completed by the RSO and Local Management.

b. Any event causing elevated, or overexposures of multiple individuals shall be classified by the cumulative Dose received from that event.

II. Action Level Exceeded for a Non-Radiation Worker or Member of the Public, all Halliburton locations that store radioactive material or radiation producing machines, that has an area dosimeter that exceeds 100 mRem/yr (1 mSv) for the previous calendar year (cumulative YTD total), that location shall investigate the dose by completing FO-GL-HAL-HSE-1202H – Member of the Public and Non-Radiation Worker Annual Dose Assessment by April 30th of each calendar year.

a. Verify the calculated final dose for a Member of the Public is below 100 mRem/yr (1 mSv) from calculations completed on the FO-GL-HAL-HSE-1202H – Member of the Public and Non-Radiation Worker Annual Dose Assessment . If the dose equals or exceeds 100 mRem/yr. (1 mSv), contact the GRSO for further instruction.

b. Verify the calculated final dose for a Non-Radiation Worker is below 500 mRem/yr (5 mSv) from calculations completed on the FO-GL-HAL-HSE-1202H – Member of the Public and Non-Radiation Worker Annual Dose Assessment . If the dose equals or exceeds 500 mRem/yr. (5 mSv), contact the GRSO for further instruction.

III. Lost or Damaged Dosimeters:

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a. Any lost or damaged dosimeters shall be reported by completing FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

b. The RSO shall:

i. Review the completed FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

ii. Complete the explanation of the dose estimate based upon previous dose history and work performed during the monitoring period and make a recommended assigned dose.

iii. Issue a visitors' badge as outlined in this standard to replace the lost or damaged dosimeter before the employee utilizes Radioactive Material or enters a Radiation Restricted Area.

IV. Inaccurate Dose Assigned:

a. Upon the RSO's review of the monthly/quarterly/annual exposure report, if a dose that was assigned is thought to be inaccurate, such as higher/lower dose than what has been historically assigned for the type of work, the RSO shall complete FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

b. An explanation and the recommended assigned dose shall be estimated based upon the previous dose history and work performed during the monitoring period.

B. Upon completion, the RSO shall maintain a copy of the completed forms on site for review and as applicable, submit the completed forms to FHOUDOSIMETRY@halliburton.com for the GRSO to review.

C. All incident severity classification and investigations shall be subject to the review of GRSO (i.e. travel X-ray exposure, planned exposure).

4.6.2 Monthly / Quarterly Exposure Reports:

A. The RSO shall:

I. Generate the employees monthly or quarterly dose report(s) within 30 days of the dose report(s) being made available by the selected service provider of Global Radiation Safety department.

II. Review the information on each monthly or quarterly dose report for accuracy.

a. As outlined in this standard, investigate and report, any exposure(s) exceeding the action limits (described in Table 1) or any inaccurate dose that was assigned.

III. Sign and date the monthly or quarterly dose report.

IV. Maintained reports on site for review.

B. Personnel shall contact the RSO to review their exposure results.

4.6.3 Annual Exposure Reports:

A. The GRSO shall:

I. Generate and distribute the Annual Form 5 Cover Letters to the locations by March 30th of each calendar year.

B. The RSO shall:

I. Generate the employees Annual Form 5 Exposure Reports from the selected service provider of the Global Radiation Safety department.

II. Review the information on each Annual Form 5 Report for accuracy.

III. If an employee has an internal dose data from a Bioassay analysis, this information shall be added to the employee's annual dose summary.

IV. Input the respective operating license number, sign, and date each Annual Form 5 Report.

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V. Distribute a copy of the Annual Form 5 Report and Cover Letter to any personnel whose annual Dose is greater than or equal to 100 mRem (1.00 mSv) or any participant who requests a copy of their annual Dose by April 30th of each calendar year. The distribution to the employees shall be documented.

VI. Maintain a copy of the Annual Form 5 Report within the local radiation safety program.

4.6.4 Notification of Pregnancy:

A. Notification of pregnancy shall be voluntary pursuant to US 10 CFR 20.1003 and 20.1208.

B. If an occupationally exposed employee chooses to declare her pregnancy, she shall provide notice in writing by completing FO-GL-HAL-HSE-1202B - Radiation Employee's Voluntary Notification of Pregnancy and submit it to the RSO.

C. The RSO shall forward the completed form FO-GL-HAL-HSE-1202B - Radiation Employee's Voluntary Notification of Pregnancy to FHOUDOSIMETRY@halliburton.com.

D. The GRSO shall review the declaration, job duties, dose limits and possible work restrictions for the employee shall be determined.

E. Any Declared Pregnant Woman that receives, or is expected to receive, a Dose equal to or greater than the action level shall not be allowed to work with Halliburton Radioactive Materials and / or Radiation Producing Machines for the duration of the pregnancy.

F. The maximum permissible Dose to the Embryo / Fetus of a Declared Pregnant Woman shall be 500 mRem (5 mSv) for the entire Gestation Period unless local regulations are more restrictive.

G. The declaration shall remain in effect until the Declared Pregnant Woman voluntarily withdraws the declaration in writing.

5.0 Training

5.1 Radiation Safety Training Curricula shall be assigned as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

6.0 References

6.1 BSD-GL-HAL-HMS-100 - HMS Definitions

6.2 BSD-GL-HAL-HSE-1203A - Storage Areas

6.3 FO-GL-HAL-HSE-1202B - Radiation Employee's Voluntary Notification of Pregnancy

6.4 FO-GL-HAL-HSE-1202C - Radiation Exposure Request

6.5 FO-GL-HAL-HSE-1202E - Radiation Dosimeter Termination Request

6.6 FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report

6.7 FO-GL-HAL-HSE-1202G - Dosimeter Area Monitoring

6.8 FO-GL-HAL-HSE-1202H – Member of the Public and Non-Radiation Worker Annual Dose Assessment

6.9 ST-GL-HAL-HMS-0804 - HSE & SQ Incident Management

6.10 ST-GL-HAL-HSE-1201 - Radiation Safety Administration

6.11 WM-GL-HAL-HSE-1201A - Radiation Safety Training

6.12 WM-GL-HAL-HSE-1202A - Dosimetry Program Management

7.0 Documentation & Recordkeeping

7.1 All HSE documents and records shall be kept as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

8.0 Responsibilities

8.1 The responsibilities of HSE/SQ personnel, management, employees, contractors, the GRSC, GRSO, RSO and authorized persons radiation worker are outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

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9.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
27-July-2023	7	Bradley Seguin / Lee Heft	06-May-2024 – Annual review and update. No changes made. 27-Jul-2023 - General Administrative Review, clarification of requirements to investigate Non-Radiation Worker Annual Exposure.
27-JUL-2022	6	Bradley Seguin / Lee Heft	The addition of BSD- BSD-GL-HAL-HSE-1203A - Storage Areas, organization of dosimetry types, dosimetry care information and dosimetry processing.
28-April-2022	5	Bradley Seguin / Lee Heft	Added in dosimetry requirements from ST-GL-HAL-HSE-1208 - Radiation-Producing Machines. Additional clarification on when area and personnel dosimetry is required
17-Dec-2021	4	Bradley Seguin / Lee Heft	Additional time and clarity provided to return dosimetry and for the RSO to generate the annual form 5 reports.
25-MAR-2020	3	Pete Hernandez	Added clarifying definitions, changed exposure to Dose throughout, changed monitors to dosimeters throughout. Clarified significant incident requirement.
29-AUG-2017	2	John Snow	General Revision. Consolidation of action limit tables, Correction of Action Limits, Addition of WM-GL-HAL-HSE-1202A - Badge Issuing, Removal of Landauer Account Access Information, Removal of work method related information, Change Low Level Exposure to significant incident and taproot required, Revision of Employees Requiring Badges, Revision of Employees Not Requiring Badges.
02-DEC-2015	1	Jillian Mead	Initial Release

For questions, comments or previous versions of HSE documents please send using the Global HSE Support Request Form.

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1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines. This standard concerns a Critical Focus Area and improper attention to this standard may result in personal injury, death, or regulatory penalty.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide.

Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Radioactive Source Control and Accountability Requirements

Figure 1: Radioactive Source Control and Accountability Flow

4.1 **General Requirements:**

4.1.1 All facilities, prior to the procurement/purchasing/possession/usage/operation of radioactive material or radiation producing equipment either from a third-party vendor or from another Halliburton location, shall adhere to the requirements outlined in the Global HSE/HMS Radiation Safety Program.

4.1.2 All Authorized Person(s) shall have access to the Global HSE Radiation Safety Program, WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures and equipment manuals/procedures as applicable.

4.1.3 Radioactive material and radiation producing equipment shall only be stored and used in areas approved by the RSO and meet the requirements as outlined in this standard.

4.1.4 Containment devices/equipment (i.e.: hole covers, magnetic trays, securely closed caps/lids/latches/doors/etc.) shall be used to:

A. Protect people and environment from the unplanned exposure to radioactive material(s).

B. Prevent the loss of radioactive material in the unplanned event of loss of control.

4.2 **Storage:**

4.2.1 All radioactive material and radiation producing equipment storage areas shall:

A. Only include inventory owned by Halliburton Energy Services, Inc.

B. At a minimum, it accommodates the maximum number of sources/equipment licensed to be stored in the area/location at any one time.

C. Be secured to restrict access to only Authorized Persons.

D. Constructed to minimize radiation exposure, danger from fire, explosion, surface/ground water accumulation, unauthorized entry, and theft.

E. Meet the applicable requirements as outlined in this standard.

4.2.2 All Full Scale radioactive material storage areas shall be reviewed and approved by the GRSO prior to usage in a MOC.

4.2.3 All Category 2 quantities of radioactive material (or higher) storage areas shall be reviewed and approved by the Global Security Operations Center prior to usage in a MOC.

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4.2.4 Storage areas are separated into two categories, Permanent and Temporary Storage areas. Reference BSD-GL-HAL-HSE-1203A – Permanent & Temporary RAM Storage Areas for additional information and examples on the requirements outlined in this standard.

4.2.5 Permanent storage areas at Halliburton facilities containing radioactive material considered Category 2 or Full Scale, shall have a distance of at least:

A. 50 ft. (16 m) away from any explosives storage or use area unless a variance has been documented and approved in an MOC.

B. 100 ft. (32 m) from the Halliburton property boundary line unless a variance has been documented and approved in an MOC.

4.2.6 PSL shared radioactive material and radiation producing equipment storage area/s, shall clearly be segregated, and marked to identify each PSL and their radioactive material inventory. Reference to GD-GL-HAL-HSE-1203A – Barriers, Segregation and Containment of Radioactive Material.

4.3 **Use:**

4.3.1 All radioactive material and radiation producing equipment that is in a controlled or unrestricted area and that is not in a storage area (as applicable) shall be controlled under the constant surveillance by an Authorized Person or use devices and/or administrative procedures to prevent unauthorized access/utilization.

4.3.2 Well Logging Supervisors shall be physically present at a well site whenever sealed sources are being handled or are not stored and locked in a vehicle or storage area.

4.3.3 Radioactive material at the well site shall be attended by Halliburton unless a MOC has been approved by the GRSO that documents the customers responsibility.

4.3.4 Radiation survey instruments used for radiation quantitative measurements shall be in the on position and set to where the audible alarm can be heard anytime:

A. Radioactive material 100mCi (3.7GBq) or greater is in an unshielded condition.

B. Neutron Generators or Radiation Producing Machines (not required for minimal threat machine(s)) are powered on at operating voltage.

4.3.5 As outlined in this standard, radiation signage shall be conspicuously posted as applicable to the measured radiation exposure level in the area.

4.3.6 Radioactive material shall be used/handled using the applicable PSL source handling equipment identified through PSL training, procedures, etc.

4.3.7 Prior to and after operation of a radiation producing machine (excluding handhelds), FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log shall be completed to ensure all interlocks, warning lights and other emergency control measures are operating properly.

4.4 **Security:**

4.4.1 Storage area exceptions or other designs that do not meet the security requirements as outlined in this standard, shall require an additional approval by the global facilities security manager and/or the security project manager in a MOC.

4.4.2 All radioactive material and radiation producing equipment shall be:

A. Secured from unauthorized access/removal/utilization. Any known or suspected unauthorized access/removal/use or loss shall follow WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures be immediately reported to the GRSO.

B. Accessed only by Authorized Persons who are acquired and current in their assigned radiation safety training curricula outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training.

C. Secured within in a properly posted storage area when not in use.

4.4.3 Physical Barriers:

A. Location inventory is separated into 3 groups which contains security requirements and physical barriers specific to each group to prevent the unauthorized removal or access of radioactive material and/or radiation producing equipment.

I. Full Scale (see BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions)

a. Two independent physical barriers.

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b. As applicable, all Halliburton locations containing or is licensed to store Category 2 quantities of radioactive material or greater, shall:

i. Adhere to the requirements set forth in Corporate Security business practice (BP) 4-11211 - Radiation Storage Facility Risk Mitigation Methodology (non-transportation). Review Local/Country regulations for additional controls.

ii. Only Authorized Personnel who have completed a background check, are specifically approved in writing and have been assigned and successfully completed the Security Training: Radioactive Material, Quantities of Concern (RAM QC) outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training shall be permitted unescorted access to Category 2 quantities of radioactive material, as applicable.

iii. RSO's shall contact Fhoubadge@Halliburton.com for Badge Access.

II. Limited Scale (see BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions)

a. One physical barrier.

III. Radiation Producing Machines (see BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions)

a. One physical barrier. As applicable, the control panel of each radiation-producing machine shall be equipped with a locking device that will prevent the unauthorized use of the system.

B. Reference GD-GL-HAL-HSE-1203A - Barriers, Segregation and Containment for Radioactive Material for additional information on requirements outline in this standard.

4.4.4 Lock & Key Management:

A. All transport shields, containers, densometers, etc. shall be secured utilizing the PSL designated lock and key assembly.

B. All keys within a radiation safety program used to prevent the unauthorized removal, access or use of radioactive material or radiation producing equipment shall be:

I. Assigned to responsible Authorized Person(s) who are acquired in the applicable curricula(s) outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training.

II. Secured and accessible by an Authorized Person who maintains control of their key(s) at all times. Keys shall not be left unsecured.

4.5 **Exposure:**

4.5.1 Area and Personnel Dosimetry:

A. When working with radioactive materials and/or radiation producing equipment, the ALARA principle shall be used to keep doses and exposures As Low As Reasonably Achievable. Reference ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring Program for the requirements for Area and Personnel dosimetry.

4.5.2 Surveys, Instruments & Exposure Limits:

A. Reference ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments for the survey instrument requirements, the radiation exposure limits that shall not be exceeded, and the radiation surveys that shall be made and recorded (as applicable).

4.6 **Posting & Labeling:**

4.6.1 Signage:

A. All radiation signage shall:

I. Be maintained in a good, legible condition. Any signage that is deteriorated or defaced which impairs its legibility, quick recognition, or meaning shall be replaced.

II. Bear the standard radiation symbol (trefoil) in magenta, purple or black on a yellow background.

III. Be conspicuously posted at all entrances to the storage and/or use area as applicable to the measured radiation exposure level. Not applicable for handheld x-ray equipment in use areas. Additional signage may be used.

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IV. Contain the words:

a. "CAUTION, RADIOACTIVE MATERIAL" or "CAUTION, X-RAY EQUIPMNET"

i. As most applicable.

b. "CAUTION RADIATION RESTRICTED AREA"

i. For an exposure rate ≥ 2mRem/hr. (.02mSv/hr.).

ii. As per ST-GL-HAL-HSE-1202 – Radiation Exposure Monitoring Program, any individual required to enter a Radiation Restricted Area (or greater) shall be monitored with personnel dosimetry.

c. "CAUTION RADIATION AREA"

i. For an exposure rate ≥ 5mRem/hr. (.05mSv/hr.).

d. "CAUTION HIGH RADIATION AREA" or "DANGER HIGH RADIATION AREA"

i. For an exposure rate ≥ 100mRem/hr. (1mSv/hr.).

ii. All Radiation producing machines creating a High Radiation Area shall be equipped with a control device that:

- Causes the level of radiation to be reduced lower than a dose of 100 mrem/hr. (1mSv/hr.) upon entry into the area.
- Energizes a visible or audible alarm signal in such a manner that the Authorized Person(s) entering the High Radiation Area is made aware of the entry.

e. "GRAVE DANGER, VERY HIGH RADIATION AREA"

i. For an absorbed dose ≥ 500 rads (5 grays) in 1 hour at 1 meter from a source of radiation.

B. In addition to the above requirements, storage areas (as applicable) shall be posted with the below sign that reads:

I. IN CASE OF EMERGENCY CONTACT HALLIBURTON

a. Global Security Control Center +1-281-575-5000 (or)

b. Local Facility Phone Number: ________________ (as required per local regulations)

C. Area(s) containing sources of radiation for periods less than 8 hours shall be exempt from posting if:

I. The sources of radiation are constantly attended during these periods by an Authorized Person who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits as outlined in ST-GL-HAL-HSE-1202 – Radiation Exposure Monitoring.

II. The area or room is subject to control by an Authorized Person.

D. Refer to local/country regulations as the signage requirements may vary from country-to-country.

4.6.2 Labeling:

A. All labeling used shall be maintained in a good, legible condition. Any labeling that is deteriorated or defaced which impairs its legibility, quick recognition, or meaning shall be replaced.

B. All Radioactive Material and/or Containers containing radioactive material, not currently in or a planned shipping and transportation status, shall be labeled specific to each group below to communicate the hazard. Reference:

I. GD-GL-HAL-HSE-1203A - Barriers, Segregation and Containment for Radioactive Material for additional information and examples on requirements outline in this standard.

II. ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material for the applicable shipping and transportation labeling requirements.

C. Radioactive Material meeting the requirements of:

I. Full Scale:

a. Each source/source holder used for well logging activities shall be engraved and contain:

i. The standard radiation caution symbol (trefoil)

ii. The wording "DANGER (or CAUTION), RADIOACTIVE, NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)".

b. The engraving is completed prior to shipping from Halliburton manufacturing. To verify the engraving and labeling is in good, legible condition, see the Inspection and Maintenance section of this standard.

c. Verify local/country regulations for additional labeling requirements.

II. Limited Scale:

a. Shall be labeled with:

i. The standard radiation caution symbol (trefoil) or

ii. Caution Radioactive Material or

iii. The Radioactive Material Excepted Package Label containing the applicable UN Number as outlined in ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material.

b. For radioactive material meeting the requirements of Limited Scale that physically cannot be labeled, the container/containment device and devices, shall be conspicuously labeled to communicate the hazard as outlined in this standard. For example:

i. Th-232 (Thorium Blankets) shall be secured in the appropriate PSL bag. Bag part numbers can be referenced on the Radiation Safety SharePoint.

ii. Co-60 (Marker Beads) not installed in a collar/tool, shall be individually secured in Tape Strips (p/n: 101537702) and be placed in a secondary container (i.e. p/n: 101344460) that is conspicuously labeled to communicate the hazard as outlined in this standard.

c. For radioactive material meeting the requirements of Limited Scale but is built/installed into a superior equipment that superior equipment's outer most surface, shall be conspicuously labeled to communicate the hazard as outlined in this standard.

D. Containers/Containment Device:

I. All containers/containment devices used shall be maintained in a good condition. Any containers/containment device(s) that is deteriorated, damaged, defaced or in any other condition which impairs its legibility, integrity, containment purpose, etc. shall be replaced.

II. Full Scale (Type A Pkg.)

a. The exterior of each Type A Pkg., containing radioactive material, shall have attached labeling (i.e., Assay Tag) that at a minimum includes the following:

i. The standard radiation caution symbol (trefoil).

ii. The wording "DANGER (or CAUTION), RADIOACTIVE, NOTIFY CIVIL AUTHORITIES (OR NAME OF COMPANY)".

iii. The radionuclides/isotopes, activity and, date of manufacture (assy date).

III. Limited Scale (Excepted Pkg.)

a. The exterior of each Excepted Pkg. containing radioactive material shall have attached labeling that at a minimum includes the following:

i. The words "Caution Radioactive Material" or

ii. The Radioactive Material Excepted Package Label containing the applicable UN Number as outlined in ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material.

E. Radiation Producing Equipment:

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I. Each radiation producing machine shall be labeled with a conspicuous sign(s) bearing the radiation symbol (trefoil) and cautions the individual that radiation is produced when energized. For all non-handheld radiation producing equipment, this label shall be affixed on the face of the control unit.

F. Any component (housings, bags, containers, etc.) that previously contained radioactive material that no longer contains radioactive material, shall have the labeling removed or covered so that the hazard is no longer communicated.

4.6.3 Logs:

A. The applicable Log shall be available and utilized:

I. FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log for all permanent storage areas when radioactive material or handheld radiation producing machine is moved in and/or out of the storage area.

II. FO-GL-HAL-HSE-1203D - Controlled Marker Bead Storage In/Out Log for all permanent storage areas when radioactive marker beads are moved in and/or out of the storage area.

III. FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log for all non-handheld radiation producing machines to ensure all interlocks, warning lights and other emergency control measures are operating properly.

4.7 **Inventory:**

4.7.1 Physical Inventories shall be:

A. Completed every three months (unless required more frequently by local/country regulations)

B. Documented in Appian GREX Quarterly Compliance Assessment. Alternatively, if instructed and approved by the GRSO, FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment (QCA) can be used.

4.7.2 Each PSL shall:

A. Be responsible for their appointed PSL radioactive material or radiation producing machine inventory within the PSL designated storage area(s) and/or operational area/s, documenting the information required on the applicable inventory sheet.

I. RAM Inventory – All Full / Limited Scale radioactive material (excluding Co-60)

II. X-Ray Inventory – All Radiation Producing Machines

III. Co-60 Inventory

B. Be present at the time the physical inventory count is performed to ensure that all radioactive material or radiation producing machine inventory is accounted for, within the shared storage area(s), as applicable.

4.7.3 All inventory discrepancies, shall immediately be communicated to the GRSO.

4.7.4 During the QCA, the RSO shall review the PSL / Plant radioactive material inventory for potential source disposition. WM-GL-HAL-HSE-1203C - Radiation Source Disposition outlines the requirements for when to redeploy and the process to retire radioactive material. The RSO shall check for:

A. Redeployment

B. Retirement

C. Abandonment / Lost

4.7.5 Reference ST-GL-HAL-HSE-1201 - Radiation Safety Program outlines the requirements for the deactivation of a SAP Plant and GD-GL-HAL-HSE-1203B - Operations Exit and Facility Disposition Guideline in the case of an operation exit from a facility requiring all of the radioactive material inventory to other facilities or manufacturing. When a plant / PSL disposition is required from a facility, complete the below forms as applicable:

A. CL-GL-HAL-HSE-1205A - HSE RA Release of Property for Unrestricted Use and License Termination

B. FO-GL-HAL-HSE-1205D - Radioactive Materials Location Exit Report

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4.7.6 The final disposition of radioactive materials for disposal designated by the manufacturing facilities shall first be approved by the GRSO.

4.8 **Inspection and Maintenance:**

4.8.1 Radioactive Material:

A. To ensure the accuracy and physical condition of all labeling, marking, signage, logging tools, source handling tools, storage/transport containers and, other components critical to radiation safety, a visual inspection shall be:

I. Completed every three months.

II. Documented in Appian GREX Quarterly Compliance Assessment. Alternatively, if instructed and approved by the GRSO, FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment (QCA) can be used.

III. Verify PSL requirements/procedures and local/country regulations for more stringent/additional requirements.

B. The repair, opening, or modification of any sealed source housing shall be performed only by persons specifically authorized by the GRSO.

C. Any modification/operation, such as drilling, cutting, or chiseling on radioactive material or radiation producing equipment, is prohibited.

D. Leak Testing

I. All Halliburton locations shall adhere to the leak testing requirements defined in this standard however shall review the local/country regulations and establish more restrictive requirements as applicable.

II. Sealed sources shall not be removed from storage, used, or transported/shipped without having first been leak tested (date source wiped) and results received (date of analysis on the Sealed Source Leak Test Certificate) and reviewed prior to being returned to service.

III. Leak Test Intervals:

a. Sealed source(s) that exceed the activities described in Table 1: Leak Test Threshold Limits shall be leak tested at intervals not to exceed 6 months.

b. Densometer devices, shall be leak tested at intervals not to exceed 12 months.

c. Sealed sources exceeding the activity of 10 µCi and is designed to emit alpha particles such as Am-241 shall be leak tested at intervals not to exceed 3 months or at alternative intervals approved by the regulatory agency, the Sealed Source Device Registry, or the manufacturer.

IV. See the Appendix section of this standard for an example on how to complete the Leak Testing Intervals.

Table 1: Leak Test Threshold Limits

Radioactive Isotope	Primary Emission Type(s)	Leak Test Threshold
Am-241/Be	Neutron, Alpha	10 µCi (370 kBq)
Cf-252	Neutron	10 µCi (370 kBq)
Co-57	Gamma	100 µCi (3.7 MBq)
Co-60	Beta, Gamma	100 µCi (3.7 MBq)
Cs-137	Beta, Gamma	100 µCi (3.7 MBq)
Ta-182	Beta, Gamma	100 µCi (3.7 MBq)

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E. The following sources shall not require a leak test:

I. Sealed sources containing 100 µCi (3.7 MBq) or less of beta or gamma-emitting material or 10 µCi (370 kBq) or less of alpha or neutron-emitting material.

II. Sealed sources containing only radioactive material as a gas.

III. Sealed sources containing only hydrogen-3 (tritium).

V. Sealed sources that typically require leak testing however have been designated and/or removed from use/service, shall be labeled as "Out of Service" and "In Storage".

F. ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments outlines the radiation exposure limits that shall not be exceeded for leak test swabs.

I. Leak tests for all sealed sources shall be capable of detecting the presence of 0.005 µCi (185 Bq) of radioactive material on a test sample.

II. If a sealed source is found to be leaking reference WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures. Notification shall be made to the GRSO immediately.

a. Sealed sources shall not be moved without prior written approval and direction from the GRSO.

b. Immediately after a test is returned positive for leaking, perform another swipe, and have a confirmatory leak test performed.

c. Upon confirmation, immediately remove the source from service. Have the source decontaminated, repaired, or disposed of by a company authorized to perform these functions.

d. Check the equipment associated with the leaking source for radioactive contamination.

e. If the equipment is contaminated, have it decontaminated or disposed by a company authorized to perform these functions.

4.8.2 Security, Safety and Other Components Critical to Radiation Safety:

A. All security, safety, and other components critical to radiation safety, shall be maintained in proper operating condition and tested according to global procedures, local regulatory requirements, license/permit conditions, and/or vendor recommendations and shall be reviewed and maintained by the Corporate Security Group or an approved local vendor.

B. If any inspection reveals damage or components in poor condition, maintenance shall be performed, or the device/component shall be removed from service at the time the damage is discovered and remain out of service until repairs have been made.

4.8.3 Radiation Producing Equipment:

A. As applicable to regulatory requirements, no person shall perform radiation machine(s) services except authorized in a certificate of registration issued by the regulatory entity.

B. Prior to and after operation, an equipment inspection, maintenance, and all other applicable requirements outlined by this standard shall first be completed on FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log to ensure all interlocks, warning lights and other emergency control measures are operating properly.

4.9 Abandonment:

4.9.1 In the case radioactive material becomes stuck downhole:

A. The incident shall be reported within the Global Radiation Abandonment Tracking System (GRATS) and follow WM-GL-HAL-HSE-0601J - Radiation Safety Emergency Procedures.

B. The recovery shall be conducted by the customer per the Halliburton Master Service Agreement.

I. A reasonable effort at recovery shall be made by the customer in the event a Sealed Source is lost or lodged downhole.

II. No attempt to recover a Sealed Source shall be conducted in a manner that could result in a source rupture.

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C. The licensee shall continuously monitor, with an appropriate radiation detection instrument or a logging tool with a radiation detector, the circulating fluids from the well, if any, to check for contamination resulting from damage to the sealed source.

I. In the case any Sealed Source that has been ruptured or is likely to have been ruptured, immediate notification to the GRSO shall be made.

II. Reference ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments.

4.9.2 In the case efforts to recover a sealed source by the customer are unsuccessful the following measures shall be taken:

A. The Sealed Source shall be immobilized and sealed in place with a red dye cement plug.

B. A whipstock or other means of preventing inadvertent intrusion on the source shall be made unless the source is not accessible to any subsequent drilling operations.

C. A permanent identification plaque containing the abandonment information shall be secured at the surface of the well if possible. Otherwise, a completed template will be kept on file.

D. Notification of the final abandonment shall be made to the regulatory agency within 30 days.

4.10 **Sale:**

4.10.1 All sales of radioactive material and radiation producing equipment shall:

A. First be approved by the GRSO.

B. Require that the final recipient of the radioactive material provide a possession license to the sending RSO prior to shipment. All final documentation shall be provided to GRSO.

C. Require an AMI correction form to be submitted to remove the sources from the locations inventory to archive.

4.11 **Naturally Occurring Radioactive Material (NORM):**

4.11.1 Naturally Occurring Radioactive Material (NORM) can deposit over an extended period on the inner surfaces of tubular goods, in tanks, filters, or on downhole tools, including wirelines and coiled tubing during the production of hydrocarbons. Due to the human interaction that concentrates the radioactivity, it is sometimes referred to as TENORM or Technologically Enhanced Naturally Occurring Radioactive Material. WM-GL-HAL-HSE-1203B – NORM Program provides details for facilities and operations to identify and manage NORM.

4.12 **Quarterly Compliance Assessments (QCA's):**

4.12.1 QCA's are:

A. Conducted to assure that the Global HSE Radiation Safety Program has been implemented in the location and area of operations and compliance to internal and regulatory requirements.

B. Completed every three months (unless required more frequently by local/country regulations)

I. The RSO's completion and submission of the QCA during the below periods is the assurance that the QCA has been completed to the best of their knowledge.

a. February 1st – 20th

b. May 1st – 20th

c. August 1st – 20th

d. November 1st – 20th

II. Reviewed for accuracy and approved by a member of management, able to direct and confirm corrective actions at the location, by the 28th of the respective month for each PSL. Responsibility for QCA completions and accuracy belongs to the approving manager. The approving managers approval of the QCA is the assurance that the QCA has been reviewed, is complete and accurate.

C. Documented in Appian GREX Quarterly Compliance Assessment. Alternatively, if instructed and approved by the GRSO, FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment (QCA) can be used.

D. Required for every location that is active within Appian GREX Plant Management.

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5.0 Training

5.1 Initial Training

5.1.1 Radiation safety training curricula as outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training shall be:

A. Assigned to employees according to the risks associated with employee job duties. Contact the GRSO for guidance on curricula assignment needs.

B. Completed by all employees with a passing grade of 80% or better. If a grade obtained is less than 80% the course must be retaken.

5.2 Refresher Training

5.2.1 Refresher training shall occur as follows:

A. As needed when identified by regulation, observation of employee practices, inspections, audits, or incidents.

B. Be completed on an annual basis unless otherwise specified.

6.0 References

6.1 (BP) 4-11211 - Radiation Storage Facility Risk Mitigation Methodology (non-transportation)

6.2 (BP) 4-17044 - Records and Information Management (RIM) -Lifecycle Management and Compliance

6.3 BSD-GL-HAL-HMS-100 - HMS Definitions

6.4 BSD-GL-HAL-HSE-1203A - Storage Areas

6.5 CL-GL-HAL-HSE-1205A - HSE RA Release of Property for Unrestricted Use and License Termination

6.6 FO-GL-HAL-HSE-1201A - Letter of Appointment - Radiation Safety Officer

6.7 FO-GL-HAL-HSE-1203A - Radiation Quarterly Compliance Assessment

6.8 FO-GL-HAL-HSE-1203B - Controlled RAM Storage In/Out Log

6.9 FO-GL-HAL-HSE-1203D - Controlled Marker Bead Storage In/Out Log.

6.10 FO-GL-HAL-HSE-1205D - Radioactive Materials Location Exit Report

6.11 GD-GL-HAL-HSE-1203A - Barriers, Segregation and Containment for Radioactive Material

6.12 GD-GL-HAL-HSE-1203B - Operations Exit and Facility Disposition Guideline

6.13 ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety

6.14 ST-GL-HAL-HSE-1201 - Radiation Safety Administration

6.15 ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring Program

6.16 ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments

6.17 ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material

6.18 ST-GL-HAL-HSE-1208 - Radiation Producing Machines

6.19 WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures

6.20 WM-GL-HAL-HSE-1201A - Radiation Safety Training

6.21 WM-GL-HAL-HSE-1203A - Radiation Quarterly Compliance Assessment

6.22 WM-GL-HAL-HSE-1203B - NORM Program

6.23 WM-GL-HAL-HSE-1203C - Radiation Source Disposition

6.24 WM-GL-HAL-HSE-1203D - Radioactive Material & Machine Procurement

7.0 Recordkeeping

All HSE documents shall be retained and maintained in accordance with (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance.

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8.0 Appendix

8.1 **Responsibilities**

Personnel Type	Responsibility
HSE/SQ functional personnel	Communicating requirements of this standard and any additional applicable regulations to management in their area of responsibility.
	Ensuring training meets requirements of this standard and any related applicable regulations.
Management	Communicating requirements of this standard and coordinating employee training as applicable.
	Identifying and ensuring that employees in their area of responsibility complete required training and adhere to the requirements of this standard.
	Confirming, in their areas of responsibility, that only the employees who meet the requirements specified in this standard are involved in the activities described in this standard.
	Ensuring, in their areas of responsibility, that any Contractors have complied with the requirements of ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety.
	Ensuring that Quarterly Compliance Assessments (QCA) are performed and reviewed to verify compliance with this standard and Radiation Protection Program.
Employees	Complying with requirements of this standard and all applicable local or country safety standards.
	Completing required training and complying with the requirements set forth in this standard and any additional site-specific standards, regulations, or work methods.
Contractors	Complying with requirements of this standard or equivalent and all applicable local or country safety standards, while working at Halliburton or customer properties or facilities.
Global Radiation Safety Committee	Reviewing and recommending improvements to company's radiation policies, practices, processes, and procedures.
	Reviewing the status of the company's radiation performance, including processes to ensure compliance with internal policies and goals, and applicable laws and regulations.
	Reviewing significant incidents, stop work authority and exposure monitoring for evaluation of risk and corrective measures for the prevention of future incidents.
	Reviewing internal assurance services audits, QCAs and regulatory inspections.
	Serving as the liaison to the Health, Safety and Environment and Sustainable Development Committee and providing pertinent information on radiation performance and risks.
	Reviewing regulatory agency inspections, internal audits, notices of violation of a significant nature, enforcement actions and corrective actions.
Global Radiation Safety	Developing and implementing policies, procedures, standards, training material, and work methods regarding radioactive source control and accountability.
	Supporting operations with regulatory interpretations, licensing and compliance assistance regarding radioactive source control and accountability.
Radiation Safety Officer	Completing the required training and duties outlined in Letter of Appointment - Radiation Safety Officer (RSO).
Source Handlers	Complying with requirements of this standard and all applicable local or country safety standards.
	Maintaining accountability & preventing unauthorized access to all radioactive material within their control.
	Preventing and excluding all unnecessary personnel from potential exposure to radiation.
	Ensure that each person under their supervision is knowledgeable in recognizing and responding to an emergency.

Table 2 Responsibilities

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8.1 **Example of Leak Testing:**

8.1.1 Source 123456 was first Leak Tested "Wiped" on Jan. 1st, 2023.

8.1.2 Because the Leak Test Certificate has not been provided for source 123456, this source shall have been labeled/designated as out of service and not be removed from storage, used, or transported/shipped.

8.1.3 A Leak Test Certificate for source 123456 was provided from the authorized vendor, that includes a Wiped Date of Jan.1st, 2023, and has an Analysis Date of Jan. 5th, 2023.

8.1.4 Source 123456 can first be used/transported effective Jan. 5th, 2023, as the Leak Test Certificate Analysis Date is the day the source has been certified not to be leaking.

8.1.5 Source 123456 can be used/transported until July 1st, 2023, which is the Wiped Date on the original Leak Test Certificate above.

8.1.6 Source 123456 is then again Wiped a second time on July 1st, 2023 which is in alignment with the 6 month leak test interval.

8.1.7 A second Leak Test Certificate was provided that includes a Wiped Date of July 1st, 2023, and has an Analysis Date of July 8th, 2023.

8.1.8 Source 123456 shall have been removed from service on July 2, 2023, and then returned to service on July 8, 2023, since July 8, 2023, is the new Leak Test Certificate Analysis date certifying the radioactive source is not leaking.

8.1.9 To ensure Leak Testing compliance, perform the wipe tests a few weeks before the 6-month-elapsed-time date has arrived. This will allow the authorized vendor time to analyze the samples and return the results before the 6 months has elapsed from the prior leak test.

9.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
23-FEB-2024	12	Bradley Seguin / Lee Heft	Renamed and updated link from GRITS (Global Radiation Incident Tracking System) to Global Radiation Abandonment Tracking System (GRATS) Previous highlights remain.
26-Oct-2023	11	Bradley Seguin / Lee Heft	Review began July 2023. The addition of the radiation producing machine requirements in this standard, the requirements for when survey meters shall be used when radioactive material is in an unshielded condition. The addition of key management. The addition of labeling and condition. Release of Appian GREX QCA and new approval date.
20-Oct-2022	10	Bradley Seguin / Lee Heft	Inventory alignment to RSO Appointments. The addition of WM-GL-HAL-HSE-1203D, General standard clarification.
17-Dec-2021	9	Bradley Seguin / Lee Heft	Included Corporate Security requirements for facilities licensed to store Cat. 2 quantities and the addition of storage area signage.
For questions, comments or previous versions of HSE documents please send using the Global HSE Support Request Form.			

Title: Radiological Surveys and Survey Instruments		HMS Document Number: ST-GL-HAL-HSE-1205		
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1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines. This standard concerns a Critical Focus Area and improper attention to this standard may result in personal injury, death, or regulatory penalty.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide.

Where local/country regulations or customer requirements are more stringent than the Global Health, Safety, and Environment (HSE) Standards, local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Standard-Specific Definitions

Refer to BSD-GL-HAL-HMS-100 – Global HMS and HSE Definitions for a comprehensive list of terms and definitions.

- **Quantitative Measurement** - is a measurement of data that is represented by a numeric value. (Example: using radiation survey instrument or equipment to record and document radiation surveys.)

4.0 Radiological Surveys and Survey Instrument Requirements

Figure 1 Radiological Surveys and Survey Instruments Flow

4.1 **General Requirements**

4.1.1 Routine radiation surveys are necessary to control and ensure the containment of radioactive material within specified areas, verify protective equipment, containers, and procedures.

4.1.2 The radiation survey frequency is specific to the radiation hazard and use. The survey frequency depends on the nature, quantity, type, and use of radioactive material; and the equipment and procedures that are designed to protect personnel and the environment from unnecessary radiation hazards and exposure.

4.1.3 Each site where radioactive materials and/or radiation producing machines are used and/or stored shall:

A. Maintain a sufficient number of calibrated and operable radiation survey instruments to ensure the surveys required by this standard are performed.

B. Manage all active survey equipment in accordance with ST-GL-HAL-HMS-710 – Calibration and Verification of Measuring Devices.

4.2 **Survey Types**

4.2.1 There are two types of surveys conducted at Halliburton:

A. Direct Radiation Survey which evaluates the physical presence and dose rate levels of radioactive material, the area or radiation activated from generating devices, equipment, or other sources of radiation.

B. Radiation Contamination Survey which evaluates the presence and concentration of loose or fixed radioactive material.

4.3 **Survey Frequency**

4.3.1 The radiation survey frequency is specific and required for the following activities:

A. Plant Activation or Deactivation

B. Radioactive Material Use/Handling, Storage and NORM

C. Transportation, Shipping and Receiving

D. Radiation Producing Machines

4.3.2 Plant Activation or Deactivation:

A. As outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Program, the following radiation surveys

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shall be made and recorded:

I. Prior to the activation of an SAP plant to establish the background dose rates.

II. Prior to the deactivation of an SAP plant to ensure the background dose rates have returned to normal or below.

4.3.3 Radioactive Material Use/Handling, Storage and NORM:

A. As outlined in ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability, the following radiation surveys shall be made for all radioactive material 3mCi (0.111GBq) to less than 100mCi (3.7GBq) and shall also be recorded for all radioactive material 100mCi (3.7GBq) or greater and neutron generators:

I. Prior to use (any activity/task where radioactive material will be in an unshielded condition or neutron generators will be powered on at operating voltage) to establish the background dose rates.

II. During use (any activity/task where radioactive material will be in an unshielded condition or neutron generators will be powered on at operating voltage) to establish the presence and location of a Controlled Area, Restricted Area, Radiation Area, and High Radiation Area. This survey is not required to be recorded.

III. Immediately upon the discontinued use (any activity/task where radioactive material will be in an unshielded condition or neutron generators will be powered on at operating voltage) to ensure the background dose rates have returned normal or below.

IV. Upon the removal of an encapsulated sealed source from a logging tool to verify the logging tool is free of contamination.

V. Immediately, during and after the use of an encapsulated sealed source that has been damaged, is likely or suspected to be damaged.

B. Quarterly radiation surveys shall be made for all permanent storage areas and recorded on FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment (QCA).

C. NORM surveys shall be made in accordance with WM-GL-HAL-HSE-1203B - NORM Program when a radiological evaluation of a facility or well site is applicable.

4.3.4 Transportation, Shipping and Receiving:

A. As outlined in ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material, radiation surveys shall be made and recorded prior to the transportation/shipment and upon receipt of radioactive material as applicable.

I. Prior to the transportation/shipment to ensure the proper packaging and labeling is selected/utilized as applicable to the radiation exposure levels measured:

a. On the surface of the package.

b. 1 meter (Transportation Index (T.I.)) of the package.

II. Prior to the shipment/transportation of Type A Packages and Overpacks to verify the radiation exposure levels:

a. In the occupied positions of the vehicle.

b. On the outer surface and at 1 meter (Transportation Index (T.I.)) of the vehicle.

III. Upon receipt to verify the presence of each source and exposure levels against the shipping documentation. If the surveys differ from the shipping documents, apply SWA and contact the RSO.

IV. Densometers mounted on a unit are exempt from shipping/transportation/receipt surveys at a job site. All other surveys required by this standard are required.

4.3.5 Radiation Producing Machines:

A. As outlined in ST-GL-HAL-HSE-1208 - Radiation Producing Machines, radiation surveys shall be made and recorded:

I. Anytime maintenance is conducted or the physical orientation of the device changes in a manner that could affect the exposure rates to ensure the rates are maintained at or less than

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the acceptable levels.

II. Daily (when used): (Not required for minimal threat machine(s)).

a. Pre-job with radiation-producing machine off.

b. During the job with the radiation-producing machine on at operating voltage to establish a Controlled Area, Restricted Area, Radiation Area, and High Radiation Area.

c. Post-job with the radiation-producing machine off. (For example, upon re-entry into exposure areas to confirm the equipment is de-energized and the radiation exposure is background.)

III. Quarterly on the Quarterly Compliance Assessment (QCA) as outlined in ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability.

4.4 **Survey Instruments**

4.4.1 Radiation survey instruments and equipment used for radiation quantitative measurements shall be:

A. Calibrated by an approved vendor or by an authorized Halliburton site that is licensed or registered as per the applicable regulatory requirements in accordance with WM-GL-HAL-HSE-1205A – Radiation Survey Instrument Calibration for the following:

I. Types of radiation used and at energies appropriate for use.

II. At accuracy within ±20% of the true radiation level at each calibration point.

III. Following each instrument repair that could potentially affect the instrument's calibration.

B. Calibrated at intervals not to exceed:

I. 6 months for use in well logging operations.

II. 12 months for use in non-well logging operations, radiation-producing machine operations and NORM.

III. If the regulatory body authorizes a calibration interval different than those listed above, a MOC shall be submitted to the GRSO for approval. A calibration interval shall not exceed 12 months.

C. Capable to detect, at a minimum:

I. Radioactive Materials:

a. Radiation levels from 0.1 mR/hr. (1 µSv/hr) through at least 200 mR/hr (2.0 mSv/hr) of the radiation of concern (neutron, beta, gamma or alpha).

II. NORM Determination and Identification:

a. Radiation levels from 1µRem/hr through at least 500µRem/hr. of the radiation of concern (neutron, beta, gamma or alpha).

III. Radiation Producing Equipment:

a. For the types of radiation used and at the energies appropriate and applicable to the radiation producing equipment.

D. Inspected for physical integrity, a legible calibration label, battery capacity, and operational response prior to each use.

E. In the on position and where the audible alarm can be heard anytime:

I. Radioactive material 100mCi (3.7GBq) or greater is in an unshielded condition.

II. Neutron Generators or Radiation Producing Machines (not required for minimal threat machine(s)) are powered on at operating voltage.

F. Removed from service and designated out of service if found to be inoperable, due for calibration, or is in excess/no-longer needed.

4.4.2 In addition to the requirements outlined above, radiation survey instruments used for contamination surveys shall be conducted with an approved survey meter designed for the detection of contamination, such as a scintillation detector, thin-end window, or thin-walled GM detector.

A. Instruments that measure gamma radiation and read in units of µR/hr or µSv/hr are used to

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determine if equipment, vessels, piping runs, tubulars or containers contain NORM. The recommended meter for checking the equipment for radiation is the Ludlum Model 3 survey meter with a Ludlum Model 44-2 sodium iodide detector or equivalent, to conduct surveys for gamma radiation.

B. Instruments that measure alpha/beta radiation and read in units of cpm are used to perform surveys of potentially contaminated surfaces and within gas systems to determine if equipment, vessels, piping runs, tubulars or containers contain regulated gas NORM. These instruments are also used to determine if loose surface NORM is present and to determine if NORM is present on clothing and personnel. A Ludlum Model 3 survey meter with a Ludlum Model 44-9 "pancake" type probe to measure for alpha/beta/gamma radiation or equivalent can be used for this purpose.

4.4.3 Other radiation survey instruments and equipment that is not used for radiation quantitative measurements shall be maintained in proper operating condition according to vendor recommendations, global procedures, local regulatory requirements, license, or permit conditions.

4.5 **Survey Records**

4.5.1 All HSE/HMS documents shall be retained and maintained in accordance with (BP) 4-17044 – Records and Information Management (RIM) – Lifecycle Management and Compliance and ST-GL-HAL-HMS-404 – Record Control.

4.5.2 Radiation surveys record that are required by this standard shall be recorded on the following forms (as applicable):

A. FO-GL-HAL-HSE-1203A – Quarterly Compliance Assessment is used to document the radiological survey for all permanent storage areas.

B. FO-GL-HAL-HSE-1203C - NORM Survey Data Sheet is used to document NORM surveys of vessels, equipment, tubulars, and containers whether NORM is detected or not.

C. FO-GL-HAL-HSE-1205A – Contamination Survey Log is used to document radiological surveys for potentially damaged, damaged, or if any leakage/contamination is suspected or has occurred from radioactive material.

D. FO-GL-HAL-HSE-1205B – Radiological Survey Record is used to document radiological surveys taken outside of the QCA reporting period for radioactive material storage and/or use areas.

E. FO-GL-HAL-HSE-1205D – Radioactive Materials Location Exit Report is used to document radiological surveys following the removal of all radioactive material and prior to discontinuance of the local radiation safety program for each site where radioactive material has been stored.

F. FO-GL-HAL-HSE-1206H - Controlled Jobsite Ram Transfer for all RAM movements to/from the jobsites.

G. FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log is used to document and ensure that all interlocks, warning lights and other emergency control measures and the machine is operating properly.

H. Or an equivalent form. Equivalent forms shall include the following:

I. The dates the survey was taken.

II. The individual making the survey.

III. Survey instrument equipment or serial number.

IV. Measurements in millirem per hour (mrem/hr) or micro sievert per hour (µSv/hr).

V. The exact location of the survey.

4.6 **Exposure Levels**

4.6.1 All Halliburton locations shall adhere to the exposure levels defined in this standard however shall review the local/country regulations and establish more restive exposure levels as applicable.

4.6.2 Area radiation exposure level(s) as outlined in ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability shall not exceed:

A. 0.01 mRem/hr. (0.1 µSv/hr.) above background, outside the facility property line.

B. 2 mRem/hr. (0.02 mSv/hr.) outside a Radiation Restricted Area.

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C. 5 mRem/hr. (0.05 mSv/hr.) outside of a Radiation Area.

D. 100 mRem/hr. (1mSv/hr.) outside of a High Radiation Area

4.6.3 ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material outlines the exposure limits for:

A. Packaging Surveys:

I. The radiation level measured on the surface of the Excepted Packages (Limited Quantity) is not greater than 0.5 mRem/hr. (5μSv/hr.)

I. The radiation level measured on the surface of the Type A Package and OVERPACK is not greater than 200 mRem/hr. (2 mSv/hr.)

II. The radiation lever measured 1 meter (Transportation Index (T.I.)) of the Type A Package and OVERPACK shall not be greater than 10.

a. The Transport Index (T.I.) shall be determined by a direct measurement taken at 1 meter (3.3 feet), from the maximum radiation level on the external surface, in units of millirem per hour (mRem/hr) removing units, and rounding to the nearest tenth or by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 meter (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 meter (3.3 feet)).

b. As applicable to OVERPACKS, the Transportation Index (T.I.) can be determined by a direct measurement taken above or the sum of the T.I.'s of all inner packages.

B. Labeling Surveys:

I. The Radioactive Category Labels used for Type A Packages and OVERPACKS (as applicable), is determined based upon the highest readings observed on all sides of the package and at 1 meter (T.I) from the package. See Table 1: Category Label Selection.

Table 1: Category Label Selection

Radioactive Category Label	Maximum Surface Readings	Transport Index (T.I.)
White I	≤ 0.5 mRem/hr (≤0.005 mSv/hr)	0
Yellow II	> 0.5 mRem/hr (>0.005 mSv/hr) but ≤50 mRem/hr (≤0.5mSv/hr)	Greater than 0 but not greater than 1
Yellow III	> 50 mRem/hr (>0.5 mSv/hr) but ≤200 mRem/hr (≤2.0 mSv/hr)	Greater than 1 but not greater than 10

C. Vehicle Surveys:

I. The number of packages and/or overpacks in a transport vehicle shall be limited so that the total Transportation Index (T.I.) does not exceed 50.

a. The Transportation Index (T.I.) of a group of packages and/or overpacks is determined by adding together the Transportation Index (T.I.) number(s) on the labels of the individual packages and/or overpacks in the group.

II. The vehicle exposure levels shall not exceed:

a. 2 mRem/hr. (0.02mSv/hr) within the occupied positions of the vehicle.

b. 200 mRem/hr. (2mSv/hr) at the surface of the vehicle.

c. 10 mRem/hr. (0.1mSv/hr) at 1 meter Transportation Index (T.I.) from the surface of the vehicle.

4.6.4 Contamination Surveys taken exceeding the limits prescribed in Table 2: Contamination Action Limits, shall be considered contaminated. Each location shall review country specific regulations and establish more restrictive limits if appropriate.

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Table 2: Contamination Action Limits		
Area of Interest	Release Limits	
	Loose / Removable (swab)	Fixed (equipment)
Sealed Source	Less than 0.02mRem/hr (.2µSv/hr) or .005 µCi (185 Bq)	N/A
NORM (vessels, equipment, tubulars, containers, etc.)	<1,000 dpm/100 cm2	< 50µRem/hr (including background) < 5000 dpm/100 cm2 (average) < 15000 dpm/100 cm2 (single point)
Field Equipment (rolling stock, skids, injectors, etc.)	<1,000 dpm/100 cm2	≤ 0.1 mRem/hr. (1µSv/hr.)
Laboratory Equipment (restricted use)		
Laboratory Equipment (unrestricted use)	Contact the GRSO	

4.6.5 Any determination of or suspected contaminated sealed source or equipment shall require immediate notification to the GRSO.

4.6.6 If a seal source is found to be leaking or for equipment decontamination, reference WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures.

4.6.7 Sealed sources or contaminated equipment shall not be released for unrestricted use until the contamination level is below the release limits described in Table 2: Contamination Action Limits and proven to be free of removable contamination or that there is no immediate hazard to personnel or the environment. Each location shall review country specific regulations and establish more restrictive action levels if appropriate.

5.0 Training

5.1 Initial Training:

5.1.1 Radiation Safety Training Curricula as outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training shall be:

A. Assigned to employees according to the risks associated with employee job duties. Contact the GRSO for guidance on curricula assignment needs.

B. Completed by all employees with a passing grade of 80% or better. If a grade obtained is less than 80% the course must be retaken.

5.2 Refresher Training:

5.2.1 Refresher Training shall occur as follows:

A. As needed when identified by regulation, observation of employee practices, inspections, audits, or incidents.

B. Be completed on an annual basis unless otherwise specified.

6.0 References

6.1 (BP) 4-17044 – Records and Information Management (RIM) – Lifecycle Management and Compliance

6.2 BSD-GL-HAL-HMS-100 – Global HMS and HSE Definitions

6.3 FO-GL-HAL-HSE-1201A – Letter of Appointment – Local Radiation Safety Officer (LRSO)

6.4 FO-GL-HAL-HSE-1203A – Quarterly Compliance Assessment

6.5 FO-GL-HAL-HSE-1203C - NORM Survey Data Sheet

6.6 FO-GL-HAL-HSE-1205A – Contamination Survey Log

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6.7 FO-GL-HAL-HSE-1205B – Radiological Survey Record

6.8 FO-GL-HAL-HSE-1205D – Radioactive Materials Location Exit Report

6.9 FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log

6.10 ST-GL-HAL-HMS-404 – Record Control

6.11 ST-GL-HAL-HMS-710 – Calibration and Verification of Measuring Devices

6.12 ST-GL-HAL-HSE-0605 – Contractor/Sub-Contractor Safety

6.13 ST-GL-HAL-HSE-1201 - Radiation Safety Program

6.14 ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability

6.15 ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material

6.16 ST-GL-HAL-HSE-1208 - Radiation Producing Machines

6.17 WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures

6.18 WM-GL-HAL-HSE-1201A – Radiation Safety Training

6.19 WM-GL-HAL-HSE-1203B - NORM Program

6.20 WM-GL-HAL-HSE-1205A – Radiation Survey Instrument Calibration

7.0 Appendix

Personnel Type	Responsibility
HSE/SQ functional personnel	Communicating requirements of this standard and any additional governmental regulations to management in their area of responsibility.
	Ensuring training meets requirements of this standard and any related governmental regulations.
Management	Communicating requirements of this standard and coordinating employee training as applicable.
	Identifying and ensuring that employees in their area of responsibility complete required training and adhere to the requirements of this standard.
	Confirming, in their areas of responsibility, that only the employees who meet the requirements specified in this standard are involved in the activities described in this standard.
	Ensuring that the responsibilities and authorities of all individuals involved within HMS are defined and understood at their respective levels within the organization.
	Ensuring in their areas of responsibility that any Contractors have complied with the requirements of ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety.
Employees	Complying with requirements of this standard and all applicable local or country safety standards.
	Completing required training and complying with the requirements set forth in this standard and any additional site-specific standards, regulations, or work methods.
Contractors	Complying with requirements of this standard or equivalent and all applicable local or country safety standards, while working at Halliburton or customer properties or facilities.
Global Radiation Safety Committee	Reviewing and recommending improvements to the company's radiation policies, practices, processes, and procedures
	Reviewing the status of the company's radiation performance, including processes to ensure compliance with internal policies and goals and applicable laws and regulations
	Reviewing significant incidents, stop work authority, and exposure monitoring for evaluation of risk and corrective measures for the prevention of future incidents

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Title: Radiological Surveys and Survey Instruments		HMS Document Number: ST-GL-HAL-HSE-1205		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 26-Oct-2023	Rev No: 5	Page: 8 of 8

	Reviewing internal assurance service audits, quarterly compliance assessments, and regulatory inspections
	Serving as the liaison to the Health, Safety, and Environment and Sustainable Development Committee, and providing pertinent information on radiation performance and risks
	Reviewing regulatory agency inspections, internal audits, notices of violation of a significant nature, enforcement actions, and corrective actions
Global Radiation Safety Group	Developing and implementing policies, procedures, standards, training material, and work methods regarding the proper performance of radiation surveys and tests performed by Halliburton
	Supporting operations with regulatory interpretations, licensing, and compliance assistance regarding the proper performance of radiation surveys and tests performed by Halliburton
Radiation Safety Officer (RSO)	Completing the required training and duties outlined in FO-GL-HAL-HSE-1201A – Letter of Appointment – Radiation Safety Officer (RSO)
Source Handlers	Maintaining accountability, and preventing unauthorized access to all radioactive material within their control
	Preventing and excluding all unnecessary personnel from potential exposure to radiation
	Ensuring that each person under their supervision is knowledgeable in recognizing and responding to an emergency event

Table 2 Responsibilities

9.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
26-Oct-2023	5	Bradley Seguin / Lee Heft	Additional clarification on survey instruments used for radiation producing equipment. General administrative review.
20-Oct-2022	4	Bradley Seguin / Lee Heft	Information on survey types, additional clarification when surveys are made, recorded and the frequency, survey instrument use. The addition of exposure levels included in the Global HSE Standards.
17-Dec-2021	3	Bradley Seguin / Lee Heft	Clarification of registry requirements for active survey meters. Survey meter calibrations not to exceed 12 months.
17-DEC-2020	2	Pete Hernandez	Updated calibration information and layout of Frequency section and updated links.
29-NOV-2017	1	John Snow	General Rewrite. Clarifies in the absence of governing documents, the inspection frequency shall be every 6 months. Removal of Survey Meter Calibration Procedure.
05-DEC-2015	0	Jill Mead	Reformatted section 8 of the Radiation Safety and Operations Manual. No changes to content were made.
For previous versions of this document, please contact FHOUHMS@Halliburton.com. HSE-related questions and comments may be submitted using the Global HSE Support Request Form.			

Title: Transportation, Shipping and Receiving of Radioactive Material		HMS Document Number: ST-GL-HAL-HSE-1206		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 31-Jan-2023	Rev No: 7	Page: 1 of 6

1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the packaging, shipment, and transportation of Radioactive Material (RAM). This standard concerns a Critical Focus Area or Life Rule. Improper attention to this standard may result in personal injury, death, or regulatory penalty.

2.0 Application

This standard used in conjunction with ST-GL-HAL-HSE-1201 - Radiation Safety Program, applies to all Halliburton locations and work activities worldwide.

Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 The Shipping/Transportation and Receiving of Radioactive Material Requirements Flow

4.1 General Requirements

4.1.1 Only trained hazmat employees who have the appropriate shipping and transportation training as described in WM-GL-HAL-HSE-1206A – Shipping & Receiving of Radioactive Material shall prepare and offer RAM for shipment. Review local/country regulations for additional training requirements.

4.1.2 The below policies, standards, work methods, guidelines and business support documents shall be followed:

A. Company Policy 3-15700 - International Non-Commercial Agents (INCAs)

B. GD-GL-HAL-LG-300 - Logistics Guidelines

C. GD-GL-HAL-LG-500 - Asset Management Integration (AMI) Guidelines

D. GD-GL-HAL-LG-407 - Global Shipping Guideline for Radioactive Shipments

E. PM-GL-HAL-HSE-1206 - Shipping and Transportation of Radioactive Material

F. WM-GL-HAL-HSE-1206A - Shipping & Receiving of Radioactive Material

G. BSD-GL-HAL-HSE-1206A – Control Points RAM Shipping and Transportation

4.1.3 Control Points have been created for the shipping/transportation and receiving of radioactive material to verify and provide assurance that the requirements and/or activities are complete and accurate. Reference BSD-GL-HAL-HSE-1206A – Control Points RAM Shipping and Transportation to help determine each activity and applicability.

4.1.4 Reference WM-GL-HAL-HSE-1206A - Shipping and Receiving of Radioactive Material for specific instructions on how the below standard requirements are met.

4.2 Control Point #1 - Verified Regulatory Compliance

4.2.1 License & Permits:

A. Prior to the shipment/transportation of RAM, as applicable, verify that licenses, registrations, permits and Category 2 controls allow the operations, sources, and personnel to be used, stored, received at the location.

4.2.2 Category 2 Evaluation:

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4.3 Control Point #2 - Controlled RAM Transfer

4.3.1 For RAM movements Plant to Plant:

A. The shipment shall follow Business Practice 4-44009 Capital Asset Transfers and be transferred using the AMI process.

I. The receiving location address and transit path is verified.

II. The AMI workflow is created requiring the PSL GAC and sending/receiving RSO approval.

a. If a shipment workflow defaults to GRSO for approval, this indicates that RSO appointments are missing, and the AMI document shall be rejected at this step.

4.3.2 For RAM movements to/from a jobsite(s), the job preparation shall be completed for assurance that the RAM transfer is controlled.

4.4 Control Point # 3 - Verified Packaging & Documentation

4.4.1 RAM Packaging:

A. Prior to offering radioactive material for shipment/transportation, the Authorized Person shall:

I. Physically verify the serial number of the radioactive source(s) to match the documentation/request (as applicable).

II. RAM shall be shipped/transported in the appropriate package and or certified shipping container type per the external exposure, activity, and isotope.

a. Survey all packages and as applicable overpacks, with current calibrated meter to determine the highest surface and Transport Index (TI).

III. Secure contents within the selected predesignated package or Overpack to prevent the contents from moving during transport.

a. Use a standard radiation padlock as applicable.

b. For third party shipments, use a serialized security seal or tape as applicable.

IV. Mark and label the exterior of each package as specified in WM-GL-HAL-HSE-1206A - Shipping & Receiving of Radioactive Material.

V. Weigh and measure the package(s) noting the weight in kilograms and the dimensions in centimeters if the package exceeds 50 kg or 110 lbs.

VI. For all RAM International and Domestic plant to plant movements, the packaging shall be verified.

4.4.2 RAM Documentation:

A. Prior to offering radioactive material for shipment/transportation, the Authorized Person shall:

I. Complete the applicable shipping documentation as specified in WM-GL-HAL-HSE-1206A - Shipping & Receiving of Radioactive Material.

II. Verify the shipping documentation against the package marking and labeling for accuracy.

4.4.3 Both the shipping and receiving locations shall maintain records of the applicable shipping papers, in accordance with ST-GL-HAL-HMS-404 – Record Control.

4.5 Control Point #4 - Approved RAM Transfer

4.5.1 Domestic Approval:

A. A shipment shall only be offered for transportation after the applicable Control Point activities have been completed.

I. Control Point RAM Shipping & Transportation #1: Verified Regulatory Compliance

II. Control Point RAM Shipping & Transportation #2: Controlled RAM Transfer

III. Control Point RAM Shipping & Transportation #3: Verified Packaging and Documentation

IV. Control Point RAM Shipping & Transportation #4: Approved Ram Transfer

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B. Each person who offers a hazardous material for transportation shall certify that the material is offered for transportation in accordance with the applicable regulations.

4.5.2 International Approval:

A. The approval to ship radioactive material is given by PM&L and FALVRAMAT upon the verification that all shipping documents and package marking/labeling is complete and accurate.

4.5.3 Approved Transfer:

A. For the ground transportation of radioactive materials:

I. ***Approved Halliburton Carriers*** shall be used for the shipping of radioactive materials by public way or as per local / country regulations. The shipper shall verify:

a. Carrier's commercial driver's license.

b. Hazmat endorsement as applicable per local regulation.

c. Medical card as applicable per local regulations.

II. ***Company Vehicles*** (owned or leased) are allowed to transport radioactive material and shall comply with Title 49 – United States Code of Federal Regulations (49 CFR) and HMS HSE Category 9: Transportation requirements or as per local / country regulations.

III. ***Personal Vehicles*** shall not be used to transport radioactive material even for business purposes.

IV. Vehicles transporting Radioactive Yellow III Packages shall display placards as per local regulatory requirements.

B. Packages shall be secured to prevent movement and unauthorized removal or access or be under constant surveillance of an authorized person.

C. Countries that require additional controls for Category 2 quantities of radioactive material (RAMQC) shall adhere to the security processes and procedures restricted to persons who have passed an additional background check, have a "need-to-know" and have received Category 2 training.

4.6 Control Point #5 - Controlled Receipt & Storage

4.6.1 Ram Receipt:

A. The receipt of RAM shall be completed Within 3 hours of delivery unless delivered after normal working hours in which case the receipt shall be conducted within the first 3 hours on the first business day At all locations (plant or jobsite) in accordance with WM-GL-HAL-HSE-1206A - Shipping & Receiving of Radioactive Material. The receipt of RAM shall include:

I. An inspection of the package / shipping container for damage and integrity.

II. Surveys of the package / shipping container to verify the presence of each source and exposure levels against the shipping documentation. If the surveys differ from the shipping documents, apply SWA and immediately contact RSO.

III. Physical verification that the serial number/s of the RAM matches the shipping documentation. If the source serial number is not accessible, the receiver shall verify the Superior Equipment number. For RAM receipt at the job site, the assay tag as applicable can be used as a means of physical verification

B. All radioactive material shall be secured from unauthorized removal or access. All radioactive material that is in a controlled or unrestricted area and that is not in storage shall be controlled and remain under constant surveillance.

4.6.2 RAM Storage:

A. Refer to ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability.

B. For empty packages, all labels required for the prior shipment of radioactive materials shall be removed, covered, or marked over entirely for storage purposes.

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5.0 Training

5.1 Radiation Safety Training Curricula as outlined in WM-GL-HAL-HSE-1201A - Radiation Safety Training, shall be assigned according to the risks associated with employee job duties and shall be completed by all assigned employees.

6.0 References

6.1 (BP) 4-17044 - Records & Information Management (RIM) - Lifecycle Management & Compliance

6.2 ST-GL-HAL-HMS-404 – Record Control

6.3 BSD-GL-HAL-HMS-100 - HMS Definitions

6.4 BSD-GL-HAL-HSE-1206A – Control Points RAM Shipping and Transportation

6.5 ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability

6.6 FO-GL-HAL-HSE-1201A - Letter of Appointment - Local Safety Radiation Officer

6.7 PM-GL-HAL-HSE-1206 - Shipping and Transportation of Radioactive Material

6.8 GD-GL-HAL-LG-500 - Asset Management Integration Guidelines

6.9 WM-GL-HAL-HSE-1206A - Shipping & Receiving of Radioactive Material

6.10 Category 9: Transportation

6.11 Title 49 – United States Code of Federal Regulations (49 CFR)

7.0 Recordkeeping

All HSE documents shall be retained and maintained in accordance with (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance.

8.0 Appendix

Personnel Type	Responsibility
HSE/SQ functional personnel	Communicating requirements of this standard and any additional governmental regulations to management in their area of responsibility.
	Ensuring training meets requirements of this standard and any related governmental regulations.
Management	Communicating requirements of this standard and coordinating employee training as applicable.
	Identifying and ensuring that employees in their area of responsibility complete required training and adhere to the requirements of this standard.
	Confirming, in their areas of responsibility, that only the employees who meet the requirements specified in this standard are involved in the activities described in this standard.
	Ensuring, in their areas of responsibility, that any Contractors have complied with the requirements of ST-GL-HAL-HSE-0605 - Contractor/Sub-Contractor Safety.
Employees	Complying with requirements of this standard and all applicable local or country safety standards.
	Completing required training and complying with the requirements set forth in this standard and any additional site-specific standards, regulations, or work methods.
Contractors	Complying with requirements of this standard or equivalent and all applicable local or country safety standards, while working at Halliburton or customer properties or facilities.
Global Radiation Safety Committee	Reviewing and recommending improvements to company's radiation policies, practices, processes, and procedures.
	Reviewing the status of the company's radiation performance, including processes to ensure compliance with internal policies and goals, and applicable laws and regulations.

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Title: Transportation, Shipping and Receiving of Radioactive Material		HMS Document Number: ST-GL-HAL-HSE-1206		
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	Reviewing significant incidents, stop work authority and exposure monitoring for evaluation of risk and corrective measures for the prevention of future incidents.
	Reviewing internal assurance services audits, QCAs and regulatory inspections.
	Serving as the liaison to the Health, Safety and Environment and Sustainable Development Committee and providing pertinent information on radiation performance and risks.
	Reviewing regulatory agency inspections, internal audits, notices of violation of a significant nature, enforcement actions and corrective actions.
Global Radiation Safety	Developing and implementing policies, procedures, standards, training material, and work methods regarding radioactive source control and accountability.
	Supporting operations with regulatory interpretations, licensing and compliance assistance regarding radioactive source control and accountability.
Radiation Safety Officer	Completing the required training and duties outlined in FO-GL-HAL-HSE-1201A - Letter of Appointment - Radiation Safety Officer (RSO).
	Implementing transportation, shipping, and receiving of RAM in accordance with Halliburton standards and in compliance of regulatory requirements.
	Knowing how to access and understanding local regulatory requirements as well as license requirements and conditions.
Source Handlers	Complying with requirements of this standard and all applicable local or country safety standards.
	Maintaining accountability and preventing unauthorized access to all radioactive material within their control.
	Notifying the RSO of any movement of RAM prior to shipment or transportation.

9.0

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Title: Transportation, Shipping and Receiving of Radioactive Material		HMS Document Number: ST-GL-HAL-HSE-1206		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 31-Jan-2023	Rev No: 7	Page: 6 of 6

10.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
31-Jan-2023	7	Bradley Seguin / Lee Heft	8-Feb-2024 – Annual review and update. No changes made. 3-Jan-2023 - General Administrative Review and Control Point Alignment
28-April-2022	6	Bradley Seguin / Lee Heft	Added the definition of RAM, clarified Control Point form applications and training requirements.
17-Dec-2021	5	Bradley Seguin / Lee Heft	Control Point Efficiency
17-DEC-2020	4	Pete Hernandez	Added Hazmat employee definition and when their training is required. Added RAM transfer verifications. Moved details for Marking and Labelling and Surveying to WM. Clarified shipping documentation requirements. Added reference to Security Program for additional information. Added references to new forms.
27.SEP.2019	3	Rick Gandenberger	Change name from "Transportation of Radioactive Material" to "Shipping and Receiving of Radioactive Material". Removed 5.1.1 as training is covered in 6.0. Added resource document to "General" section. Aligned steps and flow with hazardous material shipping documents. Bulletized paragraphs for easier reading. Added medical card requirement to para 5.6.5.
29-AUG-2017	2	John Snow	General Revision, Addition of Radioactive Material Receipt Record
02-DEC-2015	1	Jillian Mead	Initial Release

For questions, comments or previous versions of HSE documents please send using the Global HSE Support Request Form.

Title: Radiation Producing Machines		HMS Document Number: ST-GL-HAL-HSE-1208		
Owner: Global HSE	Approver: Director, HSE/SQ	Rev Date: 28-APR-2023	Rev No: 6	Page: 1 of 4

1.0 Objective

This standard establishes the requirements to prevent incidents and mitigate the risks associated with the use ionizing radiation-producing machines.

This standard concerns a Critical Focus Area or Life Rule. Improper attention to this standard may result in personal injury or death.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide. Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Radiation Exposure Monitoring Requirements

Figure 1 Radiation Producing Machine Requirement Flow

4.1 Procurement

4.1.1 Prior to the procurement/possession/usage/operation of a radiation producing machine, all facilities shall first meet the following requirements:

A. Implement the applicable components of the Global HSE/HMS Radiation Safety Standards.

B. Obtain a License/Registration authorizing the import, storage, and usage as applicable.

C. Obtain approval from the GRSO documented through the submission of a MOC for the SAP plant activation as outlined in ST-GL-HAL-HSE-1201 – Radiation Safety Program.

4.2 Storage & Use Areas

4.2.1 All radiation producing machines not located within a designated storage area shall be maintained under constant surveillance by an authorized person.

4.2.2 All storage areas shall:

A. Be approved by the RSO prior to usage.

B. Only store radiation-producing machine inventory owned by Halliburton Energy Services, Inc.

C. Be clearly segregated & marked to identify each PSL and their inventory for shared PSL areas

4.2.3 Storage and Use Areas (as applicable) shall be posted with:

A. Area Dosimetry: Refer to ST-GL-HAL-HSE-1202 – Radiation Exposure Monitoring Program for Area Dosimetry requirements.

B. Signage:

I. Area Signage: Refer to ST-GL-HAL-HSE-1203 - Radiation Source Control & Accountability for Area Signage requirements applicable to the measured exposure levels within the area.

II. Equipment Signage: Each radiation producing machine shall be labeled with a conspicuous sign(s) bearing the radiation symbol and cautions the individual that radiation is produced when energized. This label shall be affixed in a clearly visible location on the face of the control unit.

C. Log:

I. FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log.

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Printed versions of this document are considered UNCONTROLLED.

This is the minimum Halliburton Company Standard. If local, country, or contractual requirements exceed this standard then those requirements must be followed.

Title: Radiation Producing Machines		HMS Document Number: ST-GL-HAL-HSE-1208		
Owner: Global HSE	Approver: Director, HSE/SQ	Rev Date: 28-APR-2023	Rev No: 6	Page: 2 of 4

a. When a handheld machine is removed /returned from storage, fill out each applicable section. Put a N/A in the Source Activity column. An example has been provided in the appending of the form.

II. FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log.

a. To ensure all interlocks, warning lights and other emergency control measures are operating properly.

4.3 Security

4.3.1 All radiation-producing machine(s) and use area(s) shall be controlled by an Authorized Person. When not under control by an Authorized Person, a minimum of one physical barrier is required.

4.3.2 Any known or suspected unauthorized access, removal, loss or use of a radiation-producing machine shall follow WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures and be immediately reported to the GRSO.

4.3.3 All safety and security related engineering controls shall be maintained in proper operating condition: otherwise, the machine(s) shall be locked out and tagged out of service until the safety controls are back in normal operating condition.

4.3.4 Any keys to the storage area and/or the radiation-producing machine shall be kept secured and accessible by an Authorized Person only.

4.3.5 As applicable, the control panel of each radiation-producing machine shall be equipped with a locking device that will prevent the unauthorized use of the system.

4.3.6 Radiation-producing machine(s) shall always be locked, and the key removed except when under the direct visual surveillance of an authorized person.

4.4 Usage

4.4.1 Prior to and after operation, an equipment inspection, maintenance, and all other applicable requirements outlined by this standard shall first be completed on FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log to ensure all interlocks, warning lights and other emergency control measures are operating properly.

A. If any inspection reveals damage to components affecting safety, the device shall be locked out and tagged out of service until the safety controls are back in operating condition.

B. As applicable to regulatory requirements, no person shall use a radiation machine(s) or perform radiation machine(s) services except authorized in a certificate of registration issued by the regulatory entity.

4.4.2 Refer to ST-GL-HAL-HSE-1202 – Radiation Exposure Monitoring Program for all dosimetry requirements.

4.4.3 The exposure levels in use areas shall not exceed:

A. 0.01 mrem/hr. (0.1 μSv/hr.) above background outside of any Halliburton property boundary line.

B. 2 mrem/hr. (.02 mSv/hr.) outside of any Radiation Restricted Area.

4.4.4 All High Radiation Areas generated from a radiation-producing machine(s) shall be constructed to meet the following conditions:

A. Equipped with a control device that shall cause the level of radiation to be reduced lower than a dose of 100 mrem/hr. (1mSv/hr.) upon entry into the area.

B. Equipped with a control device that shall energize a visible or audible alarm signal in such a manner that the Authorized Person(s) entering the High Radiation Area is made aware of the entry.

4.4.5 Any modification (such as but not limited to the drilling, cutting, chiseling, etc.) on a radiation-producing machine is prohibited.

4.4.6 Authorized Person(s) shall have access to the equipment manual and WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures.

4.5 Inventory

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Title: Radiation Producing Machines		HMS Document Number: ST-GL-HAL-HSE-1208		
Owner: Global HSE	**Approver:** Director, HSE/SQ	**Rev Date:** 28-APR-2023	**Rev No:** 6	**Page:** 3 of 4

4.5.1 See ST-GL-HAL-HSE-1203 – Radiation Source Control & Accountability for inventory requirements

4.6 Surveys & Survey Instruments

4.6.1 ST-GL-HAL-HSE-1205 – Radiological Surveys and Survey Instruments outlines the requirements for survey Instruments.

4.6.2 Radiation surveys shall be performed at the following intervals:

A. Anytime maintenance is conducted of the physical orientation of the device changes in a manner that could affect the exposure rates to ensure the exposure rates are maintained at or less than the acceptable levels.

B. Daily (when used) on FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log.

I. A **Pre-Job Survey** with radiation-producing machine off.

II. A **During the Job Survey** with the radiation-producing machine on at operating voltage, use a survey meter to establish a Controlled Area, Restricted Area, Radiation Area and High Radiation Area. (Not required for minimal threat machine(s)).

III. A **Post-Job Survey** with the radiation-producing machine off. (For example, upon re-entry into exposure areas to confirm the equipment is de-energized and the radiation exposure is background.) (Not required for minimal threat machine(s)).

C. Quarterly on FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment (QCA) for all storage areas.

4.7 Shipping / Transportation

4.7.1 Prior to the movement (from one address to another) of a radiation-producing machine, regardless of the situation (use, transfer, disposal, sale, etc.) approval shall be given by the GRSO.

4.7.2 The radiation-producing machine(s) inventory shall be updated to reflect the location, transfer, and receipt as applicable to the regulatory requirements.

4.7.3 Radiation-producing machines shall be decommissioned by:

A. Rendering them inoperable (removing Crook's tube, cutting power cord, etc.).

B. Removing any radioactive material.

C. Removing all radiation signage.

4.7.4 Any location selling a radiation-producing machine shall adhere to all applicable regulatory requirements. For example, as applicable, the buyer shall provide a current license / registration allowing the buyer to procure the radiation-producing machine. All final documentation shall be provided to the GRSO.

5.0 Training

5.1 Radiation Safety Training Curricula shall be assigned as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

6.0 References

6.1 BSD-GL-HAL-HMS-100 - HMS Definitions

6.2 FO-GL-HAL-HSE-1208A – Radiation Producing Machine Utilization Log

6.3 FO-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment

6.4 FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log

6.5 ST-GL-HAL-HSE-1201 – Radiation Safety Program

6.6 ST-GL-HAL-HSE-1202 – Radiation Exposure Monitoring Program

6.7 ST-GL-HAL-HSE-1203 - Radiation Source Control & Accountability

6.8 ST-GL-HAL-HSE-1205 – Radiological Surveys and Survey Instruments

6.9 WM-GL-HAL-HSE-1203A – Radiation Quarterly Compliance Assessment

6.10 WM-GL-HAL-HSE-0601J – Radiation Safety Emergency Procedures

6 Radiation Work Methods

6.1 Definition: A documented process for quality activities that are intra-departmental or intra-functional. Work instructions are to be used as a reference where they will provide guidance and consistency when employees perform specific quality related tasks within a department or function.

Title: Radiation Safety Training		HMS Document Number: WM-GL-HAL-HSE-1201A		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 6-May-2024	Rev No: 10	Page: 1 of 9

1.0 Objective

This work method establishes the procedures for Global Radiation Safety Training and competency for the roles authorized to work in the radiation program.

2.0 Application

This work method applies to all Halliburton locations and work activities worldwide.

This work method satisfies the requirement of the ST-GL-HAL-HSE-1201 - Radiation Safety Administration to provide details of required radiation initial and refresher training and competency requirements for each role in the program.

Where local/country regulations or customer requirements are more stringent than the Global HSE Work Method, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Work Method. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Work Method.

3.0 Definitions

See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

- **WB:** Web Based
- **IL:** Instructor Led
- **OJT:** On Job Training

4.0 Radiation Safety Curricula and Competencies for Authorized Persons, RSO and Instructors

Figure 1 - Requirement Flow

4.1 **Radiation Safety General Awareness:**

4.1.1 All Halliburton Employees (Regular, Expat, Commuter, Union, Project Hire, Co-op/Practical, Apprentice and Temporary) (does not include Joint Venture, Agency, or External Employee Groups), visitors and contractors that work in a Radiation Restricted Area, Security Zone, or Perimeter Easement, shall first attend a radiological briefing to make them aware of the following:

A. The presence and location of radioactive material on site or facility property.

B. How the areas of source usage are identified.

C. How exposure to radiation is monitored.

D. How the employees, the public, and the environment are protected from any adverse effects from the use of radioactive materials used by HES.

4.1.2 All Halliburton Employees are automatically assigned and shall complete Radiation Safety General Awareness (WB Item: 00005469).

4.1.3 Visitors & Contractors can receive Radiation Safety General Awareness through Halliburton.tv. Such training shall be documented on FO-GL-HAL-HSE-1201F - Radiological Briefing to Visitors & Contractors and maintained locally.

4.2 **Radiation Safety Authorized Persons:**

4.2.1 **Well Logging Supervisor (ID: 54)**

A. Curricula is assigned automatically by PSL Job Role or by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Marker End User (WPS Only) (WB Item: 555255056)

III. Radiation Safety for Source Handlers (IL Item: 00010393)

Title: Radiation Safety Training		HMS Document Number: WM-GL-HAL-HSE-1201A		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 6-May-2024	Rev No: 10	Page: 2 of 9

IV. Radiation Safety for Operations Training (for respective PSL)

a. WPS (IL Item: 00010350) or Sperry (IL Item: 00005379)

V. Radiation Well Logging Supervisor (OJT Item: 55167003)

a. Documented on FO-GL-HAL-HSE-1201D - Well Logging Sup. OJT Log

VI. Radiation Knowledge Review (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C - Radiation Safety Knowl. Review

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Knowledge Review (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C - Radiation Safety Knowl. Review

4.2.2 **Well Logging Assistant – Wireline & Perforating (ID: 58)**

A. Curricula is assigned automatically by PSL Job Role or by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Knowledge Review/Breakout (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C - Radiation Safety Knowl. Review

I. Radiation Well Logging Assistant Application Review (OJT Item: 555197001)

a. Documented on FO-GL-HAL-HSE-1201E - Well Logging Asst. Inst. Review

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Knowledge Review/Breakout (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C - Radiation Safety Knowl. Review

4.2.3 **Well Logging Assistant – Sperry (ID: 4005)**

A. Curricula is assigned automatically by PSL Job Role or by Audience which identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety for Source Handlers (IL Item: 00010393)

III. Radiation Safety Operations for LWD (IL Item: 00005379)

III. Radiation Knowledge Review (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C – Radiation Safety Knwl. Review

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Knowledge Review/Breakout (OJT Item: 00008115)

a. Documented on FO-GL-HAL-HSE-1201C - Radiation Safety Knowl. Review

4.2.4 **R&M Personnel (ID: 504)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Marker End User (WPS Only) (WB Item: 555255056)

Title: Radiation Safety Training		HMS Document Number: WM-GL-HAL-HSE-1201A		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 6-May-2024	Rev No: 10	Page: 3 of 9

II. Radiation Safety for Source Handlers (IL Item: 00010393)

III. Radiation Safety for Operations Training (for respective PSL)

a. WPS (IL Item: 00010350) or Sperry (IL Item: 00005379)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.5 **Densometer End User (ID: 59)**

A. Curricula is assigned automatically by PSL Job Role or by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial & Annual Training:

I. Radiation Safety Densometer End User (WB Item: 00005491)

4.2.6 **Densometer Assembly Personnel (ID: 500)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Densometer End User (WB Item: 00005491)

II. Radiation Safety Annual Refresher (WB Item: 555255034)

III. Radiation Safety for Source Handlers (IL Item: 00010393)

IV. Radiation Densometer SVC Personal - 8 HR (IL Item: 00005213)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.7 **MFG Personnel (ID: 503)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety for Source Handlers (IL Item: 00010393)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.8 **Marker Bead End User (ID: 400)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety Marker End User (WB Item: 555255056)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.9 **Limited Quantity End User (ID: 401)**

A. Curricula is assigned automatically by PSL Job Role or by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial & Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.10 **NORM End User (ID: 507)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

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I. Radiation - NORM Awareness (WB Item: 00012871)

II. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation – NORM Surveyors (IL Item: 00006274)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.11 **Pig Tracker End User (ID: 501) (PPS Only)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety for Pig Tracking (IL Item: 00034679)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety for Pig Tracking - Refresher (IL Item: 00034680)

4.2.12 **Radiation Producing Machine Operator (ID: 403)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation X-Ray Producing Equipment:

a. Equipment Manufacturer (IL Item: 00005876) or Authorized User (OJT Item: 555191003)

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.2.13 **Shipping & Transportation End User (ID: 402) (US Only)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial & Tri-Annual (3yr.) Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Hazardous Materials Training for Ground Transportation:

a. HSE-Safe Transportation of Hazardous Materials (WB Item: 555297033) or

b. Hazardous Materials Transportation - HM126F (IL Item: 00018482) or

c. Safe Transportation of Hazardous Materials (IL Item: 00005219)

4.2.14 **Management Approval (ID: 404)**

A. Curricula is assigned automatically through Appian Plant Management.

B. Initial Training:

I. Radiation Safety Program Overview (WB Item: 555251069)

II. Life Rules and Critical Focus Areas (CFA) (WB Item: 555243012)

III. Global HSE-SQ Incident Investigation Reporting and Recording (WB Item: 555246232)

C. Refresher (3yr.) Training:

I. Radiation Safety Program Overview (WB Item: 555251069)

4.2.15 **HSE Verification (ID: 321)**

A. Curricula is assigned automatically through Appian Plant Management.

D. Initial Training:

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I. Radiation Safety Program Overview (WB Item: 555251069)

II. Life Rules and Critical Focus Areas (CFA) (WB Item: 555243012)

III. Global HSE-SQ Incident Investigation Reporting and Recording (WB Item: 555246232)

E. Refresher (3yr.) Training:

I. Radiation Safety Program Overview (WB Item: 555251069)

4.2.16 **Radioactive Material, Quantities of Concern (ID: 200896) (US Only, as applicable)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial & Annual Training:

I. Security Training: Radioactive Material, Quantities of Concern (WB Item: 00031740)

4.2.17 **Survey Meter Calibration (ID: 78)**

A. Curricula is assigned by Audience which is identified by the RSO and communicated to the GRSO.

B. Initial Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

II. Radiation Safety for Source Handlers (IL Item: 00010393)

III. Radiation Survey Meter Calibration (IL Item: 00009848)

a. Ludlum Calibration Course or other applicable approved course by the GRSO.

C. Annual Training:

I. Radiation Safety Annual Refresher (WB Item: 555255034)

4.3 **Radiation Safety Officers:**

4.3.1 The RSO Role is automatically assigned through the Appian Appointment Letter Module. The RSO Roles are listed below and include both curricula and competency assignments:

4.3.2 **HSE-RAD-Radiation Safety Officer Full Scale WP/SD**

A. Curricula - Radiation Authorized Person: RSO for Full Scale WP/SD (ID: 51)

I. Initial Training:

a. Radiation Safety Program Overview (WB Item: 555251069)

b. Radiation Safety Annual Refresher (WB Item: 555255034)

c. Radiation Safety Marker End User (WPS Only) (WB Item: 555255056)

d. Radiation Safety Officer SAP Overview (WB Item: 555255084)

e. Radiation Safety for Source Handlers (IL Item: 00010393)

f. Radiation Safety for Operations Training (for respective PSL)

i. WPS (IL Item: 00010350) or Sperry (IL Item: 00005379)

g. Radiation Safety Officer Training for Full & Limited Scale:

i. In Person (IL Item: 00005845) or Virtual (IL Item: 555251039)

II. Annual Training:

a. Radiation Safety Annual Refresher (WB Item: 555255034)

B. Competency Development Period ≤ 6 Months

I. GD-GL-HAL-HSE-AG-10484 - HSE-RAD-Radiation General Admin., Standards, & Reporting

a. Assessed to Level 4 by a Qualified Person.

II. GD-GL-HAL-HSE-AG-10486 - HSE-RAD-Storage, Inventory, and Transportation

a. Assessed to Level 4 by a Qualified Person.

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Title: Radiation Safety Training		HMS Document Number: WM-GL-HAL-HSE-1201A		
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III. GD-GL-HAL-PSL-AG-5521 - HSESQ-Incident Investigation
  a. Assessed to Level 1 by a Qualified Person.

4.3.3 **HSE-RAD-Radiation Safety Officer Full Scale PE/TSS/PPS**

A. Curricula - Radiation Authorized Person: RSO for Full Scale PE/TSS/PPS (ID: 119)

I. Initial Training:
  a. Radiation Safety Program Overview (WB Item: 555251069)
  b. Radiation Safety Densometer End User (WB Item: 00005491)
  c. Radiation Safety Officer SAP Overview (WB Item: 555255084)
  d. Radiation Safety Annual Refresher (WB Item: 555255034)
  e. Radiation Safety Officer Training for Full & Limited Scale:
    i. In Person (IL Item: 00005845) or Virtual (IL Item: 555251039)

II. Annual Training:
  a. Radiation Safety Annual Refresher (WB Item: 555255034)

B. Competency Development Period ≤ 6 Months

I. GD-GL-HAL-HSE-AG-10484 - HSE-RAD-Radiation General Admin., Standards, & Reporting
  a. Assessed to Level 4 by a Qualified Person.

II. GD-GL-HAL-HSE-AG-10486 - HSE-RAD-Storage, Inventory, and Transportation
  a. Assessed to Level 2 by a Qualified Person.

III. GD-GL-HAL-PSL-AG-5521 - HSESQ-Incident Investigation
  a. Assessed to Level 1 by a Qualified Person.

4.3.4 **HSE-RAD-Radiation Safety Officer Limited Scale**

A. Curricula - Radiation Authorized Person: RSO for Limited Scale (ID: 52)

I. Initial Training:
  a. Radiation Safety Program Overview (WB Item: 555251069)
  b. Radiation Safety Annual Refresher (WB Item: 555255034)
  c. Radiation Safety Marker End User (WPS Only) (WB Item: 555255056)
  d. Radiation Safety Officer SAP Overview (WB Item: 555255084)
  e. Radiation Safety Officer Training for Full & Limited Scale:
    i. In Person (IL Item: 00005845) or Virtual (IL Item: 555251039)

II. Annual Training:
  a. Radiation Safety Annual Refresher (WB Item: 555255034)

B. Competency Development Period ≤ 6 Months

I. GD-GL-HAL-HSE-AG-10484 - HSE-RAD-Radiation General Admin., Standards, & Reporting
  a. Assessed to Level 4 by a Qualified Person.

II. GD-GL-HAL-HSE-AG-10486 - HSE-RAD-Storage, Inventory, and Transportation
  a. Assessed to Level 2 by a Qualified Person.

III. GD-GL-HAL-PSL-AG-5521 - HSESQ-Incident Investigation
  a. Assessed to Level 1 by a Qualified Person.

4.3.5 **HSE-RAD-Radiation Safety Officer Radiation Producing Machines**

A. Curricula - RSO for Radiation Producing Machines (ID: 10309)

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I. Initial Training:

a. Radiation Safety Program Overview (WB Item: 555251069)

b. Radiation Safety Annual Refresher (WB Item: 555255034)

c. Radiation X-Ray Producing Equipment:

i. Eqpt. Manufacture (IL Item: 00005876) or Authorized User (OJT Item: 555191003)

d. Radiation Safety Officer Training:

i. Radiation Producing Equipment: or

- In Person (IL Item: 555251020) or Virtual (IL Item: 555251021)

ii. Full & Limited Scale:

- In Person (IL Item: 00005845) or Virtual (IL Item: 555251039)

II. Annual Training:

a. Radiation Safety Annual Refresher (WB Item: 555255034)

B. Competency Development Period ≤ 6 Months

I. GD-GL-HAL-HSE-AG-10484 - HSE-RAD-Radiation General Admin., Standards, & Reporting

a. Assessed to Level 4 by a Qualified Person.

II. GD-GL-HAL-HSE-AG-10486 - HSE-RAD-Storage, Inventory, and Transportation

a. Assessed to Level 1 by a Qualified Person.

III. GD-GL-HAL-PSL-AG-5521 - HSESQ-Incident Investigation

a. Assessed to Level 1 by a Qualified Person.

4.4 **Radiation Safety Instructors:**

4.4.1 Below is a list of training items that is assigned by the GRSO to certify a radiation safety instructor:

A. Radiation Safety Officer Instructor (IL Item: 555251062)

B. Radiation Survey Meter Calibration Instructor (IL Item: 555251103)

C. Radiation Safety NORM Instructor (IL Item: 555264128)

D. Radiation Densometer SVC Instructor (IL Item: 555283035)

E. Radiation X-Ray Producing Equipment Instructor (IL Item: 555283036)

F. Radiation Safety for Source Handler Instructor (IL Item: 555283037)

G. Radiation Safety for Operations Instructor (IL Item: 555283038)

5.0 Records

5.1 Records for certificates of training shall be maintained within Learning Central as applicable.

5.2 The following shall be completed for each Well Logging Supervisor who's OJT FO-GL-HAL-HSE-1201D was completed but is now missing:

A. If a location does not have/is missing record of the original OJT FO-GL-HAL-HSE-1201D documenting the certification of Well Logging Supervisor, start a new FO-GL-HAL-HSE-1201D completing as much job history as possible. A reasonable effort shall be made to identify the time period, location and witnesses (certified Well Logging Supervisor(s)) when the assistant was in training to become a supervisor and include the following statement within the OJT FO-GL-HAL-HSE-1201D.

"The original form documenting the Well Logging Supervisor's 60-day OJT is lost and not producible. This form documents the minimum 60-day OJT experience completed by the Well Logging Supervisor while in training. The employee has been a Well Logging Supervisor since [insert date] and has demonstrated their competence during the subsequent annual knowledge reviews documented on FO-GL-HAL-HSE-1201C"

B. The annual reviews documented on FO-GL-HAL-HSE-1201C provide reasonable assurance that the Well Logging Supervisor in question is competent and capable.

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C. This FO-GL-HAL-HSE-1201D is now the initial record of experience for the supervisor.

D. The RSO shall keep a copy on file and send a copy to GlobalHSE_Radiation@Halliburton.com.

6.0 References

6.1 BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions

6.2 FO-GL-HAL-HSE-1201C – Radiation Safety Knowledge Review

6.3 FO-GL-HAL-HSE-1201D - Well Logging Supervisor OJT Log

6.4 FO-GL-HAL-HSE-1201E – Radiation Well Logging Assistant Application Review

6.5 FO-GL-HAL-HSE-1201F – Radiological Briefing to Visitors and Contractors

6.6 GD-GL-HAL-HSE-AG-10484 - HSE-RAD-Radiation General Administration, Standards, and Reporting

6.7 GD-GL-HAL-HSE-AG-10486 - HSE-RAD-Storage, Inventory, and Transportation

6.8 GD-GL-HAL-PSL-AG-5521 - HSESQ-Incident Investigation

7.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
6-May-2024	10	Bradley Seguin	Administrative review, no changes made.
27-July-2023	9	Bradley Seguin	New curricula 321 and 78. Revised annual RSO training.
31-Jan-2023	8	Bradley Seguin	Added clarity for Radiation Safety General Awareness. Added clarity on the delivery of items and the assignment of curricula. Aligned RSO training to match RSO appointments. Added additional Instructor certifications.
16-Aug-2022	7	Bradley Seguin / Lee Heft	Aligning GREX Communications on Radiation Safety Training improvements to LMS Curricula.
17-Dec-2021	6	Bradley Seguin / Lee Heft	The addition of security training for Category 2 requirements and changed the refresher training requirement for X-Ray personnel
2-MARCH-2021	5	Bradley Seguin	The addition of curricula names, revised items, and training to RSO's and Managers.
21-FEB-2020	4	Santiago Aguirre	Revised definitions. Added training requirements for visitors and contractors. Aligned safety annual refreshers with all groups.
17-OCT-2018	3	Will Hendricks	Updated LRSO Source handling Training requirements for respective PSL. Updated Course IDs where required. Updated Competency for LRSOs. Updated remaining roles to show proper training courses as required in Radiation Curricula
29-AUG-2017	2	John Snow	General Rewrite, Template Update, Updated to Align with Appendix A in ST-GL-HAL-HSE-1201.
13.Nov.15	1	Jillian Mead	New

For questions, comments or previous versions of HSE documents please send using the Global HSE Support Request Form

8.0 RSO Competencies

<table>
<tr><th colspan="4">Table 1: RSO Competencies</th></tr>
<tr><th>RSO Type</th><th>GD-GL-HAL-HSE-AG-10484
HSE-RAD-Radiation General Administration, Standards, & Reporting</th><th>GD-GL-HAL-HSE-AG-10486
HSE-RAD-Storage, Inventory, & Transportation</th><th>GD-GL-HAL-PSL-AG-5521
HSESQ-Incident Investigation</th></tr>
<tr><td>Full Scale WP/SD</td><td rowspan="4">Level 4</td><td>Level 4</td><td rowspan="4">Level 1</td></tr>
<tr><td>Full Scale PE/TSS/PPS</td><td rowspan="2">Level 2</td></tr>
<tr><td>Limited Scale</td></tr>
<tr><td>Radiation Producing Machines</td><td>Level 1</td></tr>
</table>

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9.0 Appendix B: Radiation Safety Training

IT = Initial Training
IR = Initial & Refresher (1yr)
I2 = Initial & Refresher (2yr)
I3 = Initial & Refresher (3yr)
I4 = Refresher Only (1yr)
SC = Substitute Credit

Training Items \ Training Curricula	Radiation Safety General Awareness	Radiation AP: Well Logging Supervisor (54)	Radiation AP: Well Logging Assistant - WPS (58)	Radiation AP: Well Logging Assistant - SD (4005)	Radiation AP: R&M Personnel (204)	Radiation AP: Densometer End User (56)	Radiation AP: Densometer Assembly Personnel (500)	Radiation AP: MFG Personnel (503)	Radiation AP: Marker Bead End User (400)	Radiation AP: Limited Quantity End User (401)	Radiation AP: NORM End User (507)	Radiation AP: Pig Tracker End User (501)	Radiation AP: Radiation Producing Machine Op. (403)	Radiation AP: Shipping & Transportation End User (402)	Radiation AP: Management Approval (404)	Radiation AP: HSE Verification (323)	Radiation AP: Survey Meter Calibration (78)	Radiation AP: RSO for Radiation Producing Equipment (10309)	Radiation AP: RSO for Limited Scale (52)	Radiation AP: RSO for Full Scale WP/SD (51)	Radiation AP: RSO for Full Scale PE/TSS/PPS (159)	Security Training (RAMQC)
Radiation Safety General Awareness	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT	IT
Radiation Safety Annual Refresher		IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	I2			IR	IR	IR	IR	IR	
Radiation Safety Marker End User (WPS Only)		IT			IT				IT										IT	IT		
Radiation Safety for Source Handlers		IT		IT	IT			IT									IT			IT		
Radiation Safety for Operations Training		IT		IT	IT															IT		
Radiation Safety Knowledge Review/Breakout		IR	IR	IR																		
Radiation Well Logging Supervisor OJT		IT																				
Radiation Well Logging Assistant Application Rev.			IT																			
Radiation Safety Densometer End User						IT	IT														IT	
Radiation Densometer SVC Personal							IT															
Radiation NORM Awareness											IT											
Radiation NORM Surveyors											IT											
Radiation Safety for Pig Tracking (34679)												IT										
Radiation Safety for Pig Tracking Refresh (34680)												I4										
Radiation X-Ray Producing Equipment													IT					IT				
Radiation Safety Program Overview															IT	IT		IT	IT	IT	IT	
Radiation Safety Officer SAP Overview																		IT	IT	IT	IT	
RSO Training for Radiation Producing Equipment																		IT				
RSO Training for Full & Limited Scale																		SC	IT	IT		
Hazardous Materials Training														I3								
Security Training RAM QC																						IR
Life Rules and Critical Focus Areas															IT	IT						
Global HSE-SQ Incident Invest. Report. & Rec.															IT	IT						
Radiation Survey Meter Calibration																	IT					

Title: Well Logging Supervisors / Assistant - Radiation and On the Job Training		HMS Document Number: WM-GL-HAL-HSE-1201B		
Owner: Global HSE/SQ	Approver: Director, Global HSE/SQ	Rev Date: 6-May-2024	Rev No: 4	Page: 1 of 6

1.0 Objective

To provide the Well Logging Supervisor(s) and Assistant(s) information about the required training criteria, radiation specific topics and On-the-Job-Training (OJT).

2.0 Application

This Work Method applies to all Halliburton locations and work activities worldwide.

Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Well Logging Supervisors / Assistant Radiaiton Training and OJT Requirements

Figure 1 - Requirement Flow

4.1 **General Requirements:**

4.1.1 Two Halliburton Product Service Lines (Wireline & Perforating and Sperry Drilling), conduct well logging activities. This work method is meant to be specific enough for each PSL to accomplish the requirements with the flexibility to adapt it to each PSL's unique training structure.

4.1.2 Training for a Well Logging Supervisor shall be accomplished through instructor led classroom training, equipment training, On-the-Job-Training (OJT), completion of a written examination, completion of a practical field exam, annual refresher training and an annual safety review.

4.1.3 Training for Well Logging Assistants shall be accomplished through online and/or instructor led training, completion of an oral or written exam, equipment training, annual refresher training and an annual safety review.

4.2 **Well Logging Supervisor Candidate Categories:**

4.2.1 New Hires and Transitional Hires:

A. Employees hired or transitioning to be Well Logging Supervisors shall take a minimum of 6 months to complete the instructor led training and OJT. To transition to a Well Logging Supervisor, the candidate, after completing all training requirements and OJT checkouts under the supervision of a qualified logging supervisor, shall demonstrate their proficiency by completing the practical review.

4.2.2 External Experienced Hires:

A. Employees who, within the last 2 years, have been Well Logging Supervisors for other logging companies with at least a year experience shall provide evidence of their training and experience. These employees shall complete the same instruction as Well Logging Assistants.The experienced hire shall successfully complete the practical review at a temporary job site once Halliburton training is completed. If the experienced hire is unsuccessful in completing the practical review, the candidate will then have to complete the new hire process.

4.2.3 Re-hires:

A. Well Logging Supervisors separated from the company for less than 2 years shall successfully complete a practical review at a temporary job site, under supervision of a qualified Well Logging Supervisor to demonstrate their proficiency. If the re-hire is unsuccessful in completing the practical review, the candidate shall complete the new hire process.

B. Well Logging Supervisors separated from the company for longer than 2 years have to complete the new hire process.

C. Re-hires gone less than 1 year, who were in process to become Well Logging Supervisors, shall continue where the left off.

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4.3 **Training Requirements:**

4.3.1 Well Logging Assistants:

A. Initial Training:

I. Radiation Safety for Source Handlers or Radiation WebBased Modules:

a. Knowledge of Work Requirements:

i. Local, regional, national, international laws & regulations as applicable to each area.

ii. Licensing requirements to include types, and understanding license conditions.

iii. Operating and Emergency procedures as described in the radiation standards, work methods, and forms.

II. Radiation Safety Operations:

a. Equipment Training:

i. Well logging equipment,

ii. Sealed sources,

iii. Handling equipment,

iv. Radiation survey meters,

v. Daily inspections

III. Written Exam or Oral Exam:

a. The Well Logging Assistant shall complete an exam demonstrating understanding the requirements outlined in this Work Method for a Well Logging Assistant. The exam may be written or oral. Copies of the written test and dates of oral tests shall be kept as records. The candidate shall successfully complete the exam to qualify as a Well Logging Assistant. The written exam shall be administered following the training requirements outlined in this Work Method. A passing grade of 80% or better is required.

IV. Radiation – Knowledge and Safety Review:

a. Once during each calendar year the Well Logging Assistant shall complete a knowledge review observed by a Well Logging Supervisor ensuring that regulations, license requirements, and operating and emergency procedures are understood and followed. This also serves as an annual safety review of the job performance of each logging assistant. The review record for each logging assistant shall be retained. Reviews should be conducted during an actual well logging operation. If a logging assistant has not participated in a well logging operation for more than 12 months since the last review, a review should be conducted the first time the individual engages in well logging operations.

B. Annual Training:

I. Review the Following:

a. Annual review of operating and emergency procedures as detailed in the radiation standards, work methods, and forms.

b. New procedures, equipment, techniques or regulations.

c. Observations, deficiencies, and discussions of any significant incidents or accidents involving well logging.

d. Questions raised by employees regarding implementation of the program.

IV. Radiation – Knowledge and Safety Review for Assistants:

a. See Initial Training section above for information on the Annual Knowledge Review.

4.3.2 Well Logging Supervisors:

A. Initial Training:

I. Radiation Safety for Source Handlers:

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a. Fundamentals of Radiation Safety:
   i. Characteristics of Gamma Radiation
   ii. Units of radiation dose and quantity of radioactivity
   iii. Hazards of exposure to radiation
   iv. Levels of radiation from radioactive material
   v. Methods of controlling radiation dose (time, distance, shielding)
   vi. Radiation Safety Practices, including prevention of contamination, and methods of decontamination
   vii. Shipping and Transportation of Radioactive Material
b. Radiation Detection Instruments:
   i. Use, operation, calibration and limitations of radiation survey instruments
   ii. Survey techniques
   iii. Use of personnel monitoring equipment
c. Equipment:
   i. Operation of equipment, source handling equipment and remote handling tools
   ii. Storage, control, and disposal of radioactive material
   iii. Inspection and maintenance of equipment, source end caps, bull plugs, and transport shields
d. Knowledge of Work Requirements:
   i. Local, regional, national, international laws & regulations as applicable to each area
   ii. Licensing requirements to include types, and understanding license conditions
   iii. Operating and Emergency procedures as described in the radiation standards, work methods, and forms
   iv. Incident Reporting
e. Incident Review:
   i. Natural Disasters
   ii. Dropped sources
   iii. Source stuck in hole
   iv. Source stuck in tool
   v. Source Abandonment
   vi. Source shipping and transportation issues
   vii. Other pertinent incidents based on current issues.

II. Radiation Safety Operations:

a. Equipment Training:
   i. Well logging equipment
   ii. Sealed sources
   iii. Handling equipment
   iv. Radiation survey meters
   v. Daily inspections

III. Written Exam:

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a. The written exam shall be administered following the training requirements outlined in this Work Method. A passing grade of 80% or better is required.

V. On-the-Job-Training (OJT):

a. The success of a Well Logging Supervisor candidate can be demonstrated through proficiency in tasks that a Well Logging Supervisor performs routinely. Only Well Logging Supervisors, with at least one-year experience shall rate a logging supervisor candidate in their proficiency in the completion of selected tasks listed in this Work Method. Proficiency in those tasks is gained over the initial 6-month period and demonstrated by the logging supervisor candidate performing iterations of each task, under the supervision of an experienced logging supervisor. Demonstrating proficiency can take place at temporary jobsites (onshore or offshore) or at a plant that has been set up for accomplishing these OJT task requirements. A majority of the activities shall be completed at a temporary job site with the balance being at a plant and documented in the form FO-GL-HAL-HSE-1201D - Well Logging Supervisor On-The-Job-Training Log. Tasks include:

i. Job Preparation:
- Calibrating tools
- Physical verification of sources
- Completion of shipping documentation
- Loading sources for shipment or transport to well site
- Transportation vehicle surveys and placarding
- Hazardous material requirements
- Training and certification verification

ii. Well Site Activities:
- Pre Job Surveys
- Receipt of radioactive material package
- Physical verification of sources
- Storage and security of radioactive material
- Perimeter set up
- Install sources
- Well Logging
- Source removal
- Load sources for shipment or transport
- Post job surveys
- Source receipt

iii. Demobilization:
- Storage & security of radioactive material at Halliburton camp

iv. Other Tasks to Complete with the RSO at the Plant as applicable:
- Leak Testing
- Quarterly Compliance Assessment
- Use of survey instruments for exposure and contamination surveys
- Inspection of bullplug, source end cap, snap ring, transport shields

VI. Radiation – Knowledge Review:

a. Once during each calendar year the Well Logging Supervisor shall complete a knowedge review ensuring that regulations, license requirements, and the operating and emergency procedures are understood and followed. The review shall include observation of the

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performance of each logging supervisor, and a list of the topics that were reviewed. This also serves as an annual safety review of the job performance of each logging supervisor. The review record for each logging supervisor shall be retained. Separate reviews for logging supervisors shall be performed based on their tasks. Annual reviews may be done on the jobsite or in the shop depending on availability however breakouts shall be performed on the jobiste. If a logging supervisor has not participated in a well logging operation for more than 12 months since the last review, an review should be conducted the first time the individual engages in well logging operations.

B. Annual Training:

I. Review the following:

a. Annual review of operating and emergency procedures as detailed in the radiation standards, work methods, and forms.

b. New procedures, equipment, techniques, or regulations

c. Observations, deficiencies and discussion of any significant incidents or accidents involving well logging

d. Employee questions

II. Radiation – Knowledge Review:

a. See Initial Training section above for information on the Annual Knowledge Review.

4.4 **Trainers:**

4.4.1 Trainers for instructor led courses who provide training to individuals in the principles of radiation and radiation safety shall have knowledge and understanding of these principles beyond those obtainable in a course similar to the one given to prospective logging supervisors.

4.4.2 Individuals who provide instruction in the hands-on use of well logging and handling equipment should be qualified logging supervisors with at least 1 year of experience in performing well logging operations.

4.4.3 Individuals who provide instruction and personal supervision during all stages of the OJT shall be qualified logging supervisors with at least 1 year of experience in performing well logging operations.

4.4.4 Instructors with alternate experience shall be approved by the CRSO or GRSO.

5.0 References

5.1 (BP) 4-17044 - Records and Information Management (RIM) – Lifecycle Management and Compliance

5.2 BSD-GL-HAL-HMS-100 - HMS Definitions

5.3 FO-GL-HAL-HSE-1201D - Well Logging Supervisor OJT Training Log

6.0 Record Keeping

6.1 All HSE documents and records shall follow the requirements as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

6.2 On the Job Training checkpoints and completions shall be tracked in the Halliburton learning system that serves as a check to prevent completion prior to the 4 months elapsing.

6.3 Halliburton shall retain records of each logging supervisor and logging assistant training and annual safety reviews. The records shall include written tests. The training records shall be retained for 3 years following the termination of employment. Annual safety reviews shall be retained for 3 years.

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Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
6-May-2024	4	Bradley Seguin	General Administrative Changes
27-Jul-2023	3	Bradley Seguin	General Administrative and Formatting Changes
16-Aug-2022	2	Bradley Seguin / Lee Heft	General Administrative Changes
17-Dec-2021	1	Bradley Seguin / Lee Heft	General Administrative Changes
24-June-2020	0	Pete Hernandez	New. This is the initial document.
For previous versions of this document, please contact FHOUHMS@Halliburton.com. *HSE related questions and comments may be submitted using the Global HSE Support Request Form*			

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1.0 Objective

To provide specific instructions to be considered in the development of the LERP to prevent injuries and mitigate risks associated with radiation emergencies.

4.0 Application

This standard applies to all Halliburton locations and work activities worldwide.

This work method satisfies the requirement of ST-GL-HAL-HSE-0601 - Emergency Response and Crisis Management, to respond in radiation involved emergencies.

Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

5.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

6.0 Procedures

6.4 General

6.4.1 A written LERP shall be developed for each Halliburton location or site to address Level 1 and Level 2 Events as outlined in ST-GL-HAL-HSE-0601 - Emergency Response and Crisis Management.

6.4.2 Emergency response personnel shall not delay medical treatment of injured persons or other emergency response procedures (e.g. firefighting) due to the presence of Radioactive Material as the radioactive sealed sources used by Halliburton are unlikely to be damaged in a fire, provided the temperature does not exceed 1,472°F.

6.4.3 Following any radiation emergency, personnel and locations that may potentially be contaminated, shall not be released for normal work without the approval of the GRSO.

6.4.4 Radioactive Material shall be secured to the greatest extent possible (without posing additional risks to the Authorized Person).

6.4.5 HSE shall be immediately notified of any incident involving Radioactive Materials or Radiation Producing Machines in accordance with WM-GL-HAL-HMS-804D - HSE and SQ Reporting/Recording.

6.4.6 Contact the GRSO for Radioactive Waste transportation, storage, and disposal instructions.

6.5 Loss or Theft

6.5.1 In the case of missing, lost or stolen Radioactive Material, Radiation Producing Machine, or other licensed device containing Radioactive Material, the following steps shall be taken by an Authorized Person:

A. Immediately upon the discovery of missing, lost or stolen Radioactive Material, Radiation Producing Machine or other licensed device containing Radioactive Material, notification shall be given to all personnel in the area, local management and the GRSO of a missing radioactive source.

   I. As required by regulations, the GRSO (or other GRSO appointed designee) shall direct notification to the agreement state, US Nuclear Regulatory Commission or the host country regulatory agency.

B. Identify the last known location and user of the source.

C. Restrict access to and from the last known location of the source.

D. Perform an immediate search of the area and personnel exiting the area as applicable, using a calibrated and operable radiation survey instrument as outlined in ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments.

   I. If the initial search is inconclusive, broaden the search area and repeat.

E. Assist in the coordination of law enforcement, public health, and other services.

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F. The GRSO will determine the extent of damage resulting from loss or theft of any Radioactive Material or Radiation Producing Machine and determine the recovery plan (Refer to ST-GL-HAL-HSE-0601 - Emergency Response & Crisis Management).

6.6 Fire Emergencies

6.6.1 In the case of a fire emergency with radiation present, the following steps shall be taken:

A. Notification shall be given to all personnel in the area to evacuate the area immediately.

B. Only an authorized person shall attempt to extinguish a fire if the following conditions occur:

I. The fire is judged by the Authorized Person to be minor.

II. Approved fire-fighting equipment is used (Refer to ST-GL-HAL-HSE-0414 - Portable Fire Extinguishers).

III. There is no risk of personal injury based on individual assessment.

C. The fire department, RSO, and GRSO shall be notified of the location and extent of the fire.

D. Emergency response personnel shall be issued a radiation monitoring dosimeter, and provided the following information:

I. Location of materials

II. Isotope(s)

III. Quantities

IV. Type of storage

V. Other information that may be useful

6.6.2 A radiation survey, as per ST-GL-HAL-HSE-1205 – Radiological Surveys and Survey Instruments shall be performed and documented of all emergency response personnel prior to being released from the area using FO-GL-HAL-HSE-1205A - Contamination Survey Log.

6.6.3 Radiation Surveys resulting in an exposure level exceeding the limits prescribed in Table 1, above background, shall be considered contaminated.

A. If contamination is determined to be present, the material shall be disposed of or cleaned to be free of removable contamination by following the steps outlined in this work method or so that there is no immediate hazard to personnel or the environment.

6.6.4 Prior to being authorized for use, radioactive materials shall be leak tested, per ST-GL-HAL-HSE-1203 - Radioactive Source Control and Accountability.

6.7 Leaking Source

6.7.1 In the case of a leaking Radioactive Source has been identified during post surveys or leak tests, the following steps shall be taken by an Authorized Person.

A. Prevent the spread of Contamination of the accident by applying the **S.W.I.M.** method as follows:

I. Stop the source of the leak.

a. Place the source in its transport shield or container and lock the container.

b. Do not move the transport shield or container.

II. Warn other personnel in the area to evacuate the area immediately.

III. Isolate the area and establish contaminated and clean zones.

a. To prevent the spread of contamination, perform a radiation survey of all personnel entering and exiting the area verifying the source of any radiation exposure identified.

b. Quarantine any personnel that could be contaminated in a restricted area immediately outside the contaminated area.

IV. Minimize exposure by restricting your access to the contaminated zone and increasing the distance between personnel and the radioactive material. Do not leave the source unattended during this time.

B. Immediately notify the GRSO of the location, time, source, and extent of the leakage.

C. Don protective clothing, nitrile gloves, safety glasses and shoe covers.

D. Survey the affected area to identify and document any contaminated personnel or areas on FO-GL-HAL-HSE-1205A - Contamination Survey Log.

E. Circle any identified contaminated area or personnel using waterproof felt tip marker.

F. Begin decontamination with areas of lowest Contamination first and work from the edges inward.

I. In a water deficient environment, gently brush surface of contaminated area to remove and dislodge Contamination.

II. In a water sufficient environment, wash contaminated area (or have patients/victims wash themselves) with tepid water and soap, without damaging or abrading contaminated surface.

III. Add mild soap (neutral pH) to water to emulsify and dissolve Contamination.

IV. Direct contaminated wastewater directly into a collection receptacle rather than over uncontaminated areas.

V. Use disposable washcloths, gauze pads or surgical sponges to avoid recontamination.

VI. Place all cloths, pads, or sponges used on the contaminated employee or area into a single, airtight container (e.g. property bag) and label with:

a. Employee's name (if applicable)

b. Date and time of collection

c. Location of collection

d. Radiation warning label

G. Store property bags, contaminated water, and other contaminated supplies in secure location designated by RSO for appropriate disposal.

H. Perform two decontamination cycles with a Radiation Survey after each cycle and document on FO-GL-HAL-HSE-1205A - Contamination Survey Log.

I. Repeat this process until the release limits are below the Halliburton action limits (over background) described in Table 1. Each location shall review country specific regulations and establish more restrictive action levels if appropriate.

J. Wrap the transport container or shield in a non-permeable plastic cover such as shrink wrap or garbage bags and seal closed using duct tape or similar product.

6.8 Contamination

6.8.1 In the case of a radioactive Contamination, the following steps shall be taken by an Authorized Person:

B. Ensure a leaking source is not present. If a leaking source is present, follow the steps outlined in this work method.

C. Notification shall be given to the GRSO that personnel or equipment has been determined to be contaminated including the location, time, source, and extent of contamination.

D. Don protective clothing nitrile gloves, safety glasses and shoe covers.

E. Survey the affected area to identify and document contaminated personnel or areas on FO-GL-HAL-HSE-1205A - Contamination Survey Log.

F. Circle any identified contaminated area or personnel using waterproof felt tip marker.

G. Begin decontamination with areas of lowest contamination first and work from the edges inward.

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I. In a water deficient environment, gently brush surface of contaminated area to remove and dislodge Contamination.

II. In a water sufficient environment, wash contaminated area (or have patients/victims wash themselves) with tepid water and soap, without damaging or abrading contaminated surface.

III. Add mild soap (neutral pH) to water to emulsify and dissolve Contamination.

IV. Direct contaminated wastewater away directly into a collection receptacle rather than over uncontaminated areas.

V. Use disposable washcloths, gauze pads or surgical sponges to avoid recontamination.

VI. Place all cloths, pads, or sponges used on the contaminated employee or area into a single, airtight container (e.g. property bag) and label with:

a. Employee's name (if applicable)

b. Date and time of collection

c. Location of collection

d. Radiation warning label

H. Store property bags, contaminated water, and other contaminated supplies in secure location designated by RSO for appropriate disposal.

I. Perform two decontamination cycles if feasible, with a Radiation Survey after each cycle and document on FO-GL-HAL-HSE-1205A - Contamination Survey Log.

J. Contaminated equipment shall not be release for unrestricted use until the contamination is below the action limits (over background) described in Table 1. Each location shall review country specific regulations and establish more restrictive action levels if appropriate. Repeat this process until the contamination is below the action limits (over background) described in Table 1.

Area of Interest	Release Limits	
	Removable DPM	Fixed mR/hr (µSv/hr)
Field equipment (e.g., rolling stock, skids, injectors)	<1,000	≤ 0.1 (1)
Laboratory equipment (restricted use)	<1,000	≤ 0.1 (1)
Laboratory equipment (unrestricted use)	Contact the GRSO	

Table 1 Contamination Action Limits

K. Contain all remaining Radioactive Waste and contaminated materials in a closed and sealed receptacle, label the container RADIOACTIVE MATERIAL and store it in a Restricted Area.

6.9 Elevated Exposure

6.9.1 In the case a radiation elevated, or overexposure is suspected to have occurred, the following steps shall be taken by an Authorized Person:

B. Secure all sources and remove the affected personnel from the area.

C. Immediately notify the GRSO and local management of the time, location, and activity in which the exposure occurred.

D. Estimate the dose received and determine if medical treatment is necessary.

E. If medical treatment is necessary, perform the following steps:

I. Inform attending medical personnel that the affected persons were involved in a radiation accident and request clinical observation.

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II. Answer any questions that may arise concerning the accident or type of radiation involved.

III. Wait for further instruction from the medical personnel for the treatment of the employee.

F. Locate Personal Dosimeters

I. If personal dosimeters were in use by the affected persons, the RSO shall collect the devices and forward them to the vendor for emergency processing.

II. Identify immediate work duties and jobs performed during the wear period.

G. Persons directly involved in the incident must not be permitted to perform further radiation work until the GRSO has approved and released the individual for unrestricted radiation work.

H. The exposure reports and all incident reports shall be presented to the Global Radiation Safety Committee (GRSC), and if necessary, to the state, federal or host country agencies for direction and action.

6.10 Stuck Source in a Tool

6.10.1 If a source cannot be removed as per the PSL Source Instillation / Removal Procedures and is stuck in a tool, the following steps shall be taken by an Authorized Person:

A. Immediate Notification shall be given to inform the Customer Representative, Service Coordinator, RSO, Local HSE, PSL and the GRSO of the situation.

B. Review PSL specific Risk Assessments, Job Safety Analysis and Emergency Response Plans. All Risk Assessments and JSAs shall be completed as outlined in ST-GL-HAL-HMS-503 - HSE and SQ Risk Management.

C. Any drilling, altering, chiseling, or milling operation on a source holder is forbidden. If attempts to remove the stuck source are unsuccessful, perform the following steps:

I. Isolate the tool and store in a posted restricted area.

II. Prior to mobilization, the RSO and Management shall demonstrate and document that all applicable regulatory compliances have been met "UN2919 Special Arrangement" within a Management of Change (MOC) ST-GL-HAL-HMS-712 and require GRSO approval before proceeding.

III. Prior to removal of the source from the tool in the plant, the repair opening or modification of any sealed source housing shall be performed only by persons specifically authorized by the GRSO.

D. All Stuck Source in Tool Incidents shall be reported in OneView as a HSE or SQ Incident in accordance with ST-GL-HAL-HMS-804 HSE and SQ Event Management.

E. Issue Stop Work Authority (SWA) if additional guidance is required.

6.11 Abandonment

6.11.1 Periodically, during logging operations a tool containing radioactive material may become lodged or stuck downhole. It may be possible to safely retrieve the tool; in other instances, it may be necessary to secure and abandon the source. In all cases, when radioactive material becomes stuck, report it in the Global Radiation Abandonment Tracking System (GRATS) located on the Radiation Safety SharePoint.

A. Fishing Procedures:

I. Preliminary Operations - If a tool containing a sealed radioactive source becomes lodged downhole, the following shall be completed before initiating fishing operations:

a. Well Logging Supervisor shall perform the following:

i. Notify the RSO of the situation.

ii. Remain in contact with the well operator and provide recommendations and guidance to ensure that safe, nondestructive fishing procedures are implemented.

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iii. Ensure that the fishing company representative is aware that fishing procedures could damage the radioactive source, and of the possible consequences of contamination associated with a ruptured radioactive source.

b. RSO shall perform the following:

i. Complete and submit the appropriate GRITS report, providing the details of the tuck tool containing radioactive material.

ii. If regulatory notification and/or authorization is required prior to fishing operations commencing (such as in the State of Alabama), the RSO shall contact the GRSO.

c. GRSO (or other GRSO appointed designee) shall perform the following:

i. As notified by the RSO, contact the appropriate licensing agency / agencies

6.11.2 Fishing Operations:

A. Well Logging Supervisor shall perform the following:

I. Remain on location during all fishing operations involving radioactive sources.

II. Immediately report the following emergency conditions associated with wireline or logging while drilling (LWD) fishing situations to the RSO:

a. If the well operator attempts to fish in a manner considered unsafe.

b. When mud return lines monitored during a fishing operation show any increase in radioactivity.

c. When the radioactive source is in danger of being damaged.

d. When abandonment of a radioactive source seems imminent.

B. RSO shall perform the following:

I. Update the GRITS report once fishing operations have commenced.

II. Upon notification from the Well Logging Supervisor of the operators attempts to fish in a manner considered unsafe, shall notify the district operations manager and the GRSO.

6.11.3 Retrieve the Radioactive Material:

A. Well logging Supervisor shall perform the following:

I. Use a low-level beta/gamma survey meter to continually monitor the fluids circulating from the well at the surface and document survey readings on FO-GL-HAL-HSE-1205A - Contamination Survey Log at a minimum of once a hour. If possible, place a gamma logging tool in the mud return path and record the output.

II. If elevated radiation readings are detected, immediately secure recirculation, shut down operations and notify the RSO.

III. Visually inspect the retrieved radioactive source for obvious signs of damage, such as abrasions or disfigurement caused by exposure to high pressure or milling operations.

IV. The storage of the retrieved radioactive source will be in accordance with ST-GL-HAL-HSE-1203 - Radioactive Source Control and Accountability.

B. RSO shall perform the following:

I. Update the GRITS report.

II. If regulatory notification is required that elevated radiation readings have been detected, contact the GRSO

C. GRSO (or other GRSO appointed designee) shall perform the following:

I. As notified by the RSO, contact the appropriate licensing agency / agencies

6.11.4 Operations Completion:

A. Well Logging Supervisor or RSO shall perform the following:

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I. Perform a leak test on the radioactive source upon the return to the plant.

II. If regulatory notification is required, contact the GRSO.

B. GRSO (or other GRSO appointed designee) shall perform the following:

I. As notified by the Well Logging Supervisor or RSO, contact the appropriate licensing agency / agencies.

6.11.5 Radioactive Material Abandonment:

A. If a tool containing radioactive material remains stuck in the well despite recovery efforts, the radioactive material is considered irretrievable and must be abandoned, processes and plans shall be coordinated among the Well Logging Supervisor / Assistants, RSO, GRSO, applicable regulatory agencies, and the client.

B. Well Logging Supervisor shall perform the following:

I. Notify the RSO that a tool containing radioactive material remains stuck in the well despite recovery efforts, the radioactive material is considered irretrievable and must be abandoned.

II. Inform the client of applicable regulations regarding the safe abandonment the radioactive material.

III. Work with the client or client representative to develop a safe abandonment plan that includes the following:

a. A method of immobilizing and sealing the tool in place with a cement plug.

b. The placement of a non-drillable object to serve as a deflection device (unless cement plug is not accessible to any subsequent drilling operations).

c. As applicable, the placement of an identification plaque.

d. The plans for the well after abandonment [i.e., plug and abandon (P&A), sidetrack, produce at a shallower depth, etc.]

IV. Notify the RSO with the proposed abandonment details and pertinent well information.

C. RSO shall perform the following:

I. Notify the GRSO with the proposed abandonment details and pertinent well information.

D. GRSO (or other GRSO appointed designee) shall perform the following:

I. Contact the appropriate licensing agency / agencies requesting permission for abandonment. Prior to abandonment, approval shall be obtained from the appropriate regulatory agency.

E. Abandonment approval is granted:

I. GRSO (or other GRSO appointed designee) shall perform the following:

a. Notify the RSO that regulatory approval was granted for the source abandonment.

II. RSO shall perform the following:

a. Notify the Well Logging Supervisor that regulatory approval was granted for the radioactive material abandonment.

III. Well Logging Supervisor shall perform the following:

a. Notify the client or client representative that regulatory approval was granted for the radioactive material abandonment.

F. Abandonment approval is denied:

I. GRSO (or other GRSO appointed designee) shall perform the following:

a. Evaluate other acceptable alternatives with the appropriate individuals and resubmit an abandonment plan to the regulatory agency / agencies for approval.

G. Completion of abandonment:

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I. Well Logging Supervisor shall perform the following:

a. Report the final abandonment details to the RSO.

II. RSO shall perform the following:

a. Update the GRITS report.

b. Obtain a well plaque and ensure the plaque is provided to the client or client representative.

III. GRSO (or other GRSO appointed designee) shall perform the following:

a. Notify or ensure that written notification is made to the regulatory agency / agencies responsible for the licensing of radioactive materials within 30 days of the completion of the abandonment.

IV. Client or Client Representative shall perform the following:

a. Notify the regulatory agency / agencies responsible for the drilling and production of oil and gas wells (i.e., Railroad Commission, Corporation Commission, Oil and Gas Board, etc.).

6.11.6 Typical Abandonments:

B. The following examples are intended to aid the Client and Well Logging Supervisor in the development of an abandonment plan.

I. Radioactive Material below the Producing Zone:

a. This option is also practical when the well is going to be plugged and abandoned.

b. This is usually the simplest abandonment. Because the radioactive material is below the producing zone, it is cemented in place and a 200' cement plug is set above the tool. A deflection device is set above the plug. Typical deflection devices include a whipstock, an inverted drill bit, drill collars, or steel ball bearings. If possible, a plaque with the information required by the affected regulatory agency is prepared and mounted on the surface. With the approval of the appropriate regulatory agency, a plug of less than 200' may be set if there is not enough hole below the producing zone.

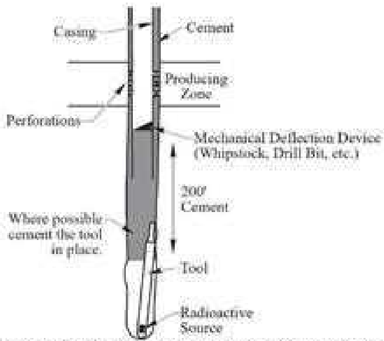

Figure 1: Source and Tool below the Producing Zone

6.11.7 Radioactive Material above the Producing Zone:

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A. If the tool/source are left above the producing zone and casing can be run past the tool, then the tool may be cemented in place behind the casing. In this case, a deflection device is not practical. After the tool is cemented in place, a gamma-ray log must be run to verify the actual location of the radioactive material. The customer shall document the depth of the radioactive material in all files associated with the well. Perforating operations should not be conducted 200' above or below the radioactive material. A warning plaque must be mounted on the surface.

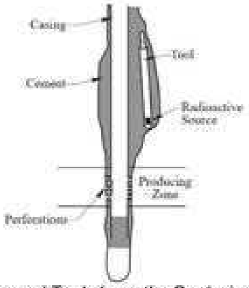

Figure 2: Source and Tool above the Producing Zone

6.11.8 Radioactive Material in the Producing Zone:

B. In this configuration, the tool may be cemented in place and a 200' cement plug set above the tool. Then the deflection device is set and the well is sidetracked. The distance between the sidetracked hole and radioactive source should be 15' (verify distances required by local regulations) or have a separation factor of 1.5 at 3 sigma, whichever is greater of the source. A plaque must be prepared and mounted on the surface.

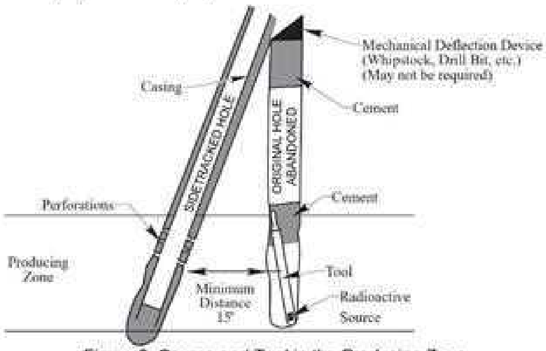

Figure 3: Source and Tool in the Producing Zone

6.11.9 Other Abandonment Procedures:

A. An alternative abandonment plan may be developed by the client, however, client-developed abandonment procedures shall be approved by the appropriate regulatory agency / agencies prior to the abandonment commencing.

7.0 References

7.4 (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance

7.5 BSD-GL-HAL-HMS-100 - HMS Definitions

7.6 FO-GL-HAL-HSE-1205A – Contamination Survey Log

7.7 ST-GL-HAL-HMS-503 - HSE and SQ Risk Management

7.8 ST-GL-HAL-HMS-712 - Management of Change (MOC)

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7.9 ST-GL-HAL-HMS-804 - HSE and SQ Event Management

7.10 ST-GL-HAL-HSE-0601 - Emergency Response and Crisis Management

7.11 ST-GL-HAL-HSE-0414 - Portable Fire Extinguishers

7.12 ST-GL-HAL-HSE-1203 - Radioactive Source Control and Accountability

7.13 ST-GL-HAL-HSE-1205 – Radiological Surveys and Survey Instruments

7.14 WM-GL-HAL-HMS-804D - HSE and SQ Reporting/Recording

8.0 Recordkeeping

All HSE documents shall be retained and maintained in accordance with (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance

7.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
06-MAY-2024	8	Bradley Seguin	Work method moved from ST-GL-HAL-HSE-0601 – Emergency Response and Crisis Management (numbered as WM-GL-HAL-HSE-0601J) to ST-GL-HAL-HSE-1201 - Radiation Exposure Monitoring Program as WM-GL-HAL-HSE-1201D
23-Feb-2023	7	Bradley Seguin	Renamed and updated link from GRITS (Global Radiation Incident Tracking System) to Global Radiation Abandonment Tracking System (GRATS) Previous highlights remain.
29-Apr-2023	6	Bradley Seguin	General Administrative Changes
28-April-2022	5	Bradley Seguin / Lee Heft	Added information pertaining to a LERP and clarified roles
20-JUL-2021	4	Beth Burbank	Administrative review to align with ISO 45001 changes
31.MAR.2021	3	Bradley Seguin	Addition of Stuck Source in Tool Procedures
11.FEB.2020	2	Pete Hernandez	Changed decontamination from low to high and inward, and changed notification of lost or stolen to immediate.
01.FEB.2019	1	Will Hendricks	Added section 4.7 for abandonments.
06.DEC.2018	0	Will Hendricks	New – Retired standard 1207 & relocated contents to WM-0601J.

For questions, comments or previous versions of HSE documents please send using the Global HSE Support Request Form.

Title: Dosimetry Program Management			HMS Document Number: WM-GL-HAL-HSE-1202A	
Owner: Global HSE/SQ	Approver: Director, HSE/SQ	Rev Date: 27-July-2023	Rev No: 7	Page: 1 of 6

1.0 Objective

The Halliburton Global Radiation Safety Program establishes the requirements to prevent incidents and mitigate the risks associated with the use of radioactive materials and/or radiation producing machines.

This standard concerns a Critical Focus Area or Life Rule. Improper attention to this standard may result in personal injury or death.

2.0 Application

This standard used in conjunction with ST-GL-HAL-HSE-1201 - Radiation Safety Administration, applies to all Halliburton locations and work activities worldwide.

Where local/country regulations or customer requirements are more stringent than the Global HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Dosimetry Program Management Requirements

Figure 1 - Flow

4.1 Establishing Area Dosimetry

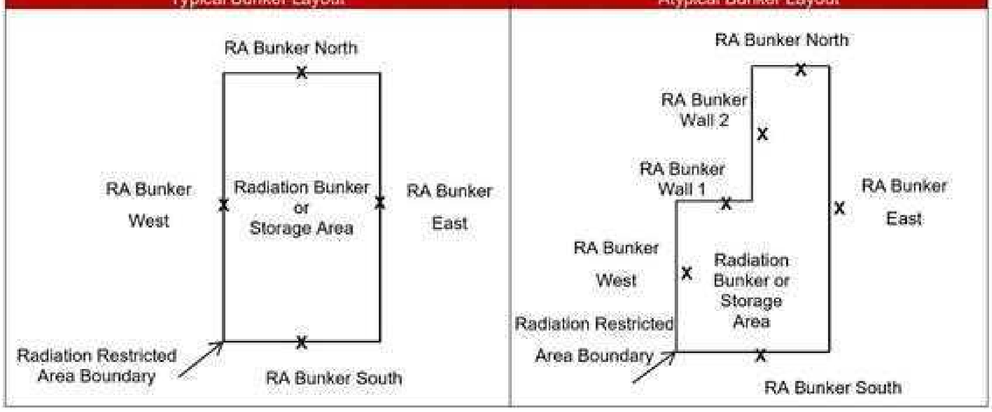
4.1.1 Follow the below steps when establishing area dosimetry for locations that store and/or utilize radioactive material or radiation producing machines.

A. At a minimum, area dosimeters shall be placed:

I. At all Full Scale Permanent Storage Area/s on the boundary (outer perimeter) of all vertical sides of a Radiation Restricted Area.

a. Locate the Radiation Restricted Area boundary of the use or storage area. This is typically the fence line around the bunker or the bunker wall that an unauthorized person would have access to as per the below figures.

Figure 1: Typical Bunker Layout | Figure 2: Atypical Bunker Layout



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b. If the Radiation Restricted Area is unknown, use a radiation survey meter as outlined in ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments to identify an exposure rate of 2mRem/hr (.02mSv/hr.)

II. All Limited Scale Permanent Storage Area/s, a single area dosimeter is sufficient.

III. All Radiation-Producing Equipment Use (operated) Areas. This does not include handheld radiation-producing machine/s.

a. Machines in dedicated rooms and enclosed machines that require room shielding, shall have area dosimeters on the outside perimeter of all vertical walls of the room(s).

b. Desktop machines shall have a dosimeter placed where the operator stands during use.

IV. Additional Dosimeters may be placed on other non-restricted occupied areas to demonstrate the dose limits are not exceeded.

V. Temporary Storage Areas are not subject to area dosimetry requirements unless otherwise required by local/county regulations.

VI. The FO-GL-HAL-HSE-1202G - Dosimeter Area Monitoring form shall be completed and submitted to FHOUDOSIMETRY@Halliburton.com to activate dosimeters for area monitoring.

VII. Area Dosimeters shall:

I. Be placed between 1 and 1.5 meters above the ground or other walking / working surfaces to demonstrate the employee or public dose limits are not exceeded.

II. Be posted on the predetermined areas that the badges were designated.

III. Be posted using a Landauer plastic pouch, clip, outdoor electrical outlet box our other securement method.

IV. Not be worn by individuals.

V. Remove the Remove tab removed from the dosimeter prior to posting.

4.2 Personnel Dosimetry Determination

4.2.1 Follow the below flow chart to help make the determination if personnel monitoring badge shall be issued.

Proceed to the next page to view the flow chart

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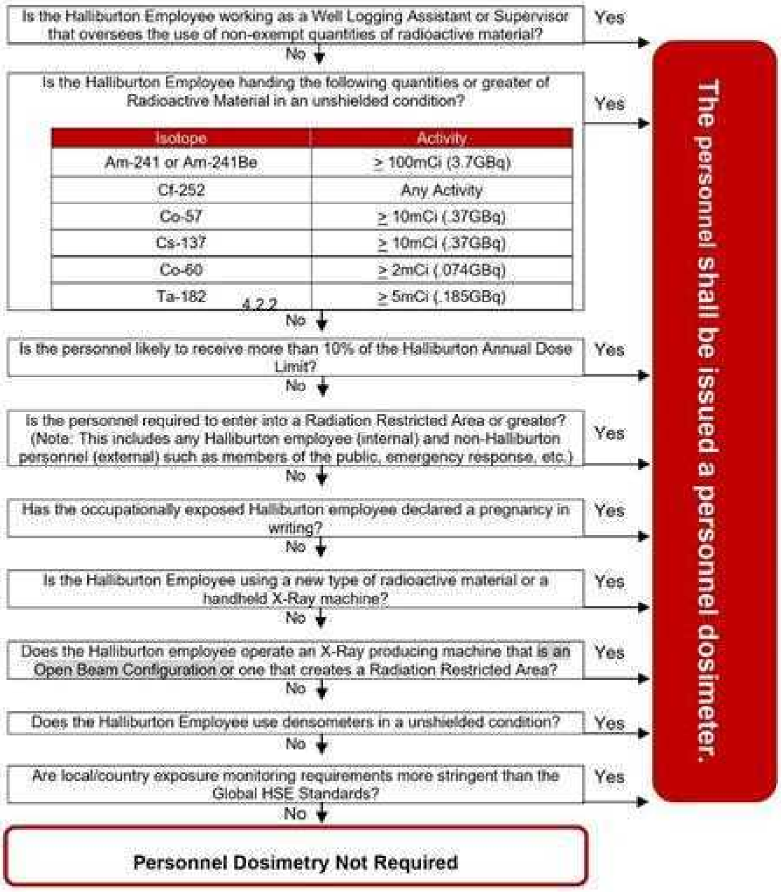

Isotope	Activity
Am-241 or Am-241Be	≥ 100mCi (3.7GBq)
Cf-252	Any Activity
Co-57	≥ 10mCi (.37GBq)
Cs-137	≥ 10mCi (.37GBq)
Co-60	≥ 2mCi (.074GBq)
Ta-182	≥ 5mCi (.185GBq)

4.2.1 If the personnel:

A. Requires a personnel dosimeter per the flowchart, then reference ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring Program Personnel Dosimetry.

B. Does not require a personnel dosimeter per the flowchart, then the RSO shall explain the reasoning to why dosimetry is not required.

4.2.2 Unless required by local regulations, the following personnel are exempt from personnel monitoring:

A. Personnel such as marker bead handlers, thorium blanket handlers, or handlers of limited quantity material who will receive less than 500 mRem/yr. (5 mSv/yr.).

B. Personnel who do not directly handle Radioactive Material or oversee the use of Radioactive Material shall not enter a Radiation Restricted Area and therefore are exempt from personnel monitoring.

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4.3 Dosimetry Processing

4.3.1 Dosimetry shall be processed by completing the following actions (as applicable) by the 20th of the month following the end of the wear period. Most Halliburton locations issue dosimetry quarterly, therefore the deadlines are as follows:

Quarter	Wear Period	Due Date
Q1	January 1st - March 31st	April 20th
Q2	April 1st - June 30th	July 20th
Q3	July 1st - September 30th	October 20th
Q4	October 1st - December 31st	January 20th

A. Dosimetry Exchanges

I. **Floor Process:**

a. Collect all used and un-used dosimeters in preparation for a Dosimetry Return.

b. Used dosimeters shall be allowed to be exchanged prior to the exact end of the wear period.

c. A new dosimeter shall be issued / posted at the time of collection.

d. Do not delay sending in dosimeters to the vendor while waiting for all dosimeters to be collected. Send multiple shipments if necessary.

II. **Book Process:**

a. Log into www.myLDR.com and locate the Packaging List - Details to verify that all dosimetry badges were collected in the Floor Process. For help in locating the Packaging List - Details, follow the below steps.

i. Visit www.myldr.com.

ii. Enter your Landauer Username and Password then select Login. If you do not have a Landauer username, reference WM-GL-HAL-HSE-1201C – Radiation Safety Officer Appointment.

iii. Select the Reports tab and a dropdown opens. Select All Reports.

iv. Under All Reports for the Report Type, select Packaging List - Details from the dropdown.

v. Under the Filter Search for Account, select your Landauer Account from the dropdown.

vi. For the Subaccount, select your Landauer Subaccount from the dropdown.

vii. For the Report Created After or On, select the applicable time-period by clicking the open field and making the selection using the calendar.

viii. Finally select Search.

ix. In the Search Results, select the report and Download Selected to view the Packaging List - Details.

b. Any dosimeter that was not collected in the Floor to Book Process, one of the following actions shall be taken:

i. Lost Dosimetry: Submit a FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report.

ii. Late Dosimetry: Create a OneView Action Plan that includes the following details:

- The PSL, plant and appointed RSO
- The Landauer Account and Sub-Account
- The participant number and badge serial number/s
- The expected return date/s

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- ➢ The reasoning for the late return
- ➢ The action/s to prevent the reoccurrence of the late return

A. **Dosimetry Returns**

I. Separate used and un-used dosimetry:

a. Start by separating all used and unused (except control dosimeters) dosimeters. Leave all unused dosimeters in their cellophane wrappers and place them in a plastic bag.

i. To help identify an unused dosimeter, a Remove tab been molded into the dosimeter that breaks away before being placed into the dosimetry into the clip (or other holder) when issued to the individual or area. Dosimeters with the Remove tab intact is an indication that the dosimeter has not been issued and are considered unused.

b. Seal (i.e. tape) the bag of unused dosimeters and place the bag in the package to be shipped.

II. Used dosimeters and controls

a. Ensure that all used visitor dosimeters have been assigned to a participant before the dosimeters are returned to the vendor. Use Landauer's online database at myLDR.com to verify that all used visitor dosimeters have been assigned.

i. If a used visitor dosimeter has not been assigned to a participant, access the Radiation Safety SharePoint and submit a Radiation Dosimetry Request.

b. If a used dosimetry badge has been returned damaged, complete FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report and send it to the dosimetry functional mailbox at FHOUDOSIMETRY@Halliburton.com

c. Place all used dosimeters and remove at least one control dosimeter from its cellophane wrapper and place them in a plastic bag.

d. Seal (i.e. tape) the bag of used dosimeters and place them in the package to be shipped along with the bag of unused dosimeters.

e. Seal the package of dosimeters and either:

i. Adhere "Do Not X-Ray" labels to the exterior of the package.

ii. Mark the exterior with "X-Ray Monitoring Badges Enclosed: Keep Away From X-Ray and Radioactive Materials".

f. Ship the package to the following address:

Landauer, Inc.

2 Science Road

Glenwood, Illinois 60425-1586

United States of America

i. For shipments within the U.S.A, only a shipping label is required.

ii. For shipment originating outside of the U.S.A. being sent to the U.S.A., ship the package using ZIR orders with ZNDP item category as the shipping method. Reference WM-GL-HAL-LG-303A - Instructions for creating a ZIR Order with a ZNDP Item Category.

5.0 Training

5.1 Radiation Safety Training Curricula shall be assigned as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

6.0 References

6.1 BSD-GL-HAL-HMS-100 - HMS Definitions

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- **6.2** FO-GL-HAL-HSE-1202B - Radiation Employee's Voluntary Notification of Pregnancy
- **6.3** FO-GL-HAL-HSE-1202C - Radiation Exposure Request
- **6.4** FO-GL-HAL-HSE-1202D - Radiation Dosimeter Request
- **6.5** FO-GL-HAL-HSE-1202E - Radiation Dosimeter Termination Request
- **6.6** FO-GL-HAL-HSE-1202F - Dosimeter Investigation Report
- **6.7** FO-GL-HAL-HSE-1202G - Dosimeter Area Monitoring
- **6.8** FO-GL-HAL-HSE-1202H - Public Dose Assessment
- **6.9** ST-GL-HAL-HSE-1201 - Radiation Safety Administration
- **6.10** WM-GL-HAL-HSE-1201C – Radiation Safety Officer Appointment

7.0 Recordkeeping

7.1 All HSE documents and records shall be kept as outlined in ST-GL-HAL-HSE-1201 - Radiation Safety Administration.

8.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
27-July-2023	7	Bradley Seguin	General Review, the addition of WM-GL-HAL-HSE-1201C
16-Aug-2022	6	Bradley Seguin / Lee Heft	The addition of information from ST-GL-HAL-HSE-1202 - Radiation Exposure Monitoring Program and dosimetry processing details.
28-April-2022	5	Bradley Seguin / Lee Heft	Added in dosimetry requirements from ST-GL-HAL-HSE-1208 - Radiation-Producing Machines. Additional clarification on when area and personnel dosimetry is required
17-Dec-2021	4	Bradley Seguin / Lee Heft	Additional time and clarity provided to return dosimetry and for the RSO to generate the annual form 5 reports.
25-MAR-2020	3	Pete Hernandez	Added clarifying definitions, changed exposure to Dose throughout, changed monitors to dosimeters throughout. Clarified significant incident requirement.
29-AUG-2017	2	John Snow	General Revision. Consolidation of action limit tables, Correction of Action Limits, Addition of WM-GL-HAL-HSE-1202A - Badge Issuing, Removal of Landauer Account Access Information, Removal of work method related information, Change Low Level Exposure to significant incident and taproot required, Revision of Employees Requiring Badges, Revision of Employees Not Requiring Badges.
02-DEC-2015	1	Jillian Mead	Initial Release

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Title: Radiation Source Disposition		HMS Document Number: WM-GL-HAL-HSE-1203C		
Owner: Global HSE/SQ	Approver: Director, HSE/SQ	Rev Date: 23-FEB-2024	Rev No: 5	Page: 1 of 6

1.0 Objective

To provide specific instructions for determining when to redeploy and the process to retire radioactive material.

2.0 Application

This standard applies to all Halliburton locations and work activities worldwide.

This work method satisfies the requirement of ST-GL-HAL-HSE-1203 - Radiation Source Control and Accountability, when to complete the procedure on disposal of radiation and the sale of radioactive materials.

Where local/country regulations or customer requirements are more stringent than the Global HMS Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HMS Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HMS Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Purpose

The Radiation Source Disposition process will assure Halliburton remains compliant with the regulatory requirements for radioactive material during its lifetime within Halliburton, and in particular, sources that have been sitting idle with no activity over a two-year period. By incorporating a process to assist with identifying sources based on activity, obsolescence, and utilization, this will allow the company and respective PSLs to ensure the dispositioning of sources are completed in a timely manner, resulting in a reduction in radioactive material inventory.

This process will assist in reducing our overall exposure as a company along with providing a heightened ability to focus efforts on improving additional processes, equipment utilization, and profit margins. The RSOs will complete the dispositioning process during the QCA period and will involve the PSL Leadership team in the approval process.

5.0 Radiation Disposition Requirements

Figure 1: Radiation Disposition Flow

5.1 Inventory Review

5.1.1 During the Quarterly Compliance Assessment (QCA), in accordance with WM-GL-HAL-HSE-1203A Radiation Quarterly Compliance Assessment, the RSO shall review the PSL / Plant Radioactive Material (RAM) inventory for potential Source Disposition. The RSO shall check for:

A. **Redeployment**: Used to categorize RAM to resolve low equipment utilization by the plant.

B. **Retirement**: Used to categorize RAM that requires SAP deactivation due to low activity, failed calibration pertaining to the source, or the source has been identified as obsolete.

C. **Abandonment / Lost**: Used to categorize RAM that requires SAP deactivation due to source abandonment down hole or the source has been identified as lost / missing. (All sources in this category shall be reported according to ST-GL-HAL-HMS-804 – HSE and SQ Event Management or through the Global Radiation Abandonment Tracking System (GRATS).

5.1.2 Upon the RSO's review of the PSL's RAM inventory, if the inventory does not meet one of the above disposition categories, then the RSO is to continue completing the QCA and no further actions are required from this disposition analysis.

5.1.3 If the RSO does find that RAM within the PSL inventory does meet a disposition category, then the RSO is to proceed with the Radioactive Source Disposition, outlined in with this work method.

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Owner: Global HSE/SQ	Approver: Director, HSE/SQ	Rev Date: 23-FEB-2024	Rev No: 5	Page: 2 of 6

5.2 Disposition Selection

5.2.1 Redeployment

5.2.1.1 Is most commonly used to redeploy RAM when it has the ability to continue generating revenue or improve the utilization of a revenue-generating tool in another PSL / Plant. This disposition is normally determined by the sending and receiving RSOs, local PSL leadership teams, and executed by the PSL's Asset Management team and Global Logistics.

5.2.1.2 The Utilization of RAM is based on regulatory requirements (25 TAC 289.252) and is used by Halliburton defining low utilization as 24 months of no usage from the last principal activity use for all locations. RAM utilization can be determined by reviewing either the SAP scheduling records or the FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log.

5.2.1.3 For high activity sources or sources built into an upper tool assembly, the tool / sources shall be scheduled to the job so that SAP records will reflect the usage. This usage can be verified by using SAP T-Code, ZMER or FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log.

5.2.1.4 For shop and lab sources, the RSO will need to review the FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log to determine the source utilization.

5.2.2 Retirement

5.2.2.1 When this disposition is selected, the RAM shall be returned to the appropriate PSL MFG. warehouse for final disposition as per ST-GL-HAL-HSE-1203, Radioactive Source Control and Accountability. Refer to the Company Business Practice, Asset Retirement Obligations, Reference No.: 4-44186 for additional requirements.

5.2.2.2 The Recommended Minimal Source Strength has been determined by the PSL's. When the activity level falls below the Minimum Source Strength listed in Table 1: Recommended Minimum. Source Strength, the RAM shall be returned to the PSL MFG. warehouse for final disposition.

PSL	Isotope	Half-Life	Min. Source Strength	Reference
SD	Cs137	30yrs.	1.26Ci	GTS-2016-FE014
LGP			1.2Ci	OEB-2005/030B
LGP	Co-60	5.27yrs.	.4m/R/hr	WM-GL-HAL-HSE-1203D

Table 1: Recommended Minimum. Source Strength

I. The Calculated Activity of the source is determined by using SAP T-Code, ZAERA, which auto calculates the estimated activity Half-life from the Initial / Nominal Activity level when the source was originally manufactured. Another way to determine low activity or strength of the source, is from a failed calibration as determined by the parameters defined in the tool's software program.

II. To properly survey the activity of a Marker sub or tubing joint collar the calibrated portable gamma survey meter should be placed directly on the sub or tubing collar where the Marker Bead is located for an accurate measurement of activity. If the survey reading is below .4 mR/hr the Marker sub or tubing joint collar should be removed from service. Every attempt should be made to remove the Marker Bead from the Marker sub or tubing joint collar. The Marker Bead should be disposed as outlined in this standard. If removal cannot be done contact the GRSO for guidance.

5.2.2.3 The Failed Radioactive Tool Calibration is used by the maintenance team and/or field professional informing the RSO that the tool failed calibration due to the source not meeting the lowest allowed limit per the tool specifications and as coded in the tool's software program.

5.2.2.4 Obsolete RAM is determined by Technology to be obsolete and approved by the PSL management team. A retirement strategy shall be developed and communicated in the technical bulletin with actions assigned to both local and global PSL owners. Please refer to the Company Business Practice, Reserve for Excess and Obsolete Inventory, Reference No.: 4-11020 for additional requirements.

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Title: Radiation Source Disposition		HMS Document Number: WM-GL-HAL-HSE-1203C		
Owner: Global HSE/SQ	**Approver:** Director, HSE/SQ	**Rev Date:** 23-FEB-2024	**Rev No:** 5	**Page:** 3 of 6

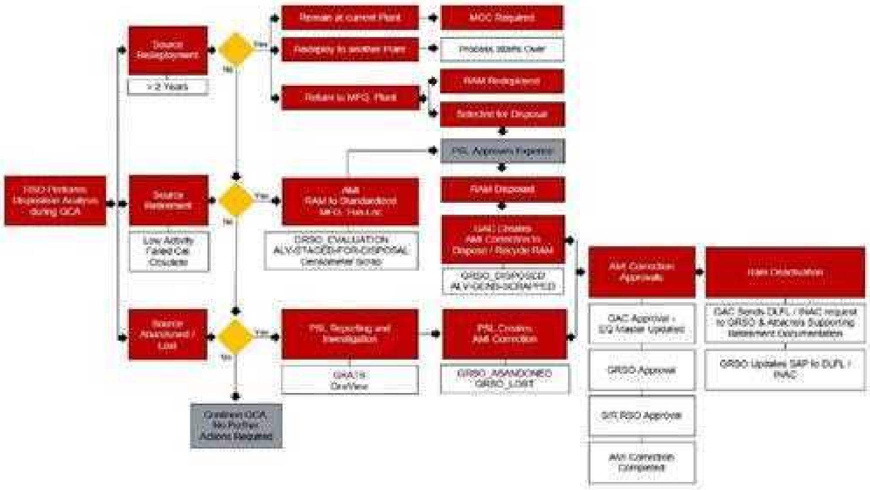
5.2.3 Abandonment or Lost

5.2.3.1 When this disposition is selected, the RAM shall be reported and investigated as per the applicable reporting system, ST-GL-HAL-HMS-804 – HSE and SQ Event Management or through the Global Radiation Abandonment Tracking System (GRATS) located in the Radiation Safety SharePoint. The investigation system shall be used and updated accordingly. Reference WM-GL-HAL-HSE-0601J - Radiation Safety Emergency Procedures for more information on the below reporting processes.

A. Source Abandonment = Global Radiation Abandonment Tracking System

B. Source Lost / Missing = OneView

5.3 Disposition Flowchart



5.4 Disposition Process Steps

5.4.1 Source Redeployment

5.4.1.1 For low utilized RAM as defined above, the RSO shall contact the PSL's Asset Management team to determine which of the following disposition steps to proceed with:

A. **RAM to remain at the current plant**: This disposition will require an approved MOC. The MOC time duration will be based on the date specified in the MOC, which will be based on future work. Once the RAM is used (last principal activity date), the Radiation Source Disposition process restarts.

B. **RAM to be redeployed to another plant**: The PSL / Plant proceeds to create an AMI transfer following Business Practice 4-44009 Capital Asset Transfers and using PM-GL-HAL-HSE-1206 – Shipping and Transportation of Radioactive Material. After the RAM redeployment, the Radiation Source Disposition process restarts.

C. **RAM to be returned to the manufacturing plant**: The PSL / Plant proceeds to create an AMI transfer following Business Practice 4-44009 Capital Asset Transfers and using PM-GL-HAL-HSE-1206 – Shipping and Transportation of Radioactive Material to return the RAM back to the PSL manufacturing warehouses for disposition.

I. Once the RAM is received at the manufacturing plant, the PSL Leadership team makes the determination, approving the expenses to either redeploy or dispose of the RAM. If chosen to dispose, the PSL GAC creates an AMI correction. For information on the AMI Correction, reference section 5.5 AMI Correction below.

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5.4.1.2 The transportation, shipping, and receiving processes for RAM, shall be completed in accordance with ST-GL-HAL-HSE-1206 - Transportation, Shipping and Receiving of Radioactive Material

5.4.2 **Source Retirement**

5.4.2.1 For RAM with a low activity / strength, failed tool calibration or an obsolete source, the PSL / Plant follows the below applicable process:

A. For serialized RAM, follow Business Practice 4-44009 Capital Asset Transfers and using PM-GL-HAL-HSE-1206 – Shipping and Transportation of Radioactive Material. The below standardized functional locations shall be used to send the radioactive material back to the applicable manufacturing warehouse.

I. **GRSO_EVALUATION**: Used for RAM that has been selected for retirement to the Houston, TX - Plant 2020 warehouse.

II. **ALVARADO REPAIR AND RETURN WIRELINE**: Used for Neutron Generators that have been selected for repair/retirement to the Alvarado, TX – Plant 2022. The Alvarado RSO will make the final determination if the equipment needs disposal.

III. **DENSOMENTER - SCRAP**: Used for RAM that has been selected for retirement to the Duncan, OK – Plant 2010 warehouse.

B. For RAM used by PPS purchased from a Third-Party Vendor, upon the completion of the job, the RSO shall return the radioactive material back to the vendor where the RAM was purchased and provide notification to the GRSO. See Ram Deactivation below.

C. For Co-60, the sending location shall follow the ZNDP process (the creation of the manual invoice and packaging list) and shall return the radioactive material back to Houston, TX - Plant 2020 retirement/disposal following ST-GL-HAL-HSE-1206 - Transportation, Shipping and Receiving of Radioactive Material.

5.4.2.2 When the AMI is received by the manufacturing warehouse RSO for final disposition, the RSO and the PSL GAC will select the most appropriate disposition method based on the following:

A. **Recycle** is to be used when a source becomes obsolete or has no other purpose within the company but has a useful purpose outside of the company. This is a sub-disposition of Retirement and is to only be used by the approved disposal facilities within the Supply Chain Manufacturing Centers.

B. **Final disposal** is usually the confinement by approved vendors. May apply other technics such as storage or donation for investigation purposes. The disposal process should be in accordance with ST-GL-HAL-HSE-1203 - Radioactive Source Control and Accountability.

5.4.2.3 The RSO communicates with the Manufacturing Supply Chain Procurement Team for a disposal quote that will contain the estimated disposal expense or transportation expense for recyclable sources and acceptance timeframe. The manufacturing warehouse RSO will attempt to bundle as many sources as possible to maximize the disposal/recycle container allowable volume to ensure cost effectiveness.

5.4.2.4 The RSO sends email containing the quote, the estimated expense, and dispositioning timeframe to GRSO, applicable PSL Sr. Leadership Team including the Global Asset Manager and PSL Controller requesting approval to proceed. If the approval is not obtained within a two-week timeframe, then the RSO will escalate to their supervisor and Global HSE Explosive and Radiation Manager for further guidance.

5.4.2.5 The PSL's Controller reviews the request, approves the expense, and agrees to the allotted timeframe through email.

5.4.2.6 The manufacturing warehouse RSO communicates by email to the disposal or recycle company to send the appropriate transport containers to the manufacturing warehouse to begin the shipment preparation.

5.4.2.7 The manufacturing warehouse RSO fills the transport containers and arranges for an approved carrier to collect the containers. The disposal or recycle company provides documentation, such as: Bill of Lading or Manifest or letter of acceptance of material referencing sources obtained in shipment.

5.4.2.8 The disposal/recycle documentation is added in the source file by the RSO. Additionally, the RSO provides a copy of such information to the PSL GAC for the update of the SAP equipment master.

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5.4.2.9 Once disposed, the PSL GAC creates an AMI correction. For information on the AMI Correction, reference AMI Correction below.

5.4.3 **Source Abandonment / Lost**

5.4.3.1 For RAM that has been abandoned down hole or has been identified as lost, upon the updating and completion of the applicable incident reporting system (GRATS or OneView), the PSL / Plant creates an AMI correction form to move the radioactive material into the applicable standardized functional location within the Houston, TX - Plant 2020 warehouse. For information on the AMI Correction, reference section AMI Correction below.

5.5 AMI Correction

5.5.1 **AMI Creation by PSL GAC**

5.5.1.1 The PSL GAC creates an AMI correction for the disposition selection of Source Retirement upon the disposal of the RAM by the PSL manufacturing warehouse, moving the RAM into the applicable standardized functional location within the listed manufacturing warehouse below. The AMI correction shall contain information applicable to the disposal of the RAM.

A. **GRSO_DISPOSED**: Used for RAM that has been disposed by the Houston, TX - Plant 2020 warehouse.

B. **GRSO_DISPOSED_ALV**: Used for RAM that has been disposed by the Alvarado, TX – Plant 2022 warehouse.

5.5.2 **AMI Creation by PSL Plant**

5.5.2.1 The PSL Plant creates an AMI correction for disposition selection of Source Abandonment or Lost, moving the RAM into the applicable standardized functional location within the Houston, TX – Plant 2020 warehouse, listed below. The AMI correction shall contain the applicable incident information which can be obtained through GRATS or OneView.

A. **GRSO_ABANDONED**: All RAM that has been lost downhole, shall be returned to the Houston, TX – Plant 2020 warehouse.

B. **GRSO_LOST**: All RAM that has been identified as lost or missing, shall be returned to the Houston, TX – Plant 2020 warehouse.

5.5.2.2 The PSL / Plant submits an AMI correction form to the applicable PSL GAC Functional Mailbox.

A. **SD**: FHOUSDSAMICORRFORMS

B. **WP**: FHOULGPAMICORRFORMS-WP-AMI Correction

C. **PE**: PE-AMI Transfer & Correction

5.5.3 **AMI Correction Approvals**

5.5.3.1 The PSL GAC will review the AMI correction form for accuracy and if approved, will update the source equipment master in SAP with the applicable information such as the incident or disposal information. As applicable, if rejected, the PSL GAC will contact the PSL / Plant to make corrections and to re-initiate the approvals.

5.5.3.2 Upon the PSL / GAC approval, the correction form moves to the International Trade Compliance (ITC) Coordinator for review and approval.

5.5.3.3 Upon the ITC approval, the correction from moves to the GRSO for review. As applicable, the GRSO will review:

A. That the incident number has been included in the AMI Correction form.

B. The applicable incident report for completion and accuracy.

C. The SAP equipment master has been updated accordingly.

5.5.3.4 Upon the GRSO approval, the correction from moves to the Sending / Receiving RSO for review and approval.

5.5.3.5 Once all approvals have been obtained, Global Asset Management will complete the SAP asset transfer to the applicable manufacturing warehouse.

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5.6 RAM Deactivation

5.6.1 GAC

5.6.1.1 The PSL GAC sends a notification to the GRSO to mark the source as deactivated (DLFL) and/or Inactive (INAC) in SAP as applicable.

A. For RAM utilized by PPS, the RSO shall be notified when sources have been received by the vendor for disposal.

B. The RSO / Vendor shall communicate this verification of receipt/disposal to the GRSO.

5.6.2 GRSO

5.6.2.1 The GRSO will coordinate the SAP system status change as deactivated (DLFL) and/or Inactive (INAC) as applicable. Only the GRSO or other designee can perform such SAP transaction.

6.0 References

6.1 BSD-GL-HAL-HMS-100 - HMS Definitions

6.2 ST-GL-HAL-HSE-1203 - Radiation Source Control and Accountability

6.3 ST-GL-HAL-HSE-1206 - Transportation, Shipping and Receiving of Radioactive Material

6.4 ST-GL-HAL-HMS-804 – HSE and SQ Event Management

6.5 WM-GL-HAL-HSE-1203A - Radiation Quarterly Compliance Assessment

6.6 WM-GL-HAL-HSE-0601J - Radiation Safety Emergency Procedures

6.7 PM-GL-HAL-HSE-1206 – Shipping and Transportation of Radioactive Material

6.8 FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log

6.9 4-44186 - Asset Retirement Obligations

6.10 4-11020 - Reserve for Excess and Obsolete Inventory

6.11 4-44009 - Capital Asset Transfers

6.12 Global Radiation Incident Tracking System

7.0 Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
23-FEB-2024	5	Bradley Seguin	Renamed and updated link from GRITS (Global Radiation Incident Tracking System) to Global Radiation Abandonment Tracking System (GRATS) Previous highlights remain.
26-Oct-2023	4	Bradley Seguin	Additional clarity on source retirement for Co-60. General Administrative Review.
20-Oct-2022	3	Bradley Seguin	Clarification in the disposal functional-locations and the addition of the disposal process for PPS.
17-Dec-2021	2	Bradley Seguin / Lee Heft	Addition of Standardized functional locations for RAM Deactivation
17-DEC-2020	1	Blake Daniels	Initial release - Creation of the Radiation Source Disposition WM
For previous versions of this document, please contact FHOUHMS@Halliburton.com. *HSE related questions and comments may be submitted using the Global HSE Support Request Form*			

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1.0 Objective

To provide specific instructions for Shipping/Transportation and Receiving of Radioactive Materials.

2.0 Application

This work method applies to all Halliburton locations and work activities worldwide.

This work method satisfies the requirements outlined in ST-GL-HAL-HSE-1206 – Transportation, Shipping and Receiving of Radioactive Material.

Where local/country regulations or customer requirements are more stringent than the Global HMS HSE Standards, the local/country regulations or customer requirements shall supersede the Halliburton Global HMS HSE Standards. Where local/country regulations or customer requirements provide additional requirements, the local/country regulations or customer requirements shall be supplemented to the Halliburton Global HMS HSE Standards.

3.0 Definitions

- See BSD-GL-HAL-HMS-100 - Global HMS and HSE Definitions, for a comprehensive list of terms and definitions.

4.0 Shipping/Transportation and Receiving of Radioactive Material Overview

Figure 1: RAM Shipping/Transportation and Receiving Flow

4.1 General Requirements

4.1.1 When the PSL decides that a radioactive material movement is required, the request to ship/transport radioactive material shall be made/communicated to the sending location RSO.

4.1.2 All RAM International shipments involving the U.S.A. shall be coordinated through one of the below plants:

A. Houston, Texas – Plant 2020

B. Alvarado, Texas - Plant 2022

C. Duncan, Oklahoma - Plant 2001/2010

4.1.3 To automate and standardize the workflow across PSL's when creating shipping papers for the movement of radioactive material, a digital solution is Appain Shipping and Transportation application can be utilized. For access, training, and use, contact the Radiation Safety Officer.

4.1.4 Reference BSD-GL-HAL-HSE-1206A – Control Points RAM Shipping and Transportation to help determine each Control Point activity and applicability.

4.1.5 Any person who is responsible for safety and preparation of a hazardous material for shipment/transportation as defined by a hazmat employee shall be an Authorized Person.

4.2 Control Point #1 – Verified Regulatory Compliance:

4.2.1 License and Permits:

A. The authorized person verifies the sending/receiving licenses, reciprocity, registrations, import/export permits and any other regulatory document that allows the operations, sources (isotopes, activities, etc.), and personnel to be used, stored, and received at the location.

4.2.2 Category 2 Evaluation:

A. The authorized person performs a Category 2 evaluation for all RAM shipments to, from, or within the USA. For additional guidance in the evaluation/determination of a Category 2 shipment, reference FO-GL-HAL-HSE-1206C – Verified Regulatory Compliance or the Appain Shipping and Transportation application.

4.2.3 The sending / receiving RSO is responsible for Verified Regulatory Compliance.

4.2.4 For all RAM International movements and Domestic plant to plant movements, FO-GL-HAL-HSE-1206C –

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Verified Regulatory Compliance shall be completed by an Authorized Person.

4.3 Control Point #2 – Controlled RAM Transfer:

4.3.1 Verified Workflow:

A. For RAM movements plant to plant, PM-GL-HAL-HSE-1206 – Shipping and Transportation of Radioactive Material outlines the process for the sending PSL to create the SAP AMI transfer. If the shipment is a Plant to Rig Site transfer, the AMI may not be applicable.

I. The receiving location address and transit path is verified.

II. The radioactive material is physically confirmed.

III. The estimated weights and dimensions are provided.

B. Once the AMI is created, the PSL Global Asset Coordinator (GAC) is responsible to verify the SAP workflow information, the ship-to party, RSO assignments and approve the AMI in SAP.

C. The sending PSL clicks Create Transfer Document on the AMI in SAP.

4.3.2 Job Preparation:

A. For RAM movements involving a jobsite, the Authorized Person completes the FO-GL-HAL-HSE-1206H - Controlled Jobsite Ram Transfer.

B. The sending RSO is responsible for the controlled ram transfer involving a jobsite.

4.4 Control Point #3 – Verified Packaging & Documentation:

4.4.1 RAM Packaging:

A. Physically Verify:

I. The Authorized Person shall physically verify the radioactive material that has been requested by the PSL to be shipped to ensure the equipment/serial number(s) of the radioactive material selected for packaging matches the equipment/serial number(s) of the radioactive material listed on all applicable shipping documents. If the equipment/serial number is not viewable, then the superior equipment number shall be verified. If the Superior Equipment number is not viewable (i.e., Co-60 beads, etc.) then verify the number of sources matches the number of sources listed within the applicable shipping documents.

B. Package Selection:

I. The Authorized Person shall select a Halliburton predesignated package(s) for the shipping/transportation of radioactive material. If the proper packaging/shipping container is not available, contact the GRSO. Remove any damaged packaging/shipping container from service immediately. The accepted package types are as follows:

a. **Excepted Package**:

i. The maximum **activity** per package (sum of sources) does not exceed the packaging limits specified below in **Table 1: Excepted Package Activity Limits**.

Table 1: Excepted Package Activity Limits

Nature of Contents	Solids: Special Form	Solids: Special Form	Solids: Special Form	Solids: Other Form	Solids: Special Form	Gases: Tritium	Solids: Special Form
Isotope:	Am-241/Be	Cf-252	Co-57	Co-60	Cs-137	T (H3)	Th-232
Activity:	< 270mCi	< 2.7mCi	< 270mCi	< 11mCi	< 54mCi	< 22Ci	Unlimited

ii. The maximum **exposure level** on the surface of the package does not exceed 0.5 mRem/hr. (5µSv/hr.)

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This is the minimum Halliburton Company Work Procedures. If local, country, or contractual requirements exceed this work method then those requirements must be followed.

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iii. The UN Number(s) and Proper Shipping Name(s) used for Excepted Package types are as follows:

- UN2908 - Radioactive Material, Excepted Package – Empty Packaging
- UN2909 - Radioactive Material, Excepted Package – Articles Manufactured from Natural Thorium
- UN2910 - Radioactive Material, Excepted Package – Limited Quantity of Material

iv. Note: A Thorium Blanket covering shall not suffice as a predesignate package for shipping and transportation. Other package materials such as fiber board boxes, plastics, and metal containers, in good condition can be used.

b. **Type A Package**:

i. The maximum **activity** per package (sum of sources) does not exceed package limits specified below in **Table 2: Type A Package Activity Limits**.

Table 2: Type A Package Activity Limits

Nature of Contents	Solids: Special Form	Solids: Special Form	Solids: Special Form	Solids: Other Form	Solids: Special Form	Gases: Tritium	Solids: Special Form
Isotope:	Am-241/Be	Cf-252	Co-57	Co-60	Cs-137	T (H3)	Th-232
Activity:	≥ 270mCi to < 270Ci	≥ 2.7mCi to < 2.7Ci	≥ 270mCi to < 270Ci	≥ 11mCi to < 11Ci	≥ 54mCi to < 54Ci	N/A	N/A

ii. The maximum **exposure level** on the surface of the package is not greater than 200 mRem/hr. (2 mSv/hr.) and the Transport Index (T.I.) is not greater than 10.

- The Transport Index shall be determined by taking a survey at 1 meter (3.3 feet), from the maximum radiation level on the external surface, in units of millirem per hour (mRem/hr.) removing units, and rounding to the nearest tenth or by multiplying the maximum radiation level in millisieverts (mSv) per hour at 1 meter (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 meter (3.3 feet)).

iii. The UN Number and Proper Shipping Name used for Type A Packages is as follows:

- UN3332 - Radioactive Material, Type A Package, Special Form
- UN2915 - Radioactive Material, Type A Package, Non-Special Form

iv. Type A packages may be placed in an enclosure called an Overpack, to contain one or more packages to form one handling unit for the convenience of handling and stowage.

- The exposure level on the surface of the Overpack is not greater than 200 mRem/hr. (2 mSv/hr.) and the Transport Index (T.I.) is not greater than 10. The T.I. for each overpack or freight container shall be the sum of the TIs of all inner packages, or if the overpack is rigid, direct measurement of the radiation level.

C. Securement and Security:

I. The Authorized Person shall secure the radioactive material by placing the radioactive material within selected predesignated package or Overpack to prevent the contents from moving during transport.

a. For lighter packages (<20 lbs.) within a cardboard the package may be secured using foam or bubble packaging.

b. For heavier packages (> 20 lbs.) the package should be secured using solid bracing, chains, or blocking. An example of acceptable bracing is in the Appendix Example 1, below.

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II. Installing a functional and secured padlock on each transport container. See Appendix Example 8 below.

III. In addition, for third-party shipments, a serialized security seal shall be placed through the hasp of the container or overpack (if applicable) and affixed in a manner that will alert the recipient if tampering has occurred. See Appendix Example 8 below. The security seal identification number shall be documented on the applicable Shipping Paper.

a. As applicable for Excepted Packages, security tape shall be used.

D. Marking and Labeling:

I. The Authorized Person shall mark and label the exterior of each package according to the contents in the package to the applicable shipping documents utilizing **Table 3: RAM Package Marking and Labeling**. Determine the column within **Table 3** that corresponds with the contents of the package. An example of a properly marked and labeled package is shown in the Appendix Examples 3-6, below.

a. Verify with local regulations if International Plant Protection Convention (IPPC) heat treat stamp is needed on wooden Overpacks and if required, have the Overpack stamped.

Table 3: RAM Package Marking and Labeling

Marking and Labeling	Excepted Package (Limited Quantity)	Type A Package	Overpack	Neutron Generators
Full name, address and telephone number of shipper and consignee*	Yes	Yes	Yes	Yes
UN Number	UN2910 UN2909 UN2908	UN2915/ UN3332	UN3332	UN3363/ UN2910
Empty Label (as applicable to UN2908)	Yes	No	No	Yes
Proper Shipping Name	No	Yes	Yes	Yes
If Found, Contact: 24 Hour Halliburton Emergency Response Number: +1 (281) 575-5000	Yes	Yes	Yes	Yes
DOT Type A Package Label	No	Yes	No	No
Halliburton Assay Tag	No	Yes	No	No
Radioactive Category Label (x2 180deg. Apart.)	No	Yes	Yes	No
Radioactive Material Excepted Package Label	Yes	No	No	Yes
Gross Weight (kg) & Dims. (cm) if >50kg (110lbs.)	Yes	Yes	Yes	Yes
Cargo Aircraft Only (Air Shipments Only)	No	Yes	Yes	No
OVERPACK Label (As Applicable)	No	No	Yes	No
Orientation Arrows (As Applicable)	Yes	Yes	Yes	Yes
Class 9 Hazard Label	No	No	No	Yes
Highly Controlled Materials Label	No	No	No	Yes
Security Seal or Tape (As Applicable)	Yes	Yes	Yes	Yes

Note: * Not required for shipment to a well site by Company Vehicles (owned or leased).

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II. The UN Numbers and Shipping Names are listed in **Table 4: RAM Proper Shipping Names.**

Table 4: RAM Proper Shipping Names

UN Number	Proper Shipping Name	Excepted Package (Limited Quantity)	Type A Package	Overpack	Neutron Generator
UN2910	Radioactive Material, Excepted Package - Limited Quantity of Material	Yes	No	No	Yes
UN2909	Radioactive Material, Excepted Package - Articles Manufactured from Natural Thorium	Yes	No	No	No
UN2908	Radioactive Material, Excepted Package - Empty Packaging	Yes	No	No	Yes
UN2915	Radioactive Material, Type A Package, Non-Special Form	No	Yes	Yes	No
UN3332	Radioactive Material, Type A Package, Special Form	No	Yes	Yes	No
UN3363	Dangerous Goods in Apparatus	No	No	No	Yes

III. When shipping to, from or within the U.S., if the activity of the isotope exceeds those listed in **Table 5: Reportable Quantities**, then the proper shipping name shall include "RQ" at the beginning or end.

Table 5: Reportable Quantities

ISOTOPE	ACTIVITY
Am-241/Be	370 MBq (10 mCi)
Cs-137	37 GBq (1 Ci)
Cf-252	3.7 GBq (100 mCi)
Co-60	370 GBq (10 Ci)
H-3	3.7 TBq (100 Ci)

IV. Determine the appropriate radioactive category label in **Table 6: Radioactive Category Label** Selection based upon the highest readings observed on the surface of all sides and at 1 meter (Transport Index (T.I.)) of the package. For additional information on survey instrumentation, refer to ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments.

a. Obtain the determined Radioactive Category Label. Complete the Label (x2 @ 180deg. apart) by filling out the contents (isotope), activity and T.I. in the designated areas.

i. Multiple isotopes shall be separated by a comma and activities must be listed in a multiple of Becquerels. If curies are included, curies shall be in parentheses.

ii. An example of a properly completed Radioactive Category Label is shown in the Appendix Example 2, below.

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Table 6: Radioactive Category Label Selection

Radioactive Category Label	Maximum Surface Reading	Transport Index (T.I.)
White I	≤ 0.5 mR/hr. (≤0.005 mSv/hr.)	0
Yellow II	> 0.5 mR/hr. (>0.005 mSv/hr.) but ≤50 mR/hr. (≤0.5mSv/hr.)	More than 0 but not more than 1
Yellow III	> 50 mR/hr. (>0.5 mSv/hr.) but ≤200 mR/hr. (≤2.0 mSv/hr.)	More than 1 but not more than 10

F. Weigh and Measure:

I. The Authorized Person shall weigh and measure the package(s) noting the weight in kilograms and the dimensions in centimeters if the package exceeds 50 kg or 110 lbs.

G. Verify Packaging:

The Authorized Person shall complete FO-GL-HAL-HSE-1206I – Verified Packaging for all RAM International and Domestic plant to plant movements, for each package(s) utilized. Multiple forms may be required for multiple packages.

H. The sending RSO is responsible for Verification of Packaging.

4.4.2 RAM Documentation:

A. For RAM movements Plant to Plant:

I. The sending RSO enters sales order (SO) details in the SAP sales order and approves it.

II. The receiving RSO verifies the SO information input by the sending RSO and approves the sales order in SAP. The receiving RSO shall not approve the SO before the sending RSO.

III. For International Shipments Export Compliance enters the export license and releases the SO.

IV. The sending PSL notifies logistics that the AMI is in ZMSHIP Mode.

V. Sending PSL and logistics personnel review the shipping information and prepare the shipment.

VI. Sending PSL confirms the final weight and dimensions and logistics updates ZMSHIP, if applicable.

VII. Sending PSL clicks Continue Processing in the AMI transfer form.

VIII. Sending logistics processes the shipment in ZMSHIP which prompts the creation of shipping paperwork (SAP Commercial Invoice, Packing List/Manifest, Shipper's Letter of Instruction, and AES Report).

IX. The ITC functional mailbox, FHOUEXIM needs to be contacted to release any embargo block, if applicable.

B. The Authorized Person shall complete the required shipping documents listed in **Table 7: RAM Shipping Documentation** based on the packaging contents.

I. Shipping Papers shall include the following information (as applicable to regulatory requirements) and can be documented on form FO-GL-HAL-HSE-1206A - Shipping Papers or another applicable form that meets applicable regulatory requirements:

a. 24 Hour Emergency Response Telephone Number +1 (281) 575-5000

b. UN Number and Proper Shipping Name (RQ as applicable)

c. Package Quantities, Weights, and Dimensions (weight in kg & the dimensions in cm)

d. Radionuclide & Activity listed in Becquerels. If curies are included, (Ci) shall be in parentheses

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e. Physical and Chemical Form if not Special Form

f. Radioactive Category Label and Transport Index (T.I.) (reference **Table 6: Radioactive Category Label Selection)**

g. Shipper's Certification

h. Serialized Security Seal Number

i. The words "Overpack Used" on the shipping paper if an Overpack was used.

i. The TRANSPORT Index (T.I.) for each Overpack. The T.I. for each overpack or freight container shall be the sum of the T.I.'s of all inner packages, or direct measurement of the overpack.

ii. Multiple overpacks shall include a unique identification number for each overpack.

Table 7: RAM Shipping Documentation

Document (Click Links for Additional Information)		Excepted Pkg.	Type A Pkg.	Neutron Generators
Shipping Papers (FO-1206A)	BOL - Bill of Lading Ground (ground)	Yes	Yes	Yes
	AWB - Air Waybill (air)	Yes	Yes	Yes
	SDDG -Shippers Declaration of Dangerous Goods (air)	No	Yes	Yes
	IMDG - Multimodal Dangerous Goods (sea)	Yes	Yes	Yes
Emergency	Emergency Response Guide	161	164	161 & 171
	Safety Data Sheet (Sulfur Hexafluoride)	No	No	Yes
Source Information	Sealed Source Certificate (Birth Certificate)	Yes	Yes	Yes
	Current Leak Test Report	No	Yes	No
	Certificate of Competent Authority (International Only)	No	Yes	No
	Densometer Profile (Densometer Only)	No	Yes	No
AMI Documents (Plant to Plant)	AMI Commercial Invoice	Yes		
	Shippers Letter of Instruction	Yes		
	Shipping Manifest / Packaging List	Yes		
Other	Excepted Pkg. Shipping Paper (UN2908, UN2909, UN2910)	Yes		
Control Points*	CP 1: Verified Regulatory Compliance (FO-1206C)	Yes		
	CP 2:Controlled Jobsite Ram Transfer (FO-1206H)	Yes		
	CP:3 Verified Ram Packaging (FO-1206I)	Yes		
	CP 3: Verified RAM Documentation (FO-1206D)	Yes		

***For the application of Control Point forms, see BSD-GL-HAL-HSE-1206A.**

I. The Authorized Person shall complete form FO-GL-HAL-HSE-1206D – Verified Documentation.

C. The Sending RSO and Receiving RSO (as applicable) provide approval on FO-GL-HAL-HSE-1206D - Verified Documentation which includes the review of all applicable shipping documents for accuracy and against the package marking and labeling for accuracy.

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D. For International shipments, upon the RSO approval, the shipping documents are sent to logistics personnel for approval.

4.5 Control Point #4 – Approved RAM Transfer

4.5.1 Domestic Approval:

A. Each person who offers a hazardous material for transportation shall be an Authorized Person that certifies by way of signature on the FO-GL-HAL-HSE-1206A – Shipping Papers or other applicable form that the named hazardous material is properly classified, described, packaged, marked, labeled, and is in proper condition for transportation according to the applicable regulations.

B. Upon the Shippers Certification above, continue with the Approved Transfer as outlined in this section.

I. For international shipments, the FO-GL-HAL-HSE-1206A – Shipping Papers or other applicable form shall be provided as part of the International Approval as outlined in this section.

4.5.2 International Approval:

A. Green Light Approval: (required for all international shipments)

I. Logistics personnel shall review and verify the entire shipment (documentation and packaging) for completion and accuracy.

II. Upon approval, the PM&L shall provide their signature on FO-GL-HAL-HSE-1206D – Verified Documentation, which serves as the Green Light authorization to proceed with the shipment.

III. The shipping documentation (as applicable) shall be organized according to **Table 7: RAM Shipping Documentation** and uploaded to the SAP AMI Number that is associated to the shipment. This action is required for all plant-to-plant shipments. Reference Appendix Example 7 below.

IV. Communication is sent to FALVRAMAT requesting approval.

B. FALVRAMAT Approval: (required for all international shipments)

I. Notification is sent to FALVRAMAT requesting the review and approval of the shipment.

II. FALVRAMAT shall confirm that the Control Point activities are complete and accurate. If the shipment is:

a. Approved, FALVRAMAT will click the GL Approval button within the AMI in SAP and communicated to the sending location that the shipment has been Approved to Transfer.

b. Rejected (Critical Rejection), the AMI will be returned to the sending location for correction, re-setting the Sales Order and trigging a notification to the PSL management team, that an Event Report, Investigation and Action Plan is required. An Event Report Number generated from OneView, is required before FALVRAMATS re-approval of the AMI in SAP.

4.5.3 Approved Transfer:

A. If the shipment is to, from or within the US and has been evaluated to meet Category 2 controls, section 1.3 Planning and Coordination in FO-GL-HAL-HSE-1206C – Verified Regulatory Compliance shall be completed and included in the shipping documents.

B. A copy of all shipping documentation shall be included inside or attached (as applicable) to the package.

C. Both the shipping and receiving locations shall maintain records of the applicable shipping papers, in accordance with ST-GL-HAL-HMS-404 – Record Control.

I. The shipping documentation (as applicable) shall be organized according to **Table 7: RAM Shipping Documentation** and uploaded to the SAP AMI Number that is associated to the shipment. This action is required for all plant-to-plant shipments. Reference Appendix Example 7 below.

II. If the Appain Shipping and Transportation application was used to create the shipping documents plant to plant, the Control Point forms are not required to be included in the packet of shipping documents that accompanies the shipment to the receiving location.

D. Cargo shall be secured to restrict movement and unauthorized access or removal during shipment/transport.

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E. Vehicles transporting Radioactive Yellow III Packages shall display 4 placards, one on the front, back, and both sides of the transport vehicle unless local requirements specify another placement.

F. The Authorized Person shall verify that the exposure levels:

I. Within the driver compartment do not exceed 2 mRem/hr.

II. At the surface of the vehicle shall not exceed 200 mRem/hr.

III. At 1 meter from the surface of the vehicle shall not exceed 10 mRem/hr.

IV. The number of packages and/or overpacks in a transport vehicle or in any single group in any storage location, incident to transport, must be limited so that the total TI does not exceed 50.

a. The total TI of a group of packages and overpacks is determined by adding together the TI number on the labels of the individual packages and overpacks in the group.

G. When the shipment is ready for departure (plant to plant), the sending PSL:

I. Adds the tracking numbers to the delivery test section of the AMI.

II. Clicks Shipment Departed in SAP within ZMSHIP.

III. Clicks the Print Packing List button to file copies of all the shipping documents locally.

IV. Sends notification to the receiving location that the AMI / shipment has departed.

4.6 Control Point #5 – Controlled Receipt & Storage

4.6.1 RAM Receipt:

A. As applicable, the receiving location PSL and Logistics are jointly responsible for notifying the receiving Authorized Person or RSO when a shipment with radioactive material arrives.

B. Prior to unloading any material, the shipment documentation should be verified to ensure the Package delivery is correct. The Authorized Person unloads the Package from the vehicle and inspect for damage or unauthorized entry.

C. All radioactive material that is in a controlled or unrestricted area and that is not in storage shall be controlled and remain under constant surveillance be secured from unauthorized removal or access until the material can be securely secured within the designated storage area (as applicable).

D. The Authorized Person shall:

I. Complete the applicable receipt record, within 3 hours of delivery unless delivered after normal working hours in which case the receipt shall be conducted within the first 3 hours on the first business day.

a. If the shipment was created and completed utilizing the Appain Shipping and Transportation application, the receipt record can be completed and maintained digitally through the application.

b. If the shipment was not created and completed utilizing the Appain Shipping and Transportation application, the receipt record is completed as per BSD-GL-HAL-HSE-1206A – Control Points RAM Shipping & Transportation

i. FO-GL-HAL-HSE-1206B – Receipt of Radioactive Materials for the receipt of RAM from a Plant to Plant or Jobsite movement.

ii. FO-GL-HAL-HSE-1206H - Controlled Jobsite Ram Transfer for the receipt of RAM involving a Jobsite movement.

II. Perform a survey reading of the surface and TI of the package.

III. Physically verify that the serial numbers of the material received matches those listed on all applicable shipping documents. If the serial number is not viewable then the Superior Equipment number shall be verified. If the Superior Equipment number is not viewable (i.e., Co-60 beads, etc.) then verify the number of sources received matches the number of sources listed within the applicable shipping documents.

IV. Note any discrepancies / nonconformances (i.e., missing radioactive sources, extra radioactive sources, wrong serial numbers, transport container is damaged "isolate the package" etc.), within the applicable receipt form and notify the RSO.

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V. Attach the applicable receipt form to the shipping documents received with the package and provide to the RSO for review.

VI. Notify the PSL or Logistics to complete the goods receipt in SAP as applicable.

4.6.2 RAM Storage:

A. The Authorized Person moves the radioactive material to the storage area (refer to ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability) and completes the applicable form:

I. FO-GL-HAL-HSE-1203B – Controlled RAM Storage In/Out Log.

II. FO-GL-HAL-HSE-1203D – Controlled Marker Bead Storage In/Out Log.

B. For empty packages, all labels required for the prior shipment of radioactive materials shall be removed, covered, or marked over entirely for storage purposes.

C. The RSO is to review all applicable shipping documentation for accuracy and completeness then sign and date the applicable record.

I. For shipments involving a jobsite, the RSO shall review the shipping documents upon the completion of a shipping cycle to and from the jobsite.

II. If any discrepancies / nonconformances is identified during the receipt, the receiving RSO reports it to the sending RSO who initiates ST-GL-HAL-HMS-804 – HSE and SQ Incident Management process.

III. The completed packet of shipping documentation shall be retained and maintained in accordance with BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance.

a. If the shipment was a plant to plant (thus requiring an AMI) and if the shipment was created/completed utilizing the Appain Shipping and Transportation application, the receipt record can be maintained digitally through the application.

b. If the shipment was a plant to plant (thus requiring an AMI) and the shipment was not created/completed utilizing the Appain Shipping and Transport application, the receipt is captured on FO-GL-HAL-HSE-1206B – Receipt of Radioactive Materials, the receipt record shall be uploaded to the SAP AMI number that was created for that shipment.

5.0 Training

5.1 Radiation Safety Training shall be assigned according to the risks associated with employee job duties and shall be completed by all employees. Refer to WM-GL-HAL-HSE-1201A – Radiation Safety Training.

5.2 Hazardous material shipping regulations may vary by country and each specific country's requirements shall be met before shipping. The following are examples of requirements for shipping radioactive material but may not be applicable for all shipments.

A. Ground: U.S. Department of Transportation (DOT) certification for all hazmat employees

B. Air: International Air Transport Association (IATA) certification for hazmat employees

C. Sea: International Maritime Dangerous Goods (IMDG) certification for hazmat employee

6.0 References

6.1 BSD-GL-HAL-HMS-100 - HMS Definitions

6.2 BSD-GL-HAL-HSE-1206A - Control Points RAM Shipping and Transportation

6.3 (BP) 4-17044 - Records and Information Management (RIM) - Lifecycle Management and Compliance

6.4 FO-GL-HAL-HSE-1203B - Controlled RAM Storage In/Out Log

6.5 FO-GL-HAL-HSE-1203D – Controlled Marker Bead Storage In/Out Log.

6.6 FO-GL-HAL-HSE-1206A - Shipping Papers

6.7 FO-GL-HAL-HSE-1206B – Controlled Receipt

6.8 FO-GL-HAL-HSE-1206C - Verified Regulatory Compliance

6.9 FO-GL-HAL-HSE-1206D - Transfer Document Checklist

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6.10 FO-GL-HAL-HSE-1206H - Controlled RAM Jobsite Transfer

6.11 FO-GL-HAL-HSE-1206I - Verified Packaging

6.12 ST-GL-HAL-HSE-1203 - Radioactive Source Control and Accountability

6.13 ST-GL-HAL-HSE-1205 - Radiological Surveys and Survey Instruments

6.14 ST-GL-HAL-HSE-1206 - Transportation, Shipping & Receiving Radioactive Material

6.15 WM-GL-HAL-HSE-1201A - Radiation Safety Training

Revision History

Revision Date	Rev. No	Revised By	Summary of Key Changes
31-Jan-2023	8	Bradley Seguin	The addition of the Appain Shipping and Transportation Application and alignment to Control Points.
21-April-2022	7	Bradley Seguin / Lee Heft	Additional clarification to packaging and labeling.
17-Dec-2021	6	Bradley Seguin / Lee Heft	Added req. for a Critical Rejection and clarification of FO-1206H
02.MARCH.2021	5	Bradley Seguin	Control Point Efficiency
17.DEC.2020	4	Pete Hernandez	Added definition for control points, green light, excepted package. Added control points for shipping and transportation of radioactive material. Reordered section 4 to represent shipping workflow and control points. Moved section from ST-GL-HAL-HSE-1206 to this WM: Surveying and packaging. All tables reformatted Clarified the definitions of Type A and Excepted package Section 10 – Storage added to link with ST-GL-HAL-HSE-1203 – Radioactive Source Control and Accountability and provide requirements for empty packages label removal Added shipping papers requirements
27.SEP.2019	3	Pete Hernandez	Added definition of hazmat employee, added choice for equivalent document for receipt of packages, and added training requirements
07-MAY-2018	2	Will Hendricks	Update to step 4.1.17 to require RSO/ARSO as one responsible to ensure FALVRAMAT approval is gained.
29-AUG-2017	1	John Snow	General rewrite. Consolidation of sections to shipping, receiving, documentation, packaging, and labeling.
13-Nov 2015	0	Jill Mead	Initial Release

For questions, comments or previous versions of this document please send using the GHSE Support Request Form.

10.0 Appendix

13.1 Example 1: Bracing for Heavy Packages

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13.2 Example 2: Radioactive Category Labels

Good Example

Bad Example

Bad Example


Bad Example

13.3 Example 3: Limited Quantity Package

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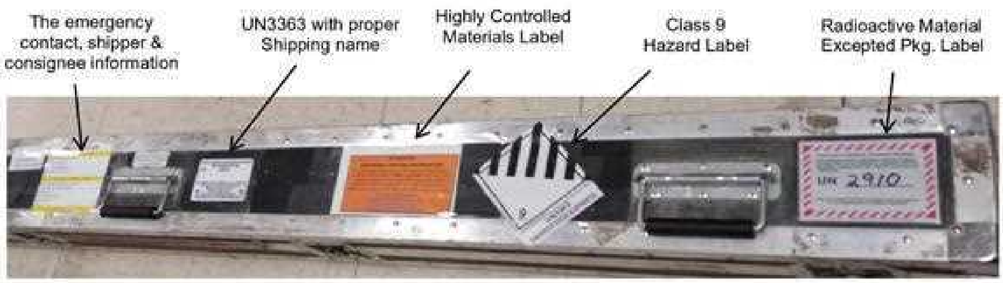
13.4 Example 4: Type A Package

13.5 Example 5: Overpack

13.6 Example 6: Neutron Generator



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13.6 Example 7: Organized Shipping Documents uploaded to the SAP AMI

13.7 Example 8: Proper Placement of a Serialized Security Seal

Bad Example

Good Example

7 Pictures and Definitions

Figure 1: Example Sources and Signage

7.1 Definitions

Aggregate - By the breach of a single physical barrier that would allow access to radioactive material in any form, including any devices that contain the radioactive material

Appointments – The annual approval by the GRSO to perform duties defined for an RSO

Area Dosimeter – A dosimeter used to monitor potential exposure to the public, placed on the outside of the room, bunker, or storage area at the highest exposure level where employees/members of the public are walking, sitting, or may have access.

Authorized Person - A person who is approved and assigned by the employer to perform specific types of duties and has successfully completed the training specified in this standard

Authorized Personnel - An employee that is approved and assigned by the RSO to perform duties related to the radiation safety program.

Category 2 Quantity of Radioactive Material – Individual sources or an aggregate quantity of radioactive material exceeding the threshold limits defined in 10 CFR part 37 (formerly RAMQC).

General Public - Any person not directly employed by Halliburton Energy Services

Global Radiation Safety - A group of employees within Global HSE that manages the Global Radiation Safety Program.

Hazmat Employee – Any person who is authorized (has successfully completed the applicable training) and is assigned by the employer, that directly affects RAM hazardous material transportation safety to include anyone who loads, unloads, or handles hazardous material.

Member of the Public - Any individual not receiving an occupational dose of radiation

Limited Quantity - A quantity of radioactive material that does not exceed the maximum amount of a hazardous material for which there is a specific labelling or packaging exception within US Code 49 CFR 173.425.

Physical Barrier - A means of securing a radioactive source from unauthorized removal or access that would require the use of additional tools to defeat.

Physical Verification -Visual confirmation of the actual source identification number as compared to applicable documentation. (e.g., remove source housing from shield and verify serial number in accordance with source handler training).

Radiation (Ionizing Radiation) - Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. As used in this standard, radiation does not include non-ionizing radiation such as radio waves, microwaves, infrared radiation, ultraviolet light, or visible light.

RAM - Radioactive Material

RSO - Radiation Safety Officer

Radiation Producing Machines - Any equipment that produces ionizing radiation when energized.

Radioactive Material - Any material including sealed sources, unsealed sources, and contaminated material that emits radiation.

Radiation Safety Officer (RSO) - An employee who is qualified to handle and/or work with Radiation, and who acts as a liaison for Radiation issues. This includes interfacing with government agencies, Global Radiation Safety, Halliburton management, and employees. Each facility set up for radiation is to have two RSO's in place.

SSDR - Sealed Source Device Registry

Source Handler - A person who is approved and assigned by the employer to work with Radioactive Material or Radiation Producing Machines and has successfully completed the training specified in section 6.0 of this standard.

Storage Area – Any area (I.E. bunkers, cabinets, racks) used to store unattended radioactive material at a facility, regardless of its status, to secure from unauthorized access, that meets the requirements outlined in this standard.

Transport Index (TI) - Transport index (TI) means the dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation.

Well Logging Supervisor - An employee who oversees the use of Radioactive Material for the purpose of logging a well.

Appendix E: Consultant's Curriculum Vitae

ENVIRONMENTAL SCIENTIST **André Faul**

André entered the environmental assessment profession at the beginning of 2013 and since then has worked on more than 220 environmental impact assessments and related environmental reports, including assessments for the petroleum industry, harbour expansions, irrigation schemes, township establishment and power generation and transmission. André's post graduate studies focussed on zoological and ecological sciences and he holds a M.Sc. in Conservation Ecology and a Ph.D. in Medical Bioscience. His expertise is in ecotoxicological related studies focussing specifically on endocrine disrupting chemicals. His Ph.D. thesis title was The Assessment of Namibian Water Resources for Endocrine Disruptors. Before joining the environmental assessment profession he worked for 12 years in the Environmental Section of the Department of Biological Sciences at the University of Namibia, first as laboratory technician and then as lecturer in biological and ecological sciences.

CURRICULUM VITAE ANDRÉ FAUL

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	ANDRÉ FAUL
Profession	:	Environmental Scientist
Years' Experience	:	22
Nationality	:	Namibian
Position	:	Environmental Scientist
Specialisation	:	Environmental Toxicology
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

First Aid Class A	OSH-Med 2022
Basic Fire Fighting	OSH-Med 2022

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Zoology/Biochemistry	:	University of Stellenbosch, 1999
B.Sc. (Hons.) Zoology	:	University of Stellenbosch, 2000
M.Sc. (Conservation Ecology)	:	University of Stellenbosch, 2005
Ph.D. (Medical Bioscience)	:	University of the Western Cape, 2018

PROFESSIONAL SOCIETY AFFILIATION:

Environmental Assessment Professionals of Namibia (Environmental Practitioner)

AREAS OF EXPERTISE:

Knowledge and expertise in:

- Water Sampling, Extractions and Analysis
- Biomonitoring and Bioassays
- Biodiversity Assessment
- Toxicology
- Restoration Ecology

EMPLOYMENT:

2013-Date	:	Geo Pollution Technologies – Environmental Scientist
2005-2012	:	Lecturer, University of Namibia
2001-2004	:	Laboratory Technician, University of Namibia

PUBLICATIONS:

Publications:	5
Contract Reports:	+220
Research Reports & Manuals:	5
Conference Presentations:	1