Petroleum Development Oman L.L.C.

Natural Occurring Radioactive Material (NORM) Specification

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i Document Authorisation

Document Authorisation		
Document Authority (CFDH)	**Document Custodian**	**Document Author**
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ii Revision History

The following is a brief summary of the 4 most recent revisions to this document. Details of all revisions prior to these are held on file by the issuing department.

Version No.	Date	Author	Scope / Remarks
Version 5.0	30/10/14	Nadiya Al-Harthy	Editorial Changes inclusion, Dose limits. Contamination levels, Instrumentation, Training, NORM guidelines,
Version 4.0	1/10/10	Brett Young MSE32	Editorial Changes, Inclusion of Appendices Forms in Appendices, Training updated
Version 3.0	30/06/05	Brett Young MSE/32	Inclusion of: 1. NORM Radiological Survey into the PTW 2. NORM in Gas systems 3. Exposure (dose) limits for work involving NORM 4. Training requirements 5. Emergency response 6. NORM Guidelines for specific tasks 7. Modification of Forms in Appendices Removal of: Specific task Appendices
Version 2.0	15/05/02	Wayne Austin CSM/32	Editorial changes. New format. Deletion of NORM Map (App. A), revision of existing procedures and inclusion of new procedures. Modifications to forms.
Version 1.0	20/03/00	Muralee Thummarukudy	Original Specification

iii Related Business Processes

Code	Business Process (EPBM 4.0)

iv Related Corporate Management Frame Work (CMF) Documents

The related CMF Documents can be retrieved from the Corporate Business Control Documentation Register *TAXI*.

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1 Introduction

Naturally Occurring Radioactive Materials, otherwise known as NORM, are widely distributed throughout the earth's crust and within the reservoirs where oil and gas are produced. These elements include the primordial radionuclides uranium and thorium and their progeny, including radium, radon, lead and polonium isotopes. Together with other naturally occurring radioactive isotopes, such as potassium-40, these radionuclides give rise to natural background radiation.

During the production of oil and gas, NORM can be transported from the subsurface to equipment, installations and byproducts. PDO has experienced that radium isotopes and radioactive lead can be co-precipitating with typical scales like barium and strontium sulfate. Contaminated scale has been detected on sub-surface equipment e.g. tubulars, pumps (ESP's), cables and surface equipment e.g. Xmas trees, valves and flowlines. NORM contaminated sludge have also accumulated in tanks, vessels and pigging receivers and evaporation ponds.

NORM not only present a potential health risk to PDO and Contractor staff maintaining and servicing production equipment or handling waste streams as these naturally occurring elements emit gamma photons and alpha and beta particles which are potentially harmful to health if inhaled or ingested, but may also result in an environmental legacy.

NORM wastes contain long-lived radionuclides (radium-226 with a half life of 1600 years). This has important implications for the choice of disposal options and long time periods for which control might be necessary.

1.1 Purpose

This specification describes PDO's minimum requirements for managing NORM, which may be hazardous to health or the environment as a result of PDO's oil and gas production. NORM will be handled in PDO on the basis of the Precautionary Principle.

This involves:

- Ensuring that no PDO employee, contractors or members of the public are exposed to NORM above the accepted International, local and PDO standards.
- Avoiding uncontrolled releases of radioactive contaminated substances and minimizing the effects of past deposits.
- Assuming NORM is present (where the potential exists) until proven otherwise.
- Continually monitoring the NORM levels in PDO operations and maintenance activities
- Incorporating NORM monitoring into the Permit to Work System.
- Constantly updating our knowledge of NORM based on international best practices.

1.2 Review and Improvement (SP1170)

Responsibility for the upkeep of this Specification shall be with the CFDH Occupational Health (Document Owner). Changes shall only be authorised and approved by the Owner.

Users of the Document who identify inaccuracy or ambiguity are requested to notify the Custodian using the form provided in CP 122 – HSE Management System Manual.

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The Document Owner shall ensure review and re-verification of this Specification every four years. However changes to the current version may be made in less than four years as the need arises depending upon the issue of new and relevant environmental legislation and/or major organisational changes in PDO.

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2 Scope

PDO has identified NORM as a health hazard and as an environmental risk to be managed in its operations, servicing and maintenance activities.

This specification covers PDO's practices for:

- Identifying NORM Contamination (Monitoring and Sampling)
- Handling NORM
- Controlling exposures (distance, time, shielding and PPE)
- Dose and Derived Limits
- Training
- Storage and Transport
- Decontaminating NORM contaminated equipment and waste disposal
- Prevention of contamination of the environment

2.1 Definitions

Alpha particle decay: A high-energy positively charged particle ejected from the nucleus of an unstable (radioactive) atom, consisting of two protons and two neutrons. E.g. radium-226 (^{226}Ra) is an alpha emitter decaying to radon-222 (^{222}Rn).

Background Radiation: The radiation to which an individual is exposed arising from natural sources such as terrestrial and cosmic radiation. The average background radiation from natural sources in Oman is 1.5 millisievert (mSv) per annum or 0.1 – 0.2 microsievert per hour (µSv/hr) when measuring using a dose rate monitor and a range from 3 - 6 counts per second (cps) when measuring using a contamination monitor in an area without manmade sources.

Becquerel (Bq): The System International (SI) unit for measurement of radioactivity

(1 Bq = 1 nuclear disintegration/sec).

Beta particle decay: The ejection of a high-energy charged particle (electron or positron) from the nucleus of an unstable atom. E.g. lead-210 (^{210}Pb) is a beta emitter decaying to bismuth-210 (^{210}Bi).

Dose Limit: The annual incremental effective dose limit to any person from exposure to ionising radiation, including NORM.

Dose rate meter: electronic device that measures the effective dose by means of a sensitive (and vulnerable) detector. It can be operated in the rate mode (µSv/hr) or integrate the effective dose over a certain time.

Gamma Radiation: Electromagnetic radiation termed rays or photons emitted from an unstable nucleus in the process of decaying. Radium-226 (^{226}Ra) for example emits alpha and gamma rays.

Gamma Spectroscopy Analysis (abbreviated as GSA): specialized techniques for the detailed qualitative and quantitative analysis of gamma radiation emitting radioactive materials.

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NORM: Naturally Occurring Radioactive Materials are materials produced by members of the decay series of naturally occurring uranium–238 (^{238}U) and thorium-232 (^{232}Th) and other radioactive nuclei. In oil- and gas operations, only progeny from the uranium and thorium decay series are encountered, together with potassium-40 (^{40}K).

NORM Contaminated Area: An area (e.g. around leaking installations pumps vessels, flow lines, well heads) will be classified as a "NORM contaminated Area" when the readings with a radiation dose rate monitor exceeds the natural background by at least 0.2 µSv/hr. NORM

Contaminated Equipment: Any equipment of which the dose rate exceeds 0.5 µSv/hr

NORM Contaminated Sludge: Any sludge or debris removed from tanks, vessels or pigging activities of which the dose rate exceeds 0.5 µSv/hr or greater than 1 Bq/g for ^{226}Ra after laboratory analysis by gamma spectrometric analysis.

NORM Controlled Area: An area or equipment is classified as a NORM Controlled Area when the external dose rate is ≥ 7.5 µSv/hr.

NORM Guidelines: Work instructions specifically written for activities that PDO or its contractors should follow when NORM is encountered.

NORM Supervised Area: An area is classified as a NORM Supervised Area when the external dose rate ≥ 2.5 µSv/hr to less than 7.5 µSv/hr.

NORM Suspect Materials: Sludge or waste material that exceeds background levels by at least 0.5 µSv/hr shall be treated as NORM Suspect Materials and be submitted for gamma spectroscopy analysis.

Radiation dosemeter (electronic, TLD or film budge); A small badge worn by the worker to measure and record the effective personal dose whilst working in NORM Controlled Areas TLD and film budges provide exposure integrated over the total time between issue of the badge and the reading of the badge in a certified laboratory. Electronic dosimeter provides direct readings of the equivalent dose rate in µSv/hr as well as the integrated dose.

Sievert (Sv): The System International (SI) unit for effective dose. Readings are typically in microsievert (µSv/hr) or millisievert per hour (mSv/hr).

2.2 Deliverables

2.2.1 Records

The following records shall be maintained:

- Corporate NORM database, in which all data from the Assets (e.g. Facilities, Wells, Sludge farms, Evaporation ponds are filed);
- NORM monitoring results e.g. workovers, pigging, facility maintenance;
- Personal dosemetery results (TLD, film badges, electronic dosimetery)
- Training records to demonstrate competence (e.g. HSE Passports);
- Calibration of NORM meters and meter inventory;
- Waste Consignments to the Bahja NORM Yard or other Inspection Yards;
- Inspection and audit reports to demonstrate compliance by tracking in PDO Incident Management (PIM

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2.2.2 Reports

NORM monitoring data (including non-detectable or background results) shall be entered into the Corporate NORM Database

PDO Staff: Any non-compliance with this Specification shall be notified, investigated and reported into PIM by the Contract Holder. The Corporate Radiation Safety Advisor shall be notified.

Contractors: Any non-compliance with this Specification shall be notified, investigated and reported to the Contract Holder or in the case of Sub-Contractors, the Main Contactor. The Contract Holder shall enter the investigation findings into PIM and notify the Corporate Radiation Safety Advisor.

2.3 Roles and Responsibilities

2.3.1 Radiation Advisory Committee (RAC)

The RAC defines and approves PDO's policy and/or specifications and procedures with respect to operational and administrative management of radiation protection, including NORM.

The RAC is established to ensure:

- The application of radiation safety principles in line with the Oman legislation and, where applicable, with the IAEA references
- The protection of staff, contractors, members of the public and the environment against the risk of ionizing radiation due to PDO work activities.

The RAC permanent members are:

- Chairman
- Corporate Radiation Safety Advisor (OH member and acts as the RAC secretary)
- Environmental Advisor

Invitees:

- Operations Representative
- Production Chemistry Representative
- Well Engineering Representative

link to RAC CHARTER

2.3.2 Corporate Radiation Safety Advisor (CRSA) CRSA

The CRSACRSA is the first source of expertise within PDO for advice concerning the management of ionizing radiation, including NORM.

Further, the CRSACRSA:

- Is secretary to the RAC;
- Monitors PDO radiation protection policy implementation and is authorized to directly communicate with the Directors in case of serious non-compliance;

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- Is current on all ionizing radiation issues within PDO;
- Is informed directly in case of accidents / incidents with sources of ionizing radiation and NORM;
- Is the corporate NORM database owner (NORM survey data and Analysis Results);
- Is contract holder for the external RPA contract.

2.3.3 External Radiation Protection Advisor (ERPA)

The ERPA is responsible for providing PDO management with expert advice on the management of NORM and shall:

- Keep updated on international best practice on managing NORM and advise PDO on the monitoring, handling, storage, transport and disposal.
- Review as requested HSE Specifications or work instructions for the safe handling of NORM contaminated equipment or materials.
- Train (as requested) PDO staff to effectively manage NORM.

2.3.4 Directorates (OND, OSD, UID, UWD & GD)

Directors are responsible for ensuring that NORM in their area of responsibility is managed in accordance with this Specification. When NORM contaminated equipment is identified, Directors shall ensure that:

- adequate resources and budgetary support is provided to undertake NORM surveys, provision or PPE and monitors, training, transport and disposal
- management of NORM is periodically audited and agreed recommendations closed.

2.3.5 Production Coordinators, Gas Plant Managers and Well Site Supervisors

Production Coordinators, Gas Plant Managers and Well Site Supervisors are responsible for ensuring that PDO operations under their remit implement this Specification. This shall ensure that people who work under them are not inadvertently exposed to NORM and that contaminated materials are managed according to the requirements of the Specification. In particular, they shall ensure that:

- All maintenance and service activities under their responsibility are monitored for NORM prior to work commencing and during the activity
- Record monitoring results into the corporate NORM database system
- When NORM are identified, controls are implemented
- All staff who working with NORM are trained to manage the risks
- The correct PPE is available and used correctly
- Records of contaminated and non contaminated equipment are maintained
- Records of NORM waste such as sludge are maintained in the corporate database.
- Responsible for sending NORM meters for calibration, maintenance or repair.

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2.3.6 Contract Holders and Company Site Representatives (CSR's)

Contract Holders and CSR's shall

- Ensure that where applicable this Specification is included in their contract (C9) and the Contractors and Sub-Contractors adopt the Specification into their own HSE managements systems.
- Ensure maintenance and service contractors including well servicing, pigging, production facility maintenance, tank cleaning, valve, spool replacement
- Perform an audit of their contractors to verify compliance with this Specification.
- Verify that the NORM training outlined in SP-1157 and Section 6.0 is included in the contractors training matrix.

2.3.7 Contractors

Contractors are responsible for incorporating this Specification and the relevant NORM Guidelines into their HSE Management System. They are responsible for:

- Providing and maintaining monitoring instruments to detect NORM as per the contract terms and conditions
- Conducting NORM measurements during maintenance or servicing activities
- Providing personal monitoring/ dosimetery during tank cleaning if exposure levels are likely to exceed 7.5 µSv/hr or as required by the CRSACRSA
- Collection, labeling and transport of NORM contaminated sludge or equipment to the Bahja NORM yard
- Training staff and sub-contractors who may handle NORM
- Provision of NORM specific PPE
- Providing and updating records (including monitoring, storage and transport) to the Asset who input these results into the corporate NORM database.

2.3.8 HSE Advisors

HSE Advisors will be the first point of contact for advice and assistance with regard to activities involved with NORM. This shall include provision of advice and assistance in relation to:

- Interpretation and understanding of SP-1170 and the NORM Guidelines;
- Investigating and reporting non-conformances
- Inspection and auditing operations, servicing and maintenance activities to verify NORM Management.

2.3.9 Corporate Environmental Advisors

Environmental Advisors are responsible for providing PDO management with advice on the disposal of NORM waste streams and assistance with any permits required for decontamination or storage of NORM waste. They will take a lead role in interfacing with the Ministry of Environment and Climate Affairs (MECA).

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2.3.10 Production Chemistry

Interior Production Chemistry Technicians (IPCT) shall

- Accept suspected NORM contaminated sludge samples collected by PDO Staff or Contractors.
- Ensure the requestor has correctly labeled the sample and completed the NORM Analysis Request Form (corporate NORM database, via Sample Manager) before forwarding to MAF Production Chemistry.
- maintain a calibrated NORM meter to support operations.
- shall receive PDO NORM meters due for calibration and ensure that the NORM Meter Calibration/Repair Form (part of the Corporate NORM database accessed via Sample Manager) is filled correctly by the meter owner, initialed, dated and forwarded to MAF PC.
- Provide suitable containers for collecting NORM samples and will also provide protocols on sampling and sample conservation techniques.

Mina Al Fahal **Production Chemistry technician shall**

- Receive samples and meters from the IPCT. They shall verify the samples are secure and operate the meters to verify the information recorded on the Forms is correct.
- Ensure that meters are timely delivered to approved laboratory and signed as received. Records are maintained by MAF Production Chemistry. MAF Production Chemistry will transport meters back to the owner via the IPCT.

It is the discretion of MAF Production Chemistry to decide whether Gamma Spectroscopy Analysis is carried out with the in-house GSA or to have this analysis carried out by an approved external service provider. The results of GSA will be entered into the Corporate NORM database and forwarded to CRSA for comments and eventually to the PDO requestor.

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2.4 Performance Requirements

2.4.1 Regulations and Performance Standards

The Ministry of Environment and Climate Affairs (MECA) issued MD 249/2003 Regulations for the Control and Management of Radioactive Materials. This Specification meets or exceeds the requirements set forth by the MECA and complies with the International Atomic Energy Agency (IAEA) references.

The performance standard for NORM in PDO is based on the IAEA for which Oman is a member. The IAEA Radiation Protection and Management of Radioactive Waste in the Oil and Gas Industry, Safety Report Series 34 and 40 have been incorporated into this document as well as RS-G-1.7 and GSR Part 3 (Interim, 2011).

2.5 Performance Monitoring

An audit program shall be developed by the Asset and relevant Contract Holders to demonstrate compliance with this Specification as per their Directorate HSE Plan. Audit tools have been developed to assist Production Operations and Maintenance, Contract Holders and CSR's to undertake Level 3 audits of PDO and Contractors. The frequency of audits shall be determined by the Directorate, however it is considered that NORM shall be included at least annually in HSE reviews. Audit reports shall be entered into fountain and recommendations tracked for close-out. The CRSA will develop an audit plan and conduct audits in-line with the Corporate HSE plan.

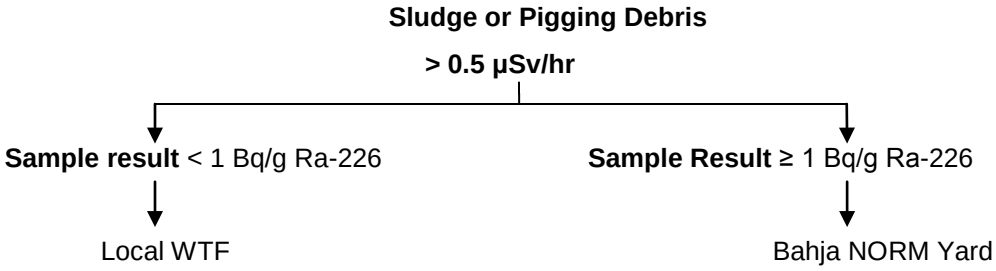
2.6 Management of NORM

2.6.1 What is defined as NORM Contaminated

General Remark

Throughout this document, for clearance purposes the radium-226 activity concentration (in Bq/g) is mentioned. Based on vast PDO experience, the radium-226 activity concentration is generally the most restrictive, but there might be exceptions where the radium-228, radium-224 or lead-210 activity concentration is limiting. So in case the radium-226 activity concentration is below 1 Bq/g but if the lead-210 or any of the other radium activity concentrations is above 1 Bq/g, the highest activity concentration must be applied since that is restrictive.

- Equipment with fixed scales (e.g. tubulars, valves, pumps etc) exceeding 0.5 µSv/hr are defined as NORM contaminated as the radium-226 activity is likely to exceed 1 Bq/g. Preferably the equipment e.g. joints, pump or valve will be run back in-hole or re-used, however equipment requiring maintenance or inspection by a third party vendor requires prior decontamination in the Bahja NORM Yard.
- Personal Protective Equipment exceeding 0.5 µSv/hr is considered NORM contaminated. Only PPE exceeding these criteria shall be taken to the Bahja NORM Yard. All other PPE can be disposed as non-hazardous waste.
- Sludge and waste removed from tanks, separators or pig traps with a dose rate greater than 0.5 µSv/hr shall have a representative sample collected for isotopic analysis. If the radium-226 activity equals or exceeds 1 Bq/g, the sludge shall be taken to the Bahja NORM yard as hazardous waste. If the concentration of radium-226 is below 1 Bq/g the waste can be mixed with other oily sludge in the local Waste Treatment Facility.
- In the Sultanate of Oman no regulatory limits have been defined for the unconditional release of NORM in produced water. Within PDO the activity concentration of 10 Bq/liter is adhered to for radium-228, radium-226, radium-224 and lead-210.



2.6.2 Permit to Work System (PtW)

PDO staff or Contractors opening, dismantling or maintaining equipment that has conveyed or stored production fluids (oil, water, gas) shall perform NORM monitoring to confirm or reject contamination. NORM readings shall be recorded on the NORM Survey Form (part of Corporate NORM database in SampleManager) and attached to the PtW. Previous NORM Surveys shall be used to predict contamination before work commences. Production Operators will quickly gain experience if frequently maintained (< 3 months) equipment is contaminated or not and this shall be used to update the Assets NORM database. The process is:

- Permit Applicant shall write NORM Survey Form in the space provided under *Section 2 – Certificates Attached to this Permit* and attach a blank copy of the NORM Survey Form for completion on-site.

- Within Process Facilities, the Production Supervisor shall refer to previous NORM Survey results or request the Production Operator to conduct external monitoring using the stations own radiation dose meter and check for NORM labels on equipment.

- Insulated or heavy walled materials may shield NORM during external measurements. Therefore internal NORM measurements must also be conducted after gas testing by the Permit Holder or PDO Production Operator

- All readings shall be recorded into the corporate NORM database, If external or internal readings exceed 0.5 µSv/hr, the NORM Restricted Area box shall be ticked. The task becomes a NORM Job ONLY if inhalation or skin contact risks exist or if there is a risk of contamination of the environment.

- Within Hydrocarbon Areas, the Permit Holder shall conduct external monitoring and once accessible internal monitoring. The results shall be recorded into the corporate NORM database and attached to the PtW. External or internal readings > 0.5 µSv/hr indicate NORM.

- Confirmed NORM monitoring results shall be added to the Assets own NORM Database. Contaminated equipment shall be labeled to alert operations and maintenance teams of the NORM risk for future activities.

- The dose rate meter used by the Process Facility shall be checked to verify it is in calibration and in good working condition by the Operator (Station) or Contractor (field). Preferably a check source is used to control the good working condition.

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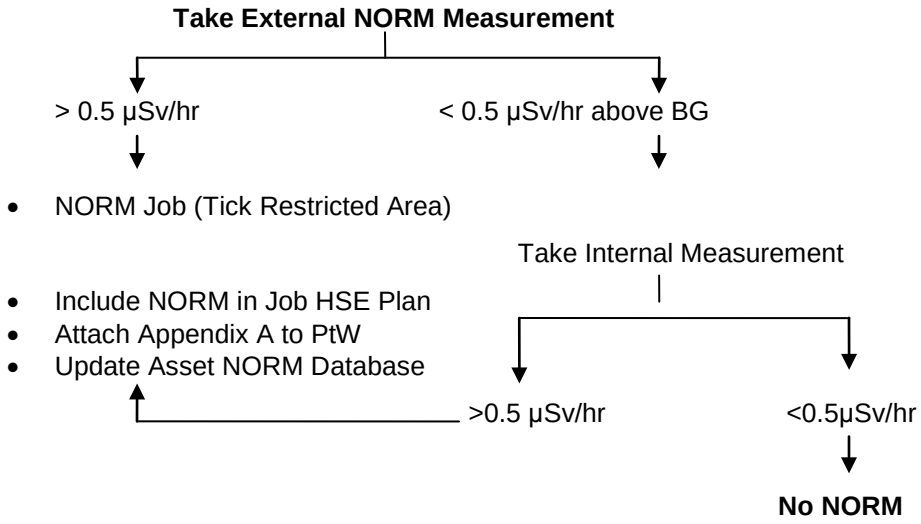

2.6.3 Sampling for NORM

NORM sampling can be required for solid samples (e.g. deposits), liquid samples (both water and hydrocarbons), gaseous samples and mixed samples, like sludge and pigging waste. Sampling of liquids and gases must be performed in full compliance with PR-1096: " Sampling of Oilfield Liquids and Gases". Especially for aqueous samples, preservation and conservation techniques (like the addition of a small amount of diluted nitric acid) are paramount. Instructions on sampling and sample conservation techniques are available at the Production Chemistry laboratory, as e.g. in PR-1982: "Production Chemistry Sampling Procedures".

Most frequently, sampling is required for sludge and pigging waste. Sludge or pigging wastes testing > 0.5 µSv/hr shall have a sample collected (approximately 100 grams) for gamma spectroscopy analysis by an approved laboratory. The sample shall be a mixture of the waste, collected into sealable 500 mL polypropylene (plastic) bottles available from the Interior Production Chemistry laboratories and labeled; Radioactive Sample Excepted Package – Limited Quantity of Material UN-2910. ***DO NOT use plastic sample bags as they are not sealable.***

There is no HSE risk provided the bottle is sealed and securely packed during transport. The NORM Analysis Request Form must be fully completed and provided with the sample. When completing the Form, include the maximum cps of the total sludge, not the reading from the sample bottle.

Laboratory samples shall be sent using the Hot-Shot Transported method from the interior production chemistry laboratory to MAF laboratory. Maintenance Supervisors of tanks shall plan for interim storage of sludge until the analysis results are finalized to determine the correct disposal technique (Refer 2.6.1).

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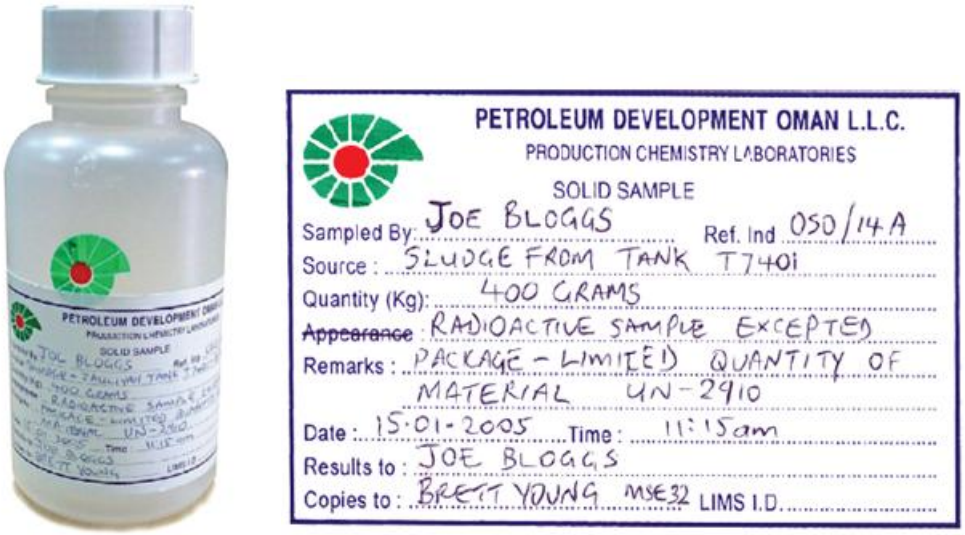

Once the analysis report from the approved laboratory is received the results shall be Reported by the CRSA into the corporate NORM database .

Samples of hard scales from tubulars and spools are generally not collected as it is commonly accepted that fixed hard scales above 0.5 µSv/hr will exceed 1 Bq/g for radium-226 and often do not require further analysis. In addition, it is difficult and bears a certain risk to collect sufficient scale from tubulars and ESP's needed for the laboratory analysis.

2.6.4 Handling of NORM Contaminated Equipment or Sludge Waste

All NORM contaminated materials must be handled in a manner that ensures no inhalation or ingestion of contaminated scale, sludge or debris owing to the internal risk from the alpha/beta particles. This generally only arises when performing maintenance or service activities.

The general principles for all operations and maintenance are:

- Limit the number of people involved in the operation to a minimum and cordon off
- Avoid environmental contamination and prevent the generation of airborne NORM containing material
- If an inhalation or ingestion risks exist, all personnel involved with the work must wear the specific NORM Personal Protective Equipment
- Eating, drinking and smoking shall be prohibited in the cordoned off area
- All personnel must wash with water before they leave the cordoned off area
- All personnel working with NORM must be monitored with an approved dose rate meter before leaving the area (after washing)
- All NORM contaminated equipment must be enclosed to prevent dislodged scale or sludge from becoming airborne (polyethylene wrapped, end capped, drummed)
- All equipment which is externally contaminated or open ended must be wrapped in polyethylene sheeting and labeled as contaminated

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- Contaminated sludge or pigging debris shall be placed into sealable drums before leaving the site or if large quantities of sludge, stored in skip bins and covered with plastic for safe transport to Bahja.

Detailed work instructions for handling NORM contaminated materials when pigging, tank or separator cleaning, well re-entry, sampling and sludge farming are covered in specific NORM Guidelines listed under Section 11.

2.6.5 Instrumentation

Each PDO production and gathering station shall have an approved calibrated detector (reeding in µSv/hrassigned for use during maintenance activities.

Gas facilities (GD) shall in addition have an approved monitor suitable for internal monitoring of lead-210 and other daughter isotopes of radon gas.

All meters, owned by PDO as well as by Contractors, shall be calibrated annually by an approved certified laboratory, include a certificate and fixed label with the calibration details. PDO meters damaged or due for calibration shall be provided to Interior Production Chemistry Laboratory with the completed NORM Meter Calibration and Repair Form (part of the corporate NORM database via Sample Manager). All PDO meters shall be recorded in SAP under the Asset Register.

Contractors involved with disconnecting flowlines from wellheads and maintenance of facilities (pigging and off plot) outside of production stations that do not require a PDO Operator/Supervisor to attend, shall provide their own approved and calibrated dose rate meter. They shall have sufficient meters to perform the work given crew locations and calibrations/repairs.

Before using a dose rate meter, its proper functioning must be checked, preferably using a check source.

Well Service contractors involved with workovers or servicing of producing wells shall have their own set of calibrated dose rate meters approved by the PDO CRSA. Each hoist shall have dedicated meters and sufficient spare meters to cater for calibration or damages.

Contractors cleaning highly contaminated (> 7.5 µSv/hr) tanks and vessels shall be provided with an intrinsically safe personal dosimeter to measure their daily dose in addition to their personal Badges (TLD or Film)

2.6.6 General Characteristics of NORM Detectors

- High sensitivity and fast response in time range
- Audible signals for radiation condition estimation
- Intrinsically safe,
- Shock-resistant (rugged and robust),
- Water-proof
- Reliable and easy to use
- Lightweight
- Working temperature range up to 50°C
- Easy replacement of batteries
- Easy decontamination
- Failure to safety

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2.6.7 Specific detectors Characteristics of NORM Gamma (γ) Detectors

Specific Characteristics of detectors	Type of Detectors	Measurement range
Gamma (γ) Detectors	GM (steel window or thin wall energy compensated) or Scintillation	Dose or exposure rate: 0.1 µSv/h - 3 Sv/h Energy range: 0.05 - 3 MeV
Alpha (α) / Beta (β) Detectors	GM (end window), Proportional or Scintillation	Activity output: Bq/cm^2 Energy range: Mixed α+β > 0.5 MeV

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3 Exposure Limits

3.1 Exposure Pathways

Internal exposures can result from the decay of radionuclides within the body. All of the NORM radionuclides have the potential to cause committed doses once inside the body. These radionuclides can enter the body via inhalation, ingestion or open wounds, Alpha particles have the greatest effect for internal exposures. Their relatively high energy and low penetrating power means that all their energy is deposited within the cell tissue.

External exposures occur when the radiation source is outside the body. Gamma radiation has the greatest effect on external exposures because of its high penetrating power. Doses from external exposure depend on factors such as the duration of the exposure, proximity to the source, the radionuclide concentration and the presence of shielding material.

3.2 Exposure Limits

The dose received from NORM by PDO staff and members of the public shall not exceed 1 mSv/year above background. PDO staff will not be classified as radiation workers and will not require any additional health surveillance.

Contractors undertaking specific tasks such as full-time tank cleaning or decontaminating equipment in the Bahja NORM Yard may receive an annual dose exceeding 1 mSv/year. Anyone likely to receive a dose exceeding 1mSv/year shall be classified as a radiation worker and wear a personal dosimeter (ThermoLuminescent Dose (TLD,film budges whilst working with or in the vicinity of NORM. TLD results shall be maintained by the Contractor and all workers shall have access to their cumulative results.

The maximum dose a classified radiation worker may receive in a calendar year is 20 mSv/year according to the Ministry of Manpower. It is recommended to investigate any worker receiving over 5 mSv at any time in a calendar year

If a female worker has declared that she is pregnant, additional controls have to be considered in order to attain a level of protection for the embryo/fetus broadly similar to that provided for members of the public.

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Table 2: Dose Limits

Classification	Dose Limit	Action
Maximum Annual effective dose received from occupational exposure as a radiological worker	20 mSv (	Stop all exposure to ionising sources and undertake investigation. Report to Regulator
Action level dose received from occupational exposure as a radiological worker	5 mSv	Employer undertakes internal investigation(ALARP demonstration)
Classified radiological worker is someone who may receive an annual effective dose exceeding this limit	1 mSv	Employer to provide TLD badges and advise physician during annual medical
PDO staff, pregnant workers, students and members of the Public	1 mSv	ALARP demonstration

3.3 Derived Limits

When the external radiation contour exceeds 2.5 µSv/h such as heavily NORM contaminated tanks, the area shall be designated as a **Supervised Area**. Work in Supervised Areas shall be monitored continuously to reduce exposures and predict an individual workers' dose. The dose-rate in a Supervised Area shall not exceed 7.5 µSv/h.

Where the radiation contour exceeds 7.5 µSv/h, the area shall be designated as a **Controlled Area** and specific systems of work and safety provisions are required. Operations and Maintenance Supervisors performing tank cleaning shall contact the CRSA if the dose rate levels exceed 10 µSv/hr. Contractors working in Controlled Areas shall wear a TLD badge as well as a personal dosimeter. Their cumulative dose records must be maintained.

If a worker receives a dose exceeding 5 mSv/year from exposure to NORM, the employer shall initiate an investigation to identify the cause and identify controls to reduce the exposures to ALARP.

3.4 Inhalation/Ingestion Limits

To ensure that workers' doses for inhalation/ingestion are minimised, PDO has adopted a total Personal Protective Equipment policy. Suitable PPE (e.g. FFP3 filter masks, gloves, disposable coveralls and boots) hand washing and personal hygiene facilities shall be provided to prevent inhalation and ingestion of NORM where particles may become airborne.

3.5 Monitoring of Personnel

As a consequence no PDO workers should be classified as radiological workers and no additional medical surveillance is necessary. Wearing of personal TLD Badges will be determined on a risk management approach. The results will be archived by the Contractor and Workers will have access to the database to see their personal results. Contractors shall keep their own registers.

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4.0 NORM Surveys

The Asset is responsible for conducting and recording the results of NORM Surveys of equipment within their production stations, manifolds, flowlines and sludge farms. Production stations and manifolds shall have a comprehensive survey performed as a minimum every four years or when undergoing a major shutdown given the internal surface access.

4.1 Background measurements

Before any dose rate measurement is performed, the background dose rate must always be determined under identical conditions as the actual measurements, but at a position where no radioactive materials are present / nearby. If e.g. the dose rate on the inside of a tubular has to be measured, the background should – if possible - be determined on the inside of a clean – no radioactively contaminated – tubular. When measurements have to be performed above a concrete surface, background measurements must be performed at the same height above the concrete surface, but away from any radioactive materials.

The reason for these precautions is that the steel wall of a tubular will reduce the natural gamma background radiation by shielding and that the gamma rays emitted by naturally radioactive potassium-40 present in concrete will increase the dose rate.

4.2 External Radiation Surveys

External surveys shall be conducted using an approved dose rate meter The major limitation of external radiation monitoring is shielding and when it comes to gas-related NORM for equipment that has been off-line for several hours. Equipment that has conveyed only wet or dry gas may emit radiation that cannot penetrate the steel walls. When such equipment is open, an alpha/beta detector must be used to detect the presence of internal contamination.

Results of previous NORM Surveys are available from the Corporate HSE Webpage

Contractors are requested to access the NORM database from their respective Contract Holder or Company Site representative.

Monitoring shall be conducted by a competent meter user) or a by qualified radiation protection supervisor.

Results of the monitoring are entered into the corporate NORM database.

4.3 Internal Radiation Surveys

As heavy wall pipe or vessels will shield radiation during external surveys, within the stations the Production Operator or a trained designate shall perform internal NORM measurements using a suitable and approved dose rate meter and record the result on the NORM Survey Form. The results shall be used by Operations or by an Asset Focal Point to update the corporate NORM database.

The internal surface of equipment from gas plants (typically parts where streams enriched in ethane or propane are present) should also be checked for lead-210 contamination, using a dedicated meter.

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4.4 Radiation Survey of Waste Products

Sludge, pigging debris, scales etc. from NORM (suspect) locations, shall be monitored with an approved and suitable dose rate meter. When the dose rate exceeds 0.5 µSv/hr but is less than 1 µSv/hr, a sample from this material must be collected and submitted for gamma spectroscopy analysis in an approved laboratory.

Sludge removed from tanks planned for treatment in the local Waste Treatment Facility shall be monitored by the yard operator using a suitable and approved dose rate meter. Sludge farms shall be routinely monitored by the yard operator to ensure that NORM hot spots exceeding 0.5 µSv/hr are identified. In case hot spots are encountered, the responsible supervisor should be consulted.

4.5 Radiation Survey of Gaseous Products

The RAC can advise to measure the radon-222 concentration in natural gas streams. This requires sampling and sample treatment. In view of the half-life of radon, it is generally preferred that these measurements are performed “in the field” by a specialized contractor.

4.6 Radiation Survey of Liquid Products

Produced oil generally does not contain NORM; sampling and analysis for NORM is deemed unnecessary. Natural gas liquids may contain lead-210 or polonium-210 and the RAC can advise sampling and analysis of these products.

4.7 Radiation Survey of Produced Water

Produced water may contain NORM, but external radiation measurements will – because of the low activity concentration and the wall thickness of the flow lines - not be able to measure it without the use of pre-concentration. For a proper assessment / baseline study of existing (like Al Noor evaporation ponds) or newly commissioned facilities (like the Nimr water treatment plant and reed beds) of the NORM legacy or the NORM potential, water sampling and laboratory analysis of the incoming and outgoing streams should be performed. Representative sampling and adequate sample conservation techniques are paramount to obtain reliable results.

5.0 Transport of NORM Waste

NORM contaminated equipment and sludge is considered as hazardous waste, however for the purpose of transport within Oman they will not be transported as Radioactive Materials as the activity should not exceed 100 Bq/g (MD 249/2003).

The following procedures are to be followed when transporting NORM:

- The openings to contaminated valves, spool pieces and pumps shall be covered with heavy duty (200 µm) polyethylene plastic and labelled as NORM contaminated.
- Internally contaminated tubulars shall be end-capped and each tubular labelled.
- Any tubulars externally contaminated or with perforations must be plastic wrapped and transported in a completion skid or basket.

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- The maximum reading at any point on the outer surface of the vehicle shall not exceed 2.5 µSv/hr.
- The maximum reading at 1meter distance from the outer surface of any vehicle carrying NORM shall not exceed 0.1 µSv/hr above background.
- The maximum reading at the driver's seat shall not exceed background.
- After loading, drums or equipment shall not be opened.
- Sludge in skip waste bins shall be covered with shade cloth to prevent airborne particles
- All NORM contaminated equipment of sludge waste shall be transported using the PDO **Waste Consignment Note**.
- All equipment or sludge shall be documented on the **NORM Generation Form** and attached to the Waste Consignment Note.
- Each driver of vehicles carrying NORM shall not drive for more than 4 hours without a break and the total working hours shall not exceed 10 hours per day.
- After unloading, the vacuum truck, vehicle tray or skip shall be monitored by the NORM yard operator for contamination before being released.

The consignment must be securely packaged in a manner that effectively prevents release of any NORM contamination during transport. Labels shall be fixed on the exterior surface of equipment, drummed sludge or tippers during transport.

Drivers of NORM waste shall undergo NORM training and understand the risks associated with the load being transported. NORM readings shall be taken in the cab of the vehicle at the drivers' position once the equipment or waste is loaded to confirm no external radiation risk exists.

The PDO contractors for the North and South are Ministry (MECA) approved to transport NORM contaminated equipment and sludge wastes to Bahja NORM yard however there may be occasions where a more appropriate transport provider may be required and some flexibility is practicable.

5.1 Transport from Wells

NORM contaminated equipment removed from wells by well services contractors e.g. joints, ESPs, cables, etc. which will not be re-run, shall be collected from the well location by 4PLContractor for Hazardous Waste (North/South) and taken to the Bahja NORM Yard.

In the event that the agreed Waste Contractor cannot reach the location prior to the hoist or well service contractor moving to another location, the well service contractor shall transport the equipment to the local Asset Waste Treatment Facility. The Asset is then responsible for arranging transport to Bahja. Contaminated equipment shall never be left at the well site unaccompanied. When completing the NORM Generation Form, the Hoist or Service Contractor can group items such as 3 ½" joints and give a range of readings, however specific items must be listed to quantify the amount of equipment.

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5.2 Transport of Contaminated Sludge or Pigging Debris

PDO Maintenance Supervisors and Maintenance Contractors responsible for cleaning NORM contaminated tanks or vessels shall plan the job. This includes estimating the volume of sludge and taking NORM measurements two weeks prior to the job. Analysis results may take one week from collection, however if readings are high (> 2 µSv/hr) then it is likely that the waste will require storage in Bahja.

Large volumes of sludge where the activity of radium exceeds 1 Bq/g should be transported in vacuum trucks, or covered tippers and waste skip bins to prevent release of airborne particles. Smaller quantities of sludge from CPI's or pigging receivers can be collected into sealable drums for transport to Bahja. All drummed NORM waste shall be monitored and individually labeled with the readings.

The drums for use shall be open head forms, with a clamp ring or flange that hold a loose lid (often with a gasket) down on the top. It is preferred that UN marked steel drums in good condition are used.

The laboratory analysis result for the radium isotopes and lead-210 shall be entered into the Corporate NORM database. The Bahja NORM yard operator shall maintain records of all transported and stored contaminated material within the yard including; date of arrival, source of waste, type of equipment, volume of sludge or number of drums and readings in µSv/hr (or cps, if µSv/hr is not available) or laboratory analysis results in Bq/g.

6.0 Training PDO and Contractors performing service or maintenance activities shall ensure staff attends the NORM training.

Production Operations (Oil and Gas), Well Servicing contractors, EMC/ODC Contractors including Static and Rotating maintenance teams shall ensure their workers and contractors are adequately trained to perform their scope of work prior to commencement work. (SP1157 – HSE Training Specification, stipulates that NORM training is compulsory which means the Target population must successfully complete compulsory courses (C) **before** commencing work in a particular job position (e.g. individuals will not be allowed entry to a NORM contaminated tank until successful completion of the NORM courses)

Course Title	Course Codes	Target Population	Type	Length	Recertification Interval	Pre-requisites for attendees
NORM for Supervisors	LXA701 LXE701 LXH701	PDO & Contractors, Production operators / supervisors, Campaign maintenance coordinators, pigging contractor supervisors, tank/separator cleaning contractor supervisors, rig/hoist managers, other supervisors working with potential NORM contaminated equipment or material	C	4 hours	3 year	HSE Induction, HSE Tools & Skills (Supervisory staff) or Dealing with Hazards & Risks (other staff) and minimum 3 months in-field experience.

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6.1 NORM Training Course

This course is designed for all PDO and contractors with potential for exposure to NORM. The training is available through PDO approved training providers.. Alternatively a competent HSE Advisor who has undergone the Radiation Protection Supervisor course may deliver the standard NORM awareness presentation with approval from the Corporate Adviser, HSE Training & Competency (. PDO has developed the NORM course to explain the health risks, enable management of NORM contaminated jobs such as tank cleaning, removing contaminated valves and pumps or well interventions such as pulling joints. The course shall demonstrate how to complete the NORM database, how to interpret NORM results, what controls are expected during NORM jobs and which meters shall be used to manage workers' exposures.

As supervisors will be directly responsible for ensuring safe working conditions for personnel, it is essential that they demonstrate competency before being allowed to supervise NORM Jobs.

The target population for the course includes PDO & Contractors production operators / supervisors, campaign maintenance coordinators, pigging contractor supervisors, tank/separator cleaning contractor supervisors, rig/hoist managers, other supervisors working with potential NORM contaminated equipment or material or any other personnel routinely or frequently working on NORM sites.

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7.0 Controls

7.1 Personal Protective Equipment (PPE)

PPE must be worn during maintenance or servicing activities if there is potential for inhalation or ingestion of NORM contaminated scales or sludge.

The PPE shall be available on-site before commencing work. It shall be worn only by personnel who may inhale or have skin contact with NORM contaminated materials. PPE shall include the following depending on the job and be included in the Job HSE Plan:

- Breathable white one-piece disposable suits (e.g. Sperian Mutex 2)
- Half-face disposable respirator (FFP3 – Toxic dusts) (e.g. 3M 8835 or equivalent)
- Rubber gloves for wet oil operations
- Leather gloves for rigging or handling hot pipe
- Rubber boots for wet operations or normal safety boots
- Safety glasses and safety helmet
- Full-face respirator for hot work or Air-Fed full-face for entry into Tanks / Vessels.

Other required commodities may include sample bottles, heavy duty UV-resistant plastic, NORM labels and NORM packing tape.

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8.0 Bahja NORM Yard

The yard accepts only NORM contaminated equipment and non-fixed sludge wastes above the PDO limits. All contaminated equipment shall be labeled by the Waste Originator prior to transport and be properly sealed or plastic wrapped to prevent scale or sludge particles becoming airborne and potentially being inhaled or contaminating the yard during storage.

The yard is perimeter fenced and segregated into the NORM Decontamination Facility (NDF) and waste receiving yard. Contaminated equipment includes sub-surface equipment e.g. joints, ESP's, valves, cables and clamps. Surface equipment includes; spools, Xmas trees, valves and separators. Non-fixed wastes such as sludge or pigging wastes are stored temporarily in HDPE lined pit to dry and then transferred into sealed storage drums.

Depending on the quantity of sludge being removed from the tank, it may be transported in sealed steel 44 gallon drums, vacuum trucked, waste skip bins or tipper truck. It is recommended that large volumes be transported in vacuum trucks or tippers and temporarily stored in the lined pits. Arrangements for a brackish water tanker at Bahja to flush clean tippers or waste skip bins should be considered by the PDO Maintenance Supervisor. It is recommended that small volumes (e.g. < 10 drums) be collected and transported in drums and placed into the designated drum area. Drums are available for use.

Within the yard, internally contaminated tubulars of similar diameter shall be segregated and neatly stacked separately from externally contaminated joints. Similar items such as valves, spools, Xmas trees etc. shall be stored together for ease of inspection and quantifying. The NORM Yard Management Contractor shall keep records of all deliveries including the Waste Consignment Notes and attached NORM Generation Forms. Quarterly inventory reports shall be provided to the PDO CSR. The Yard Contractor shall only utilise NORM trained personnel who can assess if equipment is correctly wrapped, labeled, monitor for NORM and wear the correct PPE.

Prior to transport of contaminated waste, the Waste Originator shall contact the Bahja NORM yard contractor to advice of the load type and quantity to enable preparation of offloading equipment and avoid delays.

The NORM yard Management Contractor shall keep a stockpile of NORM labels and heavy duty plastic to replace plastic that has degraded. The Contractor is responsible for all housekeeping and ensuring contaminated sludge is neatly tipped into the sludge pits on temporary requirement The Yard Management Contractor shall provide lifting equipment to offload waste streams from PDO activities in accordance with the Contract.

8.1 Decontamination of NORM contaminated Equipment

A dedicated NORM decontamination facility has been established in the Bahja NORM yard to clean contaminated equipment. Contaminated equipment arriving at the yard shall be stored separately within the yard and accurate records maintained. Joints shall be segregated into stockpiles of the same diameter and spools, valves and cables stored neatly to enable monitoring and reapplication of plastic covering that may have deteriorated.

Prior to reusing or sending cleaned equipment for scrap, measurements of the equipment must be conducted by a competent meter user (RPS) and recorded. If interior or exterior

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measurements of 0.5 µSv/hr are detected, the equipment must undergo further decontamination before scrapping or inspecting and testing. All decontamination must aim to reduce the levels to background. Where this cannot be achieved, the counts must not exceed 0.5 µSv/hr before equipment can be cleared for scrapping or released to the workshop for repair/dismantling.

All cleaned equipment must be identifiable, indicating it has undergone decontamination and is now ready for testing and inspection or disposal. The decontamination contractor shall have a quality assurance program in place to track all equipment.

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9.0 Disposal

PDO's waste streams with less than 1 Bq/g for each of the radioisotopes Ra-226, Ra-228, Ra-224 or Pb-210 are below the IAEA limit for classifying NORM waste. There are no radiological precautions for their treatment and disposal and they can be landfarmed or mixed with other oily waste.

Waste with an activity concentration exceeding 1 Bq/g are currently stored in the Bahja NORM Yard. This consists of;

- large volumes of sludge in pits and a fenced area
- sludge in drums (both cemented and loose)
- highly active scale in drums
- contaminated PPE in drums
- contaminated filters in drums
- contaminated tubulars and well site equipment
- mixed waste

Waste with an activity concentration above 1 Bq/g requires a radiological risk assessment prior to disposal to ensure the risk to workers' health, the public and the environment are not compromised. A radiological risk assessment shall include estimates of the dose contributions from potential exposure pathways such as; dust inhalation, radon emanation and inhalation, direct external exposure and the effects of contamination of surface water, ground water and the food chain taking into consideration different types of future land use. Assessments should take into consideration natural background levels around the affected area.

The design and location of the final disposal option must be approved by the Ministry of Environment and Climate Affairs and meet any additional requirements as stipulated in the environmental permit.

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10.0 Emergency Procedures

An emergency situation is defined as an unplanned, potentially harmful exposure to NORM. Recovery measures shall be implemented in the event of an emergency situation.

The most likely emergency scenarios within PDO operations are:

1. Lost or unaccounted equipment (e.g. tubulars, ESP's)
2. Road Traffic Accidents involving the transportation of NORM

In most cases, because of the relatively low radionuclide concentrations involving NORM materials, cleanup of contaminated areas is straightforward. In the case of a road traffic accident involving a vehicle transporting NORM contaminated materials the first priority is to attend to the driver. The accident can be alerted to the LECC by calling 2438 5555.

Road Traffic accidents involving tubulars or contaminated equipment pose no health risk as the contaminated scale is contained within the tubulars and cannot be readily released. If loose sludge material has been released from a damaged drum(s) or waste skip bin, the vehicle can be approached from upwind. Provided the material is not inhaled or physically handled the risk to rescue crews is minimal. Rescue crews should wear a P3 dust mask to reduce the inhalation risk based on the extent of the spill and rescue requirements.

Once the driver has been rescued and taken upwind, the site should be barricaded with tape. Spilt material shall be collected by shoveling and sweeping the waste into sealable drums or waste skip bins depending on the volume. Clean-up crews shall wear the appropriate NORM PPE including disposable coveralls, gloves and a P3 dust mask (Refer Section 7.0). The clean-up crew shall use an approved dose rate meter, to check for contamination on the surface of equipment and affected areas. Access to contaminated areas by members of the public should be restricted until the hazard has been reduced to an acceptable level.

For incidents involving the loss or theft of NORM contaminated equipment, the incident shall be brought to the attention of the Contract Holder who shall commence an investigation and alert the R.O.P. (theft only). Contaminated equipment is labeled when removed from service. Anyone finding or attempting to remove contaminated equipment will be alerted of the radiation risk. If NORM contaminated equipment is identified amongst non contaminated equipment, it shall be segregated, checked for details, opening shall be enclosed with heavy duty plastic if necessary and the item(s) shall be transported to the Bahja NORM Yard in accordance with transport requirements (Section 5.0).

Contract Holders and Production Coordinators shall ensure that emergency provisions and recovery measures are available. This shall include the provision of specific protective equipment e.g. RPE, disposable coveralls, sealable drums, handling equipment and warning signs, labels or barricading.

The Contract Holder and CRSA shall be informed immediately in the event of an uncontrolled incident to estimate exposures and assist with a planned response.

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11.0 NORM Guidelines

NORM Guideline

1. Well Services

Radiological HSE Precautions for wireline jobs

Radiological HSE Precautions for Well Re-Entry

Radiological HSE Precautions for Cleanout of Wells using Coil Tubing Units

2. Operations

Radiological HSE precautions for NORM contaminated tanks and vessels

Radiological HSE precautions for pigging operations

3. Sampling

4. Decontamination of NORM Contaminated Equipment (Bahja facilty only)

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12.0 References

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2. Ionising Radiation Safety Guide. Shell Safety and Health Committee 1993
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry, Safety Reports Series No. 34, IAEA, Vienna (2003).
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5. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry, IAEA Vienna (2010) Training Course Series No. 40
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7. Ministry of Environment and Climate Affairs MD249/97 and Supplement 2003
8. NORM Management Guidelines Al-Furat Petroleum Company, Syria 1998
9. Radioactive Substances Local Rules and Source Register Shell U.K. Exploration and Production 2000

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APPENDIX A – NORM SURVEY FORM

DATE:	WORK PERMIT No.:	INSTRUMENTS USED	TESTED (TICK)	BACKGROUND	WASTE TYPE	(TICK)	CONDITION
				CPS	SLUDGE		WET
FIELD:	LOCATION:			CPS	SAND / SOIL		
		Dose Rate Meter		µSv/h	SCALE		DRY
		Other:			FLUID		

Equipment or Area Monitored		EXTERNAL OR INTERNAL (E OR I)	CPS	CPS	Dose Rate µSv/h CONTACT	Dose Rate µSv/h AT WORK POSITION
1						
2						
3						
4						

	NORM CONTROLS: (Tick as appropriate)		NORM CONTROLS: (Tick as appropriate)
	Disposable coveralls provided & worn (e.g. Sperian Mutex 2 or Tyvek)		Area cordoned off with warning tape
	Half-face Disposable Respirator Type FFP3 (3M8835 or equivalent)		Washing & Decontamination facilities provided for workers
	Gloves - Rubber for wet oil conditions or Leather for handling metal objects		Hands & boots to be monitored prior to leaving cordoned area
	Full face respirator with FFP3 filter (On advice from CRSA)		Transport arrangements required and available to Bahja NORM yard
	Air supplied respiratory equipment for inside Tanks or Separators		Contamination check of area required after completing work
	If Dose Rate > 7.5 uSv/hour or 500 cps Contact CRSA prior to work		TLD Badges provided for cleaning NORM contaminated tanks

SURVEYED BY:	NAME:	REF IND.	SIGNATURE:

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APPENDIX B – NORM GENERATION FORM

PDO Asset:		**Station:**
Field:		**Well Location:**
Contractor Details:		

WASTE TYPE

Equipment (tick)		Description:
Sludge (tick)		
Pigging waste (tick)		
Estimated volume (m^3):		**Total quantity of equipment:** *List equipment on next page*

ACTIVITY CHECKED BY TRAINED METER USER (RPT or RPS)

HIGHEST READINGS RECORDED		
Gamma: cps	**Alpha & Beta: cps**	**Dose: µSv/hr** Dose Rate Meter
Sample taken: Yes / No	**Analysis result (Bq/g for Ra-226):** **SQU Assigned GM No.:**	
Remarks:		
Name:	**Ref Ind:**	
Signature:	**Date:**	

Note: Attach this Form to the Waste Consignment Note (Ref: SP 1009) if transporting NORM contaminated sludge or pigging debris.

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NORM CONTAMINATED EQUIPMENT INVENTORY

This form is used to record contaminated equipment e.g. tubulars, Xmas trees, ESP's, spools, valves etc and listing their highest readings. Tubulars of the same diameter can be grouped including the quantity and range of readings. However, ALL contaminated items shall be individually marked or labeled before leaving the site and transported to the Bahja NORM Yard.

PDO ASSET / FIELD:		**COUNT RATE**	**Dose rate RATE**
LOCATION:			
Item No.	**DESCRIPTION**	**γ + β +α**	

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