

Engineering Procedure

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Management of Technologically Enhanced Naturally Occurring Radioactive Material (NORM)

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Table of Contents

1	Scope.....	2
2	Definitions and Abbreviations.....	2
3	Responsibilities.....	3
4	NORM Surveys.....	6
5	Disposal of NORM Waste.....	8
6	Norm Contaminated Equipment.....	9
7	Workers' Protection.....	10
8	Contamination Control.....	11
9	Confined Space Entry.....	11
10	Transport of NORM Contaminated Materials.....	12
11	Decontamination.....	12
12	NORM Contamination Limits.....	13

1 Scope

This procedure establishes the minimum requirements for management of Technologically Enhanced Naturally Occurring Radioactive Material (NORM) and equipment contaminated with NORM to protect workers, general public and the environment.

2 Definitions and Abbreviations

Container: Any receptacle in which NORM material is stored, transported, treated, disposed of or otherwise handled, i.e., drum, carboy, lugger bucket.

Decontamination: Removing NORM contamination by physical or chemical means.

Equipment: Any apparatus associated with the potential for or actual enhancement of NORM. Examples include, but are not limited to tubulars, piping, valves, baffle plates, vessels, wellheads, separators, and condensers.

Fixed Contamination: Surface contamination (alpha, beta or gamma) which is firmly attached to the surface and which cannot be removed by simple means, such as wiping or light brushing. Mechanical abrasive or chemical methods are required to remove or reduce the fixed surface contamination.

Loose Contamination: This is surface contamination (alpha, beta or gamma), which can be easily removed, i.e., by wiping or lightly brushing and does not require chemical or mechanical abrasive decontamination.

Naturally Occurring Radioactive Material (NORM): Naturally occurring primordial radioactive nuclides and their radioactive decay products, which have been enhanced above its natural levels due to industrial operations.

NORM Baseline Survey: An initial survey of the radiological conditions in a facility, the results of which will provide information on systems/areas where NORM is present.

NORM Contamination Survey: A survey of the radiological conditions where there has been a breach of containment or a spillage of NORM contaminated material. The results provide information on the radiological conditions in the area surveyed.

NORM Management: A program of identification, monitoring, handling, storage, transportation and disposal of NORM waste and NORM contaminated equipment and with provisions for workers protection and contamination control measures.

NORM Waste: Residues and effluents which contain NORM above exempted contamination limits.

Operational NORM checks: An assessment of the radiological conditions of equipment (i.e., valve, spool piece), section of plant (i.e. vessel) or area which shall provide information on NORM levels to dictate the manner in which operations shall progress and equipment classification.

Proponent Organizations: Organizations, which generate NORM, contaminated waste and/or possess, store or handle NORM contaminated equipment.

Surface Contamination: Radioactive material which has been deposited on surfaces, either loosely deposited, or it may be firmly fixed by chemical or physical means such as chemical bonding, adsorption and adhesion.

Sievert (Sv): The SI unit of effective dose, the old unit is Rem. $1\text{Sv} = 100\text{ Rem}$.

Becquerel (Bq): The SI unit of radioactivity, the old unit was Curie (Ci). $1\text{ Ci} = 3.7 \times 10^{10}\text{Bq}$.

Abbreviations:

HEPA	High Efficiency Particulate Air
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
T&I	Testing and Inspection
EPD	Environmental Protection Department
RPU	Radiation Protection Unit
PM	Preventive Maintenance

3 Responsibilities

3.1 Environmental Protection Department (EPD)

- 3.1.1 Develop and update standards and guidelines related to NORM management in Saudi Aramco.
- 3.1.2 Develop a criteria for the certification of NORM surveyors in Saudi Aramco and certify NORM surveyors competency.
- 3.1.3 Provide technical support to proponent organizations on the interpretation of radiation/contamination measurements and results of NORM surveys and sample analysis.
- 3.1.4 Provide technical support to proponent organizations on NORM workers protection

- 3.1.5 Provide technical support to proponent organizations on handling, transportation, decontamination and disposal of NORM contaminated equipment and material.
 - 3.1.6 Monitor the compliance of proponent organizations with the requirements of this procedure.
 - 3.1.7 Provision of technical support in the selection and use of radiation detection instrumentation.
 - 3.1.8 Approve acceptability of NORM decontamination, storage and disposal facilities for use by Saudi Aramco.
 - 3.2 Loss Prevention Department (LPD)
 - 3.2.1 Verify that personnel working with NORM material or NORM contaminated equipment are wearing the correct PPE/RPE to monitor field compliance.
 - 3.2.2 Include NORM in the "Hazards Recognition" course for issuers and receivers of work permit systems.
 - 3.3 Proponent Organizations
 - 3.3.1 Ensure that workers are protected against the hazards of NORM when working with or around NORM contaminated pipes, equipment, soil or wastes, as detailed in Section 7.0 Workers Protection.
 - 3.3.2 Ensure that their staff are aware of the hazards of NORM, and that any contractors or visitors potentially affected by NORM operations are made aware of the NORM hazards.
 - 3.3.3 Ensure that an adequate number of their staff are trained to conduct operational NORM checks and pre-T&I NORM surveys.
 - 3.3.4 Ensure that NORM surveys are carried out in their facilities as specified by section 4 of this procedure.
 - 3.3.5 Ensure that adequate PPE/RPE is available to workers engaged in any activity involving potential exposure to NORM.
 - 3.3.6 Ensure that NORM control measures are followed during work activities involving opening up, entry into, cleanup or maintenance of any component in which NORM contamination is detected or suspected.
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- 3.3.7 Ensure that NORM contaminated equipment in their facilities is handled and controlled as per the requirements of section 6 of this procedure.
- 3.3.8 Ensure that all NORM contaminated equipment and materials are clearly and properly labeled, marked or identified.
- 3.3.9 Ensure the transportation of NORM contaminated equipment is conducted as per the requirements of section 10 of this procedure.
- 3.3.10 Ensure that NORM contaminated equipment is stored in DPC-280, designated NORM storage area.
- 3.3.11 Ensure that NORM contaminated equipment is decontaminated in an EPD approved decontamination facility.
- 3.3.12 To ensure proper disposal of NORM contaminated equipment or material, proponent shall submit the disposal plan (including containment, transportation and final disposal site vendor) to EPD for approval.
- 3.3.13 Manage land that is either NORM contaminated or may be potentially NORM contaminated, per the requirements of sections 5.3, 11.3 and 12 of this procedure.
- 3.3.14 Maintain records of NORM surveys and radiometric analysis results.
- 3.3.15 Maintain records of NORM contaminated equipment and waste
- 3.3.16 Procure instrumentation for the purposes of measuring levels of NORM radiation and contamination.
- 3.3.17 Include NORM procedures in facility operating instruction manual (OIM).
- 3.3.18 Collect samples of scale or sludge during T&I operations and send for radiometric analysis.
- 3.3.19 A copy of each pre T&I and PM NORM survey shall be forwarded to Radiation Protection Unit/Environmental Protection Department.
- 3.4 Al-Midra Material Service Division (MMSD) Reclamation Yard

In addition to applicable paragraphs of section 3 of this procedure, Reclamation Yards have the following additional responsibilities:

- 3.4.1 Establish and implement procedures to screen incoming and outgoing equipment for NORM contamination.
- 3.4.2 A secured fenced location for interim storage of NORM contaminated equipment as per EPD requirements has been established at DPC 280.
- 3.4.3 Do not release, dispose of or sell pipes, valves, vessels or other equipment without them being surveyed for NORM contamination unless declared NORM free by EPD.
- 3.4.4 Do not release NORM contaminated equipment from reclamation for decontamination at either a contractor or Saudi Aramco facility without prior approval from the Radiation Protection Unit, Environmental Compliance Div of EPD.
- 3.4.5 Maintain records of NORM contaminated equipment.
- 3.4.6 Ensure all open sections of NORM contaminated equipment, i.e., flange or pipe ends etc are adequately covered by heavy gauge plastic, end caps or blanking plates to ensure that no NORM material leaks. (as detailed in 6.3.1).

4 Norm Surveys

NORM surveys shall be conducted as described in the following paragraphs:

4.1 NORM Baseline Surveys

- 4.1.1 NORM Baseline surveys of all facilities where NORM is present or suspected shall be carried out.
- 4.1.2 NORM baseline survey results shall be forwarded to EPD.
- 4.1.3 A NORM baseline survey shall include (where applicable):
 - Radiation dose-rate at the external surfaces of the surveyed equipment
 - Alpha Contamination Levels (Fixed and Loose)
 - Beta Contamination Levels (Fixed and Loose)
- 4.1.4 Where an external dose-rate greater than 0.38 micro Sieverts per hour measured at the surface of any equipment, a NORM area survey shall be carried out at a distance of 0.3 meters from the contaminated equipment.

4.2 Pre T&I and PM NORM Surveys

- 4.2.1 A NORM survey shall be carried out before T&I or PM operations.
- 4.2.2 The survey shall include (where applicable):
 - Radiation dose-rates at the external surfaces of surveyed equipment.
 - Alpha/beta contamination levels (Fixed and Loose)
- 4.2.3 Records of pre T&I and PM NORM surveys shall be maintained by proponents.
- 4.2.4 Based upon the results of pre T&I and PM NORM surveys, control measures shall be established to carry out work safely during T&I operations as specified in Sections 7 and 8.

4.3 Operational NORM Checks

- 4.3.1 Operational NORM checks shall be undertaken prior to intrusive operations on any equipment/vessel suspected of having NORM contamination using field radiation detection instrumentation.
- 4.3.2 Examples of intrusive operations shall include (but not limited to):
 - Man-entry into NORM contaminated (or potentially contaminated) vessels
 - Cleaning of NORM contaminated (or potentially contaminated) equipment
 - Internal inspection of NORM contaminated (or potentially contaminated) vessels
 - Maintenance and repair of NORM contaminated (or potentially contaminated) equipment
 - Other similar work scenarios/situations which involve opening up/handling of potentially NORM contaminated objects
- 4.3.3 Based upon the results of operational NORM checks, control measures shall be established by the proponent to carry out work safely, without spreading NORM contamination.
- 4.3.4 All personnel involved in intrusive work in NORM contaminated areas or with NORM contaminated equipment shall follow workers protection and contamination control guidelines (Sections 7 and 8).

4.4 Radiation Survey Instruments

- 4.4.1 Radiation survey instruments used to perform NORM surveys in accordance with paragraphs 4.1 and 4.3 shall be able to measure radiation dose rates from 0.01 micro Sievert per hour through at least 5.0 micro Sievert per hour.
- 4.4.2 Radiation instruments shall be of robust construction and capable of being used in an industrial environment and suitable for the local climate.
- 4.4.3 Radiation survey instruments used to make surveys required by this procedure shall be appropriate for the specific application, calibrated and maintained in good condition at all times.
- 4.4.4 Each radiation survey instrument shall be calibrated at intervals not to exceed 12 months and after each instrument servicing/maintenance (other than battery replacement).
- 4.4.5 Records of radiation instrument maintenance and calibrations shall be maintained by users.

5 Disposal of NORM Waste

- 5.1 NORM contaminated waste shall not be dispatched for unrestricted release.
 - 5.2 For temporary storage, NORM waste shall be kept in suitable containers, which comply with the following requirements.
 - 5.2.1 Are in good condition with no visible indications of internal or external corrosion, and made of a durable material such that it provides adequate containment of the NORM waste during the storage period.
 - 5.2.2 Made of or lined with, materials that will not react with, or be incompatible with, the NORM waste to be containerized so that the ability of the container is not impaired or compromised.
 - 5.2.3 Be resistant to degradation from Ultra Violet radiation.
 - 5.2.4 Be closed and sealed during storage, and practical to open and re-seal when it is necessary to add or remove waste.
 - 5.2.5 Shall not be opened, handled, or stored in a manner that may rupture the container or cause it to leak.
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- 5.2.6 Shall bear the radiation symbol and a label clearly indicating that it contains NORM contaminated waste.
- 5.2.7 Areas where containers of NORM waste are stored shall be inspected by the proponent on a quarterly basis. Containers shall be inspected for signs of leaks, overall deterioration and proper labeling. Records of these inspections shall be documented and properly maintained.
- 5.3 At the end of the operational life of evaporation ponds, disposal pits, and waste disposal facilities the area of land shall be remediated such that its NORM contamination is below exemption limits as specified in Section 12.
- 5.4 Proponent organizations shall maintain records of all NORM waste disposals. This record shall include:
 - Waste material description (scale, sludge, scrappings, etc.)
 - Volume of waste material
 - Mass
 - NORM level (activity per unit weight) of waste material.
 - Method of disposal.
 - Disposal location.
 - Organization/facility where the NORM waste was generated
 - Any other relevant information.

6 NORM Contaminated Equipment

- 6.1 NORM contaminated equipment shall be subject to the following controls:
 - 6.1.1 Not be released for unrestricted use, maintenance, refurbishment, sold or disposed without adequate decontamination.
 - 6.1.2 Be stored only in designated storage areas.
 - 6.1.3 Be tagged or clearly marked as NORM contaminated.
 - 6.1.4 Be handled only by employees trained in NORM hazards and is using PPE as detailed in section 7 of this procedure.
 - 6.1.5 Not be sent for maintenance/repair to workshops without informing the workshop that the component is NORM contaminated.
 - 6.2 NORM contaminated equipment shall be:
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- 6.2.1 Disposed of only in an EPD approved NORM disposal facility.
- 6.2.2 Decontaminated only in an EPD approved NORM decontamination facility or EPD approved decontamination protocol. Once verified as free from NORM contamination either be:
 - a) Sold or disposed as scrap;
 - b) Re-used by operational departments; or
 - c) Sent for repair to a workshop prior to being re-used by operational departments
- 6.3 NORM contaminated equipment shall be stored in areas which are exclusively used for the storage of NORM contaminated equipment.
 - 6.3.1 All open sections of equipment, i.e., flange or pipe ends, etc., shall be adequately covered by heavy gauge UV stabilized plastic or other suitable materials to ensure that no NORM material leaks from the item.
 - 6.3.2 Routine checks on all stored NORM contaminated equipment shall be undertaken to ensure that the integrity of the protective measures are adequate. Routine checks shall be carried out on a quarterly basis.
 - 6.3.3 Detailed and verifiable records shall be maintained of all stored NORM contaminated equipment.

7 Workers' Protection

Workers entering NORM contaminated vessels or conducting intrusive work on NORM contaminated equipment shall adhere to the following guidelines:

- 7.1 Personnel required to work with NORM must be trained in the associated hazards.
 - 7.2 All NORM operations shall be covered by a safe system of work which shall identify the hazards and highlight the precautions to be taken.
 - 7.3 Any item or area with detectable levels of loose NORM contamination shall be subject to radiological controls.
 - 7.4 Appropriate PPE shall be worn (which may include but not be restricted to):
 - Tyvek coveralls
 - Neoprene, PVC, or NBR gloves
 - Half-face respirators with HEPA cartridges; these must be fit tested
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- Quarter-face HEPA disposable respirators.
- 7.5 Eating, drinking, smoking and chewing are not allowed in work areas where potential NORM contamination exists.
- 7.6 Only essential personnel shall be allowed in the work areas where potential NORM contamination exists.
- 7.7 Personnel shall thoroughly wash up with copious quantities of soap and water, after working with contaminated equipment, and before eating, drinking, or smoking, and at the end of the workday.

8 Contamination Control

- 8.1 All NORM operations shall be carried out in a manner which prevents the spread of NORM contamination and minimizes the potential for workers to be exposed to NORM.
- 8.2 NORM operations shall only be undertaken in areas which are clearly demarcated and access is restricted to those directly involved in the operations.

Examples of NORM operations which are subject to the above requirements:

- Clean up, hauling, transportation, storage and disposal of NORM waste
- Decontamination, refurbishment, maintenance of NORM contaminated equipment
- Entry, clean up and inspection of NORM contaminated vessels (See Section 9)
- All other operations which involve handling of NORM material and NORM contaminated equipment.

9 Confined Space Entry

Entry into vessels/tanks where NORM contamination is known (or suspected) shall be subject to the following controls in addition to the requirements specified in sections 4, 7 and 8:

- 9.1 Vessels/tanks shall be mechanically ventilated for a minimum of four hours prior to entry for cleaning or maintenance to allow adequate time for radon dispersion and the decay of radon short-lived daughters.
- 9.2 All personnel and equipment exiting the vessel(s) shall be subjected to a NORM contamination survey. Personnel or equipment found to be contaminated shall be segregated and decontaminated.

10 Transport of NORM Contaminated Materials

- 10.1 NORM materials and or NORM contaminated components shall be transported in exclusive use vehicles, other cargoes shall not be carried in the transportation vehicle.
- 10.2 Boats operating offshore and used to transport NORM contaminated material or equipment, shall utilize standard transport containers appropriately segregated and marked to house the contaminated items. NORM contaminated items that cannot be stored in standard transport containers shall be protected in such a manner as to ensure no leak/spillage of NORM material during transport.
- 10.3 Prior to dispatch of any NORM materials/components, the receiving organization shall be notified.
- 10.4 The operator of the vehicle (or boat) shall be provided with a written contingency plan detailing the actions to be taken in the event of a reasonably foreseeable emergency.
- 10.5 The NORM transportation vehicle (or boat) operator shall be aware and capable of implementing the contingency arrangements to be taken in the event of an accident.
- 10.6 The vehicle carrying NORM material or NORM contaminated equipment shall bear appropriate transport placard and signage as required by International Atomic Energy Agency (IAEA) Safety Series No 6.
- 10.7 Proponent organizations shall maintain records of all NORM transportations. This record shall include:
 - NORM material description (Contaminated equipment, scale, sludge, scrappings, etc.)
 - Volume/quantity of NORM material transported
 - Method of transportation.
 - Destination
 - Organization/facility where the NORM waste was generated
 - Any other relevant information.

11 Decontamination

- 11.1 Decontamination of equipment which is NORM contaminated shall be undertaken in a controlled manner to ensure worker protection and prevent the spread of NORM contamination as specified in section 7 and 8.
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- 11.2 Personal decontamination shall be carried out in a manner which restricts radiation exposure by minimizing potential for the inhalation, ingestion and absorption of radioactive materials.
- 11.3 Areas of land which become NORM contaminated shall be remediated such that NORM levels are at or below the exemption limits detailed in section 12.
- 11.4 Land which is NORM contaminated due to its function, such as an evaporation pond or land farm shall be remediated prior to release for unrestricted use to levels at or below the exemption limits detailed in Section 12 of this procedure.

12 NORM Contamination Limits

- 12.1 Materials and waste media such as sludge/scale containing NORM at levels below those listed in Table 1 shall be exempted from the requirements of this procedure.
- 12.2 Soil shall not have a Ra-226 contamination above 0.185 Bq per gram (5 pCi per gram).
- 12.3 Soil shall not have a U-238 contamination above 3.3 Bq per gram (90 pCi per gram).
- 12.4 Equipment, vessels, and clothing shall be considered NORM contaminated if internal or external surface contamination measures double the radiation background level.

Table 1

Radionuclide	Exemption Level (Bq/g)	Exemption Level (pCi/g)
Ra-226	1.1	30
Ra-228	1.1	30
Pb-210	0.2	5
Po-210	0.2	5
U-238	5.5	150
Uranium (Nat)	3.0	80

Revision Summary

30 March 2005

New Saudi Aramco Engineering Procedure.