NRRC Specific Regulations

Management of Naturally Occurring Radioactive Materials In Non-Radiological Practices

NRRC-R-01-SR11

2023

هيئة الرقابة النووية والإشعاعية
Nuclear and Radiological Regulatory Commission

Specific Regulation
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Preamble

In accordance with the provisions of the Radiation Safety Regulation (NRRC-R-01), approved by the NRRC's Board of Directors in resolution No. (R/1/1/2022), dated 20 April 2022, in chapter (16) section (106), this specific regulation establishes the regulatory requirements, based on a graded approach, concerning facilities and activities involving naturally occurring radioactive materials, seeking to ensure the control of the occupational and public exposure.

This specific regulation has been prepared on the basis of International Atomic Energy Agency (IAEA) standards, as well as the and the international best practices and the experiences of similar international regulatory bodies, and in accordance with the Kingdom's international commitments, and it has been approved by the NRRC's CEO resolution No. 1137, dated 13/04/2023.

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Chapter 1: Objective, Scope, and Definitions

Section 1: Objective

1. This specific regulation establishes the regulatory requirements, based on a graded approach, concerning facilities and activities involving naturally occurring radioactive materials, seeking to ensure the control of the occupational and public exposure. This specific regulation also defines the scope and content of the radiological evaluation that, in compliance with the Regulation on Radiation Safety (NRRC-R-01) (Articles 288 and 289) and shall be conducted by the person responsible for the concerned facilities and activities.

Section 2: Scope

2. The requirements of this specific regulation applies to facilities and activities involving naturally occurring radioactive materials of amounts that may cause significant occupational or public exposure. More specifically, this specific regulation applies to the following activities:

    a. Extraction of rare earth elements.

    b. Production and use of thorium and its compounds.

    c. Production of niobium and ferroniobium.

    d. Production of oil and gas.

    e. The zircon and zirconia industries.

    f. Manufacture of titanium dioxide pigment.

g. The phosphate industry.

h. Production of tin, copper, aluminium, zinc, lead, iron & steel.

i. Water treatment.

j. Cement production.

k. Geothermal energy production.

l. Mining of ores other than uranium ore.

m. Metal recycling industries.

Section 3: Definitions

NORM by-product

A secondary substance or object incidentally resulting from a NORM industrial production process for which further use is intended.

Exposure to radon

Exposure to radon progeny.

Naturally Occurring Radioactive Material (NORM)

Radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides.

Naturally occurring radionuclides

Radionuclides that occur naturally on Earth in significant quantities, such as: Potassiu-40, Uranium-235, Uranium-238, Thorium-232 and their radioactive decay products.

Occupationally exposed worker

Employee who is exposed to NORM sources of radiation as a result of their regular duties.

Projected dose

The dose that would be expected to be received if planned protective actions were not taken. It is the dose resulting from the activity and facility involving NORM.

Radon

Any combination of isotopes of the element radon Rn-220 and Rn-222 and its progeny (the short-lived radioactive decay products) as appropriate.

NORM Residue

Material that remains from a process and comprises or is contaminated by naturally occurring radioactive material (NORM).

Working activity

An activity involving the presence of naturally occurring radioactive materials that leads to the exposure of workers or members of the public although the materials are not used because of their radioactive, fissile, or fertile properties.

Section 4: Radiation Dose Limits and Constraints

3. The authorized person shall ensure that the dose limits specified in the Regulation on Radiation Safety (NRRC-R-01) for occupationally exposed workers and the representative person are not exceeded.

4. To control compliance with the dose limits and dose constraints, the authorized person shall evaluate the occupational and public exposure in terms of the projected doses.

5. The authorized person shall establish dose constraints for occupational exposure, subject to approval by the NRRC.

6. To control public exposure, the authorized person shall ensure that the exposure of the representative person due to an authorized activity does not exceed the dose constraint of 0.3 mSv/y.

7. The authorized person shall evaluate on a regular basis the annual effective doses to the occupationally exposed workers and the members of the public due to their exposure to NORM, considering the following exposure pathways:

    a. External gamma exposure.

    b. Ingestion of materials containing NORM.

    c. Inhalation of dust containing NORM.

    d. Inhalation of radon gas and its radioactive decay products.

Chapter 2: Regulatory Control

Section 5. Notification and Radiological Evaluation

8. The authorized person and any other responsible person for a facility carrying out or intending to carry out an activity as referred to in Article 2, shall notify the NRRC as indicated in Annex I, where there

is an indication or evidence that the radiological scenarios could be characterized under the following criteria:

a. The activity concentration of NORM in any of the following materials exceeds the clearance levels established in the specific regulation on Exemption and Clearance Levels (NRRC-R-01-SR01).

   i. Raw materials.

   ii. Intermediate compounds.

   iii. Commercial products generated.

   iv. Residues and waste produced on a large scale.

   v. Waste in small quantities (concentrates, scales in pipes or equipment, wet deposits) produced during the industrial process (if applicable).

   vi. Dust and suspended material present in the installation (if applicable).

   vii. Volatilized material (fly ash, precipitated ash, and smoke from chimneys) generated in processes carried out at high temperatures (if applicable).

b. There is a potential scenario indicating an annual average radon concentration inside workplaces higher than 300 Bq/m^3.

9. In accordance with Article 8 of this specific regulation, the responsible person shall develop a radiological evaluation in the time frame set by the NRRC, that includes, at least, the following elements of evaluation:

a. Radiological characterization:

i. The activity concentrations of the naturally occurring radionuclides in all materials used, processed, produced, stored or in any other way handled in each workplace, facility, or site where the working activity is performed.

ii. The activity concentrations and total annual releases of the naturally occurring radionuclides in all liquid and airborne effluents discharged from each facility into the environment.

iii. The concentration of radon in the air in each workplace where the working activity is performed, and in particular in underground workplaces and workplaces where materials containing Radium (Ra-226) are stored or processed.

b. Assessment of doses to occupationally exposed workers:

i. Identification of workplace/worksite and jobs where workers (both permanent and external) may be exposed to ionizing radiation, tasks associated with each job, number of workers affected, and time spent in workplace/worksite.

ii. Radiological evaluation of each workplace radiation levels based on a radiation survey. The survey shall include evaluations of both gamma dose-rates and airborne radioactivity as required.

iii. Exposure scenarios. Relevant exposure pathways, scenarios leading to these exposures, and parameters involved in dose calculation.

iv. Indication of potential or accidental situations likely to increase exposure.

v. Dose assessment for considered exposure pathways and scenarios.

c. Assessment of doses to representative person members of the public.

i. Identification of the representative person of the public.

ii. Evaluation of the exposure scenarios, including:

- The long-term impact of any waste that, at the moment of the evaluation, has been disposed of.

- The impact of residues containing NORM or by-products that may be recycled.

- The impact of products of the production process containing NORM.

iii. Identification of the relevant exposure pathways and parameters involved in dose assessment.

iv. Dose assessment for considered exposure pathways and scenarios.

10. The responsible person shall ensure that the evaluation conducted, as per Article 9 in this regulation, meets any related requirements specified by the NRRC.

11. The NRRC, based on the results of the radiological evaluation under Article 9, may apply one of the following regulatory approaches:

a. Exempted facility.

b. Authorization by Registration.

c. Authorization by License.

Section 6. Exempted Facility

12. A facility and the relevant working activity(ies) can be exempted from authorization if the results of the radiological evaluation performed under Article 9 indicate that the average annual effective dose does not exceed:

    a. 1 mSv for occupational exposure.

    b. 0.3 mSv for the representative person.

13. The person responsible for a facility which is exempted from authorization in accordance with Article 12 shall notify the NRRC when the origin of the raw materials, the technological process or the equipment or installations used in the technological processes are going to be changed or modified.

14. The person responsible shall notify the NRRC if external events (flooding, fire, land slippage, subsidence) have impacted the operation of the facility, as specified by the NRRC.

15. The person responsible for an exempted facility shall then perform a radiological evaluation:

    a. Every five years based on the scope and content specified in Article 9. The relevant report shall be submitted to the NRRC before the end of the 5th year.

b. If the NRRC deems it necessary based on the notifications referred to in Article 13 and 14, the responsible person shall ensure that the radiological evaluation complies with the related requirements specified by the NRRC.

16. The person responsible for a facility which is exempted from authorization in accordance with Article 12 shall allow the NRRC to perform its regulatory activities, including the conduct of supplementary measurements and the collection of samples for verification purposes as necessary, in all premises and sites where exempted activities are performed.

Section 7. Authorization

17. In case the results of the dose assessments performed in accordance with Article 9 indicate that the annual effective doses to workers exceed 1 mSv/y but are lower than 5 mSv/y and the annual effective doses to the representative person does not exceed 0.3 mSv/y, the working activity shall be registered in accordance with the Regulation on Notification on and Authorization of Facilities and Activities with Radiation Sources (NRRC-R-02), provided that the conditions prescribed in Section 8 of this specific regulation are met.

18. In case the results of the dose assessments performed in accordance with Article 9 indicate that either the annual effective doses to workers exceed 5 mSv/y or the annual effective doses to the representative person exceed 0.3 mSv/y, the working activity shall be licensed in accordance with the Regulation on Notification on and Authorization

of Facilities and Activities with Radiation Sources (NRRC-R-02), provided that the conditions prescribed in Section 9 of this specific regulation are met.

Section 8. Authorization by Registration

19. The person responsible for a facility where working activity(ies) subject to registration are or will be carried out in accordance with Section 7 of this specific regulation, shall apply for such an authorization submitting the information prescribed by the NRRC.

20. The person responsible for a facility where working activity(ies) subject to registration are or will be carried out shall implement, at least, the following:

    a. Inform the workers about NORM and associated exposures.

    b. Classify the working places where radioactive materials are used, stored or processed as supervised areas.

    c. Evaluate work procedures and protective clothing to limit exposure to NORM.

    d. Specify the training requirements and conduct the training program to control occupational exposure.

    e. Assess occupational exposure.

    f. Apply engineering controls which shall include, as appropriate:

        i. Special arrangements for the storage of bulk materials containing naturally occurring radionuclides.

ii. Limitation of exposure time and access restrictions.

iii. Dust control.

iv. Respiratory protection program.

21. The person responsible for a facility, where working activity(ies) subject to registration are or will be carried out, shall, in addition to the provisions under Article 20, ensure compliance with any further requirements and conditions specified by the NRRC to control and optimize the occupational and public exposures.

Section 9. Authorization by License

22. The person responsible for a facility where working activity(ies) subject to licensing are or will be carried out in accordance with Section 7 of this specific regulation, shall request such an authorization by submitting to the NRRC the required information.

23. The person responsible for a facility where working activity(ies) subject to licensing are or will be carried out, shall ensure compliance with the related requirements as specified in Regulation on Radiation Safety (NRRC-R-01), on case-by-case basis, and in accordance with a graded approach.

24. In case the results of the radiological evaluation under Article 9 indicate an annual average radon concentration inside workplaces higher than 300 Bq/m^3, the person responsible shall ensure compliance with the requirements as specified by the NRRC to control the exposure due to radon in workplaces.

25. The authorized person shall ensure that the transport of any NORMs under its responsibility complies with the relevant NRRC requirements, and the terms and conditions specified in the respective license.

Section 10. Release of NORM byproduct and residue for reuse or recycling purposes

26. The authorized person intending to reuse or recycle or enable the reuse or recycle of residues or by products containing naturally occurring radionuclides shall apply for an authorization as specified by in Regulation on Notification on and Authorization of Facilities and Activities with Radiation Sources (NRRC-R-02).

27. The authorized person shall ensure that residues containing naturally occurring radionuclides generated during the technological processes may be recycled or reused providing that the potential doses:

    a. to the workers involved in the transport and processing of the residues will not exceed 1 mSv/y in all relevant exposure pathways.

    b. to the representative person as a result of exposure to the recycled residues will not exceed 0.3 mSv/y in all relevant exposure pathways.

28. Residues containing naturally occurring radionuclides may be incorporated into building materials, provided that the specific conditions established under the applicable legislation are met.

Section 11. Predisposal and Discharges of NORN Waste

29. To provide for the proper management of radioactive waste arising from the operation of a facility involving NORM subject to licensing, the authorized person shall implement the relevant provisions to comply with the applicable requirements established in Regulation on Management of Radioactive Waste (NRRC-R-16).

30. The authorized person shall ensure that the radioactive waste management program includes:

    a. An outline of the processes generating waste, and a description of the waste generated.

    b. A description of routes and procedures to control the planned discharges, including the conditions and limits.

    c. A description of the system for waste management including the facilities and procedures involved in the handling, treatment, and storage of radioactive waste.

    d. A program for monitoring the concentration of radionuclides in the environment and assessment of radiation doses to the representative person.

    e. Provisions for dealing with accidental releases, or circumstances which might lead to uncontrolled releases of radioactive waste, to the environment.

    f. A schedule for reporting on the operation and results of monitoring and assessments required by this plan.

    g. A plan for decommissioning the operation and the associated

waste management facilities and rehabilitating the site.

h. A system of periodic assessment and review of the adequacy and effectiveness of procedures and to take account of potential improvements consistent with best practicable technology.

31. The authorized person shall ensure that waste is not discharged unless the amount and concentration of NORM meet the criteria specified in Annex II.

32. If the criteria specified in Article 31 are not met, the authorized person shall ensure through an assessment of the specific release conditions that the potential doses:

    a. To the workers involved in the transport and processing of the NORM waste will not exceed 1 mSv/y in all relevant exposure pathways.

    b. To the representative person as a result of exposure to the discharged or disposed NORM waste will not exceed 0.3 mSv/y in all relevant exposure pathways.

Section 12. Disposal of NORM Waste

33. The authorized person shall not dispose of NORM waste unless the relevant disposal option, conditions and limits have been authorized by the NRRC.

34. The authorized person shall request the NRRC authorization for disposal providing that the safety case and supporting safety assessment met the requirement established by the NRRC for the control of waste disposal facilities.

35. The authorized person shall ensure through the safety case and safety assessment that the potential doses:

    a. To the workers involved in the transport and processing of the NORM waste will not exceed 1 mSv/y in all relevant exposure pathways.

    b. To the representative person as a result of exposure to the discharged or disposed NORM waste will not exceed 0.3 mSv/y in all relevant exposure pathways.

Annex I. Notification form for Activities Involving NORM

1. Administrative Information:

1.1. Notifying organization:

a. Name.

b. National Address.

c. Telephone.

d. Email.

e. Government ID.

1.2. Legal representative:

a. Title.

b. Full name.

c. Telephone.

d. Email.

e. Personal ID.

2. Working activity (indicate the concerned activity):

2.1 Type of activity:

a. Extraction of rare earth elements.

b. Production and use of thorium and its compounds.

c. Production of niobium and ferroniobium.

d. Production of oil and gas.

e. The zircon and zirconia industries.

f. Manufacture of titanium dioxide pigment.

g. The phosphate industry.

h. Production of tin, copper, aluminium, zinc, lead, iron & steel.

i. Water treatment.

j. Cement production.

k. Geothermal energy production.

l. Mining of ores other than uranium ore.

m. Metal recycling industries.

2.2 Overall description of the technological processes involving NORM and basic radiological characterization of the raw materials, byproduct, residue, and wastes.

Annex II. Reference Levels for Unconditional Discharges of NORM Wastes

Table II.1 Reference levels for discharges of airborne effluents into the atmosphere through a facility stack of different heights.

Radionuclide / chain segment	Reference levels (GBq/y)			
	Stack 10 m	Stack 50 m	Stack 100 m	Stack 200 m
238U+	1.4E+02	2.3E+03	1.2E+04	2.3E+04
235U+	1.2E+02	2.2E+03	9.3E+03	2.0E+04
234U	1.1E+02	2.0E+03	1.0E+04	2.0E+04
232Th	1.4E+02	2.1E+02	7.3E+02	1.9E+03
230Th	2.8E+01	5.1E+02	2.7E+03	5.0E+03
228Th+	9.3E+00	1.7E+02	9.4E+02	1.7E+03
231Pa+	2.8E+00	4.8E+01	2.2E+02	4.6E+02
228Ra+	1.2E+02	1.5E+03	4.1E+03	1.2E+04
226Ra+	6.6E+01	7.3E+02	1.6E+03	5.4E+03
227Ac+	7.1E-01	1.3E+01	7.3E+01	1.3E+02
222Rn	1.5E+05	2.7E+06	1.6E+07	2.8E+07
220Rn	2.0E+03	3.7E+04	2.1E+05	3.7E+05
210Pb+	1.6E+02	1.6E+03	3.1E+03	1.1E+04
210Po	7.0E+01	8.0E+02	1.7E+03	5.8E+03

Table II.2. Reference levels for discharges of liquid effluents into the sea for different types of releases.

RADIONUCLIDE / CHAIN SEGMENT	REFERENCE LEVELS (GBQ/Y)	
	ON-SHORE RELEASES	OFF-SHORE RELEASES
238U+	9.2E+06	8.1E+07
234U	1.6E+07	6.2E+08
232Th	5.4E+03	6.6E+05
230Th	2.4E+05	1.6E+07
228Th+	9.3E+04	2.0E+07
228Ra+	1.2E+04	1.1E+06
226Ra+	2.2E+04	1.0E+06
210Pb+	3.0E+04	1.5E+06
210Po	8.9E+04	4.8E+06

Notes:

A. When performing assessments, the chain segments should be essentially treated as individual radionuclides with composite characteristics. These long-lived radionuclides with their short-lived progeny constitute decay chain segments for which it can be assumed that the short-lived progeny is in radioactive equilibrium with the long-lived mother.

Summary of naturally occurring radionuclide decay chain segments in TableII.1 and II.2

CHAIN SEGMENT	NUCLIDES CONSIDERED IN SECULAR EQUILIBRIUM
U+238	U-238, Th-234, Pa-234m (99.8%), Pa-234 (0.2%)
U-234	U-234
Th-230	Th-230
Ra+226	Ra-226, Rn-222, Po-218, At-218 (0.04%), Pb-214 (99.96%), Bi-214, Po-214
Pb+210	Pb-210, Bi-210
Po-210	Po-210
Th-232	Th-232
Ra+228	Ra-228, Ac-228
Th+228	Th+228 Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212 (64.1%), Tl-208 (35.9%)
U+235	U-235, Th-231
Pa-231	Pa-231
Ac+227	Ac+227 Ac-227, Th-227 (98.6%), Fr-223 (1.38%), Ra-223, Rn-219, Po-215, Pb-211, Bi-211, Po-211 (0.28%), Tl-207 (99.72%)

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King Fahd National Library Cataloging-in-Publication Data

L.D. no. 1444/10267
ISBN: 978-603-92031-3-1

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