2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Assessment of dose for NORM oil sludge disposed of in landfills

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The acronym NORM (Naturally Occurring Radioactive Materials) is used to express the radioactive materials of natural origin. In some instances, it is preferable to call it TENORM (Technologically Enhanced Naturally Occurring Radioactive Materials) to emphasize their non-natural presence or concentration in some places or media. In the oil and gas industry, these radioactive materials have potential radiological hazards to workers and members of the public, as they contain radionuclides that accompany the oil extracted from the earth and that concentrate onto internal walls of pipelines and oil separation or storage equipment in the form of scales or sludge. Therefore, this type of material, when released into the environment without treatment, involves a health and environmental problem, as they are considered radioactive waste that requires proper management. [1;2;3]

As established in Laws 4118 [4], 6189 [5] and 7781 [6], the National Commission on Nuclear Energy (CNEN) is responsible, among other duties, for receiving and disposing of radioactive waste as well as issuing regulations and safety standards for the treatment and disposal of radioactive waste. The exemption limit specified in the CNEN regulations for the main radionuclide in the waste from the oil industry (226Ra, 228Ra and 210Pb), which is now equal to the clearance level, is 10 Bq/g or 10 kBq total activity, but it is applicable to quantities not exceeding one ton [7]. For waste with more than 1000 kg, the limit is applied only on concentration, which must be below 1 Bq/g. Waste with activity concentration above 1 Bq/g of 226Ra and 228Ra should be classified in categories one through three, according to CNEN regulation [8], which classifies the radioactive waste generated by the oil industry as radioactive waste Category 2.2.

Based on inferred current CNEN policies, two options are established for the disposal of radioactive waste from the oil and gas industry. One is near-surface disposal for waste with long-lived, alpha-emitting radionuclides, in concentration below 3,700 kBq/kg. The second is in-depth disposal, with the depth to be determined according to safety analysis, for waste with long-lived, alpha-emitting radionuclides in concentration above 3,700 kBq/kg.[8] However, the formal criteria for disposal are not

yet established [9]. Consequently, there are presently no alternatives for management of Class 2, the oil and gas TENORM waste, other than long-term storage. The safety, security and economic negative effects of this option are by no means negligible.

The development of national guidelines for the permanent disposal of TENORM waste is urgent, in order to ensure the long-term safety and feasibility of the waste generating activities. The establishment of these protocols leads to the development of a common understanding between regulatory authorities and those responsible for the exploration and production of the oil and gas industry, and thus an effective and safe process.

The aim of this work is modeling a scenario to calculate the dose risk assessment to support the safety case for a new clearance level and disposal method, to be applied for the establishment of a regulation that is presently lacking in Brazil, for Class 2.2 waste. The application of the concept of 'conditional clearance' of radioactive waste, instead of 'unconditional release', was used in this work, as a means of establishing the reference levels for disposal of radioactive waste containing naturally occurring radioactive material generated by the oil industry in licensed industrial waste landfills. The application of the 'unconditional release' philosophy results in clearance levels as low as 1 Bq.g-1 of waste for Radium isotopes. The criteria for establishing new clearance levels are the constrained annual doses to members of the public and the doses for occupationally exposed workers, which will potentially result from the adoption of the proposed strategy for the management of oil production TENORM waste.

To characterize the TENORM waste, generated by the petroleum industry, the dose-risk assessment was made for two phases of the life of a disposal site:

1) The operational-phase, which includes all potentially exposed individuals (workers and public) to the effect of radioactive material, as a result of disposal processes; and

2) The post-closure, future land use-phase, which includes all individuals who could be exposed after closure and decommissioning of the landfill, and possible effects in groundwater and the atmosphere. that assess radiation doses by modeling the exposure of workers during transportation, treatment, storage, and disposal operations and the exposure of the site to the surrounding public.

In order to propose the study of the deposition site life cycles, this work focuses on presenting the results obtained for the first scenario. It is important to highlight that future work will bring the results of the second proposed scenario.

The RESRAD computer code was used to calculate potential doses to an on-site resident, and visitor resulting from all exposure pathways -this is a computer code developed by Argonne National Laboratory to analyze potential human and biota radiation exposures from the environmental contamination of residual radioactive materials.

It is hoped that with the results of the studied scenarios, it will be possible to substantiate that after the

closure of the disposal facility, finished the operational phase and no additional waste disposed of in the site; after decommissioning, no institutional control over the use of the site will be in place, so the site can be used for any purposes including housing.

Acknowledgements

The authors acknowledge the technical assistance of the Radioactive Waste Management Department of IPEN / CNEN. One of the authors (Rolindo, N.C.) acknowledges the scholarship of PROEX, CAPES.

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