REVIEW OF SAFETY ASSESSMENTS FOR RADIOACTIVE WASTE STORAGE FACILITIES

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ABSTRACT

Radioactive Waste Management standard AR 10.12.1 of the Nuclear Regulatory Body from Argentina, held on the year 2016, requires that radioactive waste storage facilities need to develop a safety assessment, prior to operation, in order to ensure safety among the lifecycle of this facilities and guarantee that radiation protection measures to the public and the environment are accomplished, as well as dose limits and constraints.

Given the national broad nuclear power plan and the large amount of radioactive facilities and activities in the country, there are several radioactive waste storage facilities already constructed, and it is expected that more will be constructed in the near future to provide capacity for all the radioactive waste generated. As some of these facilities were constructed prior to the update of the standard, they didn´t have a specific safety assessment associated independent of facility safety case. In views of improving and regularizing this situation, since 2018 the regulatory body has been requiring operators, to fulfill with the requirement of the mentioned standard and to develop the Safety Assessment including scenarios for normal operation and accidental conditions of the storage facilities located within their sites. During 2019, an instructive of the content of the safety assessment was developed by the Radioactive Waste Management Control Section of Nuclear Regulatory Authority, in order to facilitate to operators the process of preparation of the documentation needed to perform the safety assessment.

This paper addresses the regulatory review process for the safety assessment of these facilities, emphasizing on the creation of a multidisciplinary group to evaluate the documentation, the radiation protection measures and dose limits and constraints taken into account and the scenarios considered.

1. INTRODUCTION

Radioactive Waste Management standard AR 10.12.1 rev. 3 of the Nuclear Regulatory Body from Argentina, published on 2016, in line with IAEA GSR Part 4, requires that radioactive waste storage facilities develop a safety assessment, prior to operation, in order to ensure safety among their lifecycle and guarantee that radiation protection measures to the public and the environment are accomplished, as well as dose limits and constraints.

During 2019, an instructive of the content of the safety assessment was developed by the Radioactive Waste Management Control Section of Nuclear Regulatory Authority (NRA), in order to facilitate operators the process of preparation of the documentation needed to perform the safety assessment and harmonize with recommendations of IAEA GSG Part 3.

1.1 Content of the Safety Assessment

The suggested structure consists on the following information:

I. **Objective:** in this section the operator must define the main objective of the evaluation and the regulatory and legal framework.

II. **Scope:** the evaluation conditions and assumptions, type of installation, lifecycle considered.

III. **Justification:** In this section, all the evaluated scenarios must be presented, those that were discarded and their reasons.

IV. **Facility description:** Information about the facility which is essential when developing the safety assessment. The report must present a description of the characteristics that could influence safety and the analysis itself, in order to identify aspects that can be improved. These aspects can be incorporated or referenced to the corresponding documentation in which they were contemplated and must include:
    a. ***Facility:*** objective, tasks that are carried out in normal operation, maximum inventory estimated to be managed at the facility, maximum storage time expected for radioactive waste, stage in which storage is located within the facility's management process (e.g.: generation, storage, treatment)
    b. ***Site information:*** characteristics of the site that could affect or condition the facility during the expected time of lifecycle or those which could influence the safety analysis, such as: geological, hydrological, biological, meteorological or demographic characteristics, infrastructure, etc.
    c. ***Building:*** Layout with dimensions of the building, construction characteristics, sectors and location, calculation report and compliance with the maximum external dose rates allowed by the regulatory body, if applicable; equipment, structures and constituent materials; projected stowage design according to the calculations and estimated maximum inventory; sectorization according to the tasks or types of waste to be managed (for example, according to their risks, clearance, etc.); ventilation and humidity control systems; illumination; liquid collection systems; easily decontamination surfaces.
    d. ***Inventory:*** radioactive waste streams to be stored or treated at the facility; waste origin (facilities or systems from which they come); volume; radionuclides; maximum activity expected; maximum activity concentration; waste acceptance criteria of the management facility; conditioning matrix material; types of packages to be used; stability and resistance of the containers; identification of the package with minimum information (according to regulatory criteria).

e. ***Safety:*** study of fire load and fire detection and extinction systems; storage forecasts according to the radioactive waste and its conditioning characteristics (containment and leak detection systems, e.g. absorbent material or collection pallets); recovery previsions; visual inspection provisions; signaling and labels (sectors, hot spots, etc.); measures to minimize contamination; radiation protection systems and equipment (dose rate monitoring, groundwater sampling, if applicable); security systems; records; quality management; list of mandatory documentation and procedures associated with the installation, which are part of the Safety Report (Code of practice, Emergency plan, RW management, Inspections, Maintenance, Characterization, etc.)

V. **Methodology:** Identification and justification of the assumptions contemplated in the models used: times considered in the calculations, exposure distances, graded approach, existence or not of shielding, geometries of radioactive waste containers, fraction of inventory released in a certain incident, type of simulation carried out, etc. Description and justification of the amount of data used and models and computer codes. Criteria followed for the evaluation and analysis of the results obtained.

Scenarios and calculations:

Normal operation assessment: Evaluation of the probable impacts by task, category, exposure way and their relevance, external or internal exposure, exposure time; calculation of the total dose by task, calculation of individual dose, end point (worker, public), comparison against dose restrictions or limits

Accidental situations assessment:

- Expected operational incidents or accident conditions, postulated initiating events (PIEs), probability of occurrence (qualitative or quantitative) and relevance (low, medium, high).

  Natural external events (extreme rainfall, flooding, lightning, earthquake, etc.),

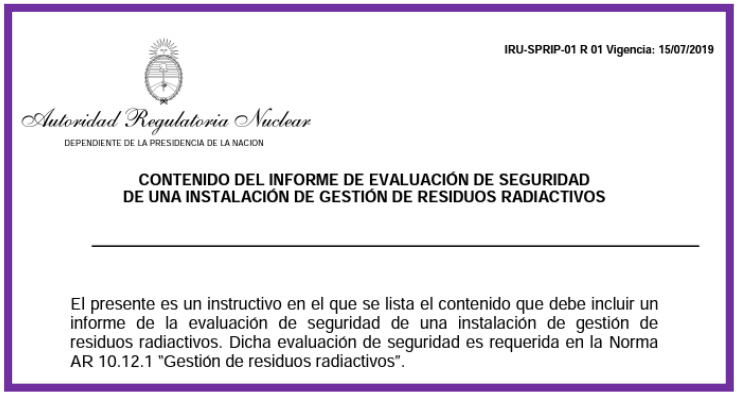
  External induced by human events (explosion, fire, airplane crash, etc.).

  Internal events (procedural errors, unauthorized entry of people, non-compliance with regulations, structural failure, human failure, etc.)
- Probable scenarios linked to the initiating events, origin, probability of occurrence and relevance of its consequences. Evaluation of the impact of each proposed scenario (external or internal exposure for the correspondent end points), radiological consequences of each impact: increase in dose due to internal exposure o release of radionuclides into the air (inside/outside the facility), migration to groundwater, others.
- Calculation of dose in each scenario, calculation of individual dose (worker o Public).
- Analysis of the results obtained, identification of mitigating measures, establishment of intervention values, if applicable.

VI. **Results:** This section should present the details of the results and findings of the analysis, covering the operation of the facility or activity, the radiological risks incurred and a discussion of the underlying uncertainties.

VII. **Conclusions:** This section should reflect the discussion and conclusions on the acceptability of the level of safety achieved and the identification of improvements and additional measures, if necessary. In the case of identifying points to improve, the mitigating measures to apply, safety barriers to implement or add, priority failure prevention points and other topics of interest must be described in detail in order to increase the safety of the facility, minimizing the risks and probability of occurrence of foreseen incidents and accidents, as well as the doses in normal operation.

VIII. **References:** details of the references used for the preparation of the analysis, including consideration of the operational experience of the facility when applicable.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Autoridad Regulatoria Nuclear

DEPENDIENTE DE LA PRESIDENCIA DE LA NACION

CONTENIDO DEL INFORME DE EVALUACIÓN DE SEGURIDAD
DE UNA INSTALACIÓN DE GESTIÓN DE RESIDUOS RADIACTIVOS

El presente es un instructivo en el que se lista el contenido que debe incluir un informe de la evaluación de seguridad de una instalación de gestión de residuos radiactivos. Dicha evaluación de seguridad es requerida en la Norma AR 10.12.1 "Gestión de residuos radiactivos".

Fig. 1: Regulatory Instructive: "Contents of the safety assessment report of a radioactive waste management facility"

2. SAFETY ASSESSMENT DOCUMENTATION

2.1. Facilities safety assessment

During 2020, NRA reviewed the safety assessment documentation from the RW storage facilities located within the NPP´s sites and an atomic center site.
On each case, the safety assessment was developed by the responsible entity. In total,13 operating RW storage facilities and 2 new constructed storage facilities were evaluated. The last two were conditioned to operate upon the approval of the safety assessment.
The documentation received by the NRA consisted on the description of the facilities, a risk matrix identifying the potential initiating events (PIEs) for each storage facility, the inventories and the calculations of the associated scenarios and impacts.

2.2 Safety assessments content information

The different documents covered the information in line with the instructive:

- General information: Objective, scope, justification, description of the facilities (general, information of the site, building, inventories, safety functions, associated documentation and procedures)
- Methodology (assumptions, data, models, codes, criteria, identification of PIEs, scenarios, impacts, end points and dose calculations). Information about the different conducted assessments:
    - Normal operation: identification of the activities on each facility (e.g. waste reception and manipulation, stowage, measurements, inspections, housekeeping), the duration and frequency of each one, associated procedures, reference dose rates.
    - Accidental situation: a master logic diagram with natural external events, induced by human and internal events and their probability. The determination of the scenarios and impacts associated with the events.
- Results, conclusions (safety level of each facility, identification of improvement opportunities on safety, procedures, barriers, etc.) and references.

3. REGULATORY REVIEW PROCESS

3.1 First step: general review

The Control of Radioactive Waste Management Section conducted the main review process with an independent verification approach. The first step was a general revision to verify the general items:

- Facilities and site information and comparison with inspection reports.
- Inventories according to the periodic information received from the facilities and calculations of a full storage situation.
- Preliminary PIEs exclusion and selection of the specific ones.
- Comparison with PIEs facilities selection according with the site and building characteristics and an appropriate graded approach.
- Identification of the scenarios, end points and impacts.
- Loading data into SAFRAN project

Radioactive Waste Section was in charge of cooordination of the SA review, verification of all the different scenarios and impacts using IAEA SAFRAN TOOL.

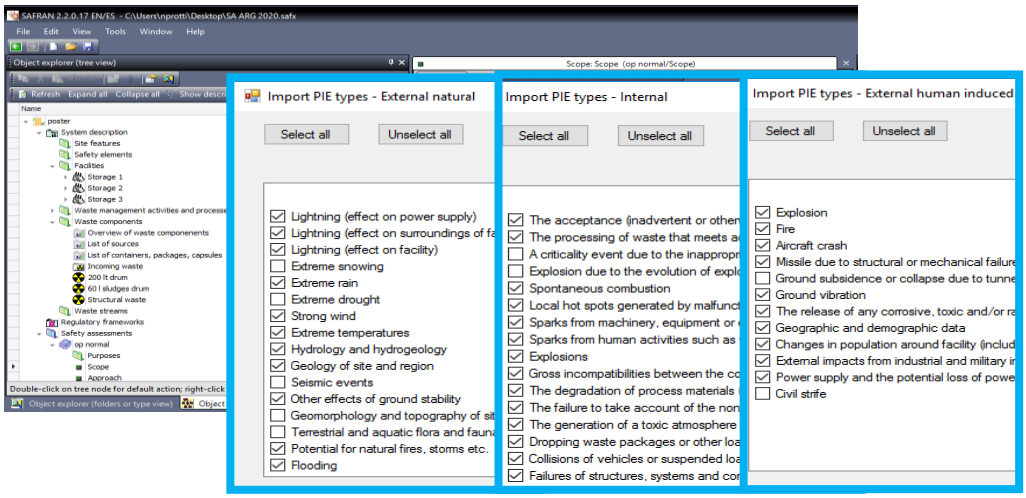

Fig. 2: Example of SAFRAN review project and selected PIEs by category (external natural, internal and external human induced)

3.2 Second step: working groups

The Radiation Protection Division reviewed the specific documentation through three multidisciplinary working groups: Modelistic, Radiation Protection and Shielding:

Modelistic Section: considering data facility and the inventories provided, this group modeled the different identified scenarios for accident situations using codes PC-CREAM and HotSpot softwares. Their final output was an assessment of the release of radionuclides to air and groundwater radionuclides migration.

Shielding Section: was in charge of verifying the dose rates on normal operation scenarios, taking into account the building characteristics and the inventory of each facility using MCNP software. In addition, external doses in case of foreseen internal events (e.g. waste package drop) were calculated using Microshield Software.

Radiation Protection Section: verified that the activities related with normal operation, in particular, their duration and frequency were coherent with the realistic situations according to the inspection reports. The doses of the workers were also compared with dose restrictions.

3.3 Final Step

The Radioactive Waste Section analyzed all the documentation reviewed and the working groups inputs in order to verify that the safety level and safety functions of each facility were adequate, taking note of the improvements needed to fulfill the safety objectives. Finally, a comparison with the safety assessment developed by the facilities owners was performed, paying particular attention in dose calculations. Every scenario dose was compared with the correspondent dose restriction (normal operation) and the criterion curve (dose vs probability on accidents situation) according to Regulatory standards.

4. CONCLUSIONS

The results of implementing the NRA new standards and procedures for the reviewing of safety assessments of radioactive waste facilities are considered to be truly successful for the Country. The process allowed to detect and promote safety improvements, as well as to harmonize the safety functions of each NPP's radioactive waste storage facility.

Nuclear Regulatory Authority has now a well-established procedure for the review and assessment of SA from predisposal RWM facilities. It is coordinated by the Radioactive Waste Management Section with strong contribution from other specialized groups within the regulatory body.

5. REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), IAEA, Vienna (2016)
[2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSG-3, IAEA, Vienna (2013)
[3] NUCLEAR REGULATORY AUTHORITY, Basic Safety Standard, AR 10.1.1 Rev. 4, Buenos Aires (2019)
[4] NUCLEAR REGULATORY AUTHORITY, Radioactive Waste Management Standard, AR 10.12.1 Rev. 3, Buenos Aires (2016)
[5] NUCLEAR REGULATORY AUTHORITY, Regulatory Instructive, Contents of the safety assessment report of a radioactive waste management facility (IRU-SPRIP-01), Buenos Aires (2019)
[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, Safety Reports Series No. 19, IAEA, Vienna (2001)
[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Methodology for Safety Assessment Applied to Predisposal Waste Management, IAEA-TECDOC-1777, IAEA, Vienna (2015)