

# Site release in the decommissioning of nuclear installations

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**Abstract.** Spanish regulatory framework for the decommissioning process of a nuclear facility ends up with a decommission statement, which releases the licence-holder of the facility from its responsibilities as an operator. It also establishes –where a restricted site release applies– the appropriate future use restrictions, and the responsible of both maintaining such restrictions and ensuring their compliance. Releasing a site implies eliminating all radiological monitoring. The Regulations, however, did not specify either the radiological conditions to be met for the site to be released, or the possibility of a partial release –with or without restrictions–. In case of restricted site release, the Regulations did not specify either the required criteria for such a release. This paper presents the main features of the Safety Instruction IS-13 “Radiological criteria for the release of Nuclear Facilities Sites” issued recently by the Spanish Nuclear Safety Council as a new specific regulation. This Safety Instruction establishes the requirements and conditions for the release of nuclear facility sites, that is, radiological criteria on the effective dose to the public, partial release of nuclear facility sites and restricted release of nuclear facility sites.

**KEYWORDS:** *Site release, decommissioning, release levels, restoration.*

## 1. Introduction

The release of nuclear installation sites from regulatory control is one of the final steps in the decommissioning of nuclear facilities. In order to make it possible, it is always necessary to analyse the scenario of future use of the site, and the potential conditions and limitations to be managed during the later site reuse. Authorisation for such a release of regulatory control is a responsibility of the competent authority. In the case of Spain, it is carried out by the General Directorate for Energy and Mining Policy of the Ministry of Industry, Tourism and Trade, taking into account the safety report issued by the Spanish Nuclear Safety Council (CSN).

Regulations on nuclear and radioactive facilities address [1] a specific administrative framework for licensing the decommissioning process for nuclear facilities. The dismantling process ends up with a decommission statement, which releases the licence-holder of the facility from its responsibilities as an operator and establishes –where a restricted site release applies– the appropriate use restrictions, and the responsible of both maintaining such restrictions and ensuring their compliance. Regarding the site, the Regulations require that a Site Restoration Plan shall be submitted along with the application for dismantling. This Plan shall specify, when necessary, the planned programmes to monitor radiation and contamination levels at the site to be released.

Decommissioning of nuclear installations causes an enormous amount of residual materials with very low contamination levels. A substantial part of these residual materials does not need to be handled, processed or disposed of taking into account their radioactivity content. A similar analysis could also be applied to the residual material that remains on site after decommissioning a nuclear or radioactive facility. A proper radiological analysis would indicate that remedial or restoration actions on land portions of the particular site to be released should be subjected to an optimisation process that would allow selecting the best strategy of remedial actions in order to obtain the more beneficial allocation for the limited social resources.

## 2. Spanish experiences

So far, authorisation for releasing a facility site from regulatory control has only been fully implemented in Spain in the closure and decommissioning process of “Lobo G” facility, an old and small uranium recovery installation. According with the Spanish regulatory framework this facility is

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not considered a “nuclear” installation, but a “radioactive” one. Spain has also acquired some experience in the restoration and rehabilitation of sites of some old uranium mines.

Up to now all clearance or release criteria applied in Spain have been issued on “ad hoc” basis, in case by case decisions. The Ministry has not yet implemented any clean up criteria for lands or sites to be applied in a general way. However, there are some particular ministerial authorisations linked to certain decommissioning projects of the first part of the nuclear fuel cycle facilities (uranium concentrate mill tailings stabilization and the restoration of old uranium mines sites). In these cases, the specific radiological criteria for site release are specifically included in the licence or authorisations granted to each individual holder the release applies, and they are only valid for these projects.

The criteria that governed the decommissioning program for the Andujar mill tailings stabilisation project were taken from the standards given by the US EPA for the rehabilitation of uranium mill tailing in the UMTRA program, and from the Spanish groundwater protection regulation. These criteria can be summarised as an effective equivalent dose to individual in the critical group below 100  $\mu\text{Sv}$ , from the stabilized tailings, plus an additional reduction of residual concentration of Ra-226 on land such as the background level is not exceeded in more than 0.2 Bq/g (in the upper 15 cm of soil) and 0.6 Bq/g (in the 15 cm thick layers of soil more than 15 cm below the surface).

At this point, it is worth to note here the establishment in 1995 of a CSN working group to derive radiological criteria for the decommissioning and restoration of uranium ore processing sites. The report, which included the criteria for site restoration and site release, was never come into force and never went beyond the draft stage. The proposed criteria were, nevertheless, subsequently included in later authorisations granted for new restoration and remediation projects.

Basically, the document indicated that intervention to decontaminate a site is justified if the effective dose to individual in the critical group is above 100  $\mu\text{Sv/a}$ . Intervention is not justified in any case if the effective dose is below 10  $\mu\text{Sv/a}$ . Intervention may be necessary in the range of 10 to 100  $\mu\text{Sv/a}$  if the dose to an individual in any hypothetical and conservative scenario is greater than 1 mSv/a, which is the dose limit for the public.

Consideration was given to plausible land use options after clearance, which must be both realistic for the location in question, and the relevant exposures pathways. This analysis stated that the agricultural/residential scenario (family farm) was the most restrictive scenario, resulting in a guideline concentration for soil contamination of 0.1 Bq/g of U-238 in equilibrium with all the radionuclides in its natural decay chain. Higher values derived from other generic exposure assessments, requiring some special additional conditions, were established for three restricted and more plausible scenarios: agricultural/residential (up to 0,1 Bq/g ), forestry/grassland use (up to 1 Bq/g), recreational area (up to 1 Bq/g and  $H < 0,1 \text{ Gy/h}$ ) and industrial use (up to 1 Bq/g and  $H < 0,3 \text{ Gy/h}$ ) with additional restriction in soils of closed buildings  $< 0,1 \text{ Bq/g}$  and limiting the radon concentration inside buildings  $< 200 \text{ Bq/m}^3$ .

### **3. Radiological approach**

To allow the free or restricted release of a previously regulated site it is necessary to demonstrate that the radiological detriment caused in the environment is as low as reasonable achievable. We find here, as a particular case of the radiological optimisation process, the so-called protection principles for exemption:

- Radiological risk to the individuals caused by the cleared material must be sufficiently low as not to be of any further regulatory concern.
- The exempted sources must be inherently safe, with a very low likelihood of scenarios that might lead to failure to meet the criteria previously mentioned.
- The collective radiological impact of the cleared policy must be sufficiently low as not to warrant regulatory control under the prevailing circumstances.

In any case, the individual-related dose limits for members of the public have to be accomplished to prevent unacceptable individual detriment:

- Individual effective dose < 1 mSv in a year
- < 15 mSv per year for lens
- < 50 mSv per year averaged over 1 cm<sup>2</sup> of skin

When clearing residual materials, a dose constraint in the range of 1/100 to 1/10 of the individual effective dose limit is usually applied to the average individual of the critical group of the affected population. The use of these constraints simplify the formal radiological optimisation process, and try to avoid that cumulative exposures due to several and non related sources exceed the established individual limits. The radiological protection philosophy when releasing lands or sites under regulatory control is essentially the same, but some particularities should be taken into consideration when establishing release criteria.

The sites should be remedied to reduce the residual risk as far as it is reasonable, taking into account the cost and risks associated with the remedial measures. It should be considered that sites are inherently not transportable in opposition to materials, so cumulative radiological impact to the affected population due to several sites is not possible, at least at the same time. It is also possible to consider much more realistic site parameters in order to elaborate a conservative future use scenario of the site to be released.

#### **4. Safety Instruction on radiological criteria for the release of Nuclear Facilities Sites**

According to Regulations, releasing a site implies to free the facility licence-holder from its responsibilities in monitoring the radiological and safety conditions of the site. Regulations, however, do not specify neither the radiological conditions to be met in order to release the site, or the possibility of a partial site release –with or without restrictions–. In case of restricted site release, Regulations do not establish either the required criteria or radiological restrictions for such a release.

The Nuclear Safety Council issued Instruction IS-13 [2] on radiological criteria for the release of nuclear facilities sites in order to standardize the criteria for such a release in all nuclear facilities decommissioning programs.

The Instruction, based on previous radiation protection analysis and Spanish experiences, shall apply to nuclear facility sites after having obtained authorisation for its dismantling, and establishes the requirements and conditions for the release of the sites:

- Radiological criteria on the effective dose to the public.
- Partial release of nuclear facility sites.
- Restricted release of nuclear facility sites.

The Instruction firstly defines the terms and concepts used in those set forth by the legislation. The following definitions shall apply to the context of this Instruction:

‘Site’: the area of land along with structures and other facilities, as described in the operating authorisation, as well as any area released prior to the statement of decommissioning.

‘Release levels’: surface contamination (Bq/cm<sup>2</sup>) or activity concentration (Bq/g) values, as derived from the authorised radiological criteria, by means of a scenario modelling process representing the potential paths for radiological exposure to members of the public.

'Use restrictions': restrictions on the usage of a site, or a part of it, in order to ensure compliance with the established radiological criteria.

'Ground': an area covering from the surface soil, the ligneous plant species growing on it, and the surface water flows running over it to the unsaturated zone or subsoil and the saturation zone and groundwater courses.

#### **4.1 Radiological criteria**

The following radiological criteria shall be accomplished when releasing a nuclear facility site:

- The effective dose to the representative individual of the critical group from residual activity on ground after site release shall not exceed a value of 0.1 mSv/year.
- These radiological criteria shall apply to the entire site released, regardless of any possible use restrictions.
- Any remaining buildings, facings or structures on the site at the time of its release shall comply with the clearance criteria recommended by the European Union publication 'Radiation Protection 113: Recommended Radiological Protection Criteria for the Clearance of Buildings and Building Rubble from the Dismantling of Nuclear Installations'.

After the site release, the new background dose will be equal to the dose that existed prior to the operation of the facility, plus the dose increment from the residual activity remaining on site.

#### **4.2 Partial release of nuclear facility sites.**

As far as radiation protection is concerned, the partial release of a nuclear facility sites shall be considered acceptable previous to the statement of decommissioning if the authorisation for dismantling has been granted by the competent authority.

If such a partial release needs to be carried out with restrictions, the criteria to be applied shall be those provided in sections Three and Five hereof, regarding restricted site releases.

The licence-holder shall keep the records including information about radiological classification data of any previously released part of the site until the last possible partial release becomes effective and the statement of decommissioning of the facility is issued.

#### **4.3 Restricted release of nuclear facility sites.**

A total or partial site release with use restrictions shall be considered acceptable:

- Provided that it can be demonstrated that any additional reduction in the residual activity that would be necessary for unrestricted site release, may cause real harm to the public or the environment, taking into account all possible radiological damages in the process; or provided that the residual levels associated with the restricted conditions are as low as reasonably achievable, taking into account social and economic factors (ALARA).
- Provided that the licence-holder supplies means to establish and keep legal and institutional controls to reasonably guarantee that the effective dose received by the representative individual of the critical group from background residual activity does not exceed 0.1 mSv/year. This value shall apply to the entire site ground, regardless of the compliance with the clearance radiological criteria in force for buildings, facings and structures.

Provided that it can be ensured that the dose received by the representative individual of the critical group as a consequence of any allowed use under the restrictions in force does not exceed the maximum established value. If the institutional control on the restrictions fail and render them ineffective, the dose received by the representative individual of the critical group shall not exceed a value of 1 mSv/year.

#### **4.4 Evidence of compliance with radiological criteria.**

The licence-holder shall propose and justify a set of release levels in accordance with the radiological criteria and with the site's planned final use.

The licence-holder shall propose and justify the methodology used to perform the final radiological site survey to demonstrate that all established radiological criteria are met.

### **5. Site Restoration Plan**

The Spanish radiological approach, expressed in terms of an effective dose limit of 100  $\mu$ Sv/year, is not a direct and quantifiable magnitude to be applied to demonstrate the accomplishment of release criteria. It is always necessary to derive some measurable values, as derived concentration guideline levels, using appropriate calculation codes.

The Site Restoration Plan is an official document required in the context of the decommissioning licensing, that include the methodology used by the licensee to perform the final radiological site survey, and to verify that all established radiological criteria for the site release are accomplished.

The Nuclear Safety Council issued Safety Guide GS.4.2 [3], on "Site Restoration Plan" format and content, to help licensees in the elaboration of the official documentation required to justify the accomplishment of the radiological requirements, when applying for the release of the site, and to help them in the decision making process.

An historical site assessment and a scoping survey should be initially performed to provide the necessary information to design the previous characterisation survey.

The content of the "Site Restoration Plan" document should be focused on the radiological surveys to be conducted to demonstrate compliance with the derived concentration guidelines levels. The document should also include the radiological assessment, the codes and parameters used to calculate the concentration guideline levels, named "liberation levels". It is also necessary to include in the document the design, the planning, and the implementation of each of the characterization phases in order to assure a proper final status survey.

The characterization survey integrates scanning surveys with direct measurements and sampling, and includes the classification of areas, the definition of survey units and the determination of the required sampling points. Appropriate statistical tests are finally used to demonstrate compliance for each survey unit.

Up to now three different "Site Restoration Plan" documents have been submitted for revision as part of the licensing process of each of the decommissioning programs currently under way. The CSN technical staff is currently reviewing the radiological criteria and the different scenarios considered in the proposals:

A partial site release site has been proposed for Vandellós 1 nuclear power plant site. This nuclear power plant has recently been dismantled in part, and it is expected that up to 60 % of the old nuclear site will be released in the near future. The remaining 40 % of the site will be under regulatory control as a dormant facility until its complete dismantling. This regulatory control includes care and maintenance controls of the reactor building until the final phase of dismantling begins.

A strategy of immediate dismantling, followed by a complete site release has been proposed for José Cabrera nuclear power plant, as the decommissioning program of the plant.

A more specific case is proposed for the Ciemat research centre, considering there will be some remaining operational radioactive facilities in the site after rehabilitation of the centre.

## **REFERENCES**

- [1] SPANISH OFFICIAL GAZETTE (BOE) number 313, dated December, Royal Decree 1836/1999, dated 3 December, approving the Regulations on Nuclear and Radioactive Installations, as amended by Royal Decree 35/2008, dated 18 January.
- [2] SPANISH OFFICIAL GAZETTE (BOE) number 109, dated 7<sup>th</sup> May 2007, Instruction IS-13, of 21<sup>st</sup> March 2007, of the Nuclear Safety Council, on radiological criteria for the release of Nuclear Facilities Sites.
- [3] NUCLEAR SAFETY COUNCIL SAFETY GUIDES GSG-4.2-2007, Site Restoration Plan