New Swedish Regulations for Clearance of Materials, Rooms, Buildings and Land

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Abstract

The Swedish Radiation Safety Authority (SSM) has developed new regulations for clearance of materials, rooms, buildings and land. The new regulations develop and widen the scope of the current Swedish regulations on the release of goods and oil from nuclear facilities. The new regulations put requirement on the procedures for clearance of materials, rooms, buildings and land during all stages of nuclear and non-nuclear practices. The proposed clearance levels are based on recommendations from the European Commission. The regulations are scheduled to enter into force in January 2011.

Introduction

The Swedish Radiation Safety Authority (SSM) is the regulatory and supervisory authority for radiation protection and nuclear safety in Sweden. SSM has developed new regulations for clearance of materials, rooms, buildings and land. The regulations specify under what conditions objects that may have been contaminated[1] by radionuclides in licensed practices with ionizing radiation, can be released from further regulatory control by SSM. Thereby materials and resources can be used and managed in a rational way, in a manner that is acceptable from a radiation protection point of view.

The regulations will replace the current Swedish regulations for release of goods and oil from nuclear facilities, SSMFS 2008:39 (Ref 1) and introduce new rules for clearance of materials from non-nuclear practices as well as new rules for clearance of rooms, buildings and land. The work builds on work performed by the former Swedish Radiation Protection Authority (SSI). A draft version of the regulations was sent for a broad national review in 2006 and a large number of comments were received (see Ref 2 for a description of the draft version). SSM developed the regulations further and a new version was sent for a broad national review in 2009. The regulations have thereafter been adjusted and clarified in some aspects and will soon (spring 2010) be notified to the European Commission (EC) according to the Euratom treaty, before being decided by SSM. The regulations are planned to enter into force in January 2011.

After the national review in 2006, the Swedish nuclear industry took an initiative to develop a common handbook or code of practice for clearance procedures (Ref 3). The handbook is planned to be issued by the Swedish Nuclear Fuel and Waste Management Company (SKB), following SSM's decision on the regulations.

Background

The work to revise the current regulations for clearance of goods and oil from nuclear facilities (Ref 1) was initiated for several reasons. The main reasons were:

[1] In this paper, the term contamination means any occurence of radionuclides on the surface or in the bulk of an object that is caused by the actual practice.

- The methods for management of conventional wastes have changed substantially since the current clearance levels were developed.
- The current regulations were originally not intended for large amount of materials arising from decommissioning of nuclear installations.
- There are currently no general clearance regulations for non-nuclear practices in Sweden.
- A need for harmonization with international recommendations from the EC and the IAEA (Refs 4, 5, 6)

The work was prepared for several years by following the international development of clearance recommendations and regulations. The actual revision project started in 2004 with an evaluation of the current regulations. The evaluation was based on inspections of the clearance procedures at the Swedish nuclear installations (four NPP:s, one fuel fabrication plant and one site with material test reactors, hot-cells for material investigations and radioactive waste management facilities). Another important preparatory work was the investigation of the applicability of the EC recommendations for buildings and building rubble in Sweden (Ref 7). Also, some of the requirements were developed on the basis of experiences from decommissioning projects in Sweden and other countries. During the work, several seminars have been held to discuss specific topics on clearance with the licensees and other interested parties. On several occasions, information and progress reports have been given to radiation protection experts of the licensees. International experiences have been included in the work, by invitation of experts from Germany and Spain to seminars in Sweden, and by participation on international conferences.

The regulations

The regulations contain the following subsections, which will be presented below.

- Introductory requirements
- Area of application
- Clearance
- Measures for clearance
- Clearance levels
- Rules for implementation of clearance levels
- Competence
- Reporting
- Other clearance options and exceptions

Introductory requirements

The introductory requirements describe the purpose of the regulations and give a definition of the term clearance. It is stated that clearance means that the Radiation Protection Act (1988:220) and the Act (1984:3) on Nuclear Activities shall no longer be applied to materials, rooms, buildings and land that may have been contaminated by radioactive substances in such practices with ionizing radiation that are subject to licensing. Thus, it is important to note that the regulations only deal with exemptions from the acts on *radiation protection* and *nuclear safety*, in the case of potentially contaminated objects due to *licensed practices*. Other legislation concerned with hazards from radioactive substances might thus still be applicable, for example legislation on transport of radioactive materials and legislation on non-proliferation of nuclear materials.

Area of application

The area of application is specified both in terms of what is included in the scope of the regulations and what is excluded. Included are: Materials, including waste, rooms, buildings and land that *may* have been contaminated by radioactive substances in practices with ionizing radiation that are or have been carried out under a license according to the Radiation Protection Act or the Act on Nuclear Activities.

Excluded are:
1. releases of radioactive substances to air or water,
2. naturally occurring radioactive substances that are not part of the license for the actual practice with ionizing radiation,
3. practices that only involve naturally occurring radioactive substances and that are carried out without any purpose of use of the radioactive, fissile or fertile properties of radioactive substances,
4. nuclear medicine.

Thus, only radionuclides that have been part of the licensed practice have to be considered when applying the regulations. Nuclear medicine is excluded since contaminated objects from such practice need special consideration and are dealt with in other regulations from SSM (for example contaminated clothes and sheets).

Clearance

Clearance of materials is treated differently than clearance of rooms, buildings and land. For materials, it is stated that a material is subject to clearance when it has been checked in accordance with the regulations and it has been concluded by the licensee that the content of radioactive substances is less than the clearance levels given in the regulations. Thus a mandate is given to the licensee to perform clearance under own responsibility, without any obligatory supervision or decisions by the authority.

For rooms, buildings and land that shall no longer be used for the actual practice, it is stated that the licensee shall take all measures that are needed to achieve clearance. An application on clearance shall thereafter be given in to SSM, who decides on clearance. To allow for some flexibility, the licensee may temporarily use rooms and buildings that have been checked for contamination for other purposes without any decision on clearance by SSM.

Measures for clearance

An obvious requirement is that objects have to be checked for radioactive substances before clearance. The regulations state that the checks shall be based on measurements. Thus it is not sufficient to only estimate the occurrence of radioactive substances based on for example knowledge of the possible ways of contamination of the object. However, it is allowed to apply nuclide vectors or correlation factors between the occurring nuclides if the vectors or factors have been established from measurements on samples that can be considered representative for the actual composition of radionuclides.

It is further stated that the methods and extent of the checks shall be adapted to the risk of contamination, the extent of contamination, and to the characteristics of the potentially contaminated object.

Also, the methods shall correspond with Swedish or international standards, or guiding documents from SSM. Although no such guiding documents are planned by SSM today, they could be issued as a complement to the standards or to override the standards (if some part of a standard for some reason would be considered not appropriate).

Some decontamination efforts may be warranted to keep the amount of radionuclides in cleared materials, and thus also the potential exposure of members of the public, as low as reasonably achievable. It is therefore stated, as an advice attached to the regulations, that decontamination should be considered and that easily removable contamination should be removed before clearance. In another advice attached to the regulation, it is stated that systems, equipment and components should be removed before clearance of rooms and buildings, in order to facilitate decontamination and activity checks of the remaining structures.

An important prerequisite for allowing the licensee to perform clearance under own responsibility is to ensure that it is performed in a well-planned, qualified and systematic manner. In order to achieve this, it is stated that the licensee shall develop a written control program that shall specify the methods and who is authorized to conduct the checks. The control program shall also describe how quality assurance, self-assessment and documentation of results is done. For clearance of rooms, buildings and land as well as for clearance of more than 100 tonnes of materials per year, the control program shall be given in to SSM. Thereby, SSM has the possibility to review the program, judge if it is appropriate and give comments and suggestions for improvements. If needed, SSM can also require the licensee to change or improve the program in a specified manner.

Also, to facilitate supervision by SSM, it is stated that the performing of checks as well as the results of checks shall be documented and that the documents shall be preserved for ten years after clearance. The only exception from this rule concerns tools and equipment that are cleared after temporary use in the practice (se below).

Furthermore, the regulations explicitly forbid dilution of contaminated materials with the purpose to achieve clearance. It is also stated that liquids shall be cleaned from radioactive particles as far as practically achievable, in order to prevent exposure of the public due to accumulation of radionuclides in filters or in sediments.

Clearance levels

As required in the European Community Basic Safety Standards (Ref 8), the clearance levels are based on the basic criteria for exemption (Annex 1 of Ref 8). The criteria are specified as a maximum effective dose to any member of the public of the order of 10 microsieverts per year and a collective effective dose of less than about 1 mansievert per year (or assessment that clearance is the optimum option).

Clearance levels are specified for four different cases:

1. Materials for unrestricted further management (reuse, recycling or disposal)
2. Oil and hazardous waste for incineration or disposal
3. Rooms and buildings for reuse
4. Buildings for demolition

For materials, oil and waste, nuclide specific clearance levels for activity concentration (becquerel per gram) are given for 196 nuclides. For materials for unrestricted further management (category 1 above), the values are those established in European Commission recommendation RP 122, Ref 4. For oil and hazardous waste for incineration or disposal (category 2 above), the values are 10 times higher for all nuclides (except for three nuclides for which the clearance values are the same as those recommended in RP 122 in order to not exceed the exemption values of the European BSS, Ref 8).

Clearance levels are also stated for surface contamination on materials. As in the current regulations (Ref 1), the values are 40 kBq/m^2 in total for beta and gamma emitting radionuclides and 4 kBq/m^2 for alpha emitting radionuclides.

In general, both the levels for activity concentration and the levels for surface contamination have to be complied with for clearance. The only exception is for tools and equipment that have been used temporarily in the practice and that are intended to be used also after clearance (i.e. not being sent for demolition or recycling). Another prerequisite for this exception is that contamination shall only be expected to be found on accessible surfaces.

For rooms and buildings (categories 3 and 4 above), nuclide specific clearance levels are given for 104 nuclides. The values are those established in European Commission recommendation RP 113, Ref 5, Table 1 (for reuse or demolition) and Table 2 (for demolition only).

No clearance levels are given for land in the regulations. The current approach is that such clearance levels will be decided by SSM on application by the licensee based on site specific considerations.

Rules for implementation of clearance levels

In the regulations, some rules are given on how the clearance levels shall be interpreted and implemented. Firstly, the summation formula shall be used for contamination that consists of several nuclides, see for example Ref 4. Moreover, the activity concentration may be determined as a mean value for up to 1000 kg (in the case of materials) or 1 m^2 (in the case of room and building surfaces, i.e. walls, floors and ceilings) when comparing with the clearance levels.

Surface contamination on materials may be determined as a mean value for up to 0.03 m^2 when comparing with the clearance levels.

As mentioned in the beginning of the paper, the Swedish nuclear industry has jointly developed a guiding document for clearance. The document gives further guidance on several different issues that should be considered in the clearance process.

Competence

There is a general requirement that the involved personnel shall have sufficient competence for the measures that they take and the judgements that they make in the clearance process. This is further specified by requirements on knowledge of which radionuclides that occur in the practice and to what extent they may occur as contamination. The personnel shall also be educated in harmful effects and risks with ionizing radiation, in rules and routines for

clearance and in methods for sampling and measurement, including inaccuracies and limitations of the methods.

Reporting

A yearly report shall be given in to SSM in order to facilitate SSM's supervision and retrospective follow up on the use of the clearance option for management of materials and waste. The report can also serve the purpose of public insight in the process of clearance. The report shall specify the amounts and kinds of materials that have been subject to clearance, the nuclide specific concentration of radioactive substances in the materials, and, in the case of oil and hazardous wastes, the receivers of the materials. No report is required from licensees that have cleared less than 1000 kg of materials during the past calendar year, in order to reduce the administrative burden on licensees.

Other clearance options and exceptions

SSM can, on a case-by-case basis, decide on other clearance levels than those specified in the regulations. This requires an application by the licensee supported by an analysis of the radiological consequences of the proposed management or use of the object(s) after clearance. If there are circumstances that limit the possible ways of public exposure, higher clearance levels may be accepted.

SSM can also permit exceptions from the requirements in the regulations, if there are special reasons, as long as the purpose of the regulations is not violated.

Discussion

Several difficult issues have to be dealt with when regulating and implementing clearance procedures. A general feature of the necessary considerations is that they include a large portion of judgement.

The derivation of proper clearance levels is a fundamental issue that is based on judgement of the expected or potential exposure that should be accepted from cleared objects. Generally, such judgement leads to the establishment of a dose criterion. In international guidance and legislation, 10 microsieverts per year is commonly used, since it is generally regarded as trivial. In some cases, for example in Ref 6, consideration is also made about low probability exposure scenarios, with the application of higher dose criteria in such cases (1 mSv/year in Ref 6).

To derive clearance levels, considerations must be made about expected and potential scenarios for exposure. This step also includes a large portion of judgement and considerations about the practices that can give rise to contaminated objects as well as about the further destiny of cleared objects (for example in the selection of considered radionuclides, identification of scenarios and choice of parameters and computational models for exposure calculations). Special attention is normally given to such realistic scenarios that would cause a higher exposure than other foreseeable scenarios. This means that the most probable doses to members of the public should be well below the dose criterion and that the dose criterion should only be exceeded in fairly extreme cases.

Internationally, a lot of work has been done on clearance levels for activity concentration in materials, which has been a good help in the development of the new Swedish regulations.

However, for surface contamination there is very sparse guidance. Thus, there is a need for international recommendations on general clearance levels for surface contamination. There is also a need for further harmonization between clearance levels and transport regulations (see Ref 9).

The treatment of naturally occurring radionuclides poses a special problem when it comes to clearance. There are practices that involve naturally occurring radioactive materials (NORM) for which the application of the 10 microsievert criterion would cause restrictions on the operations and on the treatment of residual materials that would probably not be motivated from a radiation protection point of view, taking into account the natural abundance of NORM. Instead, higher dose criteria (300 microsieverts per year, Ref 10) or clearance levels corresponding to higher doses (Ref 6) are internationally recommended.

However, for practices in the nuclear fuel cycle, where NORM has been processed in view of its fissile properties, the 10 microsievert criterion should be applied, as for other radionuclides in the nuclear fuel cycle (fission and activation products)[2]. In this case the natural abundance of NORM causes detection problems, which might mean that less confidence level has to be accepted for some nuclides, or even that higher clearance levels can be applied, based on optimization of radiation protection (cf Ref 4, footnote of Table 1).

Once the clearance levels have been established, the question is how to show compliance with the levels. As mentioned earlier, this involves judgement about the potential contamination of the object, selection of appropriate methods for determination of the contamination and proper interpretation of the results. Considerations must be made about which nuclides shall be determined, their expected distribution, the properties of the contaminated materials, confidence levels and detection limits of measurements, logistics, calibration of equipment, quality assurance, etc. Many of these issues have to be solved in a way that is adapted to the actual circumstances. In the new Swedish regulation, this step in the procedure is a responsibility of the licensee to a large extent. This emphasizes the importance of skills and competence of the personnel responsible for clearance.

Clearance levels are often regarded as “perfectly safe” levels of contamination which can be disregarded from a radiation protection point of view. However, application of the principle of optimization of radiation protection means that some efforts for decontamination before clearance may be warranted (Ref 9). It could also be warranted to direct the release of materials into the society in such a way that exposure is avoided.

Clearance procedures are closely connected to means and routines for control of radioactive materials and waste within a practice. To avoid exposure of the public or deterioration of public confidence it is crucial that no radioactive material, on false grounds, leaves the practice as cleared material. To prevent this, the clearance procedures should involve additional “lines of defence” to identify and prevent such illicit clearance. This could include random additional checks and gate monitors for goods leaving the site

Conclusions

[2] Actually, this is the main reason for the decision to use the clearance levels recommended in Ref 122 instead of Ref IAEA. This is further described in Ref 9.

Over a period of several years, SSM has developed new regulations for clearance of materials, rooms, buildings and land. The work has involved extensive consultation with stakeholders and information to licensees and other interested parties. In parallel, the Swedish nuclear industry has developed a code of practice as a common platform for implementation of the requirements in the management systems of each company. The regulations, the industry code of practice, as well as the awareness and common understanding that has developed during the process, should provide a good basis for robust procedures so that clearance will be done in a reliable and transparent manner.

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