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Licensing of complex facilities other than nuclear power plants.

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Abstract. The Swedish Radiation Safety Authority, SSM has now license applications coming up for several facilities outside the traditional domain that are by us considered and denoted -complex facilities;

- The European Spallation Source, ESS in Lund is going to be a very large proton accelerator driven neutron source intended for neutron based research. Its neutron production target will have a radionuclide inventory comparable to that of a research reactor but without fissile materials.
- Next door neighbour to ESS is MAX IV, a large synchrotron light source. This research facility will also house a linear short pulse facility and later on a XFEL (free electron laser).
- A dedicated medical treatment facility for proton therapy is under construction in Uppsala. (Kommunförbundet Avancerad Strålbehandling, KAS and Skandionkliniken)

These facilities present the biggest challenge ever concerning non-nuclear facilities at SSM and will involve several different departments and sections at the authority. The applications need to include information like that found in the PSAR (Preliminary Safety Analysis Report) used in connection to nuclear power plants. The legal base for licensing these kinds of facilities is today the Swedish Radiation Protection Act and the accompanying regulations issued by SSM that are somewhat different from those based on the Nuclear Activity Act. In parallel and apart from this licensing process there is an on-going work to merge these two laws into one in a near future.

The present regulations have not been very well adapted for this kind of “complex facilities” now addressed. A generic document has been worked out on how the necessary type of a review process can be structured to guide both the authority and the applicants. This document is intended to address the overall occupational radiation protection and the protection of general public including also security aspects and emphasizing on identifying, in a break down structure, essential reviewing areas such as; building and facility design, accelerator and target design including components in beam guides, regulating and control systems, emergency preparedness, releases and environmental impact, dismantling, decommissioning and waste handling as well as organization, resources and management.

KEYWORDS: Licensing Non-nuclear Complex Facilities, ESS, MAX IV, KAS.

INTRODUCTION

The concept complex system has in some books been defined as a structure that consists of many different subunits that interacts with each other in such ways that all details in its behaviour are not predictable. (Subsets of complex systems are those energy dissipating systems that also can organize and evolve autonomously!)

- An applicant proposes a novel kind of facility that may be considered as complex. First a proper risk identification based on theoretically possible type of events or chain of events that could happened and result in radiation exposure has to be done and communicated to the competent authority at a fairly early stage.
- The authority has to search for relevant information available to be able to understand and to evaluate the proposed facility and the accompanying risks identified. It also has to investigate if there are additional risks not properly addressed at first.
- Based on the description and the risk identification the authority should identify what legal requirements apply and what additional requirements that may need to be formulated to achieve

a necessary and reasonable level of safety and security implementing national legal demands, international standards and guides on the proposed facility.

- The potential license holder should demonstrate how he will comply with the requirements given by the authority.
- A novel facility is, if complex enough, not initially well known or even designed in all details; the design will evolve and mature over a considerable time. The license application and its review will have to closely follow the development of a progressively more detailed design. This results in an iterative process that successively goes more into details. It's not possible to have a complete application with all information at the start of such a process.
- The resulting license or licenses may be given in several steps or by prescribing partial halts for specified requirements over an extended time period. The license application review process will gradually turn into a supervision process with inspections during the finalization of the facility before regular operation is allowed.

The initially inherent information deficiency is cooped by an iterative reprocessing strategy where the information flow between applicant, authority and possible external experts involved is recycled many times. The process may be characterized by the large number of cycles needed to converge to a licence with relevant and necessary bordering conditions. The information handled is evolving toward more adequate information and the uncertainty is minimized.

EXAMPLES OF COMPLEX FACILITIES

ESS[1]

The proposed research facility ESS (European Neutron Spallation Source) in Lund, Sweden will essentially be a very large accelerator bombarding a neutron producing target with a high energy, high intensity proton beam. The facility is according to its proposed design unique in the world regarding beam power, target design and resulting neutron flux. Design parameters mentioned; Proton energy 1-3 GeV. Pulse length 20 ms. Beam power 5 MW. Target nuclide inventory may become comparable to a research reactor. Time frame to complete ESS is in the order of 10 years.

From radiation protection point of view it will offers prompt radiation including secondary particles from high energy proton interactions such as neutrons, gammas and mesons as well as substantial activations in its construction details also to some extent including surrounding gases, liquids and ground.

The risks include exposure for both prompt radiations as well as for radioactive material at possible very high dose rates. Most pronounced for radiation workers at site but also for possible exposure of the general public especially if emergencies occur in a populated area. Worst case scenario includes a significant leakage of the radionuclides in the target mimicking a nuclear reactor accident with hazardous radiation doses to the general public. The design of radiation shielding, remote manoeuvring and control as well as the tightness of radioactivity containing parts will be essential. The barrier concept as well as several other concepts used in connection to nuclear power reactors may become relevant and used.

MAX IV[2]

Another proposed research facility is the synchrotron light source MAX IV in Lund, Sweden, next door neighbour to ESS, which is based on an accelerator giving high energy electrons of 3 GeV.

Compared to the ESS this facility offers less radiation protection problems due to the lighter particles and considerable lower beam power but it still offers essentially similar risk components.

KAS (Skandion Clinic)[3]

This facility is designed for patient irradiations with proton beams for cancer treatments and is under construction in Uppsala, Sweden. The proton energy from the accelerator will be 250 MeV i.e. considerable lower energy and also lower power than ESS but still capable of producing both prompt secondary's and activation of constructions details.

GUIDING TOOLS

Some SSM documents have been produced to guide how to prepare the review of applications concerning complex facilities including also other than nuclear power plants, "Beredning av tillstånd och prövning av tillståndsvillkor gällande kärntekniska anläggningar och andra komplexa anläggningar där strålning används" (SSM131). A derivate of that document has been produced for the specific handling of ESS and similar applications "Tillståndsprövningsprocessen för European Spallation Source".
The derivate document essentially addresses the following (freely referred and translated i.e. not exact as the original text);

- Does the ordinary licensing procedure have to be modified?
- Are there indications on the need for exceptions from the Radiation Protection Act?
- Are there indications on requiring of an environmental consequence description (MKB, miljökonsekvensbeskrivning)?

[1] http://ess-scandinavia.se/

[2] http://www.maxlab.lu.se/maxlab/max4/index.html

[3] http://www.skandionkliniken.se/

- Can the requirements in the Radiation Protection Act and Ordinance be fulfilled?
- Can the applicable requirements in the regulations of SSM be fulfilled?
- The responsible licensee must during operation undertake the actions needed to; prevent faulty functions in equipment and systems, handle errors, sabotage or other events that may result in radiological accidents.
- The responsible licensee must take the actions needed to handle and store radioactive waste in a safe and secure way as well as decommission of the facility when it is no longer going to be in operation.
- The responsible licensee must during operation undertake the actions needed to prevent unauthorized operation and access to the facility and radioactive material (security).

SSM EXAMINATION AND REVIEW OF A COMPLEX LICENSE APPLICATION

SSM is the authority that issues licenses based on the Radiation Protection Act for activities involving ionizing radiation for non-nuclear facilities. SSM carries out a review of the application within several subareas, described in Appendix 1 to the referred document. The review is carried out in several steps (described in Appendix 2 to the referred document. Not included here).

Attached to the application documents addressing the specified subareas should be supplied. The information supplied in this way is expected to be gradually more specified as the facility design process proceeds. SSM gives at the initial state a comprehensive judgment on how the process should proceed including resources for review and supervision on proceeding design and construction. For this reason the applicant also needs to supply information on;

- Aim and justification
- Time schedule
- Plans to utilize external resources relevant from a radiation safety perspective

SSM also decide if an environmental consequence description (MKB, miljökonsekvensbeskrivning) based on the Environmental Protection Act is needed. The results of the review process will be documented in a report that will be the base for the decisions on licensing the facility. If the report will recommend that a license should be issued, then additional requirements may also be specified. Depending on the information supplied by the applicant and the internal resources and competence at the authority this process may take some year/s to complete.

Example of such additional requirements could be;

- Technical devices are not allowed to be installed without SSM specific approval.
- Technical device may need SSM approval before test operation
- Technical device may need SSM approval before routine operation

Also the organization and documentation at the licensee will be reviewed. The licensee must have proper competence available in his organization and proper personnel resources, information, training and local instructions regarding radiation safety and security. Managing organization as well as control facilities and systems are included along with quality assurance and self-control. Proper QM/QA is probable the most important component.

APPENDIX 1

Some subareas addressed

1. Organization, management and resources
    1.1. Evaluation of the management structure needed in relation to imposed responsibility commitments and how this is secured
    1.2. Personal resources and competence needed and how this is secured
    1.3. Economic evaluation, resources needed (costs) and how these are provided
    1.4. Evaluation of the steering documents of the licensee
2. Building and facility design
    2.1. Building design from radiation protection point of view including all relevant additional aspects such as fire, flooding etc.
    2.2. Material radiation durability, activation, corrosion and aging
    2.3. Facility function, functionality control and maintenance
    2.4. Work flows and internal transportation of radioactive material
    2.5. Physical protection against unauthorized access and sabotage
3. Accelerator and target design including components in beam guides
    3.1. Functionality of components, functionality control and maintenance
    3.2. Material radiation durability, corrosion and aging
    3.3. Breakdown exhaustion
    3.4. Barriers (spec. target) safety functions
    3.5. Physical and chemical circumstances of importance for safety functions and barriers
4. Regulating and control systems
    4.1. Primer proton beam optic control system
    4.2. Primary target control system
    4.3. Secondary and other control system i.e. cooling and ventilation etc.
    4.4. Man technique interaction and interface design
5. Releases and environmental impact
    5.1. Production at normal operation of radionuclides, quantitative nuclide specific predictions
    5.2. Radiation exposure including risk assessments outside the facility for both prompt radiation and release/activation
    5.3. Monitoring and local limits (dose constraints)
6. Dismantling, decommissioning and waste handling
    6.1. Life cycle analysis including waste handling during operation and at termination of use
    6.2. Plans for how radioactive material is taken care of including final deposit
7. Emergency preparedness
    7.1. Regulatory demands on emergency organization
    7.2. Emergency consequences, maximal possible release of radioactive material at accident or sabotage and its consequence

REFERENCES

SSM131; Document no 131 of SSM internal guiding documents, see http://www.stralsakerhetsmyndigheten.se/om-myndigheten/aktuellt/nyheter/rutiner-for-att-bereda-tillstandsansokningar-och-prova-tillstandsvillkor/