Paper to 7th European ALARA Network Workshop on "Decommissioning of Installations and Site Remediation", NRG Facilities, Arnhem, The Netherlands, 29 – 31 October 2003

Regulatory Aspects regarding ALARA during Decommissioning of Nuclear Facilities in Switzerland

Dr. S.-G. Jahn, Swiss Federal Nuclear Safety Inspectorate, CH 5232 Villigen-HSK

Abstract

The primary task of the Swiss Federal Nuclear Safety Inspectorate (HSK) is to appraise and oversees the nuclear installations in Switzerland. It assesses the radiation protection and nuclear safety of these installations. By means of inspections, controls, analyses and operators' reports the Inspectorate obtains a comprehensive picture of the installations' condition with regard to safety, of compliance with regulations and of how the installations are managed.

The role of the Inspectorate as regulator within the optimisation process on radiation protection (RP) during the decommissioning of nuclear facilities is described in particular. It will be shown at the example of the decommissioning of the former research reactor SAPHIR at the Paul Scherrer Institute in Switzerland. At the beginning of the decommission project supervision focused on the quality management system of the radiation protection division as well as on the education in radiation protection of responsible person of the project. Both aspects guaranteed the optimisation during the planning and execution of dismantling.

Introduction and Aims

The optimisation of radiological protection as it is recommended by ICRP (ICRP publication 60 (1990)) is implemented in the daily work in Swiss nuclear facilities by several different ways. The most measures in the optimisation process are performed intuitively parallel with a reduction of time and manpower. If the exposure constitutes an important ancillary condition in a work step, optimisation of radiation protection takes place generally using well experienced protection measures without any quantitative analysis on costs and benefits. Only few activities resulting in a prospective collective dose higher then about some hundreds person-mSv have been planed with a quantitative optimisation procedure. For this purpose important tools are regular employment, organisation and education of RP personal, to gain and to document experience, to line up teamwork together with engineers and health physicist as well as to afford enough time for preparation of detailed work and RP plan.

Nevertheless the recommendations about optimisation are implemented in the regulatory body at several different stages. Starting from the federal act about radiological protection via ordinance and guidelines, the optimisation process has to be implemented in company instructions within a Quality Management System. The enforcement is controlled by the Swiss Nuclear Safety Inspectorate (Hauptabteilung für die Sicherheit der Kernanlagen, HSK) via inspections, analysing reports on work and RP planning, control of experience reports, as well as approval of education courses.

One important goal of supervision is to assist the project management to think and act in a sense so that RP does not end just under the legal dose limits but that ALARA has to be considered at all work steps. This means not automatically a quantitatively analysis of costs and benefits but a qualitatively optimisation of RP measures. For this purpose regulatory prescripts have to ensure in a first instance safety culture and RP sensibility, strongly connected with education and a lively quality management system.

In our example safety culture abounds in the project management. Therefore the legal supervision could be reduced and allowed autonomy in decision as much as possible. Thus the creativity of the involved persons could be improved in searching for well advised inventions for RP-measures.

ALARA instruments of the Swiss Regulatory Body

Article 9 of the Swiss Radiological Protection Act of 1991 says:

> In order to limit the radiation exposure of each individual person as well as of the totality of all those concerned, it shall be required to adopt all measures dictated by the experience and the state of the scientific and technological art.

This aspect is repeated and explained in Article 6 of the Swiss Radiation Protection Ordinance, titled "Optimisation":

1. Radiological protection associated with justified activities shall be deemed to be optimised provided:
   a) the appropriate different possible solutions shall have been individually assessed and compared with each other;
   b) the sequence of decision that led to the particular solution remains traceable;
   c) due consideration has been given to the possible occurrence of incidents and the elimination of radioactive sources.
2. The regulatory agency shall be empowered to establish guideline values for individual cases.
3. The principle of optimisation shall be regarded as satisfied for activities which under no circumstances lead to an effective dose of more than 100 microSv per year for occupationally exposed persons or more then 10 mivroSv per year for persons not occupationally exposed.

The Inspectorate (HSK) as the authorized body for governmental supervision in all nuclear facilities describes in the HSK-guideline R-11, how optimisation has to be implemented in the planning of activities: 1. HSK requires a quality management system for radiation protection department for enterprises with nuclear installations in which personal doses over 2 mSv per year can occur during normal operation (exclusion of zero power reactors used for education purposes). For this purpose process regulations are necessary, which define the radiation protection planning, the optimisation process, the documentation as well as the relevant regulations regarding competencies. 2. If the dose estimation of a planned activity in a nuclear installation leads to higher individual or collective doses than the internally determined planning thresholds, a radiation protection planning is to be executed and documented in accordance with the internal procedure regulation.

RP and ALARA instruments of the Paul Scherrer Institute

In the "General Instructions for Radiation Protection at PSI" among other general rules and regulations it is stipulated that any work involving a risk of radiation exposure inside the controlled zones may not commenced until a positive response has been issued by the radiation-monitoring group. If the dose through exposure to external and internal radiation is likely to exceed 5 person-mSv a detailed radiation–protection planning will have to be carried out for any proposed project due to the obligation to optimise. The head of the radiation–protection group, in consultation with the project manager concerned and/or the radiation-protection delegate decides on the scale of the planning.

Within the Quality Management Handbook (QMH) of the radiation protection division at PSI the process instruction "radiation protection planning" describes

a.) under which circumstances a RP-plan has to be done (project resulting in a collective dose above 10 pers.mSv, or work with unsealed radioactive sources of more than a need a RP-plan in written form),
b.) that the scope of RP-plan depends on the risk level,
c.) what is the minimum content,
d.) who is responsible to review the planning,
e.) that in a quantitative analysis an alpha-value of 3000 CHF/person-mSv has to be taken, and
f.) how does the planning have to be implemented in the project (monitoring, intervention).

The appendix of this instruction provides a check list of all issues to be considered when preparing a RP-plan. Parts of the QMH have been accredited.

Decommissioning of SAPHIR Research Reactor

How optimisation in radiation protection could be performed will be shown on the example of the decommissioning of the SAPHIR research reactor of Paul Scherrer Insitute.

The reactor originated from the USA, was presented at the first nuclear technology exposition in Geneva 1954. The Federal Government of Switzerland acquired the reactor and the so called SAPHIR reactor building was constructed during 1955 and 1957. The reactor started up for operation at 5 MW power in 1957. The reactor was used as a neutron source in research as well as a facility to educate young nuclear scientists and technicians. After an enhancement to 20 MW in 1983 a long shut down started 1993. One year later the directorate of the Paul Scherrer Insitute decided to shut-down the reactor for ever because of the successful commissioning of the spallation neutron source SINQ the justification of SAPHIR vanished. After this decision the fuel elements were returned back to the USA. In 1998 PSI requested a licence for the decommissioning of the SAPHIR building. For this purpose a safety report, including the concept for the dismantling, disposal, clearance and radiation protection was prepared.

The Inspectorate had the function to control whether the conditions precedent to grant a license has been fulfilled. For that purpose the inspectorate reviewed the following conditions: 1) safety report, containing a guarantee of compliance with radiological protection as laid down in the radiation protection ordinance, 2) quality assurance system for radiation protection including planning (aims and measures), optimization (ALARA), monitoring (e.g. release of radioactivity, clearance of low radioactive material) and documentation, as well as 3) adequate number of experts with requisite qualification. The review of the inspectorate was finished in July 1999 and the licence was granted in November 2000.

The decommissioning of SAPHIR building was planed within 5 particular phases:
1. Removing and disposal parts not fixed to the building and not necessary for the following steps as shielding and monitoring systems. This first phase was done to gain space necessary for the waste management and tools in the next phases (the experimental hall and the storage room of neutron beamline plugs could be dispelt) as well as to reduce the radioactive sources (Beryllium-reflectors as well as other highly activated parts inside the pool).
2. Cutting and disposal of all fixed installations inside the pool, draining of the pool water
3. Removing and disposal of highly activated parts of the shielding (as for example the neutron beamlines)
4. Removing and disposal of building structures around the reactor (as for example the biological shielding). Clearance of the external parts of the building
5. Dismantling of the whole building and cultivating of the area

As a licence restraint for each phase technical reports including the subdivision in work steps, the description of dismantling equipment, concept of zones, material pathways, waste conditioning and packaging as well as estimated and optimized individual and collective dose, so called dose planning objectives, had to be shown to HSK. The inspectorate supervises the decommissioning by the following measures: 1) single permits for phases or steps 2) review of operating instructions, 3) inspections on site and control of periodical reports, 4) monitoring made by independent experts. The application of supervision measures may be varied depending on the quality of the application documents as well as on indicators for good safety practice.

Meanwhile, end of October 2003, the first two phases are finished. As a result it could be summarised that the jobs were done well prepared and professional. The project crew was able to comply with the dose planning objectives. The estimated dose at phase 1 was 10 person-mSv distributed on five persons in 31 weeks. The monitored dose amounted only 2.44 person-mSv. Explanations for this deviation are 1. that only in maximum two persons had to be near to the sources when handling and 2. improved tools were taken to cut the activated pieces saving time. In phase 2 the estimated dose was 5 person-mSv. In fact 4.9 person-mSv were monitored.

The important measures to optimise the radiation protection are scheduling the working steps to remove the high radioactive sources at first starting with not fixed installations continuing with fixed installations, using
1. protection measures still exist from reactor operation (e.g. shielding of pool water),
2. monitoring systems as they are available from the reactor operation (dose rate, air contamination monitoring),
3. remote controlled or lengthened tools like wet drilling and sewing, hydraulic press systems to crack concrete,
4. relocating work places for conditioning radioactive waste (as an example the sealing of Be-reflectors into steel tins were done inside hot cells in the hot laboratory of Paul Scherrer Institute)
5. construction of several different zones depending on the contamination level (e.g. using tents)

Conclusions and Summary

1. The *experience* of the responsible personal conducting the decommissioning projects, combined with
2. their *education in radiation protection*,
3. the *teamwork* together with engineers and health physicist since the start of the planning,
4. the provision of *enough time for preparation* of detailed work and RP plan, as well as
5 the *quality management system* with it's instructions and checklists as a helpful tool for the RP planning

process ensured an optimisation in radiation protection during the dismantling process of research reactors and kept the individual and collective dose of the occupationally exposed personal as low as reasonable achievable. Doing so, a quantitative ALARA analysis by comparing costs and benefits of measures was not necessary during the decommissioning projects at Paul Scherrer Institute. The Swiss Federal Nuclear Safety Inspectorate supervises and supports the above mentioned five objectives while examining safety reports, giving sanction to particular work stages, performing inspections and controlling experience reports.