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Self- and Regulatory Control of the Radiological Protection Optimisation in Swiss Nuclear Facilities

Dr. S.-G. Jahn, Swiss Federal Nuclear Safety Inspectorate, CH 5232 Villigen-HSK
e-mail: jahn@hsk.psi.ch, tel.: +41 56 310 3931

Abstract

As one of the fundamental principles of radiological protection optimisation is postulated within the Swiss Radiological Protection Act. The Swiss Radiological Protection Ordinance calls three main aspects which have to be considered during planning an action with a relevant risk of either occupational or popular exposure. Beside the regulatory fundamentals this paper describes how the Swiss NPP rule radiological protection planning and how the Swiss Federal Nuclear Safety Inspectorate (HSK) controls the achievement of ALARA during this process. In the guideline HSK-R-11 of the inspectorate the different approaches of self assessment and control, depending on the radiological risk of the action are explained. Generally each licence holder has to develop and to apply a quality assurance system (QS) for radiation protection including planning procedure (aims and measures), optimization procedure (ALARA), monitoring and documentation. An example on such QS will be shown. The inspectorate reviews the quality assurance system and audits the application of the QS on different occasions.

Instruction

The optimisation of radiological protection (RP) is implemented in the daily work in Swiss nuclear facilities by several different approaches resulting in a decrease of collective and individual doses over the last 15 years. The most measures in the optimisation process are performed intuitively parallel with a reduction of time and manpower by full time RP professionals. This staff is well educated by of-the-job and in-firm training, with an educational achievement as RP technician or RP controller. Mainly optimisation of radiation protection takes place using well experienced protection measures without any quantitative analysis on dose reductions and costs. In some cases, e.g. for non-routine work or modifications with long-term consequences, the dose reduction by RP-measures has been calculated. Only few activities resulting in a prospective collective dose higher then about some hundreds person-mSv have been planed with a quantitative optimisation procedure in an integral prospect.

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 Federal 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 beneath the legal dose limits but that ALARA has to be considered at all work steps. This means not automatically a quantitative analysis of costs and benefits but a qualitative 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.

Legal and Regulatory Stipulations

The optimisation of radiological protection as it is recommended by ICRP (ICRP publication 60 (1990)) is implemented in the body of legislation since 1991. Article 9 of the Swiss Radiological Protection Act 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 explained in Article 6 of the Swiss Radiation Radiological Ordinance from 1994, titled "Optimisation":

1. Radiological protection associated with justified activities shall be deemed to be optimised provided:
   a) The appropriate different possible solutions shall be 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 microSv per year for persons not occupationally exposed.

The Swiss Federal Nuclear Safety Inspectorate (Hauptabteilung für die Sicherheit der Kernanlagen, 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 educational 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 plant internally determined planning thresholds, a radiation protection planning is to be executed and documented in accordance with the internal procedure regulation. Typically this threshold is 10 pers.-mSv. In some NPP RP planning is recommended above 1 pers.-mSv, especially if the work has a risk for inhalation. One result of such planning is a dose planning objective for the planned activity.
3. If the radiation protection planning of an activity results in a prospective collective dose higher then 50 pers.-mSv, the radiation protection planning must be submitted to HSK in accordance with HSK guidelines R-15 (Reporting of NPP) and R-25 (Reporting of Nuclear Research Facilities). For the evaluation of the radiation protection planning the HSK draws on empirical values of the last years which have been achieved due to a good radiation protection practice, whereby the range of the activity will be considered.
   If an activity shall be tackled which is challenging in terms of radiation protection, but which does not exceed a prospective collective dose of 50 pers.-mSv (for example work with alpha emitters), the HSK will inquire about the procedure in the frame of regulatory meetings if necessary.
4. The nuclear power plants must determine the dose planning objectives for the respective activities before a planned shutdown (revision, fuel change, repair, etc.). Those objectives are based on:
   i. empirical values for comparable activities in the own or a comparable installation,
   ii. the current radiological situation,
   iii. inclusion of international experiences, and
   iv. optimisation processes (comparison of different options of work sequences, and preventive measures).
   The dose planning objectives of planned shutdowns are to be announced to HSK in due time in accordance with HSK guideline R-15 (Reporting of NPP), and they can be presented in the frame of a regulatory meeting if desired.
5. At the beginning of each year, the nuclear power plants determine the dose planning objectives for the power operation of their installation. These dose planning objectives are based on the extent of work known at that time, on empirical values of the preceding years and on optimisation measures as the case may be.
   If the radiation protection planning for the power operation and for planned shutdowns (revision, fuel change, repair, etc.) results in an expected annual collective dose higher than 1.5 pers.-Sv, HSK will examine the dose planning objectives in detail and will require optimisation measures if necessary.

Examples for an In-plant Instruction for an Optimisation Process

As mentioned above HSK requires a quality management system for radiation protection for all Swiss Nuclear Facilities. In several NPP this requirement is being fulfilled with a process instruction within the Total Quality Management (TQM). A typical title of such process could be “Protection of human and environment against radiation”. This main RP process is broken down reasonably in several sub-processes. Examples of these sub-processes may be “Radiological Protection: Basic Design, Attendance and Monitoring during normal Operation”, “Planned Modifications”, “Emergency Preparedness”, “Personal and Organisation”.
The process “Optimisation” is included normally in the sub-process dealing with modification. Some of the NPP distinguish between modifications with long term consequences, as changes in the design or operation mode of the plant or moving performances, and modification with consequences limited on the duration of the execution like the most jobs at outages.

Nevertheless one of the first steps in these sub-processes is the “Exposure Analysis” wherein the consequences on activity dispersion in the plant systems, contamination levels, dose rates, radioactive emissions and radioactive waste have to be considered. Therefore a detailed work plan is a compulsory input. In some cases it is necessary to “check the radiological conditions” before the exposure analysis can be performed. With the knowledge of own experiences at the site and information from other allied NPP, as well as with the help of computer codes the consequences have to be estimated quantitatively.

The next step would be “Evaluating the Exposure Risk” for which first of all the protection objectives have to be considered. These objectives, typically limits for doses or activities, are given by legislation, licences, regulatory or in-plant instructions. If the estimated consequences do not observe the radiation protection objectives protection measures have to be taken. Additional it could demand a reconsideration of the work plan.

If all consequences fall below the objective limits the next process step has to be done: Review the work plan (as well as the RP plan) with respect to optimisation opportunities. For this purpose some NPP established so called ALARA-teams. In such team well experienced and innovative specialists from different divisions look for “Optimisation Steps” and discuss advantages and disadvantages. If a real optimisation measure has been found a suggestion to modify the work plan will be applied.

Next step would be the preparation of protection measures and monitoring equipment. During and after the planned work or execution the documentation of monitoring results as well as lessons learned have to be done.

Regulatory control

Assessments and Approval of Planning Reports
As mentioned above outages, modifications and activities with a collective dose greater than 50 pers.-mSv have to be reported to the inspectorate HSK. Within the report a radiation protection plan has to be included. HSK evaluates the reports and in some cases the planned activity has to be approved. Several weeks before the beginning of an outage an official meeting between HSK and the RP division of the NPP takes part. The discussion is focused on the most important modifications and activities, the optimisation measures and the preparedness of the RP organisation in sight of the coming outage.

Inspections on Process
The HSK inspects the radiation protection process at a NPP during the outage at least once a week. Some of these inspections are unheralded. Beside these inspections HSK participates on audits about the QS on radiation protection. The creation and modification of the QS-instructions have to be reported.

Inspections on Results
Beside these inspections on processes HSK performs inspection with respect on the radiological situation for what own measurements are done. The most inspections of this kind concern the environment of a NPP (dose rates, released activity), non radioactive material derived from clearance or nuclear fuel transportation.

Review of Outage Field Reports
After the outage a report to HSK about the measured collective doses, dose rates and so on have to be prepared by the NPP. Herein lessons learned as well as a self assessment of the important optimisation progress have to be included.