

How the use of the concept “Dose Constraint” may help to lower annual individual doses

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Abstract. In ICRP publication 103 the use of the concept “Dose Constraint” is emphasized. It will furthermore be an important ingredient also in the revised RP Basic Safety Standards from both IAEA and EU and will surely later on be reflected also in National Regulations.

At Forsmark NPP the concept has been used for many years in order to lower annual individual doses in the dose span 10-20 mSv.

This paper intends to show how the number of individual doses in the higher dose intervals have been lowered by actively using dose constraints in our ALARA-program and dose planning process.

Another important question will also be asked and discussed, that is should dose constraints only be considered for individual doses and not also for collective doses?

KEYWORDS: *Dose Constraint, Individual Doses, Collective Doses*

DOSE CONSTRAINT - BACKGROUND (ICRP 60, 1990. ICRP 103, 2007)

The concept of dose constraint was introduced in ICRP Publication 60 “1990 Recommendations of the International Commission on Radiological Protection” as an important feature of optimisation. The dose constraints were recognised as source-related values of individual dose used to limit the range of options considered in the procedure of optimisation. As stated in ICRP 60 it is possible to reach conclusions about the level of individual doses likely to be incurred in well-managed operations. This information could then be used to establish a dose constraint for that type of occupation.

ICRP 60 also identified the possibility of confusion in case the concept of dose constraint is being mixed with prescriptive regulatory limits. These limits prescribed by regulatory agencies and restrictions applied by managements to specific operations as part of the day-to-day control of exposures are not constraints in the sense used in ICRP 60.

In the 1990 Recommendations, ICRP gave principles of protection for practices separately from intervention situations. In the ICRP Publication 103 “The 2007 Recommendations of the International Commission on Radiological Protection”, the Commission continues to regard these principles as fundamental for the system of protection. In the 2007 Recommendations, the Commission had formulated a single set of three principles that apply to planned, emergency, and existing exposure situations.

Two principles are source-related and apply to all exposure situations:

- The principle of justification, and
- The principle of optimisation.

One principle is individual-related and applies in planned exposure situations:

- The principle of application of dose limits.

Regulatory dose limits are determined by the regulatory authority, taking into account international recommendations. These apply to workers and to members of the public in planned exposure situations.

The second of the two source-related principles according to ICRP 103, the principle of optimisation, is closely related to the subject of this paper and presentation, dose constraints.

Optimisation is always aiming at achieving the best level of protection under the prevailing circumstances through an ongoing, iterative process that involves:

- Evaluation of the exposure situation, including the potential ones (framing the process),
- Selection of an appropriate value for the constraint or reference level,
- Identification of the possible protection options,
- Selection of the best option under the prevailing circumstances, and
- Implementation of the selected option.

For planned exposure situations, the source-related restriction to the dose that individuals may incur is the *dose constraint*. For potential exposures, the corresponding concept is the *risk constraint*. For emergency and existing exposure situations, the source-related restriction is the *reference level* as illustrated in ICRP 103 (ICRP Publication 103, 2007), and here in figure 1.

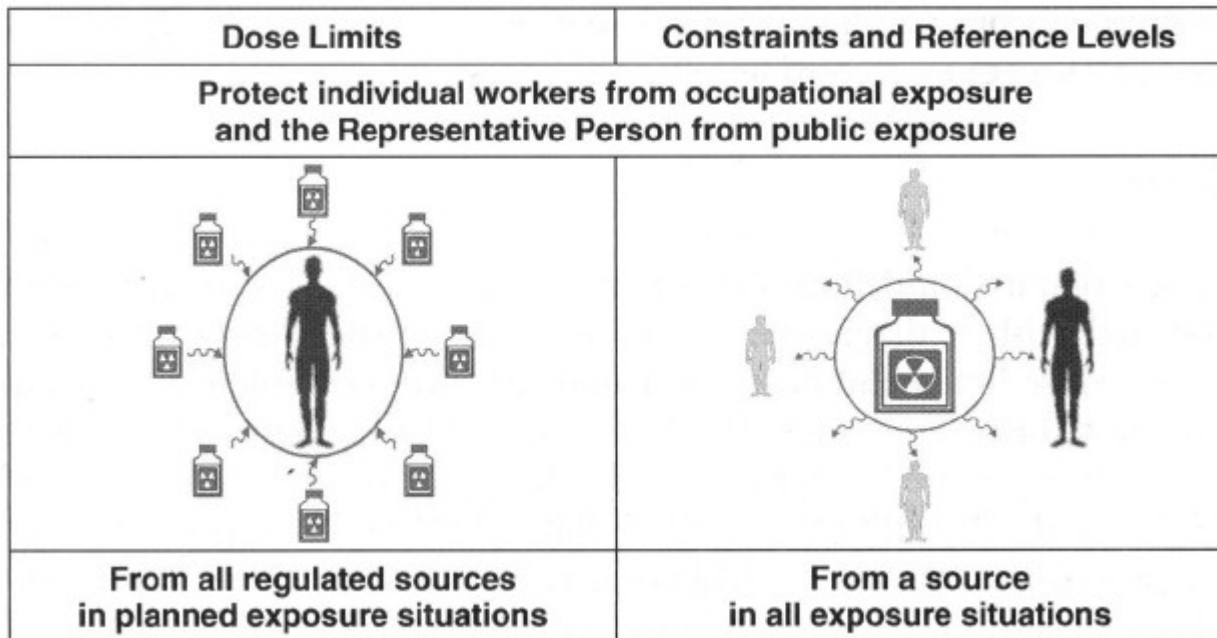


Fig. 1 Dose limits contrasted with dose constraints and reference levels for protecting workers and members of the public (ICRP 103, 2007).

Dose constraint is used in conjunction with the optimisation of protection to restrict individual doses. A level of individual dose, as a dose constraint, for example, always needs to be defined. The initial intention would be to not exceed, or to remain at, this level, and the ambition is to reduce all doses to levels that are as low as reasonably achievable, economic and societal factors being taken into account. The chosen value for a constraint will depend upon the circumstances of the exposure under consideration. It must also be realised that neither dose and risk constraints nor reference levels represent a demarcation between 'safe' and 'dangerous' or reflect a step change in the associated health risk for individuals.

A dose constraint is meant to serve as an upper bound on the predicted dose in the optimisation of protection for that source in question. It is a level of dose above which it is unlikely that protection is optimised for a given source of exposure, and for which, therefore, action must almost always be taken. Dose constraint for a planned situation represents a basic level of protection and shall always be lower than the pertinent dose limit. Optimisation of protection will establish an acceptable level of dose below the constraint which then becomes the expected outcome of the planned protective actions.

It is established that individual doses above the dose limits, represent a risk considered unacceptable. The risk can be seen tolerable when Individual doses can be kept under the limits. The individual dose, after an optimisation process represent a risk level that can be considered acceptable. A dose constraint, as stated above, serving as an upper bound on the predicted dose in the optimisation – can the level of risk in this case be graded in a similar way? How can the level then be expressed, if not being as low as “acceptable” but not being as high as “tolerable” either?

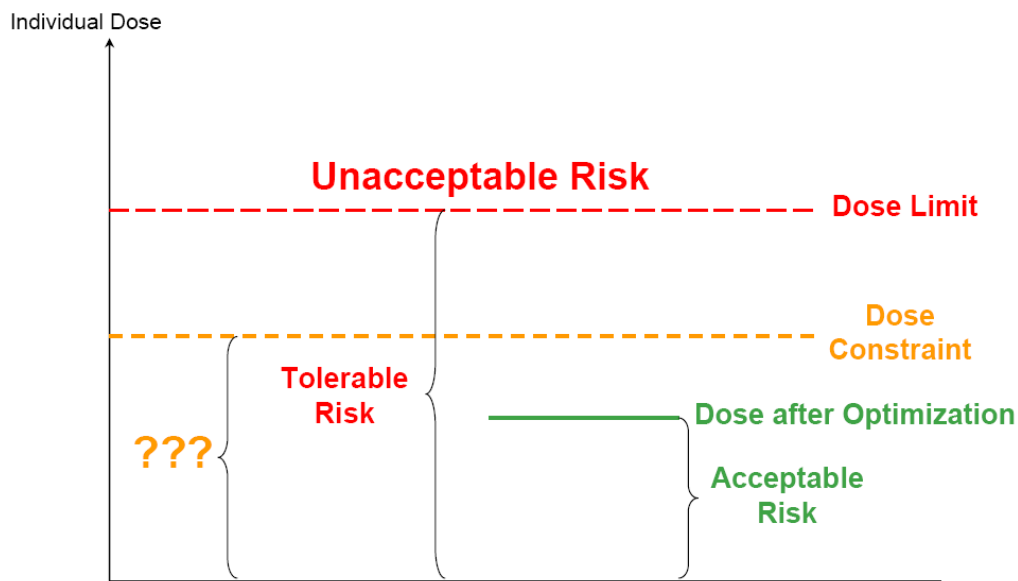


Fig. 2 Dose limit – Optimization, ALARA – Dose constraint.

According to the ICRP 103, the action necessary if a dose constraint is exceeded, includes determining whether protection has been optimised, whether the appropriate dose constraint has been selected and whether further steps to reduce doses to acceptable levels would be appropriate.

In both ICRP 60 and 103 the concept of dose constraint refers to individual doses.

DOSE CONSTRAINT – THE FUTURE: NEW EU AND IAEA BASIC SAFETY STANDARDS UNDER PREPARATION

In the draft version of European Basic Safety Standards, Title III “System of Radiation Protection”, Article 5 (b), the scope of the concept of optimisation is widened:

“In all exposure situations radiation protection shall be optimised with the intent that the magnitude and likelihood of exposures and the number of individuals exposed are kept as low as reasonably achievable, economic and societal factors being taken into account.”

Until this draft version of EU BSS the focus regarding the concept of optimising, and the concept of dose constraint as well, in both ICRP 60 and ICRO 103 has been on the individual dose only. This has certainly

resulted in optimising individual doses but resulting in an increased number of workers being occupationally exposed as well.

Further, Article 6, Dose constraints, a new section added to this revision, for occupational and public exposure, (a) states that:

“For occupational exposure, the dose constraint shall be an upper bound on the individual dose to define the range of protection options considered in the process of optimisation, to be established as an operational tool in cooperation between the employer and the undertaking under supervision of the competent authorities.”

It is important that the licencees themselves can, in cooperation and under supervision of the regulator, put the appropriate dose constraint in place.

International Basic Safety Standards (IAEA), 2011 Edition, Draft 5.0 state that dose constraints are applied to occupational and public exposure in planned exposure situations.

Dose constraints are set separately for each source under control and they serve as boundary conditions in defining the range of options for the purposes of optimisation. Dose constraints are not equal to dose limits – exceeding a dose constraint does not represent non-compliance with regulatory requirements, but it could result in follow-up actions.

For occupational exposure, the dose constraint is a tool to be established and used in the optimisation of protection and safety by the organisation responsible for a facility of activity.

The selection of the value for the dose constraint would be based on the characteristics of the exposure situation, the nature of the exposure and the practicability of reducing or preventing the exposure, for example. National or regional factors, together with a consideration of international guidance and good practices elsewhere are to be taken into account.

After these Basic Safety Standards become legally binding they are to be adopted in national legislation. The concept of dose constraint is then to be implemented by the employers, registrants and licencees for the protection of workers.

USE OF DOSE CONSTRAINTS – FORSMARK NPP

Planning values and dose goals have been used as guidelines for optimisation of dose at Forsmark NPP (FKA) for a long period of time. The long term program for optimisation of radiological protection and ALARA work is the company ALARA Programme. Each production unit shall make their own, specific plans for complementary measures, priorities etc. The overall target of the programme is to achieve high confidence in our work within radiological protection and safety from our own personnel, regulatory bodies and from the public.

The ALARA Programme is one of the company’s corporate programmes and is signed by the company president. It is crucial to have measurable targets in this programme.

The programme is evaluated/reviewed each year and revised when necessary. The evaluation/review and revision is made by FKA’s Radiological Protection (RP) Manager in cooperation with the company ALARA Group. The evaluation report is distributed to personnel as well as to regulatory body.

As planning values and dose goals for FKA in the company ALARA Programme are stated as follows:

- Site collective dose < 2,5 manSv (~ 0,8 manSv / Gw_e).
- At latest year 2014 < 2 manSv (~ 0,6 manSv / Gw_e).
- For work in the turbine plants at production units F1 and F2 < 200 mmanSv (25% of the collective dose).
- Evaluation of consequences for all measures affecting dose rates and/or moisture content in steam shall always be performed.

- Individual doses, FKA's dose constraints:
 - Planning: all doses shall be planned < 10 mSv per year,
 - Result: no individual dose > 15 mSv per year, and
 - Result: maximum 1% of all individual doses > 10 mSv per year.

For the company ALARA Programme to be successful it is crucial that all personnel take active part in the ALARA process. This is emphasized on all mandatory education and training courses as well as communicated through various media within the company.

Other important aspect in the ALARA and optimisation process is that when modifying and updating our production units, RP aspects shall be considered at an early stage of planning and projecting. Focus shall also be put on dedicated RP training for the staff and conducting proper Pre-Job-Briefing and Post-Job-Debriefing.

FKA's dose constraints, stated in the company ALARA Programme are in line with present BSS in force. The planning values and dose goals set to site collective dose can be regarded as dose constraints as well, in line with the new EU and IAEA BSS under preparation.

It has, probably, been a somewhat fixed form of optimisation practice, to avoid high individual doses by increasing the number of staff – thus keeping the individual doses lower, but increasing the collective dose instead. In the future the focus of optimisation has to be widened, it is then not practicable only to increase the number of workers executing some more extensive tasks generating dose to the personnel – lower doses individually, but higher doses collectively.

At the Swedish nuclear power plants, the “ α -value”, the reasonable monetary value of 1 manSv saved is set to 10 MSEK (about 1 M€). Specific circumstances, extremely high individual doses, for example, can justify even higher monetary value to be used as a basis for an economical assessment. In a number of cases even other aspects, than those from a radiological point of view, can be weighed in when making decisions that can affect doses to the personnel and/or environment. When the new BSS, both EU and IAEA, now under preparation, are implemented, it may be possible that a new evaluation of the level of the “ α -value” shall be reassessed.

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