ALARA and/or BAT?

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Introduction

ALARA has been used as an optimization tool for a quite long period of time. The use of this optimization principle is therefore well known and established. Historically it has been applied to exposure management of both persons working at nuclear facilities and people living nearby and being exposed by radioactive substances emitted to atmosphere and water recipient.

However, today the resulting doses to the population due to the emissions during normal operation usually are very low, in the order of tenths of a microSievert or less. Lowering these doses seldom can be justified by only applying ALARA.

During recent years initiatives like the OSPAR (Oslo-Paris convention regarding the protection of the marine eco-system in the North Sea and North Atlantic Sea), HELCOM (Helsinki convention on the protection of the marine environment of the Baltic Sea area) and others has been established. While normally the limitation of releases from nuclear facilities are risk based (limiting the dose to population) the goal with OSPAR, and other similar conventions, is to limit and lower the emission whatever risk is imposed to the environment.

Optimizing what?

The ALARA principle is aiming at optimizing the protection with respect to risk to an individual or collective. The measure of risk in this case is the radiation dose. As a guidance a monetary α-value may be used to judge whether the cost of a protective measure will be acceptable in perspective of the reduced risk in terms of dose. In practice we accept that zero risk is not a realistic alternative. But in practical cases there is also a cut off where ALARA will not be regarded as useful. For example an annual dose increment from a practice in the order of tenth of a microSv does not normally call for any ALARA optimization procedure. Money will be better spent in some other way, for example resulting in reduced dose increments for high exposed individuals.

An obvious obstacle in using ALARA for environmental releases is that regarding radiation protection we yet do not have any international accepted system for the protection of the environment.

As an enforcing instrument to lower the emissions from nuclear facilities regulators have introduced BAT (Best Available Technique) as another optimization tool beside ALARA. The BAT principle, as opposed to ALARA, is aiming at the reduction of emission of man made pollutants to the environment at the source, whatever risk imposed from the emission.

BAT is used for all pollutants, not only for radionuclides. For other pollutants no principle equivalent to ALARA are used. The goal is to reach emissions which are “near equal to zero”.

No monetary value is connected to optimization using BAT, only a general statement that the measure shall be performed without unreasonable costs for the utility. Optimization between different types of emissions (radionuclides, chemicals etc) is generally not performed as BAT is not risk based.

BAT used in practical situations at NPP´s

Still it is not very clear when and how to apply BAT, but some suggestions and procedures have been proposed.

BAT is today only used for optimization of the emissions of radionuclides from NPP´s. According to Swedish regulations control of the releases during normal operations, in parallel to the traditional dose limits, is mainly performed through the use of reference and target values.

Dose limits are given in terms of dose to a person in a “critical group” and are ALARA oriented, as are the dose limits to the workers at the NPP.

Reference values indicate the release levels typical for a situation when the filtering and hold-up systems are fully functioning and without any major fuel failure. Reference values are given in terms of annual release of activity (Bq) for specified radionuclides.

Target values indicate the utilities ambition level regarding the reduction of the releases and they are given in terms of what level of releases (or reduction of) of specified radionuclides that shall be achieved in a specified number of years.

Both reference and target levels are BAT oriented and can be used by the regulator as an indication on whether compliance with BAT is achieved or not.

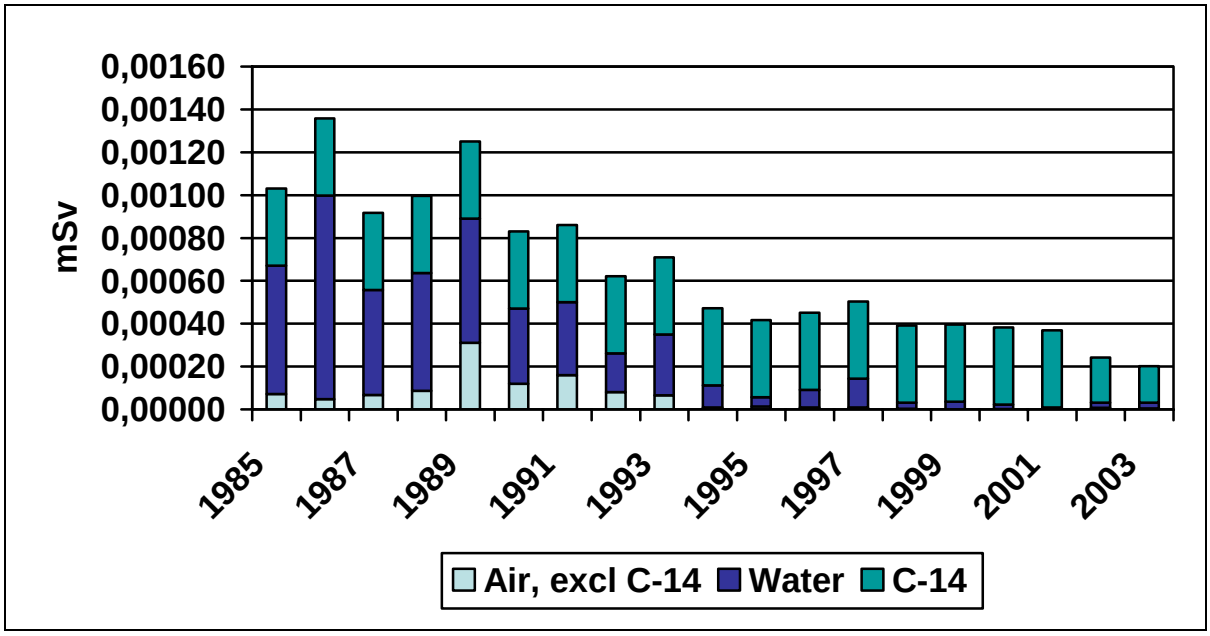
For a fairly new NPP the releases can not be reduced very much neither measured in Bq nor mSv. But technical development will probably always give some room for improvement. As the NPP gets older the introduction of new technique may not always be possible, without unreasonable costs, due to the original system and building design.

An unsolved problem in using both ALARA and BAT in parallel is how to optimize, or make a comparison between, reduced releases in Bq and increased doses to the personnel handling the waste systems.

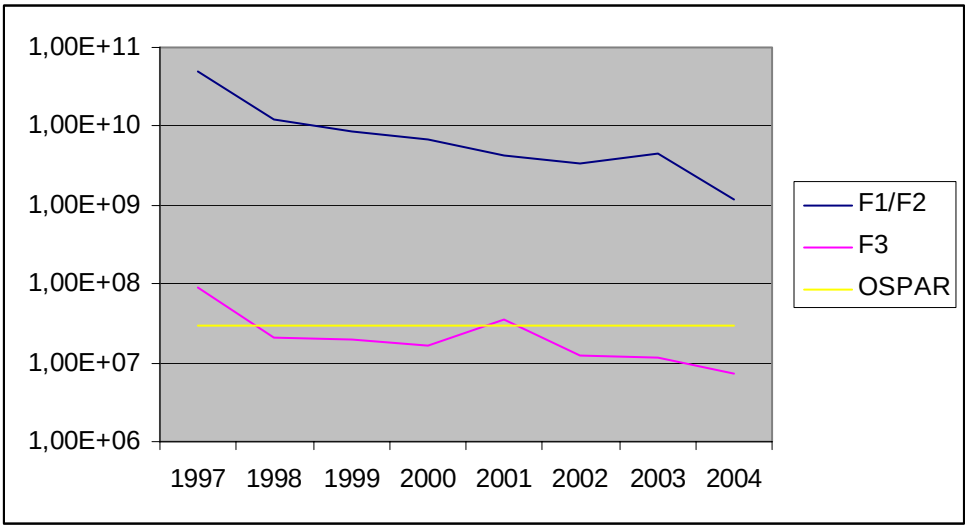
At the moment the utilities in Sweden are involved in the process of getting licenses for operation of the reactors at an upgraded thermal power, compared with the original. Besides issues regarding reactor safety and radiation dose to the NPP personnel also the relases to environment has been discussed to a large extent. The stand point of the Swedish Radiation Protection Authority, SSI, is that the releases can not be allowed to increase due to the power upgrade, exluded the emission of C-14 and H-3, or with other words the releases per produced entity of electricity shall be lowered.

In the licensing process the utilities have to show compliance with BAT, both for the existing situation and also for the future situation with planned measures to reduce the releases implemented.

How is compliance with BAT indicated? At Forsmark NPP we have mainly used two methods, namely trending and bench marking. The figure below shows a downward trend for the releases which we interpret as an indication that we are applying to the principle of "continous improvements".



Release data from UNSCEAR and OSPAR have also been compared to release data for Forsmark NPP. The figure below shows as an example the water releases in Bq/year from Forsmark compared to data compiled within OSPAR.



How can we reduce the releases using BAT? Even if we believe that the figure above indicates that we already apply BAT there is obviously some room for improvement regarding

the water releases from unit 1 & 2. One may come to the same conclusion by the following reasoning. The release of C-14 stands for 95% of the dose to critical group. Of the remaining 5%, water releases from Forsmark 1 & 2 stand for 85% of the dose to critical group. It is therefore logical to concentrate efforts to this effluent point if not unreasonable costs will arise. A simple comparison within the NPP shows that with reasonable efforts the water releases from Forsmark 1 & 2 can be reduced to the same order of magnitude as from Forsmark 3.

An interesting dilemma has been noted by our colleagues at Ringhals NPP. At least at PWR units the release in Bq of C-14 may be reduced by changing the chemical form of C-14, but it may result in increased dose to persons in critical group. What is preferred?

So far BAT has not formally been used for exposure management. But in practice many protective measures taken may be attributed the fact that new technical methods may improve both the radiological environment at the work place and the conventional safety working environment as well as money and time. But it is believed that any formal use of BAT in this respect is not possible.

Conclusions

- ALARA and BAT must be used in parallel. But there are still complications in the application of the two optimization principles together.

- BAT is used for all emission types, not only radionuclides, but no optimization between them based on risk can be performed.

- The “zero emission” vision of BAT regarding man made radionuclides from NPP´s is not realistic, but the vision may be improved when an accepted system for the radiological protection of environment is at hand.

- Practical optimization using BAT seems to be best based on bench marking rather than using so far presented or suggested theoretical methods. The lack of a corresponding monetary α-value as for ALARA is obvious.

- How low is enough?