Accident Assessment

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There is a general feeling that decommissioning is an activity involving limited risks, compared to NPP operation, and in particular risks involving the general public. This is technically confirmed by licensing analysis and evaluations, where, once the spent fuel has been removed from the plant, the radioactivity inventory available to be released to the environment is very limited. Decommissioning activities performed so far in the world have also confirmed the first assumptions and no specific issue has been identified, in this field, to justify a completely new approach. Commercial interests in international harmonization, which could drive an in-depth discussion about the bases of this approach, are weak at the moment.

However, there are several reasons why a discussion in an international framework about the Safety Case for decommissioning (and, in particular, about Accident Assessment) may be considered necessary and important, and why it may show some specific and peculiar aspects.

1 - Risk for workers could increase

The need for a safety approach optimisation, considering both radiological accident and conventional industrial accidents, will be developed later in this discussion. However, it is common experience from practical decommissioning work but also feedback experience from annual outages and major refurbishment work at the power plants. Not only is it during these periods that the majority of the collective dose is realised but many accidents also occur when people are testing or changing the systems of a plant. Handling of hazardous material (alkaline metal coolants, lead, asbestos, mercury, beryllium) requires special attention and the industrial safety issues are also of prime concern (high pressure, corrosive liquids, lasers, electrical hazards, falls, vibrations from jackhammers and scrabblers).

2 - Regulations and technical guides are usually at an early stage in the development process

This is true in most of the OECD/NEA countries. This is an additional reason why the approach to Accident Assessment in decommissioning is considered at a case-by-case level and, as a consequence, significant differences exist among different situations.
For example the Swedish Radiation Protection Authority is presently preparing rulemaking on the issue of decommissioning planning but for instance clearance levels for decommissioning material and rules for site release are still lacking. In some countries, like the U.S., the regulation of decom has lately changed when practical experiences have accumulated. (Nancy E Durbin, Rebekah Harty, U.S. Experience with Organizational Issues During Decommissioning, SKI-report 98:3, January 1998, See also www.NRC.gov, NRC Regulations, 10 CFR, Parts 2, 50, and 51.)

3 - Peculiar issues exist

Accident assessment in decommissioning may be challenging, since a reference plant configuration practically does not exist and an accurate review of the decommissioning stages and activities shall be considered in order to assure that the analysis is conservative and all-enveloping. Additional peculiarities

are, as mentioned above, the combination of radiological and industrial risks and uncertainties about quantification of releases.

4 - Harmonization advantages

A national and international harmonization process could imply positive outcome in terms of predictability of licensing processes, better public acceptance, reliable scheduling and cost reductions.

Identification, classification and grouping of events

The Identification, classification and grouping of events to be analysed is an early and one of the most important stage in the process of accident assessment. When people sit down and identify possible causes for accidents (Postulated Initiating Events or Initiating Events) it will also lead to an increased awareness of the problems at stake.

In order to perform a systematic and comprehensive listing of all events to be considered, the “rules of the game” should be clear. Experts involved in the safety analysis of operating plants might consider the same approach and rules (such as the defence in depth, the single failure, the safety classification of equipment, prevention versus mitigation, pervasive roles of Quality Assurance and Safety Culture), but it would be common sense to adapt these safety cornerstones to the real safety significance of decommissioning activities. This is certainly something that should be put on the table and discussed to arrive to a clear consensus. Also, it is possible to discuss whether the far reaching approach used for operating plants, including the so-called Beyond Design Basis Events, are to be considered also for decommissioning and how far we must go.

Of some interest could be also the type of approach considered applicable and practicable for decommissioning, i.e. probabilistic or deterministic or a combination of the two.

Human Factors and Organisational considerations

The period before and after termination of operation could be connected with stress and insecurity. The confidence in the management can deteriorate and the motivation can decrease - state of affairs which can affect safety and the decommissioning work. The process of decreasing the staff and the development of a decom organisation should be separated. Experience has shown that a special organisation for re-education and job finding could be helpful. The persons who will work with the decommissioning activities should be given the possibility to develop their knowledge and improve competence. Instead of detailed central planning it is better to work in a participative way and to have staff involved in the preparations of the decommissioning work from the beginning.

An open question is how to consider in the Accident assessment the human factors, i.e. what type of mistakes can be done, how many, for how long and what is their probability. As a difference with the plant Supervisors and plant operators, in the decommissioning personnel with lower education and shorter experience in the plant may be utilized, probably increasing the risk of radiological and conventional accidents. This is also the experience of operating plant maintenance work.

Emergency Planning – extension and content (fuel on-site)

Connected to the Accident Assessment is the question of the relevance of one of the mitigation features available, i.e. the Emergency Plan. The role (if any) of Emergency Plan in decommissioning is subject for

discussion, considering both the case of a single unit in decommissioning or the case of 2 or more units part in operation and part in decommissioning.

This is an issue that has been discussed at some length in Sweden in connection with the closure of the power plant Barsebäck 1. If also the second unit at the site, Barsebäck 2, is closed how should the Emergency plan change? A working group consisting of people from the Skåne County Administrative Board, the municipality Kävlinge, Barsebäck Kraft AB (licensee), the Swedish Nuclear Power Inspectorate, and the Swedish Radiation Protection Authority have addressed this issue. One of the conclusions of the group was that after the spent fuel has been removed, there is no need for the Skåne Administrative Board to have a special emergency preparedness plan. Six months after a reactor has closed the content of iodine-131 in the fuel is so low so that iodine prophylaxis is no longer motivated. Information to the public about the activities at the site is needed at all stages in the decommissioning process. For reasons of public confidence and psychology, a strategy for the downsizing of the emergency plan should be carefully planned and each step should be well thought-out.

The IAEA report *Preparedness and Response for a Nuclear or Radiological Emergency, Draft* Safety Requirements No. GS-R-2, DS43 addresses this issue. In this report five different categories of nuclear or radiation threat are identified:

Category I – Installations for which events that can give rise to severe deterministic health effects off-site are postulated or have occurred in similar installations, including very low probability events.
Category II – Installations for which events that can give rise to off-site doses warranting urgent protective actions consistent with international standards are postulated or have occurred in similar installations. This category (as opposed to category I threats) has no credible events postulated that could give rise to off-site doses resulting in severe deterministic health effects.

Category III – Installations for which events could give rise to doses on-site resulting in severe deterministic health effects are postulated or have occurred within similar installations. This category (as opposed to category II threats) has no credible events postulated for which urgent off-site protective actions are warranted.
Category IV – Minimum level of threat assumed for all States and jurisdictions. This category includes events involving: Facilities for which events could give rise to doses warranting urgent actions consistent with international standards on-site but for which no credible events are postulated that could result in severe deterministic effect; mobile practices using dangerous sources; medical misadministration; transportation; and other events that could occur virtually anywhere (the public finding a source resulting in exposures and contamination, loss or theft of or damage to a dangerous source, re-entry of satellite, and illicit trafficking) that may warrant emergency intervention.
Category V – Areas that could be contaminated to levels necessitating food restrictions consistent with international standards as a result of events at installations in threat categories I or II, including installations in nearby States.

Decommissioning are the administrative and technical actions taken to achieve a progressive and systematic reduction in radiological hazards. These actions involve decontamination, dismantling and removal of radioactive materials. During the decommissioning process it should therefore, at specific, identified points of time, be possible and proper to re-evaluate the need for, and the content of the on- and off-site emergency plan.

Analysis assumptions and their bases

A number of data and assumptions are relevant to the Accident analysis. In several cases the database and the assumptions used for operational safety analysis are not relevant or not applicable. Examples are:

- Source term for radiation fields and release calculations
- Statistical data on human errors, on specific job conditions
- Computer codes for release and consequence calculations
- Approach to structural analysis for intermediate plant structural configuration
- Approach to fire protection
- Acceptance criteria also in terms of plant damages and mechanical stresses

Event classification and grouping

One the list of accidents to be considered is complete, there is the need of their classification in terms of expected frequency or probability, in order to associate appropriate acceptance criteria and their grouping in accident of similar cause/evolution/effect, in order to be able to identified the most representative and reduce consequently the number of calculations to be performed.

An example (just for illustrative purpose) of event grouping is presented below. Events are grouped according to the type of challenge and the type of activities involved.

Decommissioning activities

- Chemical and Mechanical Decontamination
- Dismantling
- Material handling (including heavy load drops)
- Loss of support systems
- Electrical supply
- Service water
- Compressed air
- Other internal events
- Criticality
- Fires
- Explosions

External events (natural)

- Earthquakes
- Lightning
- Flooding
- Winds and tornadoes
- Vulcanoes

External events (man-made)

- External explosions
- Aircraft crash
- Security

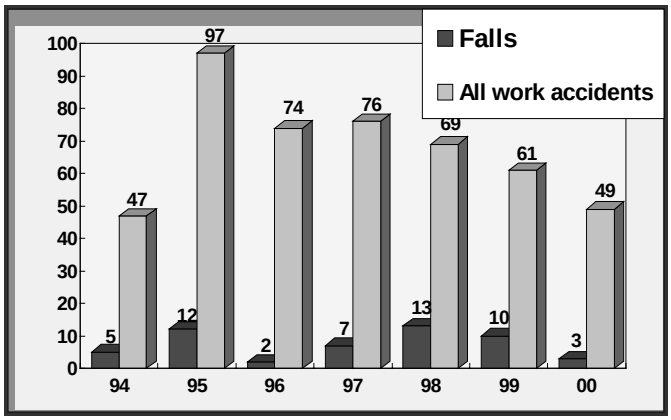
Human errors

Some of the above events might not be applicable and some may fall below the credibility threshold in various countries and for various plants. However, it could be of interest to fill out a comprehensive list of events, from which in each specific case one could identify those to be considered. It is also of interest not to spend unnecessary resources on events of small probability and with small consequences, which could

be difficult to quantify exactly. Therefore in the selection process experience and engineering judgment are of utmost importance.

Work accidents at Ringhals NPP

A specific case of the importance of considering also conventional safety in the accident assessment may be derived from the experience in Ringhals.



The graph shows work accident statistics at the Ringhals power plant, situated on the west coast of Sweden. Of these accidents, 10-15 per year are so serious that the worker cannot continue working for a period of time. The very few fatal accidents that have occurred at the Swedish nuclear power plants have also been non-radiological accidents (falls, electrical, related to pressure differences). It should be noted that during the same period no serious radiation accident has occurred. It is not likely that this picture will change during decommissioning.

Even if we in this presentation focus on the nuclear safety (i.e. protection from undue radiation hazards) the operator usually has to consider the overall hazards assessment. The hazards analysis should evaluate all hazards - radiological, chemical, biological, and physical hazards at the plant to be decommissioned. The assessment should preferentially be done by a team of people with experience and knowledge about all these issues.

Interesting thoughts about the holistic safety assessment can for instance be found in DOE/EM-0383 DOE Decommissioning Handbook, January 2000, p. 60 – 65.

References

Several references have been used to prepare this presentation and can be useful to develop further insights in the issue. However, the list below is not complete at all and more work would be necessary to have a comprehensive situation of the issue in the world.

IAEA

- Decommissioning of Nuclear Power Plants and Research Reactors, Safety Guide No. WS-G-2.1
- Preparedness and Response for a Nuclear or Radiological Emergency, No. GS-R-2 (Draft Safety Requirements, DS 43)

European Union

- Management of Occupational Radiological and Non Radiological Risks, EAN Workshop, Antwerp, November 20 – 22, 2000

National

- US NRC - Various documents
- Decommissioning Handbook, US DOE, January 2000 (DOE P450.4, Safety Management System Policy)
- Various Plant specific Safety Analysis Reports

Conclusions/Observations/Proposals

An effort for a comprehensive and systematic D&D accident safety assessment of the decommissioning process is justified. It is necessary also to explore in a holistic way the aspects of industrial safety, and develop tools for the decision-making process optimization. The expected results are the implementation of appropriate and optimized protective measures in any event and of adequate on/off-site emergency plans for optimal public and workers protection. The experience from other decommissioning projects and large-scale industrial activities is essential to balance provisions and an Operating Experience review process (specific for decommissioning) should help to focus on real issues.