INDEPENDENT OVERSIGHT OF ACTIVITIES RELATED TO DECOMMISSIONING

A product of the

Independent Nuclear Safety Oversight Industry Working Group

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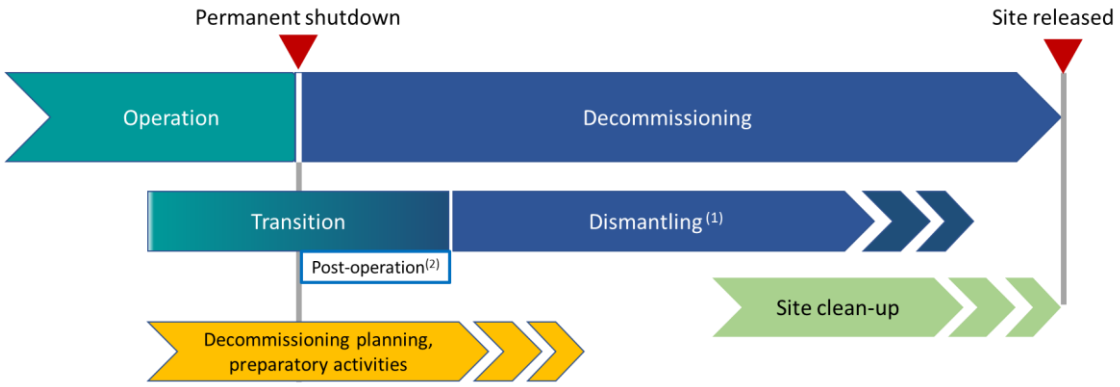
0. Framework

This document completes *WANO GL 2018-01, Independent Oversight* with independent oversight for activities related to Decommissioning. This annex can be used until the content is included in the Guideline. To make the connection clear with the Guideline, the same structure is used in this text. The annex at the end of this document is a living part of this note and serves to collect the best practices and the lessons learned by the operators that have power plants that have entered the decommissioning phase.

1. Introduction

The Independent Nuclear Safety Oversight (INSO) organisation has a role to play in the overall life-cycle of a nuclear facility. This includes the phase after the operational phase; the decommissioning phase that is divided in the post operational phase and the dismantling phase.

As indicated in the Transition to Decommissioning Roadmap, the transition to the dismantling phase covers the post operational phase as well as the preparation of the dismantling phase which starts 3 to 5 years prior to the final shutdown. Because a good preparation of the decommissioning phase is key for its success, the INSO organisation needs to be prepared as well. This document can assist the INSO organisation to be prepared to tackle the challenges of decommissioning.



(1) In some countries the commencement of dismantling activities requires a Decommissioning Authorisation

(2) The duration of the post-operation phase differs between countries and even between plants with terms ranging from few days to several years. Defueling from the spent fuel pools activities are normally included in this phase

Fig 1. High level overview of the decommissioning planning, from the Transition to Decommissioning Roadmap.

During the post operational phase all fuel is evacuated from the plant, chemical system decontamination activities are performed and systems are gradually taken out of service or modified in compliance with the nuclear island defined for this phase. During this phase the nuclear safety risk is already reduced compared to the operational phase, however the control of reactivity and removal of the residual heat remain critical to nuclear safety. After the removal of the spent fuel from the facility these risks are no longer existing. In the dismantling phase all spent fuel has left the facility and the residual nuclear safety risk is related to the contaminated and irradiated equipment and structures. The remaining nuclear safety risk is generally radiation safety, and the objective is to limit the exposure and prevent the contamination of the workers as well as to manage and secure all the radioactive material.

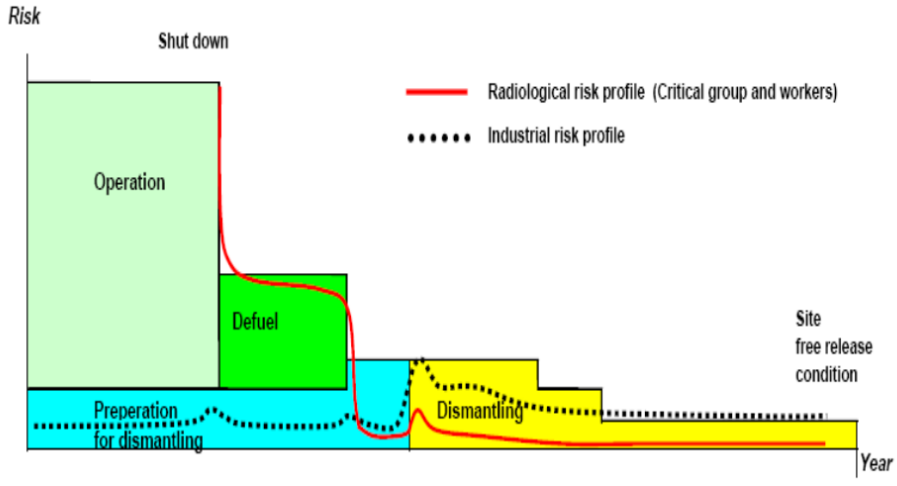


FIG. 2. Illustration of the changing risk profile for an NPP (Annex I, part A of this report).

Source: IAEA: SAFETY ASSESSMENT FOR DECOMMISSIONING, DeSa Annex II: Graded Approach to Safety Assessment for Decommissioning of Facilities Using Radioactive Material

As the risk for nuclear safety reduces, the requirements to perform an effective and efficient INSO review need to be adapted. This annex describes the specific INSO aspects related to Decommissioning.

2. Definitions

2.1 Defueling

The removal of all the spent fuel from the facility.

2.2 Decommissioning

Reference: IAEA Nuclear Safety and Security Glossary, 2022

1. Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility.
    - This does not apply for that part of a disposal facility in which radioactive waste is emplaced, or for certain facilities used for the disposal of naturally occurring radioactive material (NORM) or of residues from the mining and processing of radioactive ores. For all of these the term closure is used instead of decommissioning.
    - Decommissioning typically includes dismantling of the facility (or part thereof) to reduce the associated radiation risks, but in the IAEA's usage this need not be the case. A facility could, for example, be decommissioned without dismantling and the existing structures subsequently put to another use (after decontamination).
    - The use of the term decommissioning implies that no further use of the facility (or part thereof) for its existing purpose is foreseen.
    - Actions for decommissioning are taken at the end of the operating lifetime of a facility to retire it from service with due regard for the health and safety of workers and members of the public and protection of the environment.
    - Subject to national legal and regulatory requirements, a facility (or its remaining parts) may also be considered decommissioned if it is incorporated into a new or existing facility, even if the site on which it is located is still under regulatory control or institutional control.
    - The actions will need to be such as to ensure the long term protection of the public and protection of the environment, and typically include reducing the levels of residual radionuclides in the materials and on the site of the facility so that the materials can be safely recycled, reused or disposed of as exempt waste or as radioactive waste and the site can be released for unrestricted use or otherwise reused.
    - Decommissioning can entail activities that are similar to remediation (also an authorized process), such as removal of contaminated soil from an area within the authorized boundary of a facility, but in this case, such removals are normally referred to as cleanup activities and are typically performed under the authorization for decommissioning.
    - The terms siting, design, construction, commissioning, operation and decommissioning are normally used to delineate the six major stages of the lifetime of an authorized facility and of the associated licensing process. In the special case of disposal facilities for radioactive waste, decommissioning is replaced in this sequence by closure.

Decommissioning plan. A document containing detailed information on the proposed decommissioning of a facility.

- The approved decommissioning plan describes the actions (including decontamination and/or the removal of structures, systems and components) to be taken in carrying out procedures, processes and work activities for the purposes of decommissioning.
- The decommissioning plan is considered to have been fulfilled when the approved end state of the facility has been reached.

Dismantling. The taking apart, disassembling and tearing down of the structures, systems and components of a facility for the purposes of decommissioning.

- The two main types of dismantling are immediate dismantling and deferred dismantling.

  Deferred dismantling is deferred after permanent shutdown. For a nuclear installation, the nuclear fuel is first removed. Part or all of a facility containing radioactive material is either processed or 50 put in such a condition that it can be put into storage. The facility is maintained until it can subsequently be decontaminated and/or dismantled.

  Deferred dismantling can involve the early dismantling of some parts of the facility and the early processing of some radioactive material and its removal from the facility, as preparatory steps for storage of the remaining parts of the facility.

  Immediate dismantling begins shortly after permanent shutdown. Equipment and the structures, systems and components of a facility containing radioactive material are removed and/or are decontaminated to a level that permits the removal of regulatory control from the facility and its release, either for unrestricted use or with restrictions on its future use.

Entombment. The encasing of part or all of a facility in a structure of long lived material for the purposes of decommissioning.

- Entombment is not considered an acceptable strategy for decommissioning a facility following planned permanent shutdown.
- Entombment may be considered acceptable only under exceptional circumstances (e.g. following a severe accident). In this case, the entombment structure is maintained and surveillance is continued until the radioactive inventory decays to a level permitting termination of the license and unrestricted release of the structure.

2. All steps leading to the release of a nuclear facility, other than a disposal facility, from regulatory control. These steps include the processes of decontamination and dismantling.

2.3 Post-operational Phase

Reference: Transition To Decommissioning Roadmap.

This phase is initiated before the end of the operational phase to facilitate a smooth transfer to the decommissioning phase. This phase includes a preparatory and an execution part, the preparation phase ends when the plant is finally shut down and at that moment the execution phase starts.

The preparation phase covers the following activities (non-exhaustive list):

- Definition of the nuclear island for the execution phase

- Preparation of the required hardware modifications for the nuclear island and chemical system decontamination
- Preparation of the defueling
- Preparation of the chemical system decontamination

The execution phase covers following activities (non-exhaustive list):

- Executing the modifications related to the new nuclear island
- Taking systems out of service
- Defueling of the installation
- Chemical system decontamination
- Modification of the programs related to periodic testing& inspections as well as the preventive maintenance program

3. Independent Oversight Function

During the decommissioning phase the interaction with the radioactive waste and/or environmental authorities will become more important as they have impact on the evacuation and/or management of the radioactive waste. The waste clearance, characterization and transport process are particular domains to review as these processes can cause unwanted exposure or spreading of contamination to the environment and the public. As the decommissioning of a facility is a cost driven project, an important new approach for the Independent Oversight is the evaluation of the balance between safety and economy.

As these domains are very specific and require specific competences in larger extent than during plant operation phase (including radiation measurement techniques, chemistry, decontamination techniques, eg.) they need to be present in the Independent oversight team. For facilities that go from their operational phase to the decommissioning phase, acquiring these competences needs to be anticipated well before the preparation for the decommissioning phase starts. The specific required INSO competences are indicated in Appendix 2. These competences are ideally developed before or at the start of the post operational phase; during this phase the preparation of the decommissioning phase starts and the effectiveness of the Independent Oversight impact is higher when Independent Oversight is involved in the early stage of a project and/or program.

The assessment of the effectiveness of the Operating Experience program is key, because incorporating the lessons learned during the decommissioning phase in a swift way, can result in immediate reduction of exposure to radiation and/or contamination for the workers.

3.1 Cultural Change

The transition from operation to decommissioning involves relevant changes in the way of working that must be adopted by the organisation. This will induce a cultural change.

Some of the most relevant cultural differences between operations and decommissioning are:

- Project-driven focus on cost control and schedule
- Occupational safety issues become more dominant as the radiation risk decreases
- Off-site effects due to inventory removal
- Dynamic and changing work environment

- New tasks that are the first of their kind. Work planning for safety-critical workplaces
- Regulatory - Quick approvals are often required

This implies that the approach applied by Independent Oversight will need to change as well.

During the decommissioning phase, it is common practice that a lot of people are contracted to perform activities that have limited or no nuclear expertise. The operator needs to define the required competences, to verify that these competences are present and to make sure that training is foreseen when required. The verification of the presence of the required competences related to the nuclear and radiation principles, is a specific activity of Independent Oversight during the Decommissioning.

4. Executive Influence

The senior corporate and site leaders assure that the Independent Oversight remains empowered during the decommissioning phase. Even though the nuclear safety risks are greatly reduced, there are still radiation safety risks present. Therefore the need for an Independent Oversight remains.

5. Independent Oversight Program

5.1 Scope

During the decommissioning phase the risks are different than during the operational phase. The decommissioning phase represents a continuous change; technically in the field with different dismantling activities and modification of processes. This continuous change needs to be managed well and requires human performance at a high level. It is of importance that the Independent Oversight adjust their approach to the different risks that occur which are mainly related to industrial safety, radiation protection and safety culture.

If a site has operating reactors at the same time as reactors are planning for or undergoing decommissioning, it is of importance that the scope of the Independent oversight program is adjusted to match the risks and challenges for both nuclear operations and decommissioning activities.

A significant proportion of independent assessments should be proactive rather than reactive. The assessments that contribute proactively to improving the safety performance for organisations planning for or are conducting Decommissioning are:

- Assessments and reviews of readiness for decommissioning, such as short and long term planning, risk management, waste management, contract management including the interface with the licensee, sufficient human and financial resources.
- Assessments, observations and reviews of any decline in safety culture (specifically during the period when a station is moving from an operating state through to a decommissioning state)

5.2 Special and Topical Assessments

For organisations that are planning for or are conducting Decommissioning special and topical assessments and review of readiness should be performed which should include assessment of, for example:

- Short and long term planning
- Risk management
- Change management
- Configuration management
- Radiation Protection & ALARA principles
- Waste management
- Clearance procedures
- Job qualification
- Resource planning
- Safety culture and human performance
- Management system effectiveness
- Security arrangements

5.3 Independent Assessment of Operating Events

The independent oversight should assess selected operational events at the plant to ensure that the analysis performed by the plant is appropriately conducted and rigorous enough. During decommissioning Independent Oversight should also assess the structure of contract management, for example:

- Prerequisites for hired resources and contractors
- A sufficient on- and off-boarding process of resources.

6. Independent Oversight Processes and Working Methods

Processes and working methods are similar to those in operational phase.

7. Continuous Improvement of Independent Oversight

As the Independent Oversight activities change during the transition from the operational phase to the decommissioning phase, the timely preparation of the team is required. This needs to be taken into account during the Self Assessments that are performed.

7.1 Key Performance Indicators

Processes and working methods are similar to those in operational phase.

7.2 Self-Assessment

During the self-assessment the competences of the INSO team members need to be assessed periodically. This becomes more important when the decommissioning phase is approaching. The identification of the required and available competences of the team to enable the independent oversight role during the transition to and in the Decommissioning phase, is a key topic to discuss. In that way training and staffing needs should be identified early and the required qualification can be performed before the preparation for the dismantling starts.

8. Warning Signs of the Independent Oversight Function

Processes and working methods are similar to those in operational phase.

9. References

1. IAEA-WANO GL 2018-01: Independent Oversight
2. IAEA GSR Part 6: Decommissioning of facilities
3. IAEA Safety report Series No 77. Safety assessment for Decommissioning
4. WANO TTD I-WG: Transition to Decommissioning Roadmap
5. IAEA Nuclear Safety and Security Glossary, 2022

10. Acknowledgements

Contributors

- Wendy Stirton, EDF Energy
- Frits Hannes, Engie
- Jari Tuunanen, Fortum
- Douglas Kearns, Nawah
- John Annebäck, OKG
- Marlene Fornbaeck, Vattenfall

Reviewers

- Kristiaan Peters, Engie
- Chantal Mommaert, IAEA *(independent review, not a formal review on behalf of the IAEA)*
- James Szivos, Nawah
- Pascal Brailly, WANO Paris

Appendix 1: Examples of the Independent Oversight Arrangement at a Typical Company

No gap Identified.

Appendix 2: Independent Oversight Competence Model

The Independent Oversight role can be spread over different levels. As the topics treated by the different Independent Oversight teams can be different, the required competences should be appropriate to enable the executions of the activities by the specific team.

Competence Area	Competence Description	Skill Level
All	The required competences described in GL 2018-01 remain valid, although the level of skill can be different.	(see GL 2018-01)
Nuclear Technology	**Radiation protection principles:** - basic radiation physics: interaction of ionising radiation with matter, protection principles exposure time, shielding distance - accident and risk management from a radiation protection perspective - Radiation measurement techniques: measurement technology, measurement accuracy - Clearance techniques and codes	Basic/Specialist *
	Nuclear Chemistry: - Chemical decontamination techniques and technology - Isotope characterisation techniques and codes	Basic/Specialist *
	Post operational phase: - Competences on activities related to nuclear safety executed during this phase	Basic/Specialist *
Decommissioning	**Defueling:** - Radioactive transport - Packaging of radioactive and nuclear material - Criticality - Ageing phenomena of spent fuel	Basic/Specialist *
	Dismantling: - Dismantling techniques: o Dismantling of Highly radiating of irradiated equipment o Techniques to avoid the spread of contamination during dismantling - Clearance/free release criteria - Waste management techniques	Basic/Specialist *

** The skill level depends on the local requirements for Independent Oversight*

Appendix 3: Independent Oversight Working Methods

A3.1 Performance monitoring and identification of potential focus areas

The decommissioning plan is an additional source of information that will be available during the decommissioning phase.

Appendix 4: Success Stories and Failures related to Decommissioning

A4.1 Logging operating experience of Radiological events

In preparation of the decommissioning, it is key to have a precise view of what isotopes are present in the materials to ensure proper characterization and the redirection to the correct radioactive material/waste stream.

Therefore, the systematic logging of radiological events is key, including the characterization of the radioactive materials concerned.

E.g. when a spill of a radioactive liquid occurs, it is important to log the precise location of the spill and its size, as well as analyzing the radiological content that was spilled. Otherwise a lot of effort will required to have an overview of what isotopes will be present in the radioactive waste from the nuclear facility, this might include an elaborate sampling campaign.

A4.2 In depth knowledge of the characterization code for radiation waste

An in depth knowledge of the codes used in characterization and clearance is required, because it is the basis for the development of the sampling method when radioactive waste is generated. E.g. if a certain isotope is used as a marker to calculate the amount of other isotopes, the half-life of those markers needs to be linked to the planning for the final disposal. After a certain period these markers might not be correct for the associated isotopes.

E.g. during the chemical system decontamination a lot of samples were taken and analyzed, but no actual alfa activity was measured. If the final disposal of the acceptance criteria for this type of radioactive waste change, the marker isotopes used are not clearly representative after a certain period. So an additional sampling needs to be performed that generates some technical and radiological challenges.

The same goes for delayed dismantling, the markers used in operation aren’t necessary representative for the decommissioning period.