

IAEA's position on Entombment

Regional Workshop for Central Governments and Regulatory Bodies of Asia, for the Development of National Strategies and Regulatory Requirements for Decommissioning

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Decommissioning - definition



In IAEA Safety Standards decommissioning is defined as:

- the administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for the part of a disposal facility in which the radioactive waste is emplaced, for which the term 'closure' instead of 'decommissioning' is used).
- Decommissioning is the last phase in the lifetime of a facility. Aspects of decommissioning have to be considered throughout the other phases (siting, design, construction, commissioning and operation).

Decommissioning – typical activities



- Characterization
- Dismantling
- Decontamination
- Waste management (segregation, pre-treatment, treatment, conditioning, storage, disposal) aiming towards waste minimization
- Clearance of materials
- Site release
- Not much of this happens when entombment option is implemented
- Entombment creates an end state that is de facto a near surface or sometimes even above-ground disposal of RAW

Decommissioning Strategies – GSR Part 6 (2014)



Decommissioning of Facilities, IAEA Safety Standards Series No GSR Part 6 (2014) identifies two decommissioning strategies:

Immediate dismantling: In this case, decommissioning actions begin shortly after the permanent shutdown. Equipment and structures, systems and components of a facility containing radioactive material are removed and/or decontaminated to a level that permits the facility to be released from regulatory control for unrestricted use, or released with restrictions on its future use.

Deferred dismantling: In this case, after removal of the nuclear fuel from the facility (for nuclear installations), all or part of a facility containing radioactive material is either processed or placed in such a condition that it can be put in safe storage and the facility maintained until it is subsequently decontaminated and/or dismantled. Deferred dismantling may involve early dismantling of some parts of the facility and early processing of some radioactive material and its removal from the facility, as preparatory steps for the safe storage of the remaining parts of the facility.

The Entombment Option



In addition to these two decommissioning strategies, GSR Part 6 identifies one decommissioning **option**:

Para 1.10. **Entombment**, in which all or part of the facility is encased in a structurally long lived material, is not considered a decommissioning strategy and is not an option in the case of planned permanent shutdown. It may be considered a solution only under exceptional circumstances (e.g. following a severe accident).

In the previous IAEA publications (WS-R-5):

Entombment is the strategy by which radioactive contaminants are encased in a structurally long lived material until radioactivity decays to a level permitting the unrestricted release of the facility, or release with restrictions imposed by the regulatory body.

GSR Part 6 (2014)



- Not a decommissioning strategy.
- Not an option for a planned permanent shutdown.
- A solution only under exceptional circumstances.

GSR Part 6 is clear that entombment would not be an acceptable strategy for an IDP, nor would it be an acceptable option for a normal planned permanent shutdown.

GSR Part 6 does leave open to interpretation the notion of "exceptional circumstances".

Exceptional Circumstances



In addition to Para 1.10 in GSR Part 6, situations that might possibly give rise to exceptional circumstances:

- Entombment has been used in cases relating to the cold war legacy – for facilities located within large contaminated sites where there are other facilities and where the sites will require long-term institutional control.
- In rare circumstances, where a complete loss of control might occur (e.g., social or political instability, war), entombment might be the only means to expeditiously secure a site against intrusion and looting.

SSG-47 (2018)



No action (leaving the facility after operation as it is, and waiting for decay of the radioactive inventory) and entombment (encasing all or part of the facility in a structurally long lived material) are not acceptable decommissioning strategies.

Entombment, in which all or part of the facility is encased in a structurally long lived material, should not be considered an acceptable strategy for planned decommissioning. It might be considered as a last option for managing facilities that have been damaged in an accident, if other options are not possible owing to high exposures of workers or technical difficulties.

SSG-47 (2018)



Even under exceptional circumstances, the choice of entombment might lead to technical and regulatory difficulties, owing to a lack of specific regulations and guidance in the State and a lack of acceptability of entombment. Additionally, the intention to apply entombment might not be accepted by the public. In this context, all efforts should be made to reduce the parts of the facility that will be subject to entombment and to reduce to the extent possible the radioactive inventory that will be encased on the site, especially the long lived radionuclides. Entombment actions should not reduce the technical feasibility of surveillance and maintenance of the remaining barriers. If entombment is selected, it will impose a burden on future generations owing to the need for long term monitoring of the site and owing to possible future actions necessary to prevent and reduce leakages of radioactive material from the facility.

SRS-50 (2007, under revision)



- Entombment is not relevant for a facility that contains long lived isotopes because these materials are not suitable for long term surface disposal
- Consequently, reprocessing facilities, fuel fabrication facilities, enrichment facilities or facilities that use or process thorium or uranium would not be appropriate for entombment
- Since the end state of an entombed site is equivalent to a waste disposal site, it cannot satisfy unrestricted release conditions
- An entombed site will need measures of monitoring and control well into the future
- This option may be considered if a waste disposal site does not exist within a Member State; the waste disposal facility could be created at the facility site. Such a new waste disposal facility would be of the 'near surface disposal' type that could receive radioactive waste from other sites, but only waste containing short lived radionuclides.

SRS-50 (2007, under revision)



Important considerations:

- Assessment of the isolation of the enclosure in retaining the residual radioactivity
- Analysis of the exposure to the public from the likely exposure pathways from the entombed waste
- Long term physical integrity of the entombment enclosure structure and its
- Capability to exclude groundwater
- Time that the entombed structure needs to remain effective to confine specific radionuclides present in the entombed structure
- Time for the radionuclides to decay to levels that would allow licence termination
- Monitoring and institutional controls during the period of entombment

The entombed facility can be considered as a disposal facility and an operating organization studying this decommissioning strategy needs to be aware of the requirements for this type of facility.

SRS-50 (2007, under revision)



Advantages (?):

- Relatively low cost of associated waste transport and disposal
- Reduced amount of work involved in encasing the facility in a structurally long lived substance
- Reduced worker exposure compared with the exposure from decontaminating and dismantling the facility
- Reduced public exposure from transported waste to waste storage processing or disposal sites
- Reduction in the size of the controlled area
- Possible reuse or conversion of the site to a waste disposal site for other facilities

Disadvantages:

- Unsuitability for facilities with long lived radionuclides
- Cost of long term monitoring and institutional controls
- Public acceptance of creation of a near surface waste disposal site

The Waste Hierarchy



Is a widely-applied principle for sustainability.

Supports life-cycle thinking.

Intended to be applied to nonhazardous waste management, but has many parallels with hazardous and radioactive waste management.

Not a new concept – introduced into European waste policy in 1975.



The IAEA's Fundamental Safety Principles (SF-1) and the principles promoted by the waste hierarchy are closely aligned.

Decommissioning and waste minimization





Source: *Decommissioning of Nuclear Installations in Germany*, 3rd Revised Edition, S.Thierfeldt and F. Schartmann.

Implications of entombment



- May not eliminate the need for potential interventions/corrective actions in the future.
- Does not align well with the "waste hierarchy" and the principles in SF-1.
- Limits re-use of sites.
- Is largely irreversible (future retrievals difficult).
- Imposes a burden on future generations (future monitoring, security, regulatory supervision).
- Would represent a major departure from decades-long practice based upon concentrate and contain.
- Re-purposes a facility that was sited and designed for another purpose to become a disposal facility.
- Conveys the message that nuclear power is not a sustainable technology.

Terminology



- Terms "in situ decommissioning" and "on site disposal" are sometimes used in the context of decommissioning end state
- Wide range of situations
 - Leaving in place slightly contaminated underground structures of a facility which has been dismantled almost entirely (site release with restrictions) - no encasement in structurally longlived material, does not create a disposal facility
 - Covering the whole facility with huge amount of concrete or other material, with almost no dismantling and waste removal performed (entombment, near surface disposal or even above ground disposal is created, often with long-lived RAW inside)
- Using the same term for so different situations is misleading

Discussions in WASSC



- 1. At the 44th meeting of the Waste Safety Standards Committee (15 November 2017) the position in Para 1.10 of GSR Part 6 was discussed and re-affirmed. That entombment is an option under exceptional circumstances not on equal footing with immediate dismantling or deferred dismantling, and that it should be avoided whenever possible.
- 2. WASSC discussed whether the notion of exceptional circumstances should be elaborated upon. The consensus view was it should be left to Member State discretion.

Conclusions



Much progress has been made over past decades to develop optimized systems for decommissioning and waste management.

Even for immediate dismantling, worker exposures can be kept very low. Average annual effective doses of monitored personnel during decommissioning are typically 10% to 20% of those during operations (example from German NPPs).

Entombment does not benchmark favourably against sustainability principles:

- Not an optimized solution for decommissioning and RWM.
- Widespread application of entombment would lead to a proliferation of sites with permanent objects that require longterm institutional controls, which is not consistent with avoiding transfer of undue burdens to future generations (nor with concentrate and contain).

Conclusions



- "Social licence" / acceptance of a new facility usually includes the understanding that the facility will be there for a certain period of time, but that in the end it will be removed. For entombment, the radioactivity and facility structures will not be removed but remain for a long time, this change implies that a new "social licence" would be needed.
- Although some entombment has been done in countries that are contracting parties to the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, it has not garnered visibility over 5 review cycles of the JC.
- Decommissioning in the JC is defined: 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; This would seem to preclude consideration of entombment as means of decommissioning.



Thank you!