International Conference on Management of Spent Fuel from Nuclear Power Reactors –

An Integrated Approach to the Back-End of the Fuel Cycle

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

Enhancing nuclear safety

Safety and technological aspects

IAEA
International Atomic Energy Agency

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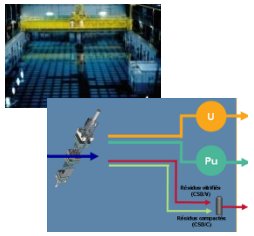
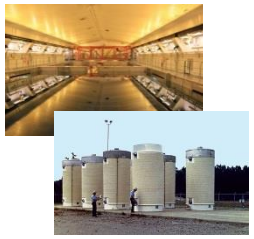
The Spent Fuel Management context

- The management of spent fuel is based on several necessary and essential steps, regardless of the selected cycle (open or closed).

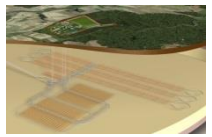
1) The spent fuels are stored in pools close to the reactor directly after its removal from the reactor core.



2a) If the spent fuels are to be reprocessed, they are stored under water in the reprocessing plant before being reprocessed and recycled.



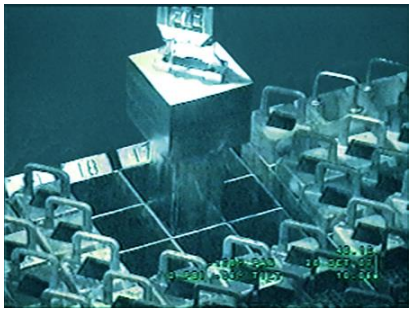
2b) If the fuels are no reprocessed, they remain stored in the reactor storage pool or put in another storage facility (pool or dry storage).



3) Finally spent fuels or wastes coming from reprocessing are put in a repository.

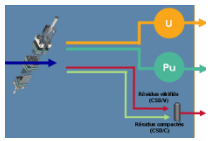
The Spent Fuel Management context

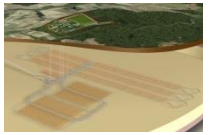
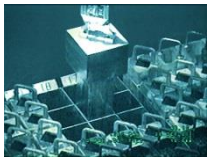
- Between these “passive phases”, operations are performed: handling, packaging, transport ...



The Spent Fuel Management context



- All these stages are technically different and their design depends of a lot of parameters.

- The safety issues are different and risks evolve throughout operations (decrease of thermal power, ageing of structure…). So, the design of each installation is adapted each time to the fuel concerned.

The Spent Fuel Management phases

First, it is important for the safety of installations to take into account this context.

- choices made at one stage may have consequences on the following stages.
  - For example, the storage of structure of fuel elements in silos without preliminary packaging causes significant difficulties for the recovery and conditioning.

The Spent Fuel Management phases

- choices at one stage may have consequences on the previous stages.
  - In particular, to ensure some safety parameters of a stage, provisions may be necessary in previous stages.
  - For example, minimal mechanical characteristics of the fuel at the time of unloading may conditioning the method that can be used for this operation (dry or under water process).
    - How to monitor these mechanical characteristics and the spent fuel behavior?
    - Have you need of specific research and development programs in advance?
    - Some periodic inspections of spent fuels are they required?
    - Are there safety constraints on previous storage to guarantee the mechanical behavior of spent fuels during future handlings? Like the maximum temperature of rods, the drying of casks and defective fuel rods, the filling gas of cask?
  - **All of these questions can directly influence the design of the previous phases.**

The Spent Fuel Management phases

- The industrial context of a step is often dependent on the next step.
  - For example, the duration of a step and the necessary capacities are defined by the constraints of the following steps.
  - In this context, the period of time required to set up a step, including the studies, with necessary technical developments, the administrative aspects and the consultation of public must be considered.
- These are important data for safety, for example to define provisions to control the ageing.

The Spent Fuel Management phases

- Therefore, to optimize the safety of spent fuel management, it's important to have a global vision of the spent fuel management and of the key points for safety.

- This vision should allow to anticipate difficulties, identify the need for new installations and ensure the consistency of Spent Fuel Management.

- It's not always easy to develop this vision. The different stages of the management of the fuel cycle involve generally a large number of actors and the development of different stages is not done at the same time.

- **So, a specific process of reflection, including safety issues, must be defined at a national level (with all actors).**

The Spent Fuel Management phases

- This is especially important when choices are made in energy policy (reactors shutdown or startup). Indeed, they will result in significant changes in fuel management.

- Furthermore, the spent fuel management can induce constraints on the development of these choices. For example, the removing of spent fuels is an important issue in the context of a reactor shutdown.

The Spent Fuel Management safety aspect

- A notable point of the management of spent fuel is the diversity of facilities (storage, repackaging, repository) and operations (including transportation).
- Moreover, the facilities have been built in very different periods and with different conceptions.
- This diversity leads to produce a safety analysis for each installation.

The Spent Fuel Management safety aspect

In this context, it seems important:

- To develop guides laying down the framework of the safety analysis (what must be taking into account, safety objectives, good practices...). For example, the SSG-15 IAEA guide is a good support for the safety analysis of spent nuclear fuel storages.

- But also to develop the skills to provide the safety analysis, to maintain control of the safety over time and to ensure safety in the facilities.

- This must be the subject of a close attention of operators and safety authorities, especially in very specific technical areas of the fuel cycle (criticality safety, for example).

The Spent Fuel Management safety aspect

- Another aspect of the safety of fuel cycle installations is that analysis of severe accidents is less developed than for NPPs.

- The feedback of Fukushima accident shows the interests to work on some severe accidents (extreme aggressions for example). It is an interesting way to increase the safety level of the installations, provided to take into account the specificities of each installation to define these accidents.

- For example the loss of all redundant cooling systems of the spent fuel storage facility (wet or dry storage) should be taken into account in the framework of the beyond design basis accidents. This leads to develop means to quickly bring water in pool or to restore cooling for dry storage. These developments enhance the safety.

The Spent Fuel Management safety aspect

- However, this should not lead to reduce the importance that must be given to the first levels of defense in depth.

- Indeed, the safety of spent fuel management installations depends primarily on the control of normal operation and degraded situations.

The Spent Fuel Management safety aspect

- The last point I want to highlight in this brief introduction, it's the facilities of the SFM will be operated during a very significant period of time and are generally complex to modify.

- Moreover, it can be difficult to empty a storage to do works or controls (Especially if it requires creating a temporary storage).

- In this context, how to check and improve the safety of the SFM installations, taking into account ageing and feedback?

The Spent Fuel Management safety aspect

- The first way is to have a robust design. Margins in the design should be adopted in case of changes in requirements, due to a feedback for example, and ageing phenomena inadequately addressed initially.

- Periodic safety reviews, like for NPPs, are a good way to achieve those objectives in taking account the specificity of each installation.

- But for the safety reviews fill their objectives and more generally for operators follow the ageing of installations, the ability to monitor the safety functions and equipment is crucial. This issue must be taken into account in the design and, for old installations, requires some developments.

The Spent Fuel Management safety aspect

Thank you for your attention.