Slovenian Nuclear
Safety Administration

DESIGN EXTENSION CONDITIONS FOR SPENT FUEL STORAGE AT THE PWR NPP KRŠKO

Technical Meeting on Back End of the Fuel Cycle Considerations for Small Modular Reactors

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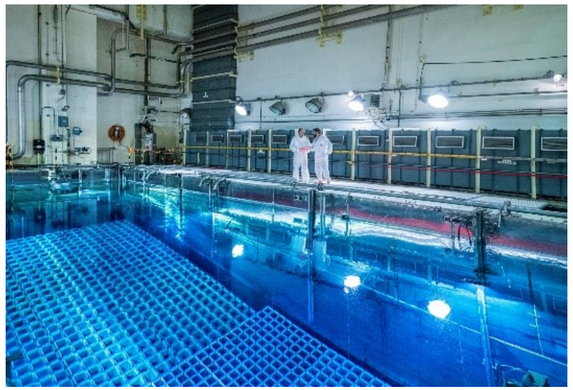
Fukushima Accident and Safety Upgrade in the Krško NPP

- There was an issue concerning safety of spent fuel in SFP in Fukushima
- Slovenia decided to upgrade the safety for severe accidents of the Krško NPP, safety of spent fuel was also considered [1]
- The original solution for storing spent fuel in the Krško NPP is spent fuel pool.



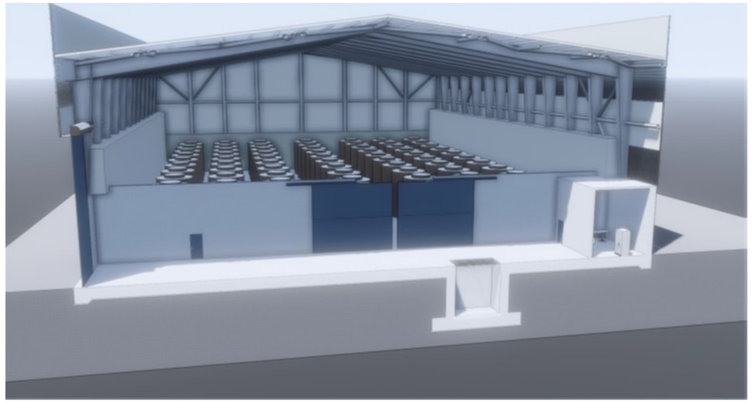
- Capacity was increased to 1694 spent fuel assemblies in 2003
- Not big enough to ensure storing of spent fuel until the end of the Krško NPP long term operation in 2043

Safety Upgrade of the SFP

- Solution: Safety upgrade of the SFP and building spent fuel dry storage (SFDS).
- The Spent Fuel Pool Alternative Cooling is a safety modification for the SFP. It includes installation of a fixed spray system on the spent fuel pool with provisions to use mobile equipment and acquisition of a mobile heat exchanger, which is located outside the nuclear island and with provisions for quick connections to the SFP.
- If design basis heat removal system fails, the SFP can be cooled under DEC A conditions, using mobile heat exchanger. It can remove 8.5 MW of heat load and keep the SFP water temperature below 80º C.
- The mobile heat exchanger can be cooled in two ways, using water from the fire protection system or the Sava river with provisions for quick connection to the SFP.
- Modification completed in 2020.

The Spent Fuel Dry Storage

- The SFDS is being constructed within the NPP Krško site. It will have capacity of up to 2,590 spent fuel assemblies in 70 casks, type HI-STORM FW from HOLTEC. The decay heat removal in the SFDS is passive.
- The floor plan dimensions of SFDS are 69.80 m by 47.70 m. The maximum height above the terrain will be 20.48 m. The SFDS building is a reinforced concrete and steel structure with a primary function to store the HI-STORM FW system on the pad.



- The concrete structure of the building with additional steel plates installed inside the building provides additional shielding so that the building and HI-STORM FW system meet the site boundary dose requirements for independent storage of spent nuclear fuel at the Krško NPP site.
- The SFDS includes handling area, technical area, storage area and cask transfer facility.

Design Criteria for the SFDS

- The SFDS is designed for Design Extension Conditions (DEC) applicable to the earthquake with peak ground acceleration (PGA) = 0.78 g.
- It can also withstand extreme atmospheric conditions (temperature, humidity, glaze ice), strong wind (up to 240 km/h), flooding, fire and airplane crash.
- The design criteria are presented in more detail elsewhere [2, 3].
- The construction of the SFDS is expected to be finished in 2022.
- The transfer of spent nuclear fuel from the SFP into the SFDS is expected to start in 2023.

General requirements for storage of spent fuel

- The SFDS is designed and casks are chosen considering properties of spent fuel from the Krško NPP.
- Slovenian legislation requires [4] that acceptance criteria for the storage or disposal of spent fuel shall include the limits for a number of parameters, namely: the content of emitters and specific activity, dose rates on the surface and at reference distances from the package surface, specific surface contamination, strength, leachability, corrosiveness, chemical stability, heat generation, degradation effects of radiation, i.e. changes in the properties of materials resulting from exposure to ionising radiation, change in volume, flammability, gas formation and gas content, content of toxic substances, content of organic substances with potential effects on microbiological degradation, free liquid content, presence of chelating and other complexes, explosiveness, combustibility, corrosion resistance, permeability and porosity, void fraction, criticality, suitable method of the labelling of radioactive waste or spent fuel packages and adequacy of the packaging and the method of packaging radioactive spent fuel.

Krško SFDS and Spent Fuel from SMRs

- The Krško SFDS can in principle be used for storing spent fuel from other reactor types.
- It means that, in principle, it can also be used for storing spent fuel from SMRs.
- However, before that it should be proven that spent fuel from SMRs fulfils the above acceptance criteria for storing in the Krško SFDS.
- SMRs can have various enrichment of fuel and operating conditions.

References

[1] NEMEC T., CIMEŠA S., PERŠIČ A., BAJCAR T., ŽIVKO T., "Regulatory Approach to Licensing of Design Extension Conditions (DEC) Modifications of the Krško NPP Safety Upgrade Program", Proc. 27nd Int. Conf. Nuclear Energy for New Europe, Nuclear Society of Slovenia, Portorož, Slovenia (2018).

[2] PERŠIČ, A., "Design Extension Conditions for Spent Fuel Storage", Proceedings of the 12th International Conference of the Croatian Nuclear Society, Zadar, Croatia (2018).

[3] PERŠIČ A., NEMEC T., BAJCAR T., "New Safety Requirements for Power Reactor Spent Fuel Storage", Proc. 27nd Int. Conf. Nuclear Energy for New Europe, Nuclear Society of Slovenia, Portorož, Slovenia (2018).

[4] Rules on radioactive waste and spent fuel management, Official Gazette RS No. 49/06, 76/17 – ZVISJV1 in 125/21.

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