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Division ENERGOPROJEKT PRAHA

Development of the interim spent fuel storage facility concept in the Czech Republic

Bretislav Horak

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Contents

Development of the interim spent fuel storage facility concept

- Initial conditions for the development of a new concept of spent fuel management
- Specific requirements for development of concept of spent fuel management
- Cost drivers influencing evaluation of alternatives

Essentials for concept development

- **Original concept of spent fuel management**
  - Returning of the spent fuel to the country of its origin (to the former Soviet Union)
  - Central storage of the spent fuel at Jaslovské Bohunice before its shipment to SU
  - Generally 3+ years storage in reactor building spent fuel pool
  - Experience with wet storage alternative including transport cask
- **Production of spent fuel**
  - Dukovany NPP 4x440 M started operation in period 1985-1988, expected production of 50 t HM/reactor, year
  - Temelin NPP 2x1000 MW started operation in period 2000-2001, expected production of 40 t HM/reactor, year
  - Research and training reactors: 2xUJV Rez, Czech Technical University of Prague
- **30 years of Dukovany and Temelin operation would produce totally 2850 tHM**

Conditions for new back end concept development

- Break-up of The Council for Mutual Economic Assistance (Commecom) – the concept of returning the spent fuel to the country of its origin was cancelled
- Break-up of the former Czechoslovakia brought necessity to ship the Dukovany spent fuel from the wet central storage at Jaslovske Bohunice located in the Slovak Republic back to the Czech (16 t HM)
- Dukovany: in each reactor hall spent fuel pool with capacity of 7 fuel reload – in 1994 re-recking increased capacity by 90% - capacity for Plant operation till 1997
- Temelin: original design concept similar to the Dukovany one – re-racking was performer during construction of plant
- Completion of new spent fuel storage capacity for Dukovany spent fuel not later than 1997 was condition for continuation of the plant operation
- The state owned company SURAO takes over responsibility for siting and development of final disposal facilitiy for spent fuel

Solving spent fuel storage task under time pressure

- **Bidding process for Dukovany NPP spent fuel storage started 1990**
  - Two stage process for 600 t of spent fuel storage
  - First stage – review of proposals to different type of available spent fuel storage concepts: wet pool above ground and underground, dry vault storage, wet casks and dry casks
  - Second stage – for cask concept shortlisted in the first stage supplier was selected
- **Storage building**
  - Serves as protection against external impact (mostly environment protection)
  - Includes service systems for casks (monitoring of cask tightness, dosimetry, service facility)
  - Collapse of the buiding does not lead to nuclear safety risk

Solving spent fuel storage task under time pressure

- Location of spent fuel storage facility in location of each NPP
  - Storage at nuclear power plant site Dukovany. Dry cask storage. Capacity of 600 t commissioned in 1997, further extension by 1340 t. Capacity was limited by size of storage hall. Casks are supplied gradually as needed for spent fuel
  - Locality Skalka serves as back-up site during process of licensing site of storage facility (Skalka is site implemented for long term underground storage tests)
  - Storage at nuclear power plant site Temelin site. Dry cask storage. Capacity 1370 t in 2010 for 30 years operation.

Criterion for evaluation of fuel cycle strategies

- Discounted cash flow criterion applied for comparative time
- The State/ privat ownership should be considered
- Scope of activities that are evaluated in the calculation
- Options consideration
- How to account uncertainties

Highlight from comparison of storage concept

Criterion	Wet pool	Dry Cask
Nuclear safety	• Normal operation: opened radioactive source • Source term for accident: all or large part of stored inventory	• Normal operation: closed radioactive source • Source term for accident: radioactive inventory is limited to contents of one cask
Discouted Cash Flow (DCF)	Total DCF lower than Casks under particular conditions	Low risk of unused facility
Licensing	Facility with active systems	System with passive features, cask and building are licensed separately
Malevolent actions	Costly technical measures must be implemented	Cask poses inherent high resistency to external impact
Transportability of spent fuel	Transport cask and instrumentation for loading fuel	Transportable dual purpose cask or modification of storage cask or reload to transport cask
Waste production	Low and medium level radioactive wastes	Generaly without radioactive wastes

Highlight from comparison of storage concept – 2nd

Criterion	Wet pool	Dry Cask
Scope of maintenance	• Servis of hydraulic and cooling systems • Chemical treatment of water • Dosimetrical control systems • House and cask cleaning	• Monitoring system of cask tightness • Dosimetrical control systém • House and cask cleaning
Duration of storage facility construction	More than 24 months	Duration depends on capacity of production shop (12 months)
Financing	Whole CAPEX spent before storage facility starts its operation	• Casks are purchased when they are needed • Long Lead Time Component
Participation of local industry	Oportunity for local contractor only in some areas of civil part	Complete civil part can be erected by local contractor
Scope of proven technologies	The whole system is proven	The whole system is proven
Impact on shut down period for fuel replacement	Core reload duration	Core reload duration + Duration of the cask drying and transport from reactor building

Central versus on site spent fuel storage alternatives

Dry cask storage

- Separate interim storage facilities at the site of each NPP
- Central interim storage facility at the site of one of the NPPs
- Central interim storage facility at the new site

Central versus on site spent fuel storage

Criterion	Central	On site
Cost (examples of cost factors)	• Capital and operation costs are lower because of economy of scale • Only one Servis Room	Use of existing NPP infrastructure: • Dosimetry control of site • Energency plans • Decommissioning of facilities at one site Fewer transports with spent fuel
Servis of casks	Hot cells	In reactor pool
Public acceptance	Additional site with nuclear facility should be selected and licensed	Additional site with nuclear facility is avoided
Transport of spent fuel	Regular transport shoud be organized from NPP sites to central site	Single transport or several batchs transport is organized

Cask VVER 440/19 sample information

- External diameter 2,66 m, height 4,2 m
- Mass of empty cask 93,7 t, loaded 112 t
- Casks are closed with two lids, space between them is filled with He with overpressure 0,6 MPa. Change of overpressure is monitored.
- Cask is licensed for 60 years operation (extension of license will be possible from the current point of view)
- Casks keep tightness
  - After fall from maximum height that occur in the cask transport way from reactor hall to the storage facility,
  - Heated up to temperature 800 ºC and emerging to water into depth 200 m.

SÚRAO, management of radioactive waste repository

- Operator of nuclear facility is responsible for spent fuel till its final storing provided by the Czech state. The State established company SURAO for management of the final repository of waste.
- Radwaste are subjected to control of State Office for Nuclear Safety (SÚJB)
- Activities of SURAO are financed from the nuclear account administrated by the Czech National Bank on behalf of Ministry of Finance
- Operators of NPP and other producers of radioactive wastes contribute to the nuclear account.
- Czech concept for spent fuel management is open cycle with fuel stored in cask/canisters with direct disposal underground repository

Concept of Deep Geological Repository preparation

Systematic assessment of potential sites for the siting of DGR

- Safety criteria
- Environmental criteria
- Design criteria
- Socio-economic criteria

Milestone	Planned date
Two sites selected (from preliminary survays incl position of public)	2020
Selection of final site of Deep Geological Repository (DRG)	2025
Research laboratory at selected site	~2030
Start of EIA procedure for construction DGR	2036
Submission of Safety report for siting	2040
Completion of documentation for construction license	2045
Construction of DRG including the first disposal section	2050
Completion of documentation for operation license	2065
Start of DRG operation	2065

Thank you for attention

Bretislav Horak

Bretislav.horak@ujv.cz

Cell: +420 606 716 554