Proceedings of the 15th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2007
October 21-26, 2007, Miami, Florida, USA

THE FIRST INTERIM SPENT FUEL STORAGE FACILITY IN EUROPE COMPLETELY LOADED

Stanislav Kuba
CEZ plc – Nuclear Power Division, Prague, Czech Republic

ABSTRACT

The paper describes the current situation in the spent fuel storage facility at the Dukovany NPP focusing on the operational experience. The Czech power utility CEZ plc decided on a new technology in the storage of spent nuclear fuel at the end of the Eighties. The main feature is the dual-purpose CASTOR® 440/84 metal cask delivered by the company GNS Essen in Germany for fuel assemblies of the Russian type VVER 440. The first building was designed for 60 casks and the proposed life time is 40 years starting from 1995.

In 1999 CEZ plc adopted a concept for the fuel cycle back-end for its nuclear power stations. To implement the strategy for spent fuel management, the Long-Term Spent Fuel Storage Preparatory Programme of CEZ was developed and subsequently approved in June 2000. The main aspect relating to spent fuel is that the first spent fuel should be handed over to the governmental authority for final disposal after 2065 at the earliest.

<u>The main milestones of the Storage Facility Dukovany I:</u>

- 1993: Contract signed between CEZ and GNS for the delivery of 60 CASTOR® 440/84 casks
- 1995: December: Commissioning of the storage facility Dukovany I and first cask deployed for storage
- 1997 January: Finish of trial operation
- 1997 October: End of international spent fuel transports between Slovak and Czech Republic. 9 CASTOR® casks (90 tHM) used for transport from Bohunice NPP to Dukovany NPP
- 2006 March: CASTOR® 440/84 cask No. 60 deployed for storage – full capacity achieved

<u>The main milestones of the Storage Facility Dukovany II:</u>

- 1997 project for capacity 132 casks (1340 tonnes of HM)
- 2001 May contract between CEZ and GNS Essen (e.g. winner of competition)
- 2005 July licence of advanced CASTOR® cask type 440/84M in Czech Republic
- 2006 December start of trial operation and storage of first cask

<u>Future Storage Facility in Temelin NPP:</u>

- 1998 start of project for capacity 150 casks approximately (1370 tonnes of HM)
- 2005 EIA was accepted by state authority
- 2006 December contract between CEZ and GNS Essen (e.g. winner of competition)

<u>Main conclusions:</u>

- The first Czech interim spent fuel storage is completely loaded – with 60 casks stored (600 tonnes of HM)
- 12 years of safe and reliable operation
- The storage license for the facility is valid until 2010 (validity 10 years)
- Good experience of Dukovany NPP and understanding by a large part of the Czech public
- The 2nd storage facility at Dukovany NPP is under trial operation from December 2006
- The storage facility at Temelin NPP is under design preparation

INTRODUCTION

The Czech Republic is a country with a developed nuclear industry and having several nuclear facilities on its territory. One of these facilities is the Dukovany Interim Spent Fuel Storage Facility (ISFSF), which uses dry cask technology for the storage of spent fuel (SF) from Dukovany NPP.

Dukovany Nuclear Power Plant (NPP) belongs to the largest Czech power utility CEZ plc, which has a share of approximately 70% of the electricity market in the Czech Republic. CEZ plc operates 2 NPPs (Dukovany and Temelin), 10 coal-fired power plants, 13 hydroelectric power plants and some smaller power sources. The total installed capacity is approx. 12 300 MW. CEZ plc is a member of the CEZ GROUP which is the leading utility in the Czech electricity sector.

In the Czech Republic, there is an open nuclear fuel cycle now. For this purpose CEZ plc decided on the technology of dry storage of SF in the end of 1980's. The main feature is the dual-purpose metal cask of the type CASTOR® 440/84 for the storage of Russian VVER fuel assemblies.

The first storage building (Dukovany I) was designed for 60 casks (see Fig. 1). Its capacity became full in March 2006 (see Fig. 2). The second stage of the ISFSF (Dukovany II) is in trial operation until January 2008. At the same time a new ISFSF for the Temelin NPP is under preparation in the final project stage. The winner of the cask tendering procedure was the CASTOR® 1000/19 supplied by the German company GNS in Essen.

The capacities for spent fuel storage in the Czech Republic are as follows:

- Dukovany NPP 1940 tHM (1st stage 600 tHM + 2nd stage 1340 tHM)
- Temelin NPP 1370 tHM

The total capacity until the year 2030 will be 3310 tHM in the Czech Republic.

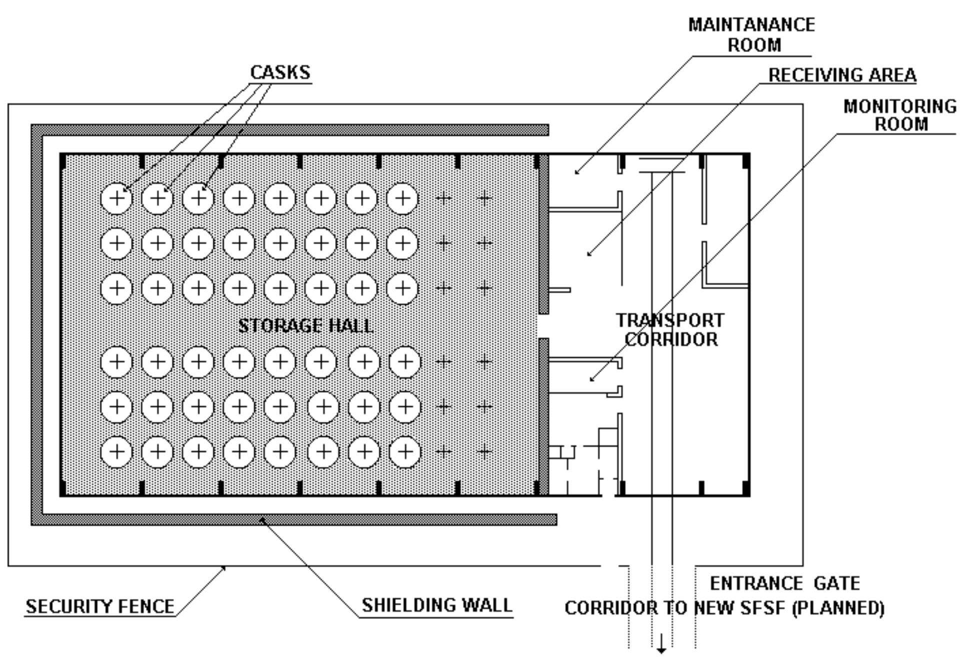

Figure 1. Arrangement of the ISFSF Dukovany I

Figure 2. Photograph of the completely loaded ISFSF Dukovany I

THE SPENT FUEL MANAGEMENT IN CZECH REPUBLIC

The power utility CEZ plc is the only nuclear operator in the Czech Republic. In the year 1999 the management of CEZ plc approved the concept for the back-end of the fuel cycle with the following key aspects relating to spent fuel:

- CEZ, together with addressing the fuel cycle back-end, also considers extending the life of the existing nuclear power stations and, if necessary, construction of a new one
- CEZ considers handing over of spent fuel to an underground repository as the final solution
- CEZ is going to use dry storage technology based on dual-purpose cask systems for the spent fuel generated in its nuclear power stations; the first spent fuel should be handed over to the governmental authority after 2065 at the earliest
- CEZ does not give up the option of long-term storage of spent fuel for a hundred years, depending on future experience with long-term storage and other conditions
- CEZ does not exclude the potential future use of reprocessed spent fuel for energy generation
- CEZ gains more time for a possible change in the final decision on spent fuel management which would take into consideration future technology and economic conditions
- The concept of long-term spent fuel storage fits into the overall back-end strategy of CEZ plc. The key activities are declared in the time schedule until the year 2065.

THE DUAL-PURPOSE CASK CASTOR®440/84

The CASTOR® 440/84 is a dual-purpose cask allowing both the long-term storage of SF and its transport. The supplier is the German company GNS in Essen. The spent fuel (84 fuel assemblies of the VVER 440 type) is stored in the cask with an inner atmosphere consisting completely of

helium. The leak-tightness of the cask is provided by the system of two lids made of stainless steel, each with metal seals.
The empty CASTOR® 440/84 cask is shipped from the manufacturer's facility by railway to the corridor of the reactor building. After tilting from the horizontal to vertical position, it is lifted up to the reactor hall to its service place using a special lifting beam. There, several operations are performed starting with the disassembly of the lids and ending with the check of cleanness. Subsequently the cask is transported using a lifting beam into the loading pit near the reactor and the storage pool. Then the refuelling machine loads the cask with 84 fuel assemblies, inspections including an inspection with participation of IAEA inspectors are carried out and the cask is covered under water level with its primary lid. The cask is then lifted from the pit and its surface is initially decontaminated. The cask is transported back to the service place in the reactor hall where all tests of its leak-tightness and other control operations are carried out. After completion of all checks, the cask is fully assembled including its protective lid and is secured using IAEA seals. In such a configuration and following the dosimetry measurement and final decontamination, the cask is transported on a railway wagon into the ISFSF. Following the transport to the entrance corridor, (see Fig.1) the cask is rotated into vertical position and then transported directly to its storage position. At this place it is connected to the pressure and surface temperature monitoring system.

THE MONITORING SYSTEM OF THE DUKOVANY ISFSF

During the operation, the greatest importance is placed on the monitoring of the leak-tightness and surface temperature of the casks and on the measurement of the radiation inside the storage hall and in its vicinity.

The CASTOR® 440/84 cask is continuously monitored by a system which measures the pressure in the gap between the primary and secondary lid. This space is filled during the cask assembly with Helium to a pressure of 0.6 MPa. Obviously the pressure varies with the temperature of the ambient atmosphere. If the pressure falls below the lower limit of 0.45 MPa, there is a signal for the NPP staff to find out the cause.

In the worst case (such as the very unlikely leakage of the primary lid) the cask can be transported into the reactor unit. The cask is filled with water by a special procedure and can then be unloaded in the pool at the reactor.

The pressure sensor is the main part for pressure measuring in the space between the cask lids. This sensor is subjected to periodic inspections according to the Czech Metrology Act and related regulations. A period of 6 years was proposed by NPP, and the Czech regulatory body approved it.

DIFFERENCES IN THE ISFSF OF DUKOVANY II

Design Changes of the Advanced CASTOR® 440/84M

CEZ has ordered a new advanced cask for Dukovany II because the parameters of spent fuel are higher. It can be said that these parameters will be higher and higher.

The advanced CASTOR® 440/84M cask has a new internal basket made of aluminium. The greatest emphasis was placed on radiation shielding for staff protection. Shielding plates were added to the secondary lid and onto the bottom of the cask. A second row of high-density polyethylene rods for shielding in the cask body protects staff in the radial direction. The shock absorbers on the lid and bottom ends are also advanced in design.

<u>The New Operational Monitoring System</u>

The principles of operational monitoring in Dukovany II are very similar, that is the monitoring of the pressure in the space between primary and secondary lid as well as temperature monitoring on the outer surface of the cask. The system is based on the latest digital technology and fulfils all regulatory body requirements (permanent viewing of monitoring trends, periodic reports on each cask, evaluation of alarms, etc.).

<u>The Air Activity Monitoring (AAM)</u>

It was decided to prepare a new monitoring system for the drying process of the cask. CEZ has ordered special equipment from a German supplier for continuous monitoring, the so-called Air Activity Monitoring (AAM). The main parts are as follows:

- main control units for measurement on the service place in each reactor hall
- equipment for sample preparation on the refuelling machine (a simple sipping-on-line system)
- a special gripper for sipping-on-line in loading pit
- a special 20-foot IP-2 container for the transport of contaminated equipment

The principle of the AAM monitoring is as follows:

- the main control unit contains two measuring chambers – one for aerosol activity and one for noble gas activity
- the gas and steam mixture goes from the cask cavity through the aerosol activity chamber to the vacuum pumps and subsequently back to the noble gas chamber
- after measurement the gas mixture goes out (to the ventilation)
- if the activity limit level is exceeded, then the drying process is interrupted.

In case of leaking fuel, the corrective actions are as follows:

- the cask is prepared by back-cooling equipment (filled with water) on the service place in the reactor hall
- the cask is loaded back in loading pit
- a sipping-on-line control of 84 FAs is done
- any leaking FA are exchanged with insertion of sound FA
- the drying process of cask is repeated

The first monitoring test was performed successfully in January 2006.

LIMITS AND CONDITIONS

Special rules characterize the operation of both storage facilities (with the same principles but difference according to cask type):

- Maximum cask number and minimal distance among axes of them (Dukovany I has a capacity of 60 casks and distance 3.15 m, Dukovany II has a capacity of 132 casks and distance 3.4 m)
- Limit for pressure between primary and secondary lid (0.45 MPa)
- Maximum cask surface temperature (100 ºC)
- Maximum cask thermal output (Dukovany I – 21 kW, e.g. 250 W/FA and Dukovany II – 24.7 kW, e.g. 6 x 340 W/FA and 78 x 290 W/FA)

- Radiation limits for cask (2 mSv/h + 0.1 mSv/h in 2 m, 4 Bq/cm2 for non-toxic alpha+beta+gamma nuclides and 0.4 Bq/cm2 for other alpha nuclides)
- control of the lower and upper openings for cooling air once a week (natural convection)

RADIATION MONITORING OF DUKOVANY ISFSF

The systematic monitoring of the radiation situation in the ISFSF Dukovany and its surroundings belongs to the most serious tasks of the operator. The extent of the monitoring is as follows:

- Monitoring inside storage building: gamma + neutron dose rate
- Monitoring inside storage building:
  - volume activity of noble gases (6 collectors under the roof)
  - cask surface (dose rate + non-fixed contamination)
- Monitoring at the boundary of the storage building:
  - personnel monitoring (collective dose ~50 mSv/y, max. individual dose ~0.4 mSv)
  - transfer of material, solid waste
- Monitoring in the surroundings of the storage facility:
  - monitoring at stable points (average 0.2 microSv/h)
  - soil activity and activity in underground water

SECURITY AND SAFEGUARDS

The storage buildings are placed inside a guarded NPP area. The main features are as follows:

- Storage buildings are an independent nuclear installation
- They have their own massive fence with sensors and cameras
- They have a special permit category for entrance (very restricted)
- There is an entrance rule for a minimum of 2 authorized persons
- Safeguards on the casks:
  - During loading: IAEA seal on cask secondary lid + 2 types of seals on cask protection plate (metallic + optoelectronic)
  - During storage period: the 2 earlier-mentioned seals on the cask protection plate + convoy metallic seal on 3 casks
  - Regulatory body + IAEA inspection once every 3 months

CONCLUSIONS

Looking back on almost 12 years of operation of the Dukovany I Interim Spent Fuel Storage Facility, it can be said that this operation is safe and with no abnormal events. Interim Spent Fuel Storage belongs to the best practices and as such it has become the subject of professional visits. Now we will focus on trial operation of the Dukovany II Storage Facility.

REFERENCES

[1] Dukovany Interim Spent Fuel Storage Facility, Preliminary Safety Report, Revision 4, Energoprojekt Prague, (2003)

[2] Lietava P., Kuba S.: Status and Experience in Dry Spent Fuel Storage in the Czech Republic (Licensing, Operation and Inspections), TM on Dry Spent Fuel Technology, IAEA, Lublana, Slovenia, 2005

[3] FOLTYN K. et al. : Annual operational report of Dukovany ISFSF, 17 January 2006, Fuel Handling Department of Dukovany NPP