Operational Experience of Castor 440/84 Casks in Dukovany NPP

Stanislav Kuba

CEZ plc – Nuclear Power Division, Prague, Czech Republic

The paper describes the current situation in operational experience in the Dukovany NPP (Czech Republic) focussed on the monitoring experience. A Czech power utility CEZ plc decided on a new technology in the storage of spent nuclear fuel in the end of eighties. The main feature is dual-purpose metal CASTOR® 440/84 cask for fuel assemblies of Russian type VVER 440. The first building was designed for 60 casks and the proposed life time is 40 years since 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. Main key aspect relating to spent fuel: the first spent fuel should be handed over to the governmental authority into final disposal after 2065 at the earliest.

The CASTOR® 440/84 is a dual-purpose metal cask and provides dry storage of 84 assemblies in a 100 % helium atmosphere. The cask is monitored according to the design by a system which measures the pressure in the gap between the primary and secondary lid. The measurement of surface temperature is another monitoring system.
Main monitoring systems:

Pressure Monitoring for CASTOR® 440/84 Cask: description, pressure sensor continuously measures pressure in the gap between the primary and secondary lid, system is wired to Main Dosimetry Control Room, no abnormal event in 9 years of operation, periodical inspection of pressure sensor in 6 years period.

Surface Temperature Monitoring for CASTOR® 440/84 Cask: description, temperature sensor continuously measures each cask in half height, no abnormal event in 9 years of operation, periodical inspection of temperature sensor in period 6 years.

Cask Body Periodical Inspection for CASTOR® 440/84: the visual control of cask surface and trunnions is performed per 3 years, the greatest importance is laid on trunnion bolts
Radiation Monitoring of Dukovany ISFSF: systematic monitoring of the ISFSF radiation situation inside and outside, no abnormal event in 9 years of operation, very low level in all measured points.
Main conclusions:
Czech interim spent fuel storage concept is dry storage in dual-purpose metal casks, no abnormal events in 9 years of operation in first part of Dukovany ISFSF. Currently 53 casks are stored (530 tonnes of HM). Intensive effort for finish of Dukovany ISFSF construction till December 2005.

1. Introduction

The Czech Republic is a country with developed nuclear industry having at its territory some nuclear facilities. One of these facilities is also the Dukovany ISFSF, which uses dry cask technology for the storage of spent fuel (SF) from Dukovany NPP.
The Dukovany NPP is part of the largest Czech power utility CEZ plc with approximately 70% share of electricity market in Czech Republic. CEZ plc operates 2 NPPs (Dukovany and Temelin), 10 coal-fired power plants, 13 hydropower plants and some smaller power sources. Total installed capacity is approximately 12 300 MW. CEZ plc is member of CEZ GROUP which is the leading utility in the Czech electricity sector. In Czech Republic is an open nuclear fuel cycle now. Therefore CEZ plc decided on a new technology in the storage of SF in the end of eighties. The main feature is dual-purpose metal CASTOR® 440/84 cask for storage of Russian WWER assemblies.
The first building (Dukovany I) was designed for 60 casks (see Fig. 1). The second stage of ISFSF (Dukovany II) is under construction now because the capacity of Dukovany I will be exhausted roughly by the year 2005 (see Fig. 2). At the same time the tender of new ISFSF for Temelin NPP is under preparation.
Project capacity of spent fuel storage in Czech Republic:
Dukovany NPP ... 1940 tHM (1st stage 600 tHM + 2nd stage 1340 tHM)
Temelin NPP ... 1370 tHM
Total capacity till year 2030 will be 3300 tHM in Czech Republic.

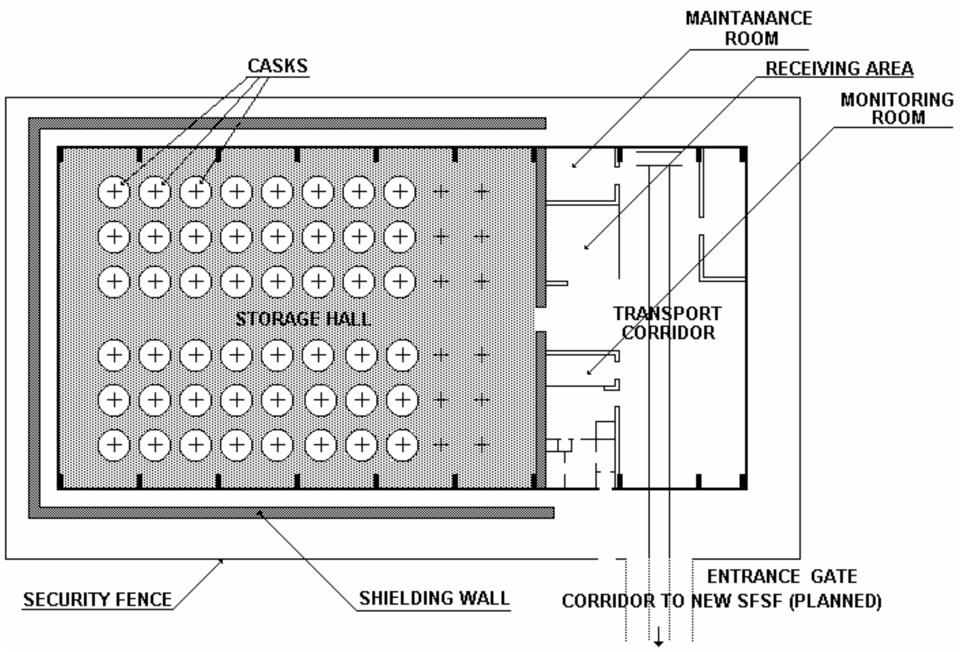


Fig. 1. Arrangement of ISFSF Dukovany I

2. The Spent Fuel Management in Czech Republic

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

- CEZ, together with addressing the fuel cycle back end, also considers the life extension of the existing nuclear power stations and, if necessary, construction of a new one
- CEZ considers handing over of spent fuel to the underground repository as the final solution
- CEZ is going to use dry storage technology based on dual-purpose cask system 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 refuse in 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 time schedule till year 2065.

3. Operational Experiences of Dukovany ISFSF

The CASTOR® 440/84 is a dual-purpose cask allowing both the long-term storage of SF and its transport. The main subsupplier is Czech firm Skoda Pilsen. Spent fuel in amount of 84 fuel assemblies of the VVER 440 type is stored in the cask with 100 % helium atmosphere. Leak-tightness of the cask is provided by the system of two lids made from 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 rotation from horizontal to vertical position, it is lifted up to the reactor hall to its service place using a special lifting beam. There several operations starting from the disassembly of the lids and ending with the check of cleanness are performed. Subsequently the cask is transported again 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 inspection with participation of IAEA inspectors are carried out and the cask is covered under water level with its primary lid. Cask is then lifted from the pit and its surface is fully decontaminated. The cask is transported back to the service place in the reactor hall where all tests of its leaktightness and other control operations are carried out. After completion of all checks, the cask is fully assembled including its protective lid and it is secured using IAEA's seals. In such a configuration and following the dosimetry measurement and appropriate decontamination, the cask is transported on railway wagon into the ISFSF. Following the transport to the entrance corridor, (see Fig.1) the cask is rotated into vertical position and then it is transported directly to its storage position. At this place it is connected to the pressure and surface temperature monitoring system.

4. Monitoring System of Dukovany ISFSF

During the operation, the greatest importance is laid on leaktigthness and surface temperature monitoring of the casks and on measurement of the radiation situation inside the storage hall and in its vicinity.

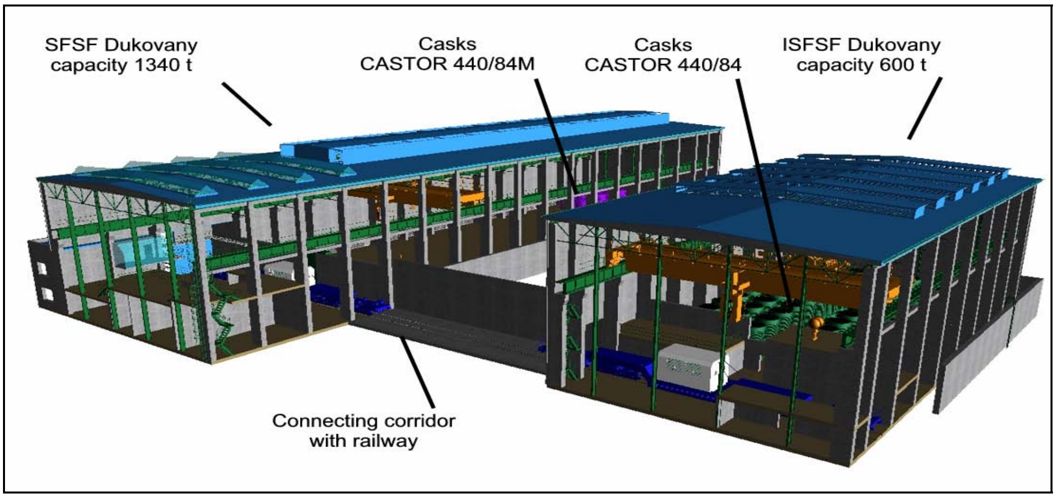


Fig. 2. Planned area ISFSF Dukovany with new building of Dukovany II (left)

4.1 Pressure Monitoring for CASTOR® 440/84 Cask

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 He-gas with the pressure of 0.6 MPa. Obviously the pressure varies with the temperature of the ambient atmosphere. Especially the lowering of the pressure below the lower limit 0.45 MPa is a signal for NPP staff to find out whether the cask lids have any leakage.

In case of a pressure change in the monitored void space, the following possibilities are investigated:

∗ Failure of the pressure sensors (checking of electric circuits),

∗ Leakage of the secondary lid (indication of He-leakage above the secondary lid),

∗ Leakage of the primary lid (evaluation of all verifications leading to this conclusion).

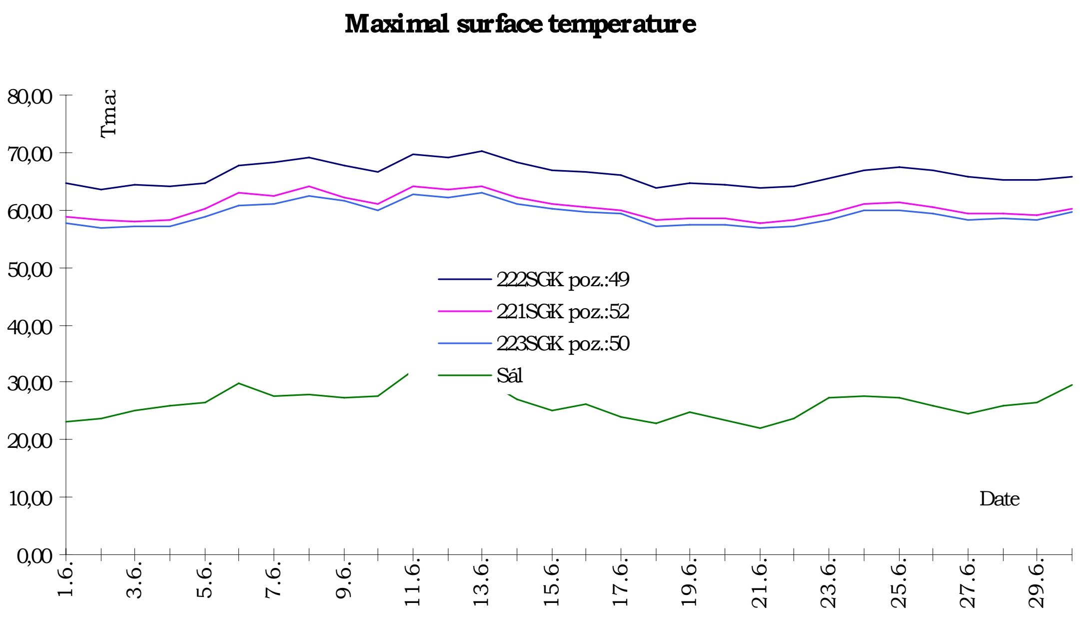
In the latter case (with lowest occurrence probability) transport into the reactor unit follows, the cask is filled with water by a special procedure and then it is unloaded in the pool at the reactor.

Periodical Inspections of Cask Pressure Sensor in ISFSF

The pressure sensor is the basic part of the chain for pressure measuring in the space between the cask lids. According to the Metrology Act and related regulations of the Czech Republic this sensor shall be subject to periodic inspections. A period of 6 years was proposed with regard to the CASTOR®440/84 cask periodical terms, which gives to be checked ten casks per year after full capacity of Dukovany I Storage Facility. The metrological service authorities had approved this proposal and therefore calibration tests have begun in the year 2001.The sensor have to be dismantled before tests from CASTOR® 440/84 cask. It means that the protective lid is dismantled, the He gas between the primary and secondary lids released and then the pressure sensor with flange is dismantled. The cask is subsequently completed again into the condition for further storage by a reverse procedure including leak-tightness tests.

4.2 CASTOR® 440/84 Cask Surface Temperature Monitoring

Original German project considered only pressure monitoring (leaktightness). Immediately at the beginning of the storage operation the NPP Dukovany started measurements of the casks surface temperature. The measurements were carried out once per week and the temperature was measured in the middle height of cask's surface. Upon the regulatory body request continual measurements of three hottest casks (those with the spent fuel having the highest residual heat) have been introduced later. The operator mounted special thermometers on the surface of each CASTOR® 440/84 cask, in order to introduce the possibility to collect and analyse their data. The records of the continuous temperature measurement are also included in the month report about the ISFSF operation. The highest cask surface temperature, which has been registered until now was 71.2°C in the summer 2003. The highest value of the individual cask thermal output upon its delivery to the storage hall was 17.3 kW. The standard uncertainty of the temperature measurement represents ±0.5°C.



4.3 Periodical Inspection of CASTOR® 440/84 Cask Body

The visual control of cask surface and trunnions is performed per 3 years. If the external surface coated by polyurethane multilayer is damaged then surface is repaired by special procedure. The greatest importance of trunnion control is laid on bolt condition mainly on the possibility of corrosion. At the same period as the inspection of pressure sensor the 4 bolts per each cask trunnion are controlled.

4.4 Radiation Monitoring of Dukovany ISFSF

Systematic monitoring of the radiation situation in the ISFSF Dukovany and its neighbourhood belongs among the most serious tasks of the operator. The extent of the monitoring is as follows:

Radiation monitoring inside the storage building:

- equivalent gamma dose rate,
- equivalent neutron dose rate,

The gamma and neutron dose rates are measured with two sets of four detectors, which are placed in the middle of the ISFSF building wall, in the height of 4 meters. The measurement is carried out every 60 seconds. If the approved limit is overrun the alarm in the storage building is activated and the information is parallel transferred to the Main Dosimetry Control Room.

- volume activity of noble gases,

Volume activity of noble gases is monitored under the roof of the storage building. There are six measurement points (collectors), which are continuously controlled by special electronic device. The filters placed in the collector captures for the aerosols are every week analysed in the laboratory of NPP.

- aerosol activity (^{51}Cr, ^{54}Mn, ^{60}Co, ^{110m}Ag, ^{134}Cs, ^{137}Cs and others),
- dose rate on the cask surface, non-fixed contamination of the cask surface,
- non-fixed contamination of the place in selected areas of ISFSF building.

Radiation monitoring on the boundary of the ISFSF building controlled area:

- radiation monitoring of personnel, collective equivalent dose, individual equivalent dose

The collective equivalent dose is on the average 50 mSv per year, maximum individual equivalent dose was 0.4 mSv.

- checking of material transfer from the controlled area,
- checking of solid wastes transport from ISFSF,
- checking of liquid wastes discharges.

Radiation monitoring on the of ISFSF surroundings (NPP´s area):

- equivalent dose rate in the near surrounding of the ISFSF – at four stable points,

The equivalent dose rate level on the boundary (wire fence of ISFSF area) is on the average 0.2 microSv/h.

- equivalent dose rate in the near surrounding of the ISFSF – with hand held device,
- equivalent dose rate in the distance surrounding of the ISFSF – at seven chosen points,
- soil activity (^{51}Cr, ^{54}Mn, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{110m}Ag, ^{134}Cs, ^{137}Cs and others),
- volume activity in groundwater (^{3}H, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{110m}Ag, ^{134}Cs, ^{137}Cs and others)

  into 6 wells in the near surrounding of the ISFSF

Radiation monitoring of neighbouring villages

- equivalent dose rate in the neighbouring villages,

The equivalent dose rate level in the nearest villages is the same as the natural background on the average 0.07 microSv/h.

5. Conclusions

Looking back to almost 8 years of operation of Dukovany I Interim Spent Fuel Storage Facility it can be said that this operation is safe and with no abnormal events. The Interim Spent Fuel Storage belongs to the best practices and as such it became the part of professional visits. Now we have to accelerate the construction of Dukovany II Storage Facility.

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