IAEA-SM-352/13

XA9951781

THE DRY SPENT RBMK FUEL CASK STORAGE SITE AT THE IGNALINA NPP IN LITHUANIA

V. V. PENKOV
INPP Ignalina Nuclear Power Plant,
Visaginas,
Lithuania

R. DIERSCH
GNB Gesellschaft für Nuklear-Behälter mbH,
Essen,
Germany

Abstract

At present, there are about 15,000 spent RBMK fuel assemblies stored in the water pools near the reactors at the Ignalina Nuclear Power Plant (INPP). Part of them are cut in two bundles and stored in standardized baskets in the pools. Each basket is loaded with 102 bundles. For long-term interim storage of this fuel, it was decided to use dry storage in casks. For this reason, the total activity to be stored is split into individual units (casks). Each cask represents a closed and independent safety system, fulfilling all safety-relevant requirements for both normal operational and hypothetical accidental conditions. The main safety relevant features of the storage cask system are:

(1) Inherent safety system;
(2) Double barrier system;
(3) Passive cooling by natural convection;
(4) Safety against accidents.

The cask dry storage system is a cost effective and multi-functional system for storage, transport after the operation time and final disposal under consideration of additional protective elements. From an economical point of view, cask storage has a number of advantages. Two cask types have been intended for the INPP storage site:

(1) The CASTOR RBMK cask made of ductile cast iron;
(2) The CONSTOR RBMK sandwich cask made of an inner and outer steel shell and reinforced heavy concrete.

The CASTOR RBMK and the CONSTOR RBMK casks are designed to withstand severe storage site accidents and – with help of impact limiters – to fulfil the IAEA test criteria for type B(U)F packages. The INPP spent RBMK fuel storage site is designed as an open air storage for an operational time of 50 years. The casks are arranged on the concrete storage pad. The site is equipped with a crane for cask handling and technological buildings and security systems. The safety analyses for fuel and cask handling and for cask handling and for cask technology at the site have been made and accepted by the Lithuanian Competent Authority.

1. BACKGROUND INFORMATION

The Ignalina nuclear power plant is situated in the north-east of Lithuania near the borders of Latvia and Belarus, on the shore of the Drukshiai lake, the largest lake in Lithuanian. The nearest cities to the plant are Vilnius at 130 km with over 600,000 inhabitants and Daugavpils in Latvia at 30 km with 126,000 inhabitants. The residence of the INPP's personnel is Visaginas, situated 6 km from the plant.

The INPP consists of two similar units of RBMK-1500 reactors. "RBMK" is a Russian acronym for "Channel-type Large Power Reactor" and is a water-cooled graphite-moderated channel-type power reactor. The RBMK-1500 reactor is the largest power reactor in the world and has a thermal power output of 4,800 MW and an electrical capacity of 1,500 MW. The first unit went into service at the end of 1983, the second unit in August 1987. Their design lifetime is projected to 2010 and 2015, respectively. A total of four units were originally planned on this site. Construction of the third unit was terminated in 1989.

The INPP has a direct cycle configuration - saturated steam, formed in the reactor by passing light water through the reactor core, is fed to the turbine at a pressure of 6.5 MPa. The light water circulates in a closed circuit. Each unit contains two K-750-65/3000 turbines with 800 MW generators. Each unit is provided with a fuel handling system and unit control room. The turbine room, waste gas purification and water conditioning rooms are common for the units.

2. HISTORICAL OVERVIEW OF SPENT FUEL MANAGEMENT

The problem of storing spent fuel at INPP arose several years ago. Spent fuel was originally intended to be shipped back to Russia for reprocessing and disposal. But, as a consequence of the disintegration of the former Soviet Union, this became impossible. Therefore, it was decided to build an interim spent nuclear fuel storage facility on the INPP site with a lifetime of about 50 years. It was supposed that the problem of spent nuclear fuel reprocessing and disposal will be resolved in this period.

Originally, a spent fuel storage facility was designed and proposed to the INPP by the All-Union Research and Development Institute of Power Engineering (Russian abbreviation - VNIPIEhT) in 1992. The design provided for two storage phases, i.e. a wet storage and dry storage, including an intermediate preparation of spent fuel for dry storage by encasing spent fuel in leak-tight casks to be filled with inert gas. The wet storage facility was supposed to be a separate on-site building measuring 220x60x40 m and equipped with all auxiliary systems required for its safe operation. It was a huge project which required a large material, financial and time expenditure.

Research on safe ways to store spent fuel done in countries operating nuclear power plants has shown that "dry" storage in inert environment is recognized as the safest long-term fuel storage after a certain period of wet storage. This method allows to store the fuel safely for 50 and more years. It can be done in two ways: the spent fuel can be stored in metal casks or in steel canisters placed inside concrete vaults.

In order to be able to make a decision which technology would be the best for INPP, an international tender was announced by the INPP and the Ministry of Energy of Lithuania. Nine companies which are world leaders in marketing of dry spent nuclear fuel facilities took part in the tender.

- Framatom/PNS, France/USA
- GEC Alsthom, UK
- GNB, Germany
- Ontario Hydro/AECL, Canada
- Siemens, Germany
- SGN, France
- VNIPIEhT, Russia
- Westinghouse, USA.

After the evaluation, the proposal of GNB was accepted to store spent nuclear fuel outdoors in sealed metal casks of the CASTOR type filled with inert gas. GNB's casks may be further licensed as transport casks for transportation of spent fuel outside Lithuania to a reprocessing facility or to a final repository.

An agreement was signed in December 1993, for the supply of 60 metal casks of the CASTOR type including technical documentation and handling equipment. Twenty CASTOR casks have been delivered up to now. In order to reduce the storage costs within the framework of the signed agreement, a decision was made to move to the CONSTOR type cask, which is made of a steel-concrete sandwich design.

In parallel with the active contract, the Lithuania Ministry of Energy has initiated a new tender for a dry spent fuel storage facility. Two Canadian companies: AECL and OH, and GNB from Germany were invited. In October 1996, the first round of the evaluation was performed. Two companies, GNB and AECL, were on the short list. AECL has proposed a concept of steel canisters loaded into concrete vaults, and GNB offered a steel-concrete sandwich cask of the CONSTOR type.

For some reasons, it was decided to conclude a contract with AECL. The licensing procedure for the CONSTOR type cask was started in January 1998. In October 1998, the Lithuanian Competent Authority VATESI has issued the permission for manufacturing of the CONSTOR cask. This type of cask has passed the licensing procedure in Russia as type B(U) package.

3. THE SPENT FUEL STORAGE AND HANDLING SYSTEM

The system for handling and storing the spent fuel assemblies is designed to perform the following main functions:

- cooling of the spent fuel assemblies (SFA);
- cutting of the fuel assemblies (FA) into fuel bundles (FB);
- placing them into transport baskets designed to accomodate 102 fuel bundles;
- storing of the loaded transport baskets in the pools;
- loading of the transport baskets with 102 spent fuel bundles in casks; and
- moving of the casks to the on-site spent fuel storage facility (SFSF) for long-term storage.

In addition, the system considers the treatment and disposal of process wastes generated by various fuel handling systems. The system also provides transport services for maintenance activities which involve the use of special technologies.

The main safety goals are to ensure radiation safety under normal operational conditions and to keep radiation exposure of the personnel, general public and environment in case of an accident within the limits set by radiation standards and health regulations. The major objectives of *radiation safety are:*

- prevention of occasional accidental criticality;
- provision of the required radiation protection;
- prevention of unacceptable radioactive releases.

The spent fuel storage and handling system is represented by several independent subsystems, each performing its own function in a certain sequence. The system includes the following subsystems:

- handling of spent fuel in the unit;
- storage of the spent fuel assemblies extracted from the reactor prior to cutting;
- cutting of the spent fuel assemblies into fuel bundles and placing them into the transport basket;
- storage of the loaded transport baskets with cut fuel assembly in the storage pools;
- storing of spent fuel bundles in the storage casks (CASTOR and/or CONSTOR)
- transporting of spent fuel outside the unit to a separate on-site storage facility.

The components of the spent fuel storage and handling system are located in the reactor building.

Spent fuel assemblies discharged from the reactor and spent fuel bundles in casks are stored in storage pools of which the ceilings come out in the storage pool hall (SPH). All process operations related to handling of the spent fuel are performed in the SPH.

After placement in the pool, the spent fuel assemblies remain for at least a year, after which they may be removed for cutting. The cutting bay is located in the reactor compartment between the storage pool hall and the reactor hall. The bay, which includes a hot cell (He), control room and maintenance area, is designed for:

- cutting of the spent fuel assembly into two fuel bundles;
- placing them into a transport baskets;
- cutting of the structural parts central rod, load bearing tube of the spent fuel assembly;
- containerizing the pieces and taking containers away for disposal.

After spent fuel bundles have been stored for a certain time, the loaded transport baskets with spent fuel are placed into the casks and are taken away for a long-term storage (up to 50 years) to the on-site spent fuel storage facility.

The storage time before loading into the "CASTOR" type metal container and "CONSTOR" type steel-concrete sandwich cask is at least 5 years after discharge from the reactor. The on-site spent fuel storage facility for spent fuel is planned to be constructed at the Ignalina site approximately 1 km away from the units. This will be a dry storage facility in which spent fuel will be stored in the CASTOR and CONSTOR casks.

At the initial stage, 20 metal "CASTOR RBMK" casks delivered by GNB (Germany) will be used for storing and transporting spent fuel. At a later stage, the steel-concrete sandwich CONSTOR RBMK cask (also made by GNB), will be used.

The treatment of process wastes generated in the course of fuel handling, consists in cutting of long pieces of the fuel assemblies (LPCF), containerizing the cutted pieces and transferring containers to the solid radwaste storage facility (SRWSF).

Transport and process areas are equipped with hoisting-and- conveying machinery such as cranes, electric overhead-track hoists, electric hoists and hand pulleys, self-propelled transport trolleys. The rooms are linked together by a system of transport and railway corridors which allow to transfer material and equipment via corresponding doors.

4. CASTOR AND CONSTOR STORAGE SYSTEMS

For long-term interim storage of the spent fuel bundles, it was decided to use dry storage in casks. For this reason, the total activity to be stored is split into individual units (casks). Each cask represents a closed and independent safety system, fulfilling all safety-relevant requirements for both normal operational and hypothetical accidental conditions.

The main safety relevant features of the storage cask system are

- Inherent safety system;
- Double barrier system;
- Passive cooling by natural convection.

The cask dry storage system is a multi-functional system for storage, transport after the operation time and final disposal under consideration of additional protective elements. From an economical point of view, the cask storage has the following advantages:

- High flexibility and easy expandability;
- Easily adaptable fabrication technology for local manufacturing conditions in case of the CONSTOR steel concrete sandwich cask;
- Low costs for operation, maintenance and decommissioning only.

Two cask types have been intended for the INPP storage site:

- The CASTOR RBMK cask (see Fig. 1) made of ductile cast iron and closed with a screwed double barrier lid system;
- The CONSTOR RBMK sandwich cask (see Fig. 2) made of inner and outer steel shells steel on and of reinforced heavy concrete. The lid system consists of a bolted lid and two welded lids.

The CASTOR RBMK and the CONSTOR RBMK casks are designed to withstand severe storage site accidents, such as:

- drop;
- earthquake;
- fire;
- gas cloud explosion;
- airplane crash.

With the help of impact limiters the casks fulfils the IAEA test criteria for type B(U)F transport packages.

The nuclear safety of both cask concepts has been analysed by internationally accepted codes [1]. The safety analyses results were confirmed by experimental programmes in which the mechanical and thermal cask behaviour under accident conditions has been tested [2, 3].

The CASTOR RBMK cask has been licensed for storage by the Lithuanian Competent Authority VATESI. The CONSTOR RBMK cask was certified as a type B(U)F package by GOSATOMNADZOR of Russia.

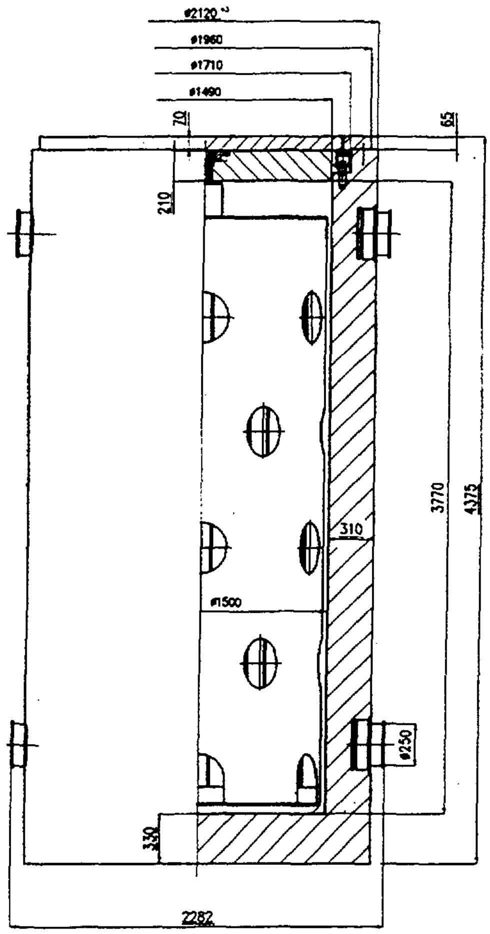

FIG. 1. CASTOR RBMK storage cask

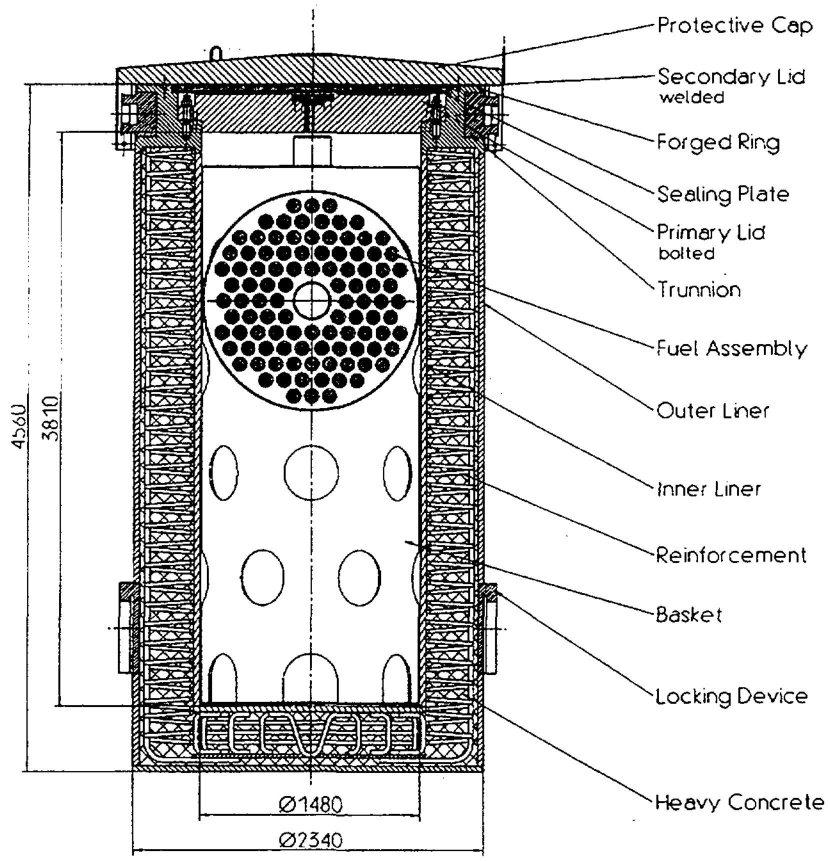

FIG. 2. CONSTOR RBMK storage cask

5.STORAGE SITE AT IGNALINA NPP

The INPP spent RBMK fuel storage site (see Fig. 3) is designed as an open air storage for an operational time of 50 years. The spent fuel storage facility is located at the INPP site at a 700 m distance from the INPP Unit 2 and at a 400 m distance from the Drukshai lake.

The main parts of the spent fuel storage are:

- the concrete storage pad for loaded and empty casks;
- production building;
- transformer substation;
- rain-water drainage system;
- observation wells;
- engineering service lines;
- checkpoint;
- radiation and dose rate control systems;
- roads and railways.

The spent fuel storage site is surrounded by a protective steel concrete wall and 3 rows of safeguard fence equipped with an alarm system. For safe handling of the storage casks a gantry crane will be used.

The casks are set in groups on the concrete pad at the site; the distance between the cask centers within each group is 3 m. The distance between the casks' groups is 4.1 m. Such a disposition allows the return of each cask if necessary. Along the whole perimeter of the storage there is a system providing a permanent dose rate control. The measuring signal's output will be transmitted to the INPP radiation control board.

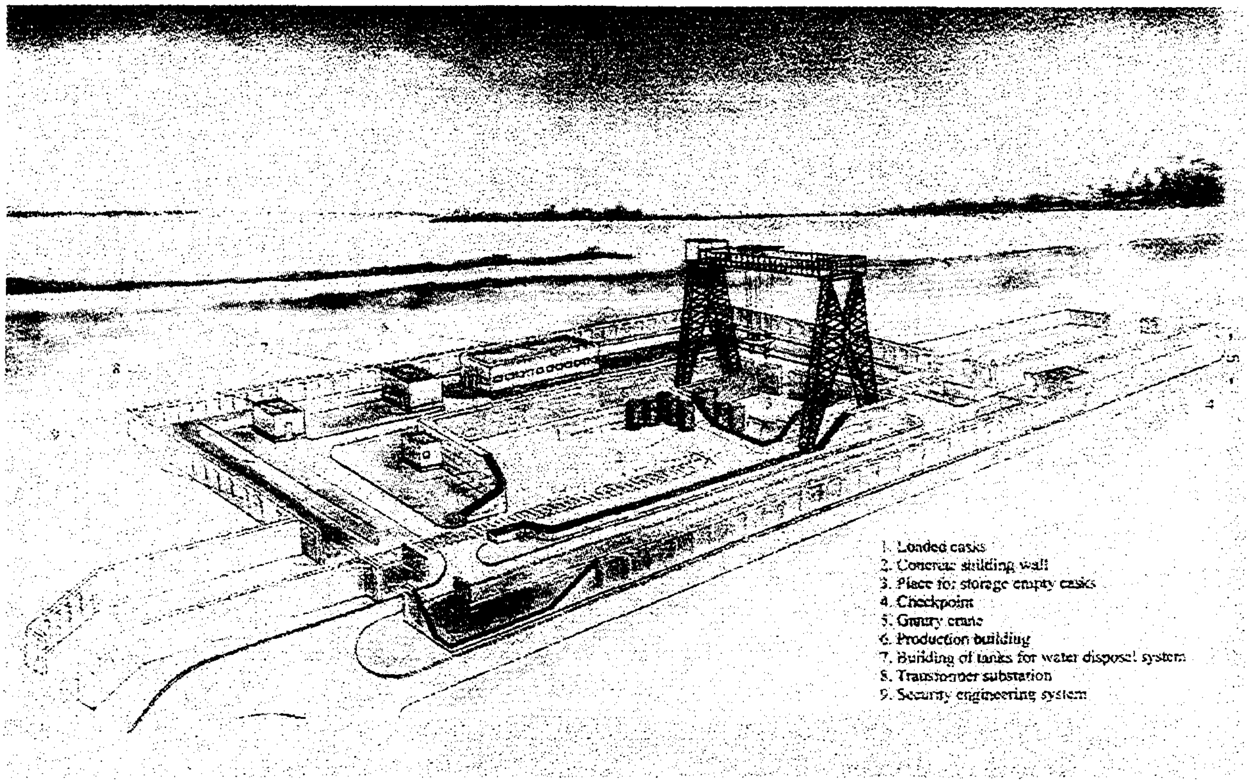

FIG. 3. Ignalina spent RBMK fuel cask storage site

The safety analyses for fuel handling and for cask handling at the site have been made and accepted by VATESI the Lithuanian Competent Authority. The site is planned to be put into operation in 1999, with the first loading of a CASTOR cask at the beginning of 1999. The delivery of the first CONSTOR RBMK cask will take also place at the beginning of 1999. Recently the spent fuel storage facility is in the stage of commissioning, with completion at the end of this year.

REFERENCES

[1] Diersch, R. et all, Nuclear Safety Aspects of the Dry Spent RBMK Fuel Cask Storage Site at the Ignalina Nuclear Power Plant in Lithuania, Proc. Int. Symp. On Storage of Spent Fuel from Power Reactors, Vienna, 9-13 November 1998, IAEA-TECDOC-..., (to be published in 1999).

[2] Instrumented drop tests with the CONSTOR VB-1 test cask: Test performance and results, GNB Report, (July 1997).

[3] Fire test with the CONSTOR VB-1 test cask, Test performance and results, TÜV Report, (March 1998).