IDEES: Spent-Fuel Dry Storage Facility

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INTRODUCTION

IDEES (Installation D'Entreposage d'Eléments combustibles à Sec) is a Dry Storage Facility designed for interim storage of LWR spent-fuel assemblies. The spent-fuel assemblies are stored in vertical position in Concrete Storage Casks placed in a bunker configuration.

This paper provides a description of IDEES, its major components, and its operation. It shows how safety issues are addressed in IDEES design. It describes IDEES unique heat transfer system and the advantages thereof.

IDEES SYSTEM DESCRIPTION

IDEES is composed of four major components: the Storage Canister, the Transfer Cask, the Site Transfer Equipment, and the Concrete Storage Cask.

The Storage Canister is designed to meet IAEA transportation requirements (during transfer) and ANSI storage requirements (in the storage configuration). It is composed of a stainless steel cylinder with a welded closure lid. The borated aluminum basket provides individual locations for the LWR spent-fuel assemblies (24 PWR).

The Transfer Cask is designed to meet IAEA transportation requirements. It is a multilayer cylinder composed, from the inside out, of: stainles steel, lead, PNT7 compound, and carbon steel. The PNT7 layer contains embedded copper fins and forms a Thermal Switch as described in the related paper presented to the PATRAM'95 conference in Las Vegas (Béra, R.C., Bochard, C.M. *Lead-Shielded Spent Fuel Transport Casks, The Thermal Switch Concept*, PATRAM'95 conference). The Transfer Cask is provided with a top lid (for under water loading of the spent-fuel assemblies) and a bottom lid (for transfer of the Storage Canister to and from the Concrete Storage Cask).

The Site Transfer Equipment is a mobile crane moving on rail tracks and used for handling both Transfer Cask and Storage Canister. It is designed to be remotely operated, thus decreasing operational dose rates.

The Concrete Storage Cask is designed to meet ANSI/ANS 57.9 storage requirements. It is composed of two modules: (1) an internal part composed of the stainless steel containment with its patented cooling system, and (2) an external reinforced concrete cylinder. The inner module provides for containment and heat dissipation. The outer module provides for shielding and mechanical protection.

IDEES SYSTEM OPERATION

Loading of the Concrete Storage Cask is performed in eight major steps: (1) immersion of the Storage Canister (placed in the Transfer Cask) in the spent-fuel pool, (2) loading of the spent-fuel assemblies in the Storage Canister, (3) Storage Canister preparation (welding of the Storage Canister lid and closure of the Transfer Cask), (4) remote transfer of the Transfer Cask above the Concrete Storage Cask using the Site Transfer Equipment, (5) operation of the Transfer Cask bottom drawer (removal of the bottom closure lid), (6) loading of the Storage Canister into the Concrete Storage Cask, (7) preparation of the Concrete Storage Cask for storage, and (8) monitoring.

Monitoring activities during storage include: monitoring of the Concrete Storage Cask inner pressure, periodic inspection of air inlets and outlets, and sampling of the Concrete Storage Cask cavity atmosphere for analysis.

IDEES SAFETY FEATURES

Subcriticality is ensured during transport and storage by the borated aluminum basket.

Shielding is provided by the Concrete Storage Cask.

IDEES provides three barriers of containment: the fuel cladding, the Storage Canister containment barrier, and the Concrete Cask containment barrier. The Storage Canister containment barrier consists of a stainless steel shell and a welded closure lid. The Concrete Cask containment barrier consists of a stainless steel shell, a bolted closure lid, and a metal seal.

The mechanical design accounts for dropping of the Storage Canister in the Concrete Storage Cask.

IDEES thermal design is based on the use of a patented passive cooling system presented in the next section.

IDEES HEAT TRANSFER SYSTEM

IDEES patented passive cooling system consists of several rows of copper tubes located in an annulus external to the Concrete Storage Cask containment. The copper tubes inner row is in contact with the containment wall. The copper tubes are embedded in a temperature-resistant material (same PNT7 compound used in the Transfer Cask). The system is completely passive; air circulates by natural convection in the copper tubes: from air inlets at the bottom, to air outlets at the top of the Concrete Storage Cask. Conduction between the copper tubes is ensured by the PNT7 compound.

The efficacy of the system was verified by testing on a full-length, 1/8 circumference model. An inside thermal load of 15 kW was simulated using a heated water tank. Cooling was ensured by natural convection of air through two rows of copper tubes. The air temperature measured after reaching equilibrium was 38°C at the input and 66°C at the output. This corresponds to the following maximum temperatures in the Concrete Storage Cask and the Storage Canister: 66°C maximum PNT7 compound temperature (compared to the 120°C material limit) and 320°C maximum fuel cladding temperature (compared to the 350°C storage limit).

The system heat evacuation capability is a function of the copper tubes section and the number of copper tubes rows. This makes it possible to optimize the concrete storage cask design to the specific characteristics of the spent fuel in storage.

CONCLUSION

IDEES key feature is its patented passive cooling system which, with improved thermal evacuation capabilities, allows for three containment barriers.

Also, the passive cooling system modularity makes it possible to adapt easily the Concrete Storage Cask to the specific spent-fuel characteristics and therefore optimize design and cost.

REFERENCES

Béra, R.C., Bochard, C.M. *Lead-Shielded Spent Fuel Transport Casks, The Thermal Switch Concept*, PATRAM'95 conference, Las Vegas (1995).

Bochard, C.M. *Device For Cooling Containment*, U.S. Patent Application N° 08/525,209 (1995).