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Design Process for Dual-Purpose Nuclear Spent Fuel Casks

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Abstract

Nuclear spent fuel management has become a key activity within national nuclear strategies. Spent fuel casks shall be customized, in order to release space in the pools of the nuclear power plants to continue operating. The final goal is to complete the decommissioning activities in some nuclear facilities or to load spent fuel with new enhanced irradiation parameters.

Cask designers develop complex technical processes that require very skilled staff to understand and compile the requirements of the cask users. It's necessary to adapt and validate the cask design concepts to comply with the applicable regulation. Finally, it is required to provide the detailed technical documentation as well as appropriate justifications to the nuclear regulators, for the safe management of the nuclear spent fuel.

Peer-review under responsibility of the organizing committee of IYNC2016

Keywords: Nuclear spent fuel casks, design, licensing, dry storage, transportation, back-end.

Nomenclature

ANSI	American National Standard Institute
ASME	American Society of Mechanical Engineers
CoC	Certificate of Compliance
CFR	Code of Federal Regulations
ENUN	Ensa Universal
IAEA	International Atomic Energy Agency
ISG	Interim Staff Guidance
NPP	Nuclear power plants
SAR	Safety Analysis Report
TSAR	Topical Safety Analysis Report

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1. Introduction

Removal of spent fuel assemblies stored in pools of nuclear power plants (NPPs) to dry storage or off-site transportation (to another type of storage or reprocessing facility) creates the necessity for cask vendors to provide customized solutions. There are three main reasons why NPPs request improved casks designs, licensed, manufactured and ready for loading within very short periods of time, for optimal development:

- Necessity of release space in the NPPs pools to store new spent fuel assemblies and continue the operation of the reactor, once density of pools has reached their limits.
- Planning the decommissioning of the NPPs once they are approaching the end of their operating license periods. It implies that activities of spent fuel removal from the containment building should start soon after the plant shutdown, in order to reduce decommissioning times and costs. Sometimes, this implies very short cooling times and loading spent fuel with very high thermal power.
- New fuel designs and reactor loading plans have increased the time the fuel is irradiated in the reactor. Enrichment and burnup parameters have increased. It implies that spent fuel casks have to be re-designed in order to allocate spent fuel with new and challenging higher irradiation parameters.

Currently, there are two different technologies of casks designs for storage and transport of spent fuel in the market, each of them with particular benefits and drawbacks. The ‘canisterized type’ solutions are based on a canister made of a thin stainless steel vessel that contains the spent fuel assemblies. During dry storage, the canister is transferred to a concrete overpack specifically built at the independent spent fuel storage installation (ISFSI). Another possibility is to store the canisters inside specific cavities in a ‘vault type’ building specifically designed for interim dry storage. In case of transportation outside the NPP or the storage installation, the canister is transferred to a transport overpack fabricated in carbon steel. On the other hand, the ‘bare type cask’ solutions are constituted by a single carbon steel cask that includes a basket cell structure inside that allocates the spent fuel. The same package is used either for dry storage at the ISFSI or for transportation to a different facility, without the need to re-condition the spent fuel.

This paper tries to describe the main activities performed during the design process for the customization of a generic spent fuel cask design (a ‘bare fuel type’ solution), to the specific requirements of a power plant or cask user. Cask designers & vendors shall face the new challenges that nowadays, the nuclear industry is requesting for the safe management of the nuclear spent fuel.

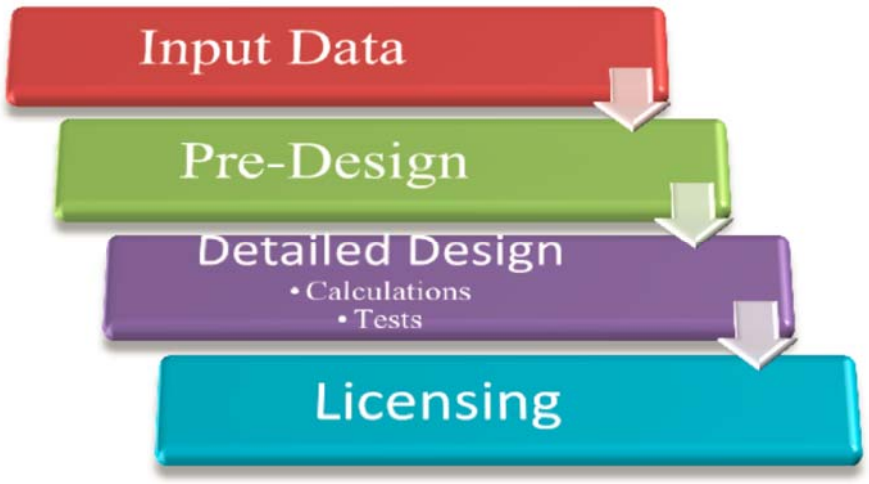

Fig. 1. Principal phases involved in the design process of a spent fuel cask