SAFETY EVALUATION OF THE ENSA-DPT CASK FOR SPENT NUCLEAR FUEL STORAGE AND TRANSPORTATION

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The ENSA-DPT cask is a double-purpose container for storing and transporting up to 21 PWR-KWU type, 16x16-20 spent fuel assemblies. It was designed for ENRESA by Equipos Nucleares (ENSA), basically in keeping with the characteristics of the NAC-STC cask. A resolution of the Spanish Department of Energy dated

October 23, 1997 approved the ENSA-DPT cask for storage and as a B(U)F type transport drum model.

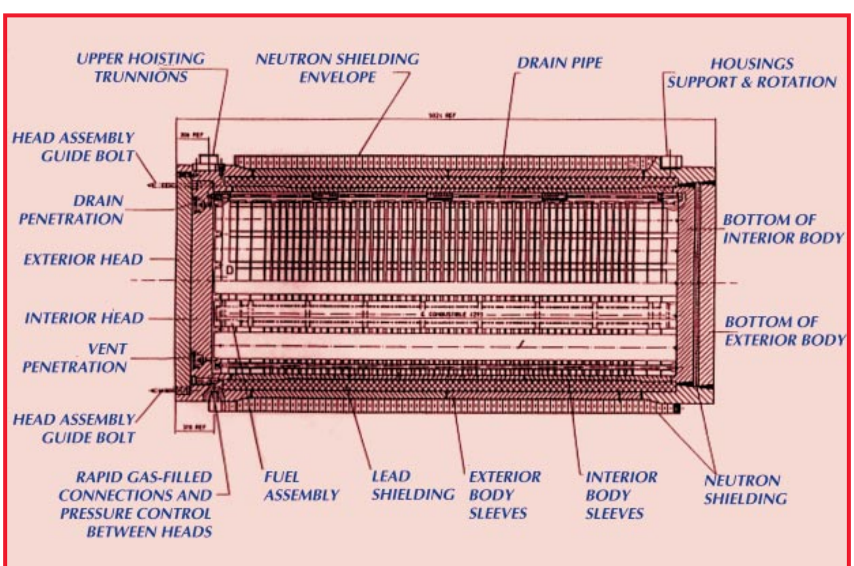
ENSA recently demands authorization for construction.

INTRODUCTION

Temporary storage of spent nuclear fuel from nuclear power plants is primarily based on two techniques: dry storage (casks and chambers), and pool or wet storage. Casks provide modular capacity as the need arises, whereas chambers and pools provide massive capacity as of the time they are operative.

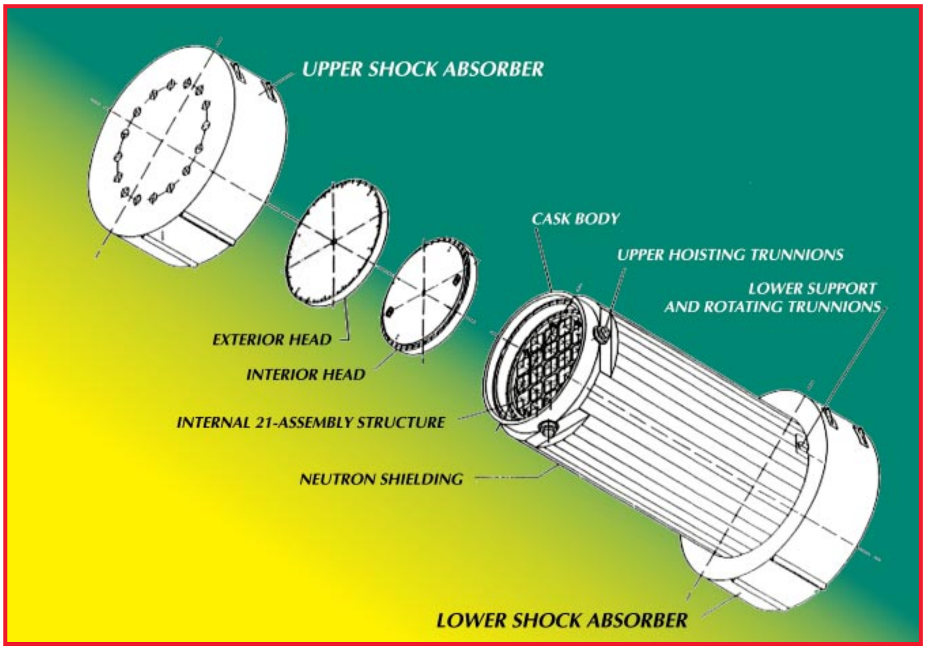
The successive General Radioactive Waste Plans have been drafting the strategy to be followed by these two methods of intermediate spent fuel storage: on one hand an increase in the storage capacity of nuclear power plant pools, and on the other the use of metallic casks.

F I – ENSA-DPT Cask



The Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA) undertook a program to develop metallic casks. This program was intended to make three kinds of casks available for licensing in Spain: a PWR 17x17 fuel storage cask, another for storage and transportation of this same kind of fuel, and a third for storage and transportation of spent fuel from the Trillo Nuclear Power Plant. To achieve this goal, it set a joint venture with Nuclear Assurance Corporation (NAC), a North American firm with extensive experience in cask design and licensing that also provided the application of widely developed standards. On the other hand, it reached an agreement with Equipos Nucleares, S.A. (ENSA) to provide consulting and cask manufacturing, and commissioned Empresarios Agrupados, S.A. to provide the support engineering.

In the United States, NAC had designed a cask, the NAC S/T-26, for storage and transportation of 26



F II – ENSA-DPT Cask. Assembly with Shock Absorbers

Westinghouse PWR type 15x15 spent fuel assemblies, with a maximum initial enrichment of 3.3% by weight, 35,000 MWd/tU maximum burn degree, a cooling time of no less then five years, and a decay heat of no greater than 1 kW per assembly. In addition, it has designed three additional versions of the NAC S/T cask for 28 intact assemblies and for 28 and 31 consolidated assemblies, in all cases 15x15. All these versions of the NAC S/T, except for the one for 31 consolidated assemblies, have already been licensed by the NRC for use as storage, but it has desisted from the idea of using and thus licensing these casks for transportation.

To achieve a double-purpose storage-transportation cask, NAC designed the NAC-STC for up to 26 Westinghouse PWR type 17x17 spent fuel assemblies with a maximum initial enrichment of 4.2% by weight, 40,000 MWd/tU maximum burn degree, a minimum cooling time of five years, and decay heat below 1 kW per assembly. In Spain, on the basis of the experience of its American partners and their technology, ENRESA has contracted the desing of the double-purpose cask ENSA-DPT to be similar to the NAC-STC, but adapting it to the characteristics of the KWU PWR type 16x16 spent fuel in the Trillo Nuclear Power Plant.

The purpose of this article is to describe the licensing process followed by the cask design in the Nuclear Regulatory Commission (CSN) until it obtained authorization, which was granted by the Department of Industry and Energy by the aforementioned Resolution of the Spanish Department of Energy dated October 23, 1997.

In December 1992, ENRESA, as the title holder of the ENSA-DPT cask, requested design approval of the cask as a nuclear component to be used as spent nuclear fuel storage, and submitted the appropriate documentation to the Department of Industry and Energy. The observations made by CSN technicians and modification of the internal rack design resulted in successive revisions of the Generic Safety Analysis for Storage that had been submitted. Revision 2 of September 1994 (Reference 1) was the one finally evaluated by the CSN.

In March 1994, ENRESA asked for certification of the cask as a B(U) type drum model, fissionable class, for transporting spent fuel. The observations made by the CSN's Technical Management resulted in a new revision of the Generic Safety Analysis for Transportation, and Revision 1 of November 1994 (Reference 2) was the one used in the mandatory evaluation.

In February 1998, ENSA requested authorization from the Provincial Branch in Cantabria of the Department of Industry to manufacture the cask.

Having briefly described the background and history of the ENSA-DPT cask, the second and third sections of this article below provide a brief description of the cask and a summary of the methodology used in the evaluation carried out by the CSN from the perspective of nuclear safety and radiological protection. The article ends with the conclusions drawn from this evaluation.

ENSA-DPT CASK DESIGN

The ENSA-DPT Cask (Figure I) is a multi-walled cylindrical vessel weighing 118 metric tons loaded and with shock absorbers. The main components are as follows:

- The vessel, composed of: two cylindrical stainless steel envelopes, one interior and one exterior, separated by a lead envelope, a radial neutron shielding and a bottom formed by two forged frameworks.
- Interior and exterior heads provided with bolts and metallic joints.
- Penetrations provided with lids and end caps, bolts and metallic joints.
- Hoisting trunnions and housings for the rotating trunnions.
- Fuel rack.
- Shock absorbers.

The cask body or vessel is made of two concentric stainless steel envelopes separated by a lead layer that acts as the primary shielding for gamma radiation in the radial direction of the cask. A receptacle is welded to the outside of the external envelope, on the inside of which thirty-six bimetallic cooling blades have been radially arranged, and the space between them is filled with a solid synthetic polymer (NS4FR) that acts as a neutron shielding. The cask bottom is made of two forged frameworks, one interior and one exterior, and the space between them is filled with a neutron shielding material layer. The cask is closed with two steel heads, one interior and one exterior. The exterior head acts as a redundant barrier to protect the interior one (Figure II).

The cask is provided with six penetrations. One is the test line penetration located on the exterior head. The vent and drain penetrations are located on the interior head and are protected by end caps and two metallic joints. The fourth penetration, called inter-annulus, is also located on the interior head, but it does not access the inside cask cavity. The upper framework has two additional penetrations: the pressure control penetration and the so-called inter-head penetration. The latter is used to drain the space the heads and fill it with helium; the former is a penetration to monitor the pressure existing in the space between heads with its corresponding pressure transducer. These penetrations are protected by stainless steel caps that are sealed with two metallic joints.

The cask is provided with four hoisting trunnions arranged at 90 degrees angles to one another, which serve to lift and handle the cask. There are also two housings for rotating trunnions that are welded near the cask bottom.

The fuel rack is made of high-resistance stainless steel; it is equipped with a series of disks capable of housing and supporting twenty-one tubes for storing the fuel assemblies. These tubes contain the neutron poison that ensure the assembly's subcritical conditions. Twenty-six aluminium disks have also been provided to optimize the cask's thermal performance.

To dampen the acceleration forces that would act on the cask during transportation (Figure III) as a result of impact forces produced in the event of an accident and fall, two shock absorbers have been designed, consisting of a stainless steel shell with sequoia and balsa wood on the inside. These absorbers are built into the ends of the cask.

EVALUATION STRATEGIES AND RESULTS

STANDARDS APPLIED

As there is no model defined in Spain for licensing casks for spent fuel and as these casks are based on North American technology and manufactured with the advice of a company also from North America, it was deemed advisable to apply in Spain a standard similar to the one used in the United States. Thus, the licensing model applied in Spain is similar to the one used by the U.S. Regulatory Body, the Nuclear Regulatory Commission (NRC).

In the United States, the NRC grants a Compliance Certificate for each cask model that authorizes its design and use for transfer and storage of spent fuel in an Independent Spent Fuel Storage Installation (IIACG) on a specific site as per 10CFR72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation", or in an installation already licensed as per 10CFR50, "Domestic Licensing of Production and Utilization Facilities". It also grants the transportation authorization if the cask is double-purpose, in accordance with the criteria set forth in 10CFR71, "Packaging and Transportation of Radioactive Material". The contents of the documentation submitted by the title holder to the Regulatory Body for evaluation and acceptance correspond, in accordance with 10CFR72, to the contents of Regulatory Guide 3.61, "Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask" (R.G. 3.61).

This licensing model means that a cask has a generalized usage license for storing or for storing and transporting spent fuel, but whenever a specific installation wants to use it, it must request and receive approval for its use on a specific site.

The NRC also follows the "Standard Review Plan For Reviewing Safety Analysis Reports for Dry Metallic Spent Fuel Storage Casks" (UCRL-21137) to evaluate the safety documentation for metallic storage casks. This guideline is divided into a series of chapters, each of which addresses one of the vital safety aspects of the cask. Each of these chapters is subdivided into three sections, corresponding to the areas of review, acceptance criteria and revision procedures. The guideline also includes a chapter regarding the main design criteria, such as: spent fuel to be stored, codes and standards, protection against environmental conditions and natural phenomena, etc.

The United States has no guideline for evaluating metallic casks for spent fuel transportation similar to the storage guideline indicated above, whereas Spain does have a suitable regulation for transportation of hazardous goods, including radioactive materials. Therefore, the design suitability of a cask for transporting spent fuel – B(U) type drum model fissionable class I – was evaluated in keeping with the conditions stipulated in this regulation, which in turn contains the requirements indicated in 10CFR71 as detailed below:

- National Regulation for Hazardous Goods Travelling by Highway (TPC). Ministry of Public Works, Transportation and Communications. Madrid, July 1987.
- Safety Collection No. 6, "Regulation for Safe Transportation of Radioactive Materials". 1990 IAEA Supplement, Vienna, 1985.
- "European Agreement for International Transportation of Hazardous Goods by Highway" (ADR). Ministry of Transportation, Tourism and Communications. Madrid, July 1987.

On the basis of the above, the following licensing model was decided on, which adapts the North American format to the Spanish situation:

1) Design approval, equivalent to the Compliance Certificate issued by the Regulatory Authority in the United States, in accordance with the criteria of 10CFR72. This authorization involves a series of structural, neutronic, thermohydraulic, shielding, etc. specifications, which define the operating conditions and cask surveillance and control requirements, and also regulates the subsequent licensing process.

2) Manufacturing approval, which authorizes the applicant to build the cask, as per Title VII of the Nuclear and Radioactive Installation Regulation currently in force. This authorization addresses quality assurance and manufacturing control.

3) Authorization for using the container at a specific site.

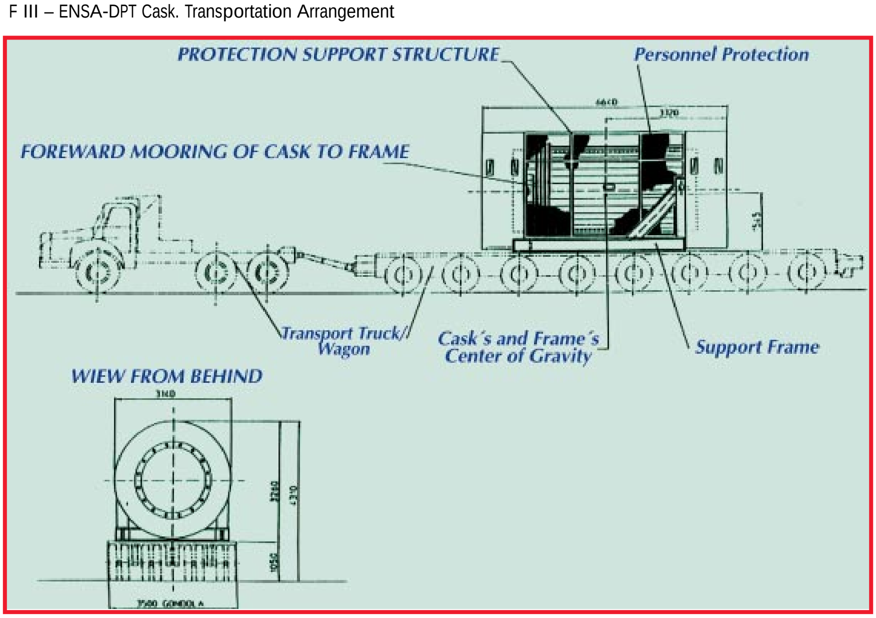
4) Approval or certification of the drum model for transportation, as per the provisions of the above mentioned national regulations on hazardous goods, if the cask is double-purpose.

This article does not cover evaluation of the application submitted by ENSA, in accordance with paragraph 2, for manufacture of metallic casks for storing and transporting spent fuel, which is currently being carried out by the CSN.

EVALUATION SYSTEM

The documentation submitted by ENRESA (References 1 and 2) addresses aspects of nuclear safety and radiological protection that have been evaluated by different specialists in the CSN. Analysis of the safety support documentation for use in storage addressed the general design basis, the acceptance criteria, the analysis methodology used and the areas

F III – ENSA-DPT Cask. Transportation Arrangement



of evaluation for each of the following aspects: thermal-structural, shieldings, criticality, confinement, operating procedures, acceptance tests and maintenance program, radiation protection, accidents, dismantling, operating limits and controls, and quality assurance.

The scope of the transportation evaluation encompasses the same areas as for storage, and therefore many aspects evaluated already for storage were considered as valid for transportation and it was not necessary to repeat their analysis. Logically, certain components or aspects not considered previously, such as the shock absorbers, tests with the model at scale 1/4 and those aspects inherent in radioactive material transportation, were taken into account in this evaluation.

EVALUATION RESULTS

The analysis results established that the ENSA-DPT cask design is suitable for use in spent fuel storage. However, it was considered that the documentation covered by the evaluation should include certain additional considerations. The title holder included these considerations in a new revision of the Generic Safety Analysis for Storage (Rev.3 of March 1997). Subsequently, the Plenary Meeting of the CSN held on June 23, 1997, reported favorably on the ENSA-DPT cask design for use in storage.

After the evaluation of the transport design carried out by the CSN, the title holder included the pertinent considerations in a new revision of the Generic Safety Analysis for Transportation (Rev. 2 of March 1997). Subsequently, the Plenary Meeting of the CSN held on June 23, 1997, proceeded to issue a favorable report on the ENSA-DPT cask design as a B(U)F type transport drum.

Both reports were forwarded to the Department of Industry and Energy for approval of the cask design for use in transportation and storage, as indicated above.

CONCLUSIONS

It can be concluded from the documentation, proceedings, analyses and evaluations that the ENSA-DPT cask design, as described in the documentation submitted by ENRESA (References 11 and 12), fulfills the requirements stipulated by the applicable regulations and ensures safe operation under normal operating conditions. As regards conditions in the event of an accident, it is considered that the maximum amount of radiation on the cask surface and the maximum leak rate admissible on the outside are also in compliance with the applicable regulations. The cask is considered as suitable for safely storing or transporting spent fuel as indicated below:

- Up to 21 intact KWU type 16x16-20 fuel assemblies
- Maximum burn degree of 40,000 MWd/tU.
- Minimum cooling time for each assembly: 5 years.
- Maximum decay heat: 1.16 kW per assembly (24.36 kW per cask).
- Maximum initial enrichment: 4% by weight of U-235.

The cask's identification mark for transportation will be E/077/B (U) F-85, and the valid time limit established for use in storage is 20 years and for transportation 5 years.

By obtaining approval of this cask's design, ENRESA has demonstrated its technical capability to undertake a program for developing metallic casks for storage and transportation of spent nuclear fuel. For the CSN, evaluation of the ENSA-DPT cask has been its first experience in analyzing this kind of nuclear component, which has made it possible, among other things, to perfect new applications of already available calculation codes. In short, it has increased its technical know-how, allowing for subsequent evaluations of similar casks to be carried out more efficiently.

REFERENCES

1. Estudio Genérico de Seguridad (ES-44.3-A Revision 2), September 1994.
2. Estudio Genérico de Seguridad (ES-44.3-T Revision 1), November 1994.
3. Proposed evaluation of metallic casks for irradiated fuel. CSN/SIR/ICCO/CON.MET/5/93.
4. Evaluation guideline of metallic casks for storage of spent nuclear fuel from nuclear power plants. CSN/SIR/ICOO/G.EV/6/93.
5. Evaluation guideline of metallic casks for transportation of spent nuclear fuel from nuclear power plants. CSN/IEV/TEGEN/DPT/TRA/95.07/10.
6. 10CFR72, Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation. Part 72, Title 10.
7. 10CFR71, Packaging and Transportation of Radioactive Materials. Part 71, Title 10 of the Code of Federal Regulations, 1988.
8. Reglamento Nacional del Transporte de Mercancías Peligrosas por Carretera (TPC). Ministerio de Obras Públicas, Transporte y Medio Ambiente.
9. Safety Guideline No. 6, Regulation for the Safe Transportation of Radioactive Materials. 1990 Supplement. IAEA. Vienna, 1985.
10. Acuerdo Europeo para el Transporte Internacional de Mercancías Peligrosas por Carretera (ADR). Ministerio de Transporte, Turismo y Medio Ambiente. Madrid, July 1987.
11. Estudio Genérico de Seguridad (ES-44.3-A Revision 3), March 1997.
12. Estudio Genérico de Seguridad (ES-44.3-T Revision 2), March 1997.

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