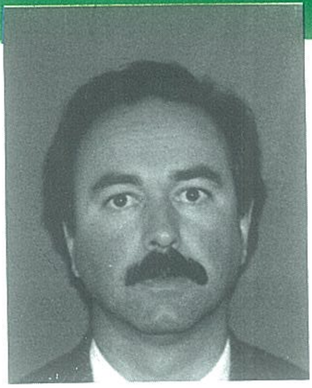

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DRY SHIELDED CANISTERS FOR SPENT NUCLEAR FUEL MANUFACTURED BY EQUIPOS NUCLEARES, S. A. (ENSA-Spain)

E. GONZALEZ - F. TOVAR

Francisco TOVAR is Technical Engineer, specialized on different subjects like materials, termic treatment and solder. He joined ENSA en 1976, where he had been responsible of some projects, i.e. the Dry Shielded Canister. Presently he is manager of the Engineering Documentation Section.

INTRODUCTION

Among the different programs being developed in the USA to solve the problem of spent nuclear fuel storage, Equipos Nucleares has participated as the manufacturer of the "Dry Shielded Canisters" for the NUHOMS system. The basic design has been developed by the US company "NUTECH" of California. The canisters have been ordered by Carolina Power & Light, and with the existing NRC authorization will be used to store spent fuel from the Robinson-2 Nuclear Power Plant in South-Carolina. These canisters will be used as prototypes to monitor adequacy of the design system. The program is sponsored by the designer, the electric company, the Departament of Energy of the United States (DOE) and the Electric Power Research Institute (EPRI).

The final design of the canisters has been developed with the collaboration of the designer, the customer and Equipos Nucleares, as an expert designer and manufacturer of nuclear components.

In a preliminary phase, the program provides for the manufacture of three DS Canisters and their corresponding storage bunkers. Two of these three DS Canisters have been manufactured with complete instrumentation so that the evolution of different variables, mainly temperatures and activity level of the spent fuel, can be monitored during the specified storage period. The data collected from these two DSC will be used to optimize the design of future DSC's.

Also as part of the program, a mock-up has been manufactured consisting of a simulation at full scale of the closing and sealing system of the canisters. This mock-up has proved to be useful to check the adequacy of the design of the closing systems, valves, covers, etc., and also to qualify the welders and welding procedure that will be used for the sealing weld on the container once it is filled with the spent nuclear fuel.

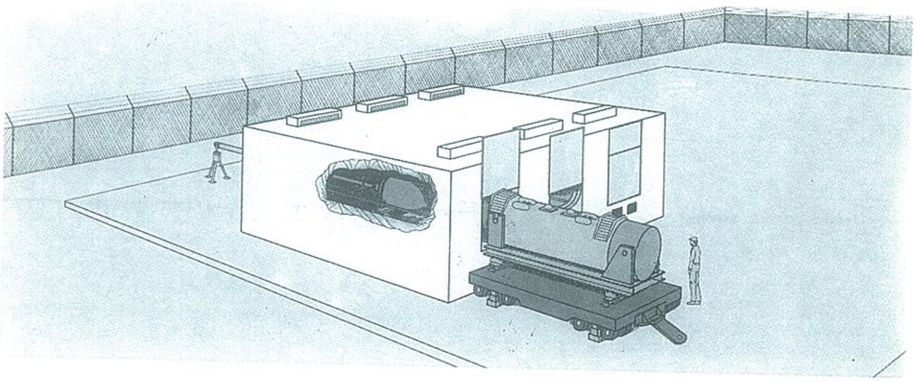
DESCRIPTION OF THE SYSTEM

The Dry Shielded Canister is the fundamental link in the storage scheme, which is made up of the following main components:

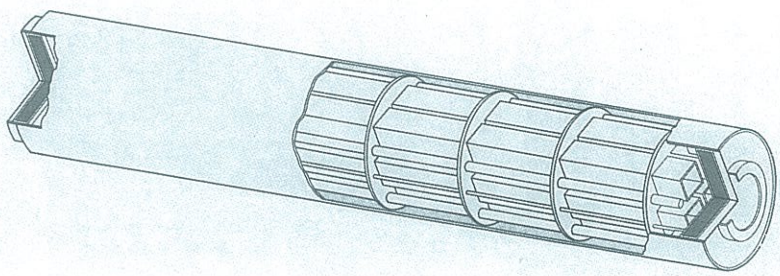
- Storage container (Dry Shielded Canister).
- Transport container (Cask).

– Storage module (Bunker).

The storage procedure can be described as follows:
The Dry Shielded Canister is inserted into the transport container and this assembly is submerged in the pool where the spent nuclear fuel is stored. The spent fuel is introduced into the DS Canister in a vertical position and after inserting the top lead plug, the storage assembly is then lifted out of the pool. An internal air-pressure system ejects the remaining water out of the canister, the cover is then put into place and carefully welded in order to establish a double containment barrier. Finally, the storage assembly is transported in the horizontal position to the storage module site. The storage module (bunker) is a thick walled reinforced concrete containment of great resistance and designed to provide natural air flow to dissipate the heat generated by the nuclear waste and keep the surface temperature of the DSC below 200/250 °C. The whole storage system has been envisaged to withstand any possible event for a minimum period of 50 years.



F I *Insertion of the Dry Shielded Canister into the transport container.*



F II *Dry Shielded Canister.*

DESCRIPTION OF THE DRY SHIELDED CANISTER

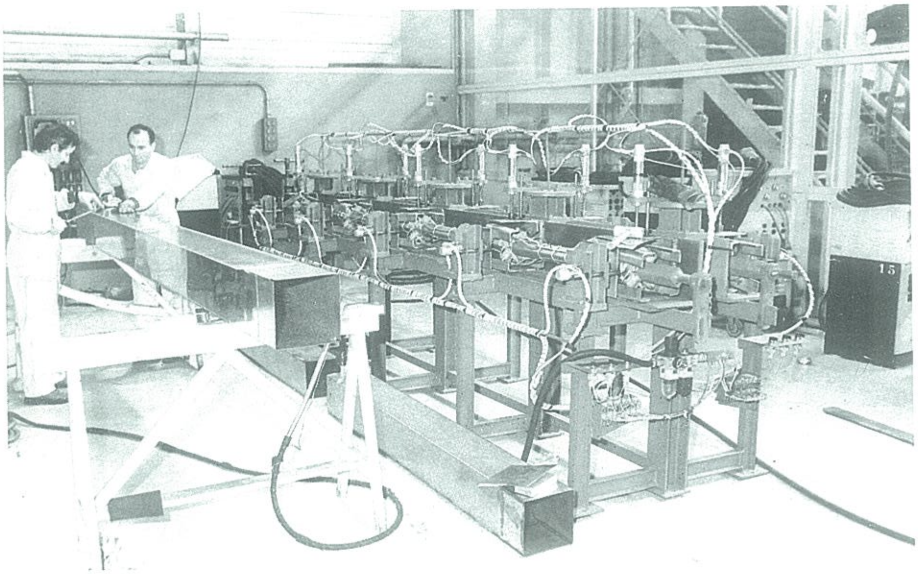
As previously mentioned the DSC is the essential component of the storage scheme and it is made up of five parts:

- Cylindrical shell measuring 1 m in diameter and 4 m long approx.
- End cap manufactured from a hollow cap filled with lead to act as shielding for radiological protection.
- Internal parts subassembly. This is where the spent nuclear fuel shall be housed and is therefore the most essential part of the DSC. It is formed by several discs held together by stiffening bars (support rods) and designed with "windows" to locate the sleeves that are attached to the cut-outs. These sleeves incorporate boron-aluminium alloys that work as neutronic poison to control the fuel activity which will take place inside these sleeves.
- An upper plug as radiological protection, with equivalent characteristics to the ones described above.
- An external cover which is basically a circular plate to achieve the final sealing and with several pieces to link the hydraulic system already described. This hydraulic system is used to manipulate the transport-canister in/out of the storage module.

DRY SHIELDED CANISTER MANUFACTURING

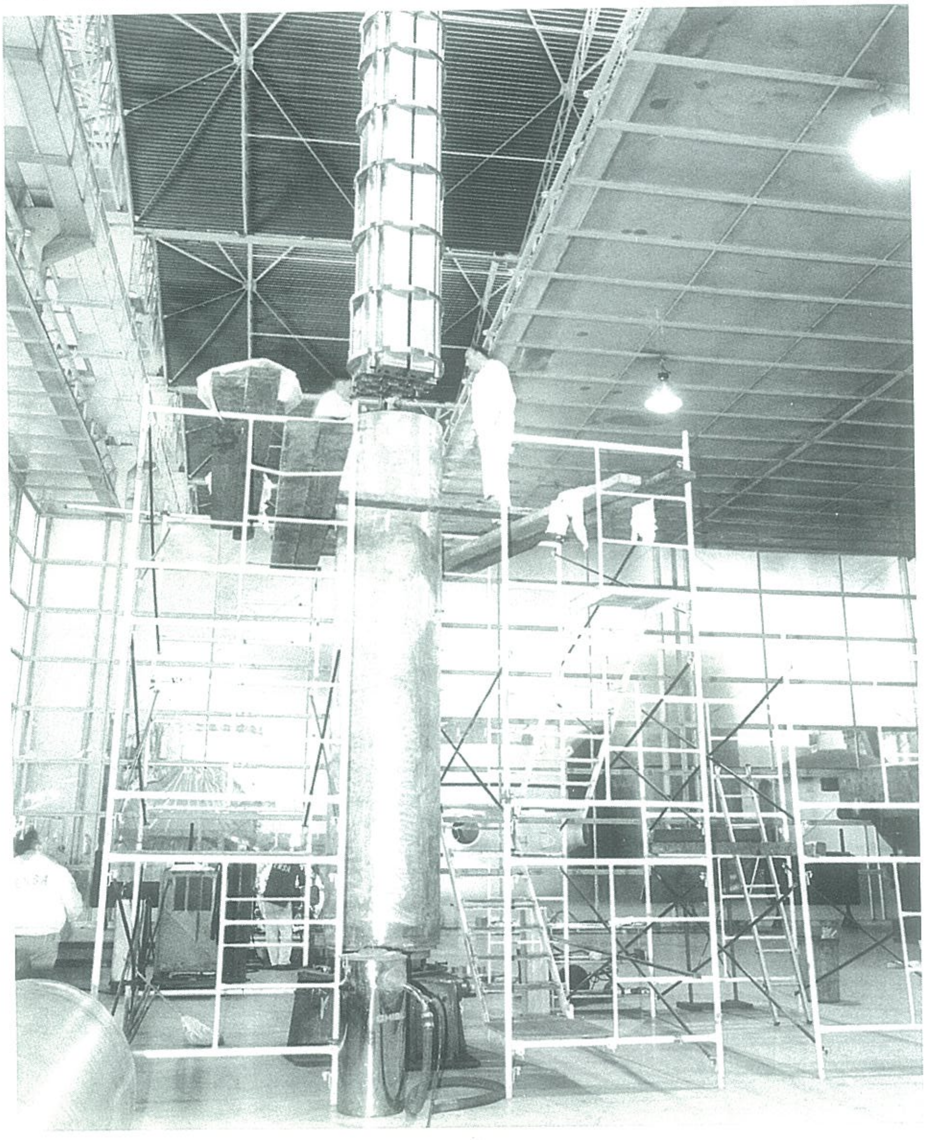
As we are referring to a nuclear fuel container, we have to understand that manufacturing requierements are extremely high. ASME Code Section III-NB has to be fulfilled, that means that homologated material suppliers, manufacturing procedures, qualified welders, qualified non-destructive operators and as a résumé to satisfy all Quality Assurance requirements asked for by this ASME Section. Additionally, it is also required to satisfy the Nuclear regulator 10CFR50 and 10CFR21 requirements.
Further to the above, it is also necessary to point out that due to the fact that we are manufacturing components that have to be located inside the fuel -pool, the cleaning requirements, especially those applying to final assembly, are also extremely stringent. As a result, all these final assembly activities have to be performed inside special "clean areas" separated from other shop-areas, and the operator has to wear clean shoes, cloths and gloves. Even with the above requirements, components have to undergo several cleaning tests to guarantee absence of dirtiness and contamination, especially of the ferritic type.
The main manufacturing steps and the main characteristics of each step are the following:
Material used is stainless steel, mainly type 304 and XM-19 high yield strength steel, lead and boron-aluminium alloys.

After this the shell course is bent and longitudinally welded & the lower cap is added by automatic circumferential welding to form the basket assembly. The lower cap has previously been filled with lead and non-destructively tested to guarantee absence of defects. Internal parts are manufactured and after an accurate machining of the spacer discs, we execute the assembly with the support rods. It is essential to obtain an adequate alignment of the discs to avoid problems with the sleeves in the assembly. To obtain a suitable alignment, it is required to use optical methods and once such alignment has been obtained, the discs are attached with a tool specially designed for this purpose.
This tooling and a sensible control of the heat input will prevent displacements between the discs and the support-rods during further welding operations.
Afterwards, guide sleeves, so called because they will be the guides of the fuel elements when they are put inside the canisters, are assembled. The guide sleeves may be manufactured from square extruded tubes with the boron-aluminium alloys inside (as a sandwich) or from stainless steel sheets enveloped with the boron-aluminium alloys.
It is important to note that these guide sleeves must pass a very stringent test



F III *Sleeves fabrication. Equipment designed by ENSA.*

F IV *Internal parts subassembly.*



before and after their assembly in the spacer discs. This test basically consists of passing a gauge elightly greater than the real fuel element along their entire length which, due to the very small clearances, proves to be a difficult operation.

Once the guide sleeves are assembled with spacer discs and support rods, it is also necessary to assemble several minor parts to complete all the canister internals.

After a very careful cleaning, the internals assembly is ready to be introduced into the basket assembly.

Before the internals are introduced into the basket, it is necessary that the basket assembly complies with several very strict requirements regarding circularity, ovalness, straightness, diameter tolerance, etc., and the internals with other similar requirements concerning cylindricity, alignment, etc., in order to perform this operation without problems.

After the above, it is necessary to check the easy assembly of the upper lead plug and the external cover into the basket in order to avoid any subsequent problems when this operation is performed in the fuel pool.

Finally, it is necessary to paint the lower longitudinal half of the canister with a special lubricant coating so that the canister can slide easily into the concrete bunker. To optimize the coating characteristics, it is necessary to cure the coat by placing the canister in a furnace for several hours.

After final cleaning and very careful preparation for transport the canister is ready for shipment.

At this point, all the certificates produced during the fabrication period must be compiled, which will mak up the "Final Data Package", in which fulfilment of all the above mentioned requirements is certified.

All the above mentioned steps were developed by Equipos Nucleares, S. A. in its Santander factory during the last part of 1986 and he first half of 1987, and the components were shipped in July, 1987.

As we are dealing with a nuclear fuel container, it must be remembered that manufacturing requirements are very stringent. ASME code section III-NB must be fulfilled, which means that homologated material suppliers, manufacturing procedures, qualified welders, qualified non-destructive operators, etc., must satisfy all Quality Assurance requirements stipulated in this ASME Section. Additionally, it is also required to comply with the Nuclear regulator 10CFR50 and 10CFR21 requirements.