Design/Licensing of On-site Package for Core Component

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INTRODUCTION

For storage of used core components which are produced from reactors, Tohoku EPCO decided to construct a site bunker at Onagawa site. It was also decided to develop and fabricate one packaging to transport core components from the reactor buildings to the site bunker.
The packaging will be used within the power station; therefore, it shall comply with "The Law for the Business of Electric Power" and relevant Notification.

The main requirements of the packaging are as follows :

1) The number of contents, such as channel boxes and control rods, shall be as large as possible.
2) The weight and the outer dimensions of the packaging shall be within the limitation of the reactor building and the site bunker.
3) Materials shall be selected from those which have been already applied for existing packagings and utilized without any problems.
4) It shall be considered during design of trunnions that handling equipment, such as lifting beam, can be used for not only this packaging but also for existing spent fuel packagings.

The design of the packaging is completed and has been licensed. The packaging

is scheduled to be utilized from November, 1993.

PACKAGING DESIGN

－CONTENT CONDITION

The contents are channel boxes, control rods and LPRMs which will be loaded with various combinations in the packaging.

Channel boxes and control rods are loaded as they are, LPRMs are loaded which are contained in exclusive boxes after LPRM is cut in 3 or 4 piceses.

The dimensions of contents are shown in Figure 1.

The packaging was designed based on these conditions such as dimensions, weights and the source term of each content.

－SHIELDING ANALYSIS

The basket and basket adaptor are designed so that various combinations of contents are positioned regularly in the packaging. Shielding analyses are performed under conditions of the various combinations of core components, and the shielding thickness is determined based on the results of the most severe condition.

The dose equivalent rates of the packaging are less than 2mSv/hr at the surface and 100μSv/hr at 1m from the surface which are prescribed by the regulation.

The packaging is designed based on the shielding thickness.

The states of some combinations of contents in the packaging are shown in Figure 2. The specification of the packaging is shown in Table 1.

STRUCTURE AND FEATURES

The packaging structure is shown in Figure 3.

The maximum weight of the packaging is 93 tons including contents, a basket and

water inside cavity. It was confirmed that the maximum weight including the weight of a lifting beam is within the maximum load limit of the overhead crane in the building.

In the design process, materials were selected from those which have been already applied for existing packaging without any problems, and the wet type is adopted to decrease shielding thickness. In addition, design without projections such as orifices and shock absorbers are adopted from the results of structural analyses.

The shell and the bottom plate is made of a forged carbon steel with a stainless steel overlay on the inside and the outside to improve the decontamination performance. Additional shielding plates were installed on the inner surface of the shell, and due to the shielding plates the number of the contents can be increased. The shielding plates also serve as a guide when a basket is inserted inside the cavity and serve the function for anti-rotating of the basket.

Trunnions are attached to the outside of the shell with dimensions so that the packaging can be treated by handling equipments for a existing spent fuel packaging, and can be applied to a double lifting from a viewpoint of safety handling. A drain orifice is installed within the shell, which has a structure to ensure sealing performance considering deposits in the cavity during drain operation.

Details of the drain orifice structure are discussed as follows, because of its complexity and originality.

The structure of the drain orifice is shown in Figure 4. The drain orifice has two functions.

The first function is to drain water so that the water level inside the cavity is adjusted after core components are contained in the packaging.

A plug operation tool is attached to part of orifice after the orifice cover and seal plug is removed.

The screw of the orifice plug is loosened to the specified position by turning the handle of the plug operation tool, and then water in the cavity is drained through the holes of the orifice plug. After the specified volume of water is drained, the orifice plug is fastened by turning the handle of the plug operation tool.

The second function is to ensure the sealing performance of the orifice. The sealing performance of the gasket G7 is assured by the gasket G6, the sealing peformance at the drain pass is assured by the gasket G4.

In addition, the gaskets G2 and G4 are prepared as final sealing bounds to ensure the sealing performance considering deposits in cavity.

CONCLUSIONS

1. By various calculations on structural strength, thermal and shielding performance, the packaging was designed. The main specifications are as follows :

   1) Number of Contents : 9 control rods + 16 channel boxes or 52 channel boxes
   2) Maximum Weight : 93 ton (including contents and water inside cavity)
   3) Main Material : Body — forged carbon steel with stainless steel overlay
      Lid — forged stainless steel
      Basket — stainless steel

2. Features of the Packaging are as follows :

1) Large number of contents can be contained.
2) Adoption of materials which has been already applied for existing packaging without any problems and stainless steel overlay.
3) Design without projections such as orifices and shock absorbers.
4) Decrease of shielding thickness due to adoption of wet type packaging
5) Double lifting can be applied from a viewpoint of safety handling.
6) Handling equipment of existing spent fuel packaging can be used.
7) Design of drain orifice to ensure sealing performance considering deposits in cavity.

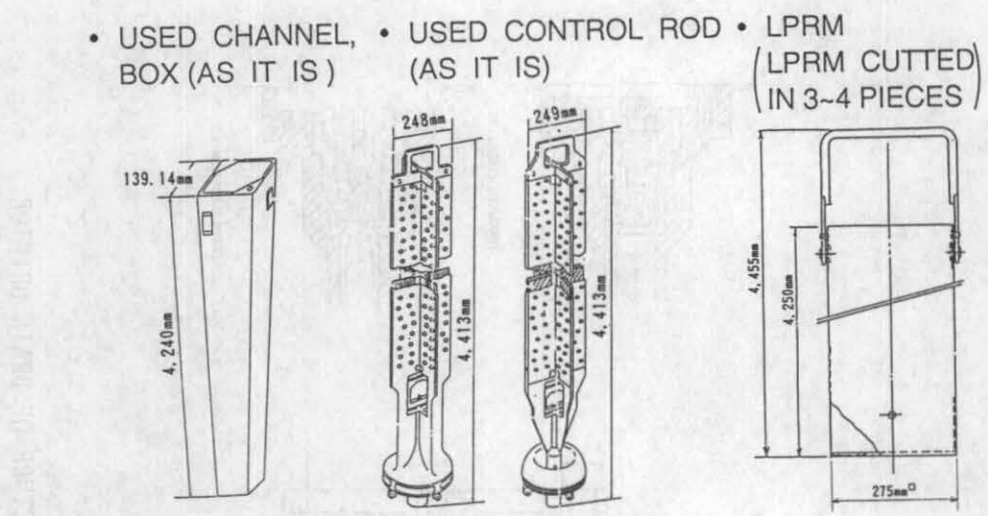

Figure 1. CONDITION OF CONTENTS

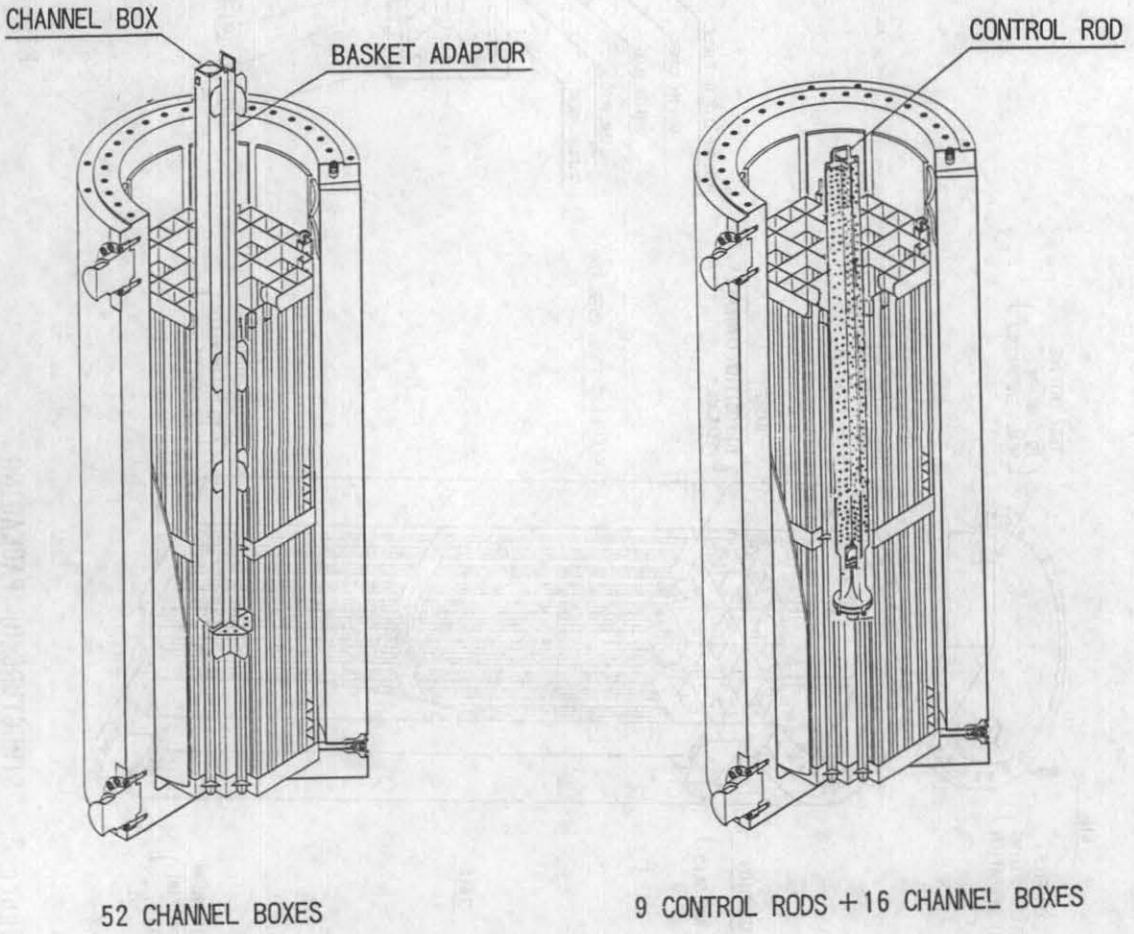

Figure 2. STATES OF SOME COMBINATIONS OF CONTENTS IN THE PACKAGING

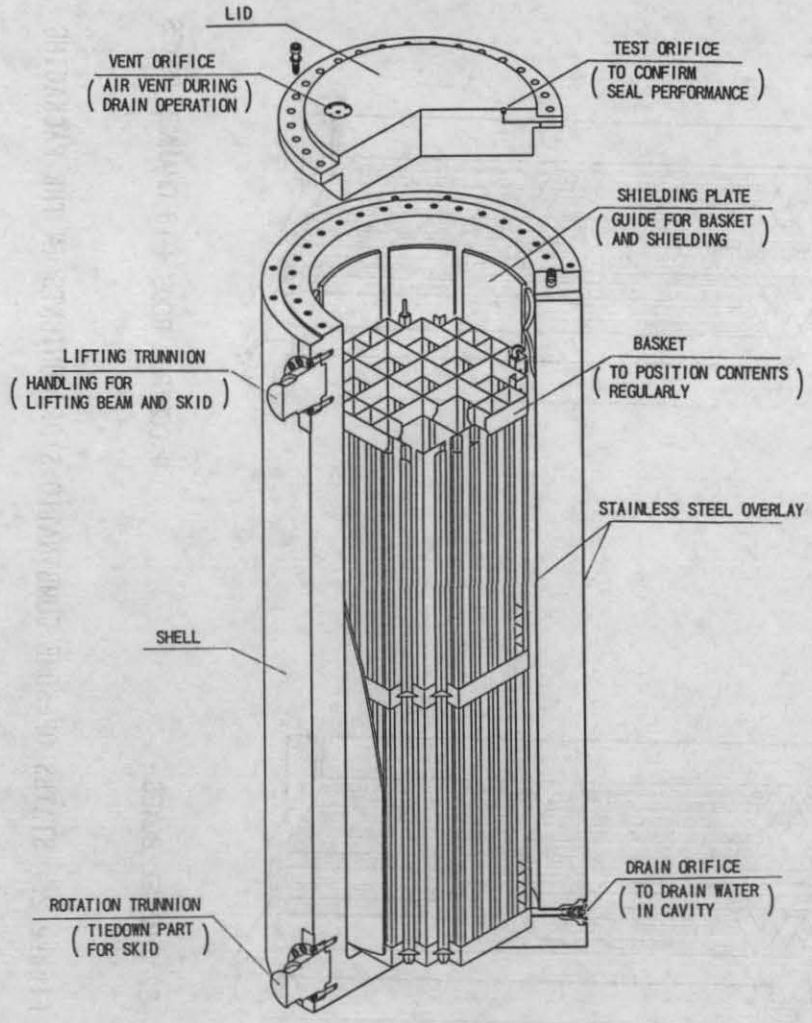

Figure 3. STRUCTURE OF PACKAGING

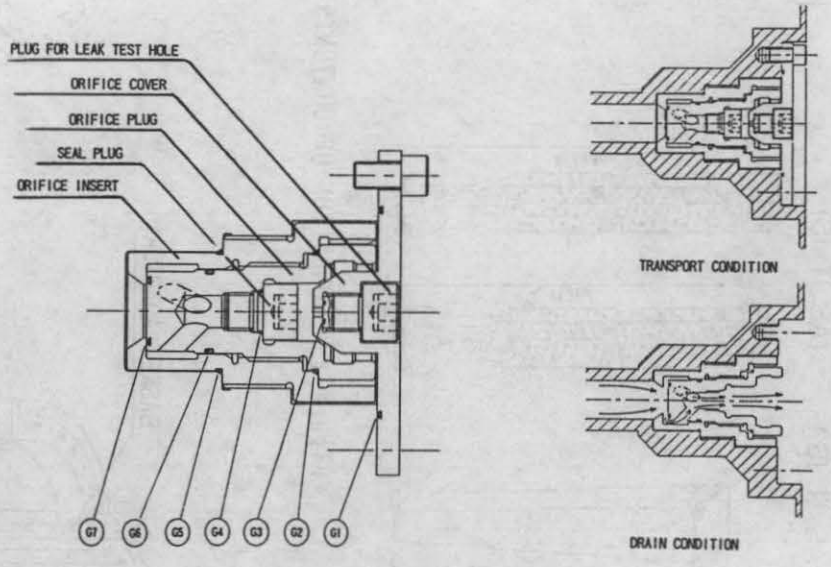

Figure 4. STRUCTURE OF DRAIN ORIFICE

Table 1. SPECIFICATION OF THE PACKAGING

SHAPE		CYLINDRICAL
TYPE		WET TYPE
DESIGN PRESSURE		≦ 7kg/cm² G
SURFACE TEMPERATURE		< 85 ℃
OUTER DIMENSION		2010mm ϕ × 5443mm ℓ
MAIN MATERIAL		SHELL, BOTTOM PLATE—GLF1 OVERLAYED BY STAINLESS STEEL LID–SUSF304 STAINLESS STEEL
WEIGHT		93 TONS (INCLUDING CONTENTS AND WATER INSIDE CAVITY)
CONTENT	CASE 1	52 CHANNEL BOXES
	CASE 2	9 CONTROL RODS + 16 CHANNEL BOXES
	CASE 3	9 BOXES INCLUDING LPRM + 16 CHANNEL BOXES