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PREPARATION AND TRANSPORT OF THE SHIPPINGPORT REACTOR PRESSURE VESSEL/NEUTRON SHIELD TANK PACKAGE

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INTRODUCTION

The Shippingport Station Decommissioning Project is a Department of Energy (DOE) project to dismantle the Shippingport Atomic Power Station. One of the more challenging technical aspects of the Project, which is being managed for DOE by GE Nuclear Energy, is the one-piece removal and shipment of the Reactor Pressure Vessel (RPV) and its associated Neutron Shield Tank (NST) to the government owned Hanford Reservation in Richland, Washington.

DESCRIPTION OF RPV/NST

The RPV is approximately 10 feet in diameter and, with its head installed, approximately 31 feet long. Along with its non-fuel bearing internals the RPV weighs approximately 370 tons, and contains approximately 16,000 Ci of radioactivity, predominately Co^{60} and Fe^{55}. The lower two-thirds of the RPV is surrounded by the Neutron Shield Tank which supports the RPV and provided approximately 3 feet of water for neutron attenuation during Reactor operation. The NST is approximately 18 feet in diameter, and when empty, weighs approximately 71 Tons.

DISPOSAL ALTERNATIVES

An engineering study[1] performed by Nuclear Energy Services, Inc. considered the following alternatives for removal and shipment of the RPV/NST:

1. Segmentation for subsequent Truck Shipments

2. One-piece removal with Barge or Rail Shipment

Although the study indicated that current technology could be utilized to accomplish either alternative, one-piece removal of the RPV was selected as the safest, most cost effective method. When compared to segmentation, it was estimated that one-piece removal would reduce the duration of the Project by 1 year, reduce cost by $4 M, and result in a radiation exposure savings of 150 man-Rem. Rail transportation of an integral RPV/NST package is not feasible due to the physical size and weight of the package.

REGULATIONS

The aforementioned Engineering Study[1] also concluded that a one-piece RPV/NST Package would comply with the Department of Transportation (DOT) definition[2] for Low Specific Activity (LSA) Material. A Safety Analysis Report for Packaging (SARP)[3] has been prepared, consistent with the provisions of NRC Regulatory Guide 7.9, which demonstrates compliance of the RPV Package, in accordance with both DOE[4] and NRC[5] requirements, as a Type B (U) single-use Package. The non-fissle package will be shipped as an escorted, one time shipment by exclusive use vehicle.

PACKAGE PREPARATION

At the time of plant turnover for decommissioning, the fuel and core internals had been removed, the RPV was partially drained, a temporary cover was installed in place of the Reactor Head, and the NST was filled with water. The following discussion outlines the sequence of major events required to prepare the RPV and its NST as an integral, one-piece package:

- Install Core Components - A cost-benefit analysis concluded that the safest, most cost effective approach for transport and burial of the non-fuel bearing core components which were removed during defueling would be to reinsert them into the RPV cavity to take advantage of the available void space within the package. The temporary cover was removed and the water level was raised above the RPV into the refueling canal. The irradiated core components were installed into the RPV cavity and the water level was returned to the initial, partially drained condition.

- Install RPV Head - The 51" thick RPV Head was installed to provide the shielding required to allow complete draining of the RPV with an insignificant increase in radiation levels.

DISCLAIMER

- Install Engineered Fill into RPV Cavity - In order to provide structural support for the core components, increase the structural rigidity of the package, and assure fixation of the contamination layer on the inside of the RPV, approximately 56 yd^3 of engineered fill was installed inside the RPV cavity. RPV Head penetrations were capped and the RPV inlet and outlet piping nozzles were cut inside the plane of the NST outer wall.

- Install Engineered Fill into NST - After draining the NST, approximately 140 yd^3 of engineered fill was installed into the NST and into the annular air space between the RPV and the NST to provide shielding from the irradiated RPV, provide structural support for the RPV Package, and to provide an energy absorber to protect the RPV during hypothetical accident conditions.

- Install Lifting Beam and Skirt - A Lifting Beam and Skirt (LB&S), designed to provide redundant load paths for lift and rotation of the Package, was installed onto the Package. The LB&S complies with the requirements of the DOE Nuclear Standard for Hoisting and Rigging of Critical Components[6], and along with the NST forms the containment boundary for the Package.

- Install Engineered Fill into the LB&S - Approximately 54 yd^3 of engineered fill was installed inside the LB&S to provide shielding from the irradiated RPV, to provide structural rigidity to the Package, and to provide an energy absorber to protect the RPV during hypothetical accident conditions.

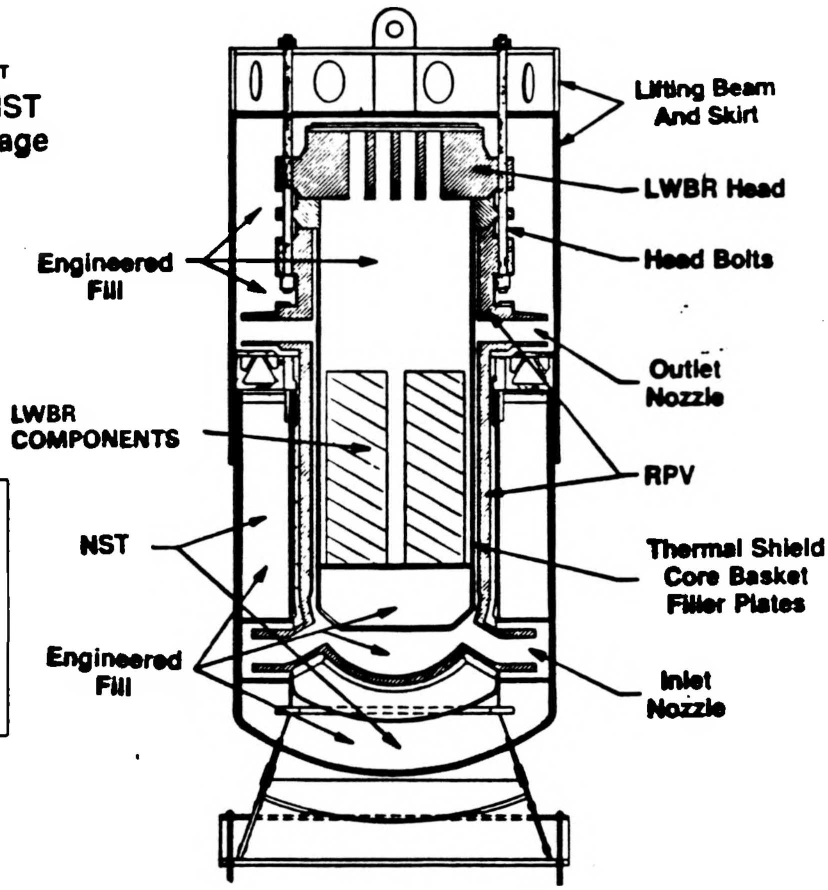
FINAL PACKAGE DESCRIPTION

The final condition of the RPV/NST Package is depicted in Figure 1. The completed package is essentially a monolith which can be structurally described as a concrete cylinder 10 feet in diameter and 26 feet long, surrounded by over eight inches of steel, and encased in three feet of concrete, all confined by a one inch thick outer casing of steel. The resultant package is 41 feet long, 18 feet in diameter, weighs approximately 1,000 tons, and has an average specific activity of <0.02 mCi/gm. The package has been demonstrated[3] to comply with Federal Regulations for a Type /B(U) Package and is capable of withstanding any credible accident to which it may be subjected during its transport with insignificant resultant radiological consequences to the public or the environment.

SHIPPINGPORT STATION
DECOMMISSIONING PROJECT

Shippingport RPV/NST Transportation Package

FIGURE 1



DIAMETER	18 FT
HEIGHT	41 FT
WEIGHT	1000 TONS
ACTIVITY	16,000 Ci
-50% Co^{60}	
-50% Fe^{55}	

REMOVAL AND TRANSPORT

The work required to remove the RPV/NST Package from its current location 63' below grade at Shippingport, Pa. and transport it to its burial location at the Hanford Reservation in Richland, WA has been divided into the following operations.

- Lift RPV/NST Package and Load on Barge - The RPV/NST Package will be vertically lifted from the reactor enclosure by use of a specially designed lifting tower, placed on a land transport vehicle, and loaded onto a barge located at a temporary barge loading facility at Shippingport on the Ohio River. References 7 through 12 have been utilized to establish the technical design criteria for the evolution.

The lifting mechanism in the tower will consist of four 600 Ton capacity, hydraulically operated center hole jacks which are rigged to the LB&S lifting lugs. Once the tower has been load tested, the RPV/NST package will be lifted approximately 77 feet, and moved horizontally approximately 43 feet using the lifting tower trolley to a position above the land transport vehicle. The package will be lowered onto a shipping cradle/upending fixture attached to the land transport vehicle and rotated from its vertical orientation to the horizontal orientation. After removing the LB&S lifting lugs and the lower support cone, the package will be secured to the shipping cradle and to the land transport vehicle, a trailer with 320 rubber tires, each pair being hydraulically suspended to equally distribute the weight of the vehicle onto the roadway surface.

Once the package has been secured to the land transport vehicle, it will be transported over a specially prepared road to the barge facility and onto the grounded barge. The land transport vehicle will be lowered directly onto barge deck using its hydraulic suspension system. The shipping skid and the transport vehicle will be attached to the barge deck and to each other using fastenings designed to meet the design criteria of the ANSI Standard for Barge Transportation of Highway Route Controlled Quantities of Radioactive Material[13].

- Barge Transportation - The 200 feet long, by 54 foot wide barge of 1877 ton dead weight capacity with a maximum draft of 9 feet loaded with the RPV/NST package will be debalasted and pushed by river towboat down the Ohio and Mississippi Rivers to New Orleans. At the mouth of the Mississippi River, the river towboat will be replaced by an ocean-going tug, which will tow the barge across the Gulf of Mexico and Caribbean Sea, through the Panama Canal and up the west coast of North America to Astoria, Oregon. In the vicinity of Astoria, the ocean-going tug will be replaced by another river towboat for the voyage up the Columbia River to Richland, Washington where the barge will be ballasted and grounded at the Port of Benton barge facility.

- Hanford Transportation - After removing the attachments between the shipping skid and the barge, the land transport vehicle's hydraulic suspension system will be used to lift itself and the package off the barge deck and to transport the package approximately 26 miles to the DOE Hanford Reservation. The package will be winched off the land transport vehicle onto a loading pad in a trench prepared for its ultimate resting place.

SIGNIFICANCE

This is the first application of one-piece removal and barge transport of an irradiated commercial nuclear reactor pressure vessel. Its potential application to future decommissionings would appear to provide significant cost, schedule and radiation exposure savings over the more conventional segmentation methods.

REFERENCES

1. SSDP Decommissioning Plan, Engineering Study 3.2

2. 49 CFR 173.403, Part n.

3. Safety Analysis Report for Packaging (SARP) for the Shippingport Reactor Pressure Vessel/ Neutron Shield Tank Package; Docket No. 87-7-9515

4. DOE Order 5480.3.11 (a-i), and .12 (a-d).

5. 10 CFR 71.43 (a-h), .45 (a & b), and .47.

6. NE-F-8-6T: Nuclear Standard - Hoisting and Rigging of Critical Components and Related Equipment, dated November 1985.

7. ANSI A58.1 - Building Code Requirements for Minimum Design Loads in Buildings and Other Structures

8. ANSI B30 - Safety Standards for Cableways, Cranes, Derricks, Hoists, Hoods, Jacks & Slings

9. AISC - American Institute of Steel Construction

10. ACI - American Concrete Institute

11. AWS D1.1 - American Welding Society D1.1-84 "Structural Welding Code"

12. NE-F-86T - Nuclear Hoisting & Rigging of Critical Components & Related Equipment

13. ANSI N.14.24-1987 - American National Standards Institute (1985) "American National Standard of Highway Route Controlled Quantities of Radioactive Materials - Domestic Barge Transport"