R- & P- REACTOR VESSEL IN-SITU DECOMISSIONING VISUALIZATION
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The R- & P- Reactor facilities at the Savannah River Site (SRS) have become obsolete and are no longer needed for their intended missions. As part of the Department of Energy's Decommissioning & Decontamination (D&D) activities at SRS, both reactor buildings have been identified for decommissioning. Of significant interest are the reactor vessels at the heart of the buildings. Plans are to grout the vessels to the maximum extent practical and to then place a seven foot cap over the top. The Savannah River National Laboratory (SRNL) has assisted with vessel visualization through the development of 3D CAD models and scale physical models developed in the SRNL Rapid Prototyping Laboratory.

I. INTRODUCTION

The R- & P- Reactor facilities were constructed in the early 1950's in response to Cold War efforts. The mission of the facilities was to produce materials for use in the nation's nuclear weapons stockpile. R-Reactor was removed from service in 1964 when President Johnson announced a slowdown of the nuclear arms race. P-Reactor continued operation until 1988 until the facility was taken off-line to modernize the facility with new safeguards. Efforts to restart the reactor ended in 1990 at the end of the Cold War. Both facilities have sat idle since their closure and have been identified as the first two reactors for closure at SRS.

The closure technique for the reactor buildings is called In-Situ Decommissioning (ISD). In this method, the building will be filled with grout up to grade to encapsulate any residual debris and structurally stabilize the building, demolish select portions of the above grade building, and capping the area with a concrete slab. The reactor vessels themselves will be filled with grout to the maximum extent practical and then have a concrete cap placed over the top of the vessel.

SRNL has assisted site D&D by developing 3D models of the reactor vessels from engineering drawings, using models to determine fill volume estimates, and creation of a 1:8 scale model of P-Reactor for visualization and work planning.

II. REACTOR VESSEL MODELING

R- & P- Reactors are classified as heavy water production reactors and were the first two of their kind and are nearly identical in design (See Figure 1). In a heavy water reactor moderator water is used both for cooling and moderating the nuclear reaction. Both vessels were designed to flow upwards of 80,000 gpm. Models of the vessels were developed from legacy engineering drawing originally developed in the 1950's. Due to the nature of design techniques at that time and limitations in reproduction techniques the drawings themselves were very difficult to decipher and interpret. In addition, due to the amount of time that has passed since the closure of the reactors nearly all of the knowledge about the vessels themselves has either moved on or retired. An intimate knowledge of the reactor vessel internals was necessary in order to develop a feasible plan to grout the vessel.

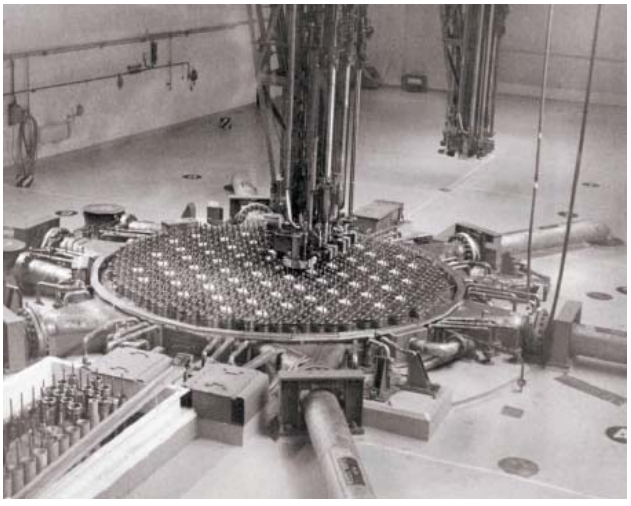

Fig. 1 - Topside of reactor vessel plenum from Process Room with charging & discharging machines at work

Pro Engineer was used to develop the models of the reactors. The design of the permanent systems in R- & P-Reactor vessels are identical and are shown in Figure 3.

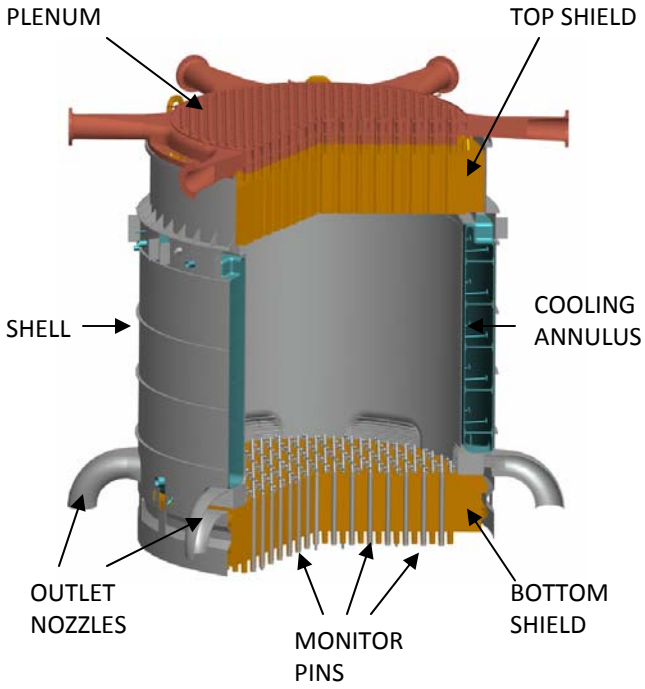

Fig. 2 – Reactor Vessel Cross-Section

When R-Reactor was taken off-line the design of the components for the reactor internals continued to develop. Because of this, the configurations which R- & P-Reactors were left in differ.

All of the reactors used similar components inserted in differing locations in the reactor plenum. A list of these components and a brief description is provided below:

- Universal Sleeve Housing (USH) – The USHes contained the varying fuel and target assemblies. These occupied the majority of the reactor locations

- Sparger – The spargers were located at six central locations in the reactor and mixed the cooling/moderator water within the reactor with jets located along the length of the assembly. In an emergency the spargers were able to inject a neutron poison to kill the reaction

- Septifoil – The septifoils contained the control rods and were used to control and shape the radiation field

- Thimble – Thimbles were smaller tubes that contained either safety rods or instrumentation

- Semi-Permanent Sleeve – The semi-permanent sleeves were tubes within the permanent plenum tubes which fuel/target assemblies were inserted into. In the event of an emergency the entire semi-permanent sleeve could be removed from the reactor. These eventually were replaced by the USH. R-Reactor is the only SRS reactor which currently contains semi-permanent sleeves.

- Gas port – Gas ports are semi permanent sleeves which isolate plenum volume from the tube location preventing cooling water from entering that location. The gas ports also have bars along the bottom of the tube which prevent a fuel assembly from being inserted into the non-cooled location.

- Long Plenum Plugs (LPP) – LPPs are aluminum plugs which isolate the plenum from the tube location which they occupy.

II.A – Reactor Configurations

The as-left state of P- & R- Reactors differs significantly in the types of rods and instruments that were left inside the reactor. The configurations of each reactor can be seen in Figures 3 - 6.

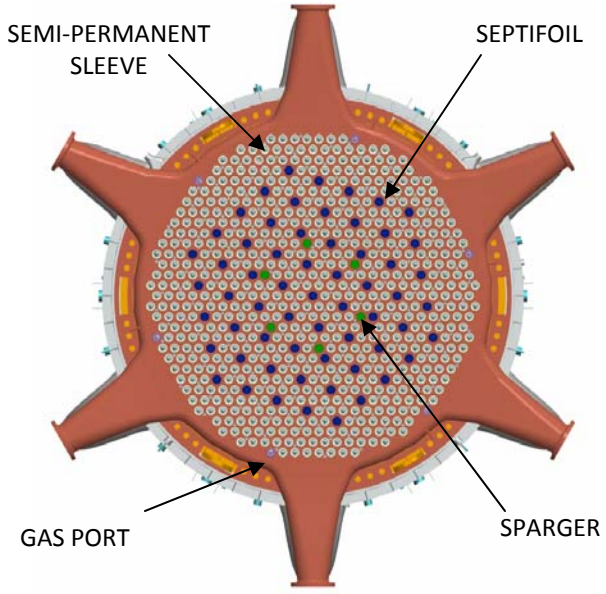

Fig. 3 - R-Reactor Top View

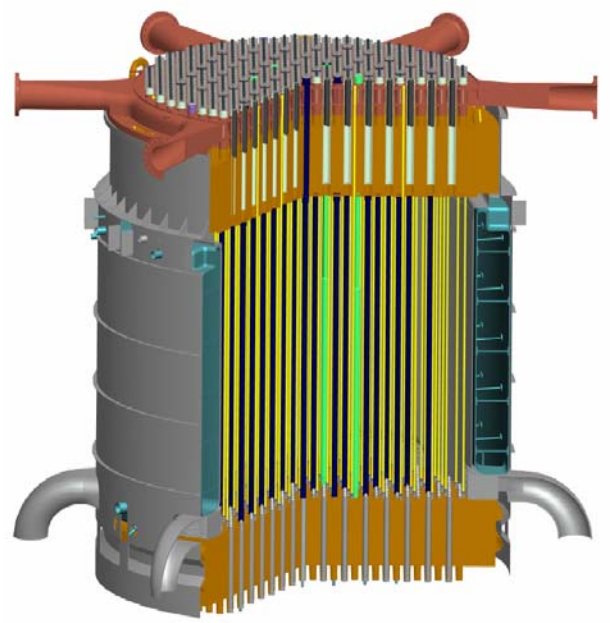

Fig. 4 – R-Reactor Cross-Section

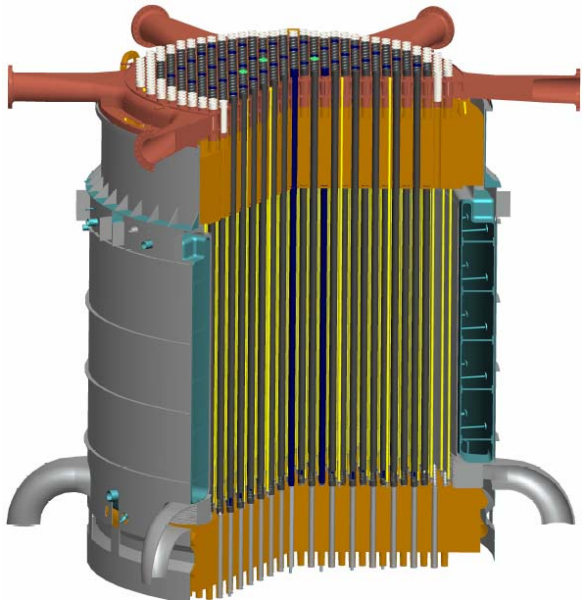

Fig. 6 – P-Reactor Cross-Section

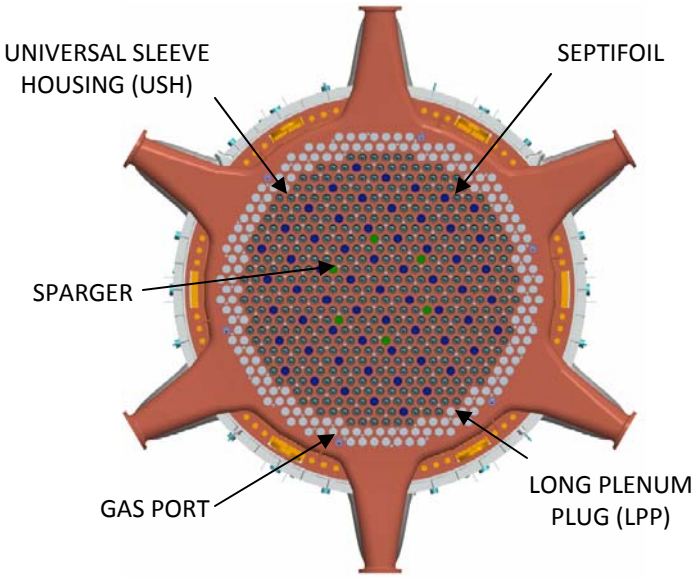

Fig. 5 – P-Reactor Top View

III. REACTOR VESSEL RAPID PROTOTYPING

To prepare for final grouting of the reactor vessels it was desired to develop the CAD models of the vessels themselves to help with visualization. This is the first time that any 3D CAD system had been used with the SRS reactors. The models were developed from legacy fabrication drawings originally developed in the 1950's. From the CAD models it was possible to develop actual plastic models with the use of SRNL's rapid prototyping (RPT) capabilities. The maximum size of piece that the RPT machines are capable of producing is 16"x16"x16". By looking at the smallest feature desired to be shown in the RPT model a scale of 1:8 was selected. This drove the reactor model to be made from 50+ parts individually made and glued/pinned together. Figure 7shows how the vessel shell & annulus were sliced up to be fabricated. Figures 8 through 11 show the reactor vessel at various stages of fabrication.

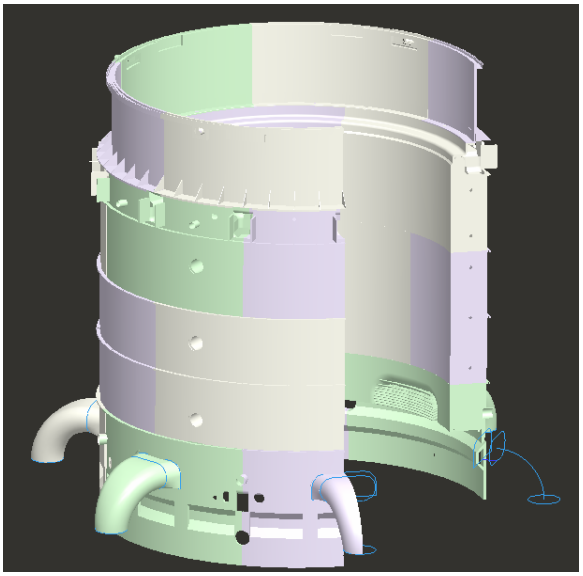

Fig. 7 – Model sectioned for RPT fabrication

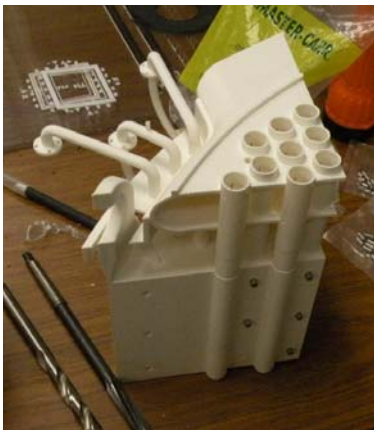

Fig. 8 – Individual Top Tube Sheet section

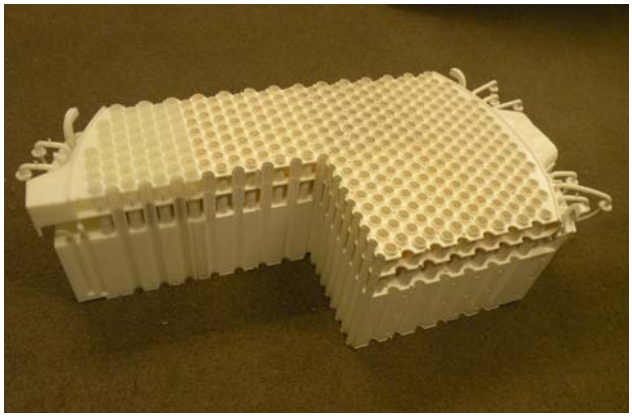

Fig. 9 – Partially assembled Top Tube Sheet

Fig. 10 – Assembled Shell/Annulus

Fig. 11 – Assembled Reactor Vessel (w/o inserts)

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