Latest Experience from José Cabrera Reactor Vessel Dismantling Project - 15214

Per Segerud, Joseph Boucau, Stefan Fallström
Westinghouse Electric Company

ABSTRACT

Westinghouse is performing a decommissioning project at the José Cabrera NPP in Spain. The project was awarded in June 2013 and the main scope is to cut and package the reactor vessel and the reactor vessel head. The project is performed in the necessary sequential steps needed to prepare, segment, separate, and package the individual component segments using under water mechanical techniques. The first activities to be performed on site included e.g. cutting of all pipe penetrations on the reactor, sealing of some of the pipe penetrations, lifting and transportation of the reactor and sealing of the reactor pit. The results of these activities were very good and gave a perfect foundation for the cutting and packaging of the reactor vessel. Cutting of the reactor vessel head and the reactor vessel is made with different types of Westinghouse designed cutting equipment. The flexible nature of the cutting equipment has proved to be very valuable for the execution of the cutting work. The project is planned to be finalized in April 2014.

INTRODUCTION

In June 2013, ENRESA (Empresa Nacional de Residuos Radiactivos) awarded Westinghouse Electric Company a contract for the dismantling of the reactor vessel (RV) and the reactor vessel head (RVH) at the José Cabrera Nuclear Power Station. It is a small single loop Pressurized Water Reactor (PWR) of 160 MWe that was in operation between 1968 and 2006. The Power plant is located in Almonacid de Zorita, 43 miles east of Madrid, Spain. José Cabrera will become the second commercial NPP (after Vandellos 1) to be dismantled in Spain. This contract is in full synergy with another award related to the segmentation of the Zorita reactor vessel internals (RVI) and operational waste [1].

SCOPE OF WORK

The contract scope covers the dismantling and segmentation of the RV and RVH, including the upfront engineering studies. It also includes some necessary plant modifications, the supply of equipment and the loading of the primary and secondary waste, respectively, into dedicated containers for low- and intermediate-level waste (LILW). Before leaving site, the pool environment will be restored to the initial condition and all equipment will be decontaminated and shipped off site.

DESCRIPTION OF COMPONENTS TO BE CUT

The objects to be segmented are the reactor pressure vessel and the reactor vessel head. The height of the reactor vessel is around 7,4m and the weight is about 100 ton; corresponding figures for RVH are 1,5m and 19 ton. The components are categorized as LILW. Fig. 1 below shows the RV and the RVH with main dimensions.

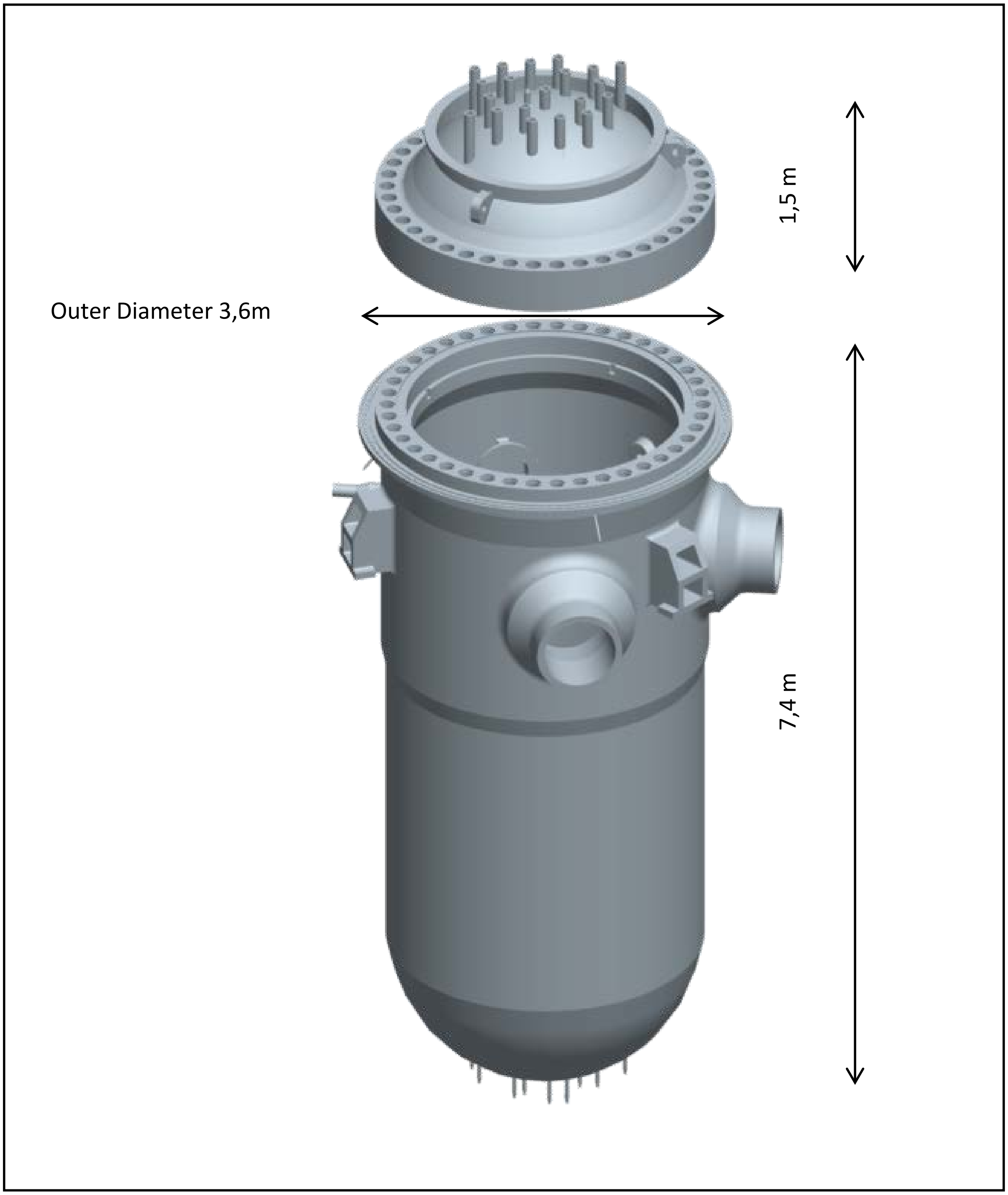

Fig. 1. Reactor vessel and reactor vessel head

DESCRIPTION OF WASTE CONTAINERS

The waste containers are very essential in a segmentation project as they set the boundaries for the size of the pieces that can be cut. The Spanish waste containers that will be used in this project for LILW are so called CE-2A and CE-2B containers and are shown in Fig. 2 below.

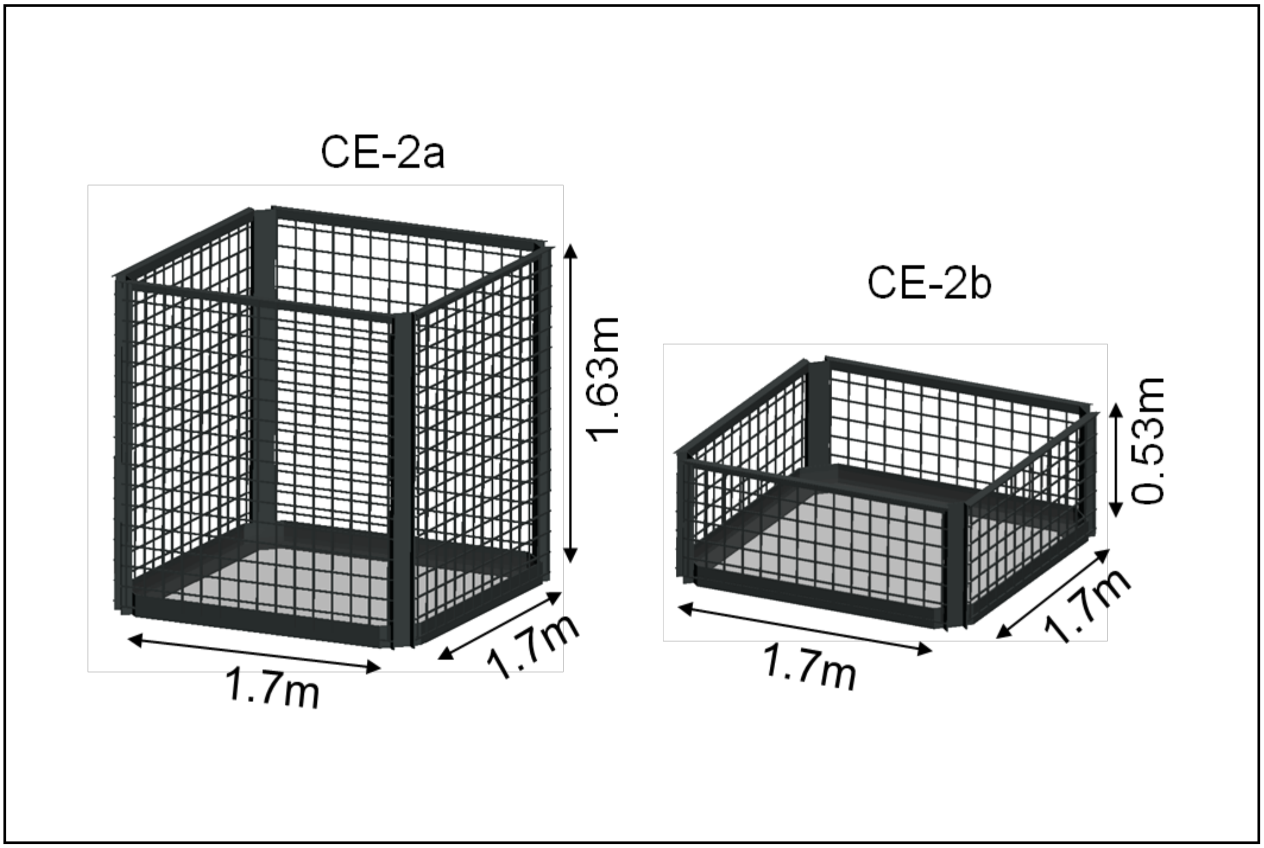

Fig. 2. Waste containers

DESIGN ACTIVITIES

As all segmentation projects, this project must be thoroughly planned together with the customer. The radiation level of the components and complexity of the site work has to be foreseen in all aspects and all procedures and design of advanced tools has to be tested and qualified before the work on site starts.

The first 6 months of the project was dedicated to engineering studies, design work and manufacturing of equipment needed to perform the work. Detailed 3-D modeling is the basis for tooling design and provides invaluable support in determining the optimum strategy for component cutting and disposal in waste containers, taking account of the radiological and packaging constraints. Equipment and personnel were thereafter qualified in a specially designed test facility before the equipment was sent to site. The chosen strategy for the cutting work, which was also favored by the customer, was mechanical cutting.

QUALIFICATION

Most of the segmentation tools to be used in this project were previously used with great success in the segmentation of the reactor vessel internals (finalized in November 2013). The qualification was therefore limited to the new tools and equipment that was developed specifically for this project. The qualification of wire cutting equipment was performed in Westinghouse test facility in Västerås where 1:1 scale mockups had been manufactured. The mockup testing is an important step in order to verify the function of the equipment and minimize risk on site. When the qualification was approved by the customer, the equipment was transported to site.
The lifting and transportation of the reactor vessel from the pit to the cutting position in the spent fuel pool was a very crucial step in the project that was also qualified before performing this activity on site. The lifting and transportation equipment were qualified in Spain.

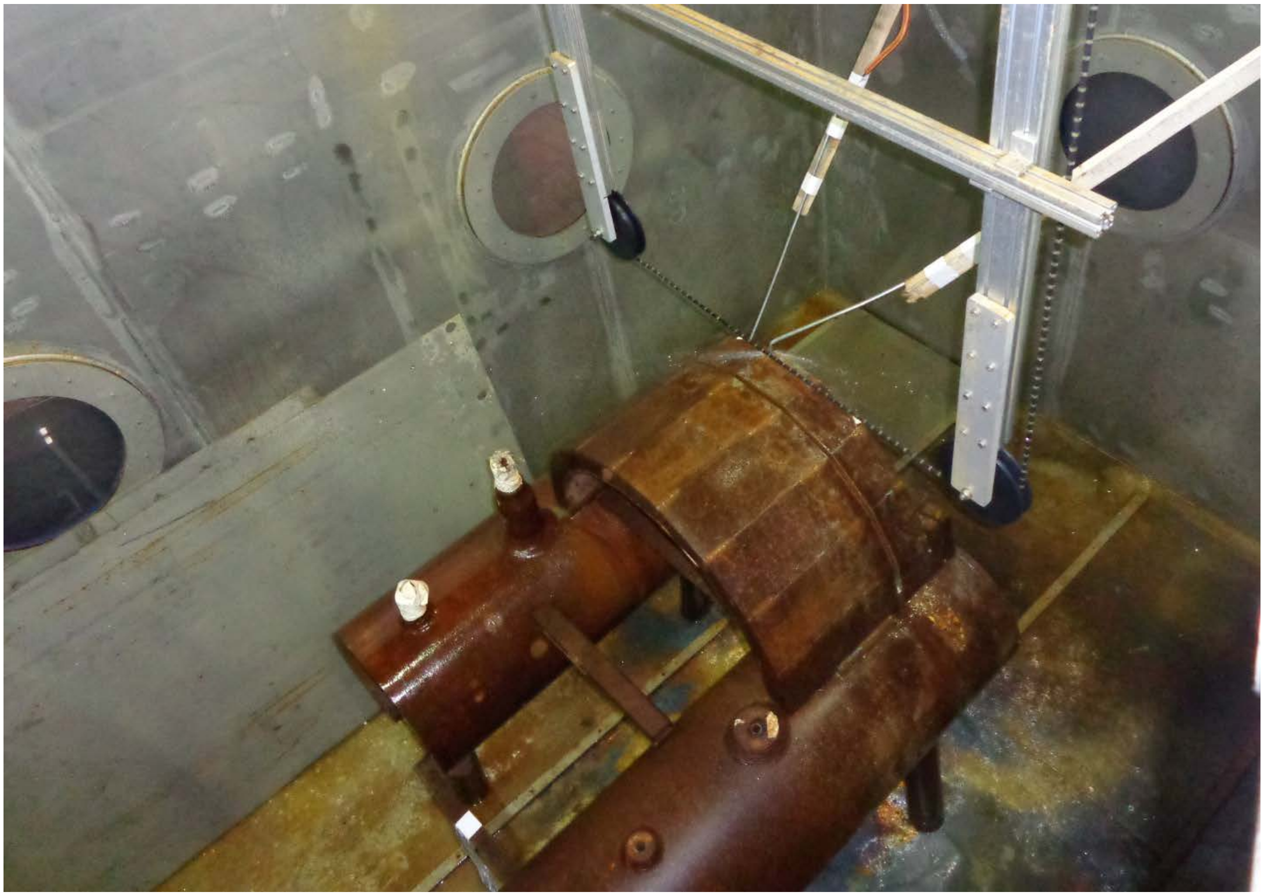

Fig. 3. Qualification of wire cutting equipment in Västerås

CUTTING OF REACTOR VESSEL HEAD

The first activity that was performed was the cutting of the reactor vessel head. This component was placed onto a turntable in order to facilitate the cutting. The cutting of the 19 ton heavy RVH was mainly performed with a band saw placed on the pool floor, see Fig. 4. Some cuts were also performed using disc cutting technique. The band saw equipment that was used had previously been used for cutting the RVI, the new challenge was to cut through thick carbon steel with stainless cladding. The cutting operation went well and the RVH was cut in 26 pieces that were packaged into 3 CE-2a containers. The cutting of the RVH served also as qualification of the band saw equipment that was to be used for cutting the RV.

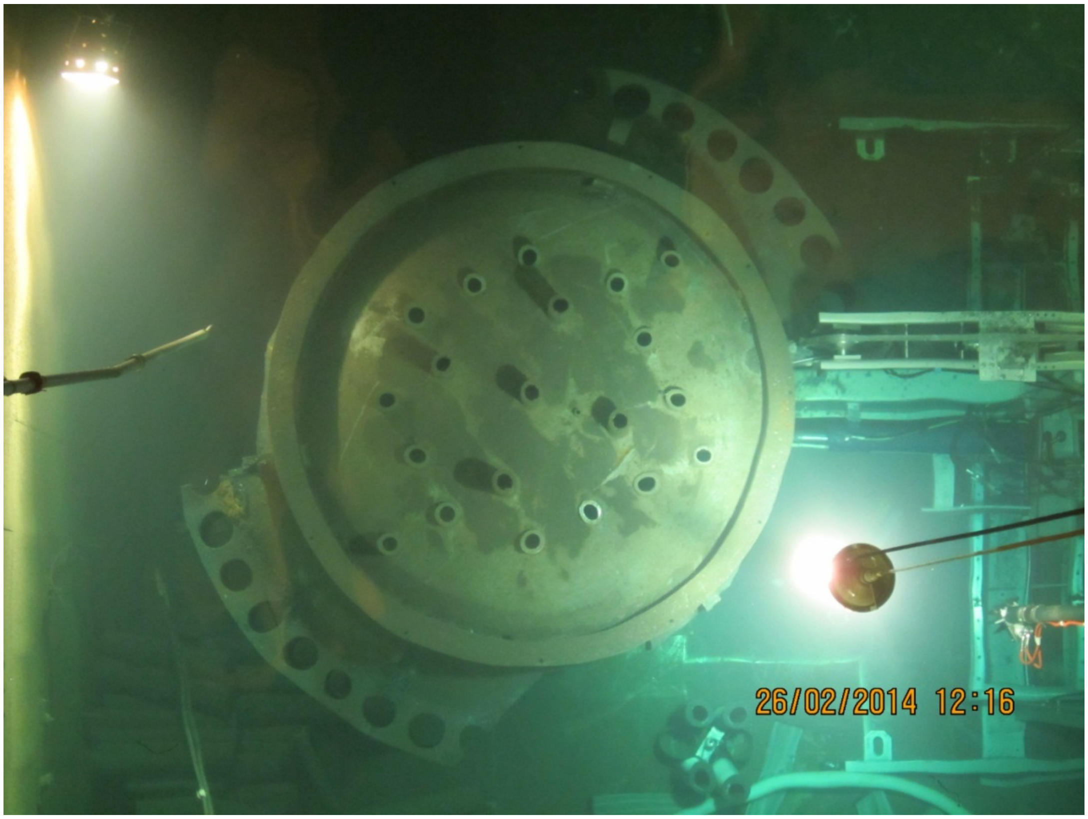

Fig. 4. Cutting of RVH

PREPARATORY ACTIVITIES

A number of activities had to be performed before the actual cutting of the reactor vessel could start: e.g. .cutting of all pipe penetrations on the reactor, sealing of some of the pipe penetrations, cutting of the reactor vessel insulation, lifting and transportation of the reactor and sealing of the reactor pit. These activities were performed in the spring 2014.

The first thing that was done was to cut the concrete around the vessel pit, this was done in order to access the primary piping from above and to enable the lifting of the vessel at a later stage. In parallel with this work, the instrumentation tubes in the bottom of the reactor vessel was cut and the bottom insulation was removed. The primary piping was cut with a wire saw, see Fig. 5 below.

Fig. 5. Cutting of primary piping (left) RV bottom with insulation removed (right)

Next step was to install the lifting and transportation equipment for the reactor vessel. The equipment was needed as the gantry crane on site has a load limit of 70 ton. The vessel that was lifted was water filled up to the primary piping and weighed around 150 ton. The insulation around the vessel was removed manually as the vessel was lifted up from the pit. The vessel was transported through an opening between the reactor cavity and the spent fuel pool and placed in a specially designed stand, see Fig. 6 below.

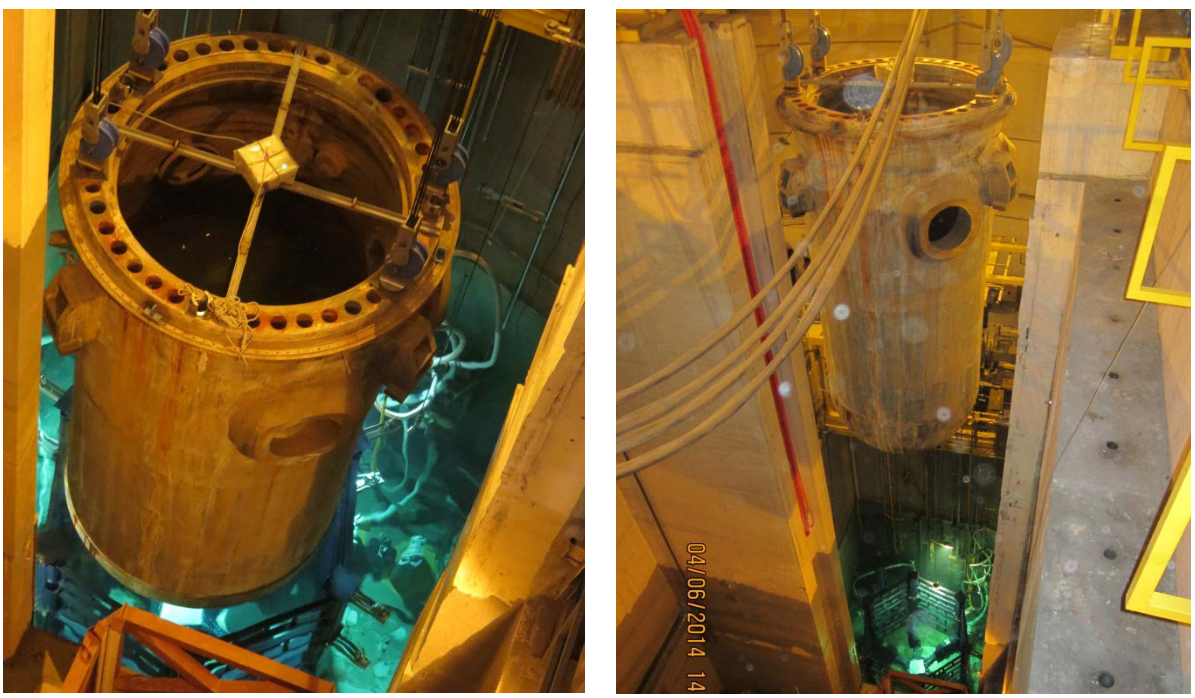

Fig. 6. Lifting and transportation of reactor vessel

When the vessel was placed on the stand, next step was to seal the pit in the reactor cavity so that the water level could be raised to a normal water level in order to minimize the dose exposure for the personnel.

CUTTING OF REACTOR VESSEL

The first step of the cutting was to cut the instrumentation tubes on the inside of the vessel, this was done with a disc saw equipment, next was to cut a hexagon hole in the bottom of the vessel and install a band saw placed on a column in the center of the vessel. The band saw concept was very similar to the concept used to successfully cut the Lower internals at José Cabrera the year before. The same equipment was used with minor modifications. The first cut with the band saw in the top flange was made in the middle of August 2014. Cutting continued and the cut pieces were packaged as they were removed. The 100 ton heavy RV is planned to be cut into more than 100 pieces, weighing in average 1 ton per piece. At today´s date (2015-01-09), about two thirds of the RV weight has been cut and packaged, see Fig. 7 below. The cutting work is scheduled to be finalized in March 2015.

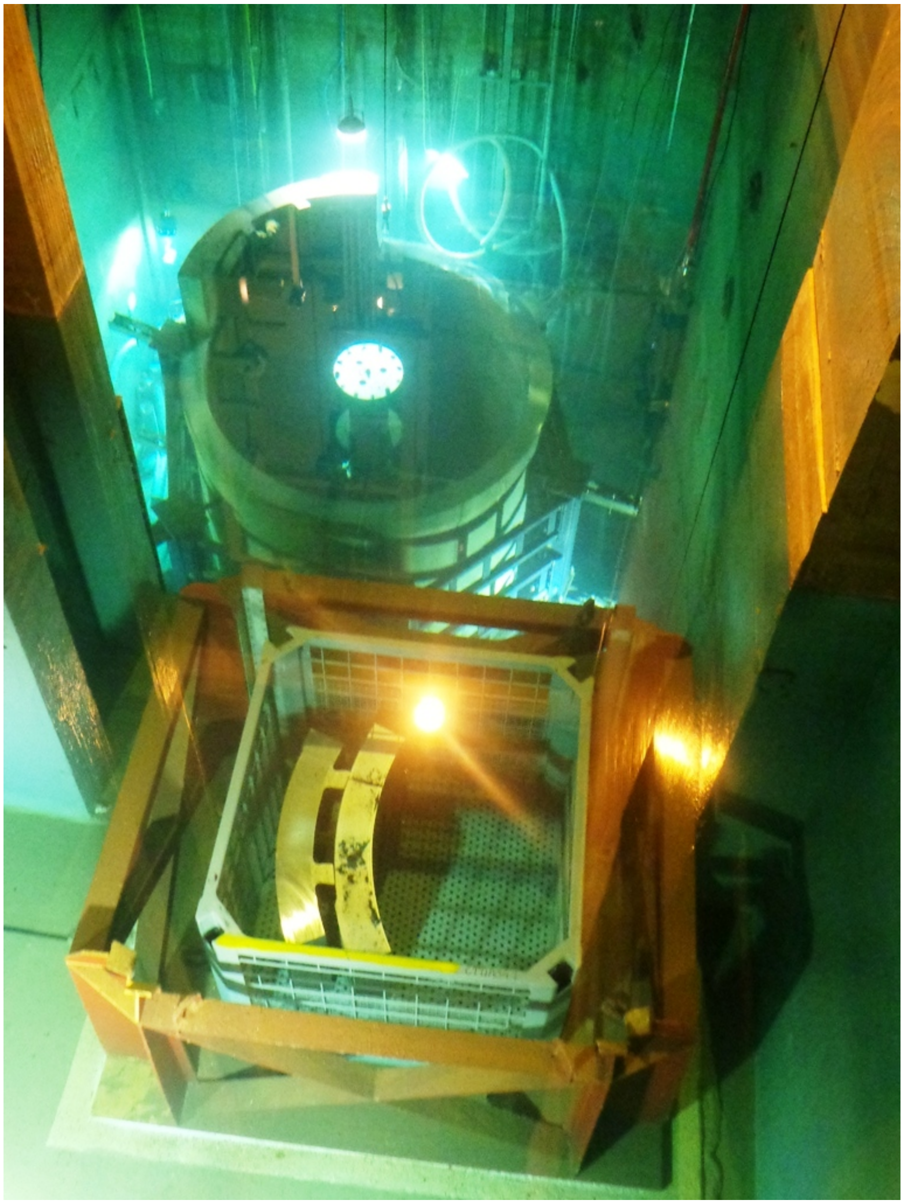

Fig. 7. Reactor vessel and waste container with cut pieces

PACKING OF WASTE

The cut parts were packaged in LILW waste containers called CE-2A and CE-2B. The waste was packaged and transported out of the pool continuously as the waste was produced. An optimization of the cutting time versus the number of containers have been done by Westinghouse to get a cutting and packing plan that is as cost efficient as possible. An underwater gamma characterization of the activated cut pieces has also been done to further validate the packing plan.

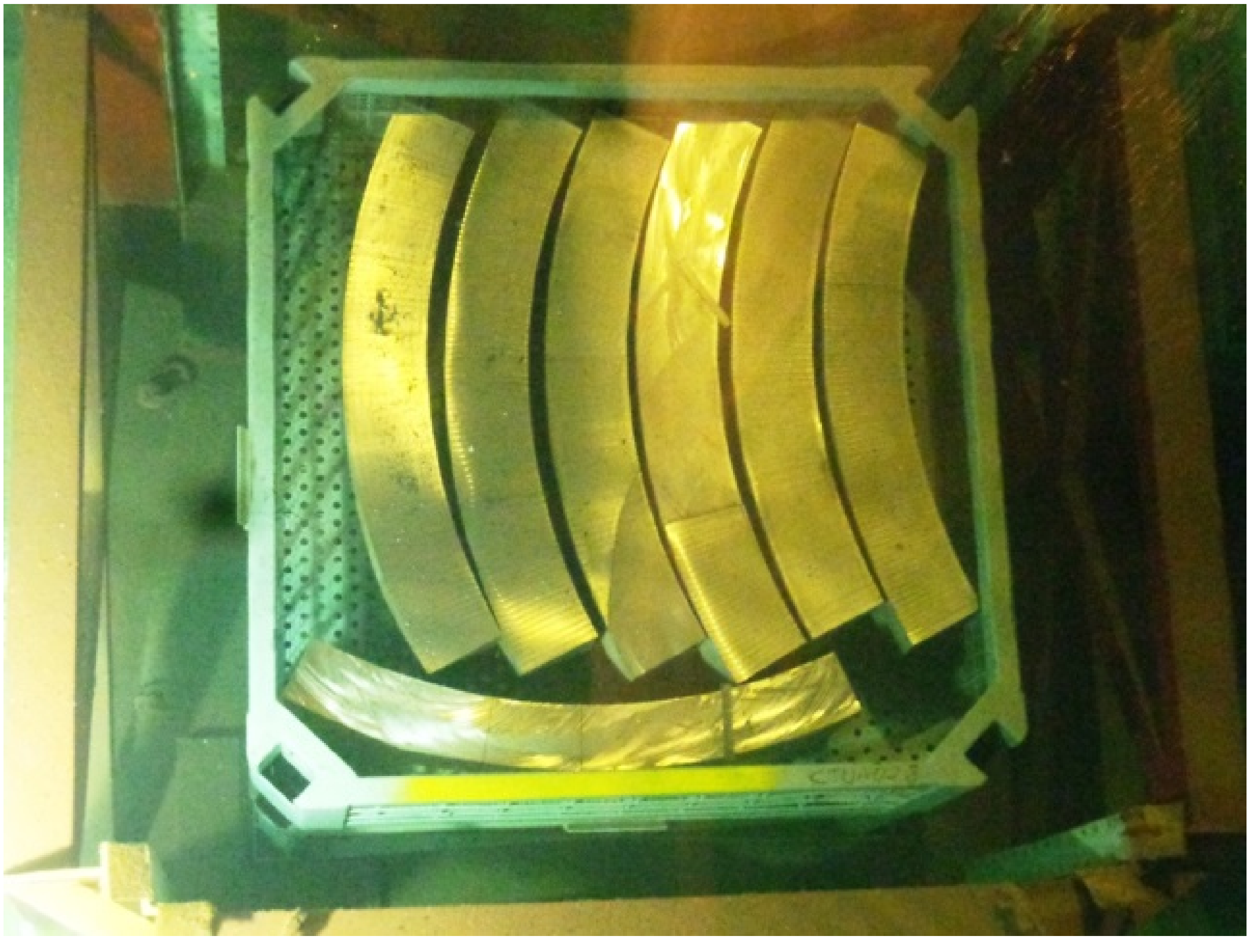

Fig. 8. Packaged waste container

CLEANING OF POOL AND EQUIPMENT

A continuous activity in the segmentation project is to clean all tools that have been used. Cleaning is performed by rinsing the equipment with high pressure water, if needed the equipment is also wiped with decontamination fluid. Chips that are produced during the cutting operations are picked up by the means of a scoop tool and finally with an underwater suction device. Westinghouse scope ends when the pool and all equipment are cleaned and all waste is loaded in dedicated containers. The equipment that is not project specific will be packed in containers and transported to Westinghouse hot storage facility where it will be stored until it can be used again in another segmentation project.

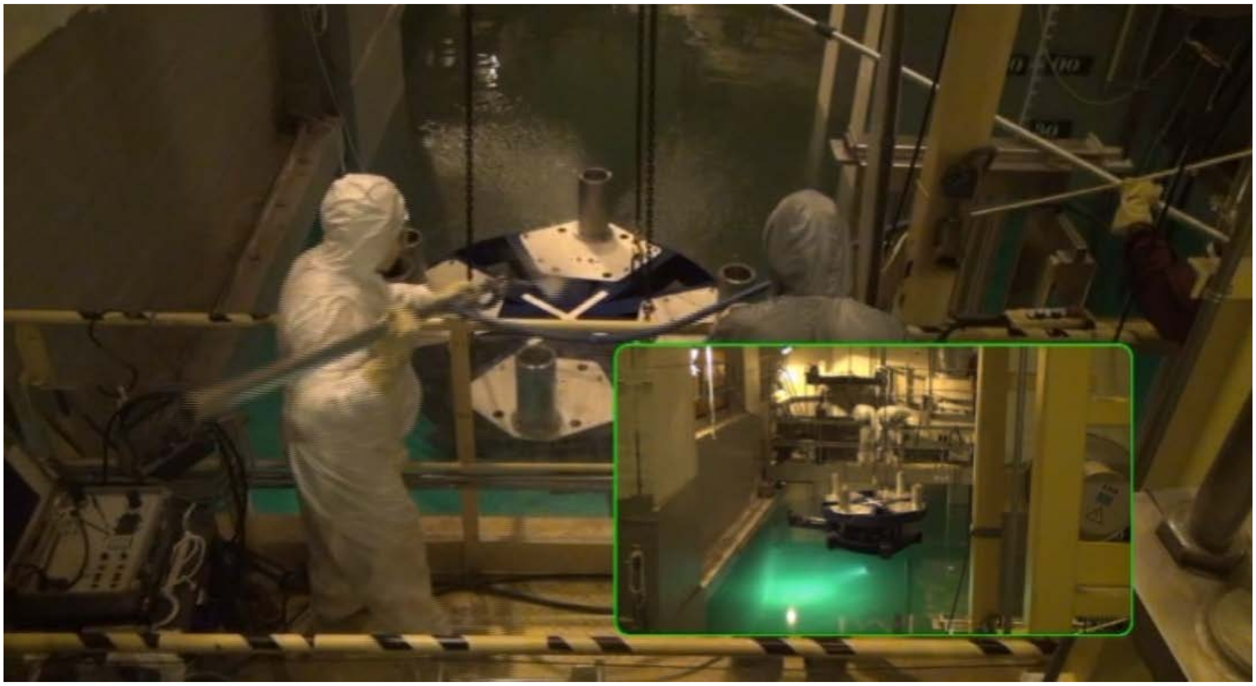

Fig. 9. Cleaning ongoing

CONCLUSION

Many lessons have been learned during the execution of the project which has been ongoing since the spring of 2013. The most important ones were as follows:

- Preparatory work is very essential – needs to be planned thoroughly.
- Many plant functions, such as compressed air and water were shut down, making the preparation more complicated.
- Mechanical cutting worked very well for cutting RV and RVH.
- The use of flexible tools that can be re-built at site has proved to be very valuable.
- Most of the equipment previously foreseen for the previous RVI segmentation project has been reused making the vessel segmentation project more efficient.

These lessons learned together with past experiences that Westinghouse has accumulated gives us the skills necessary to successfully perform dismantling of reactor vessels, regardless of the reactor type and various plant conditions.

REFERENCE

1. PER SEGERUD, MOISÉS SANCHEZ, JOSEPH BOUCAU, « Feedback From José Cabrera Plant Decommissioning Project », Phoenix WM 2014 – paper 14272