Feedback From José Cabrera Plant Decommissioning Project - 14272

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ABSTRACT

Westinghouse has performed a decommissioning project at the José Cabrera NPP in Spain. The project was awarded in July 2010 and the main scope was to cut and package the reactor vessel internals and some operational waste. The project was performed in the necessary sequential steps needed to prepare, segment, separate, and package the individual component segments using under water mechanical techniques. The preparatory work which included e.g. cutting of the wall between the reactor cavity and the spent fuel pool and securing the pool integrity were very challenging and took longer time than anticipated. The result was however very good and gave a perfect foundation for the successful cutting and packaging of the internal parts. Cutting of the upper and lower internals were made with different types of Westinghouse designed cutting equipment. The flexible nature of the cutting equipment proved to be very valuable for the execution of the cutting work. The project was finalized after the last container with cut parts was loaded in November 2013.

INTRODUCTION

In July 2010, ENRESA (Empresa Nacional de Residuos Radiactivos) awarded Westinghouse Electric Company a contract for the dismantling of the reactor vessel (RV) internals 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.

SCOPE OF WORK

The contract scope covers the dismantling and segmentation of the RV internals and operational waste, including the upfront engineering studies. It also includes some necessary plant modifications, the supply of equipments and the loading of the primary and secondary waste, respectively, into Multi-Purpose Canisters (MPCs) for the highest activated material and into dedicated containers for low- and intermediate-level waste (LILW). Before leaving site, the pool environment is restored to the initial condition and all equipment is decontaminated and shipped off site.

DESCRIPTION OF COMPONENTS TO BE CUT

The objects to be segmented are the upper and lower internals as well as some operational waste that has been stored in the spent fuel pool (SFP). The height of the upper internals is around 3m and the weight is about 10 ton; corresponding figures for the lower internals are 7m and 50 ton. Operational waste to be cut and packed is dummy fuel, flow diffusers, Rod Cluster Control Assemblies (RCCA's), thimble plugs, primary and secondary sources, thimbles and a number of assorted wastes. The components are divided into LILW and non-LILW depending on the level of irradiation which is more or less proportional to the distance from the core region. Figure 1 below shows the internals and the division of waste categories. Most of the operational waste is categorized as non-LILW.

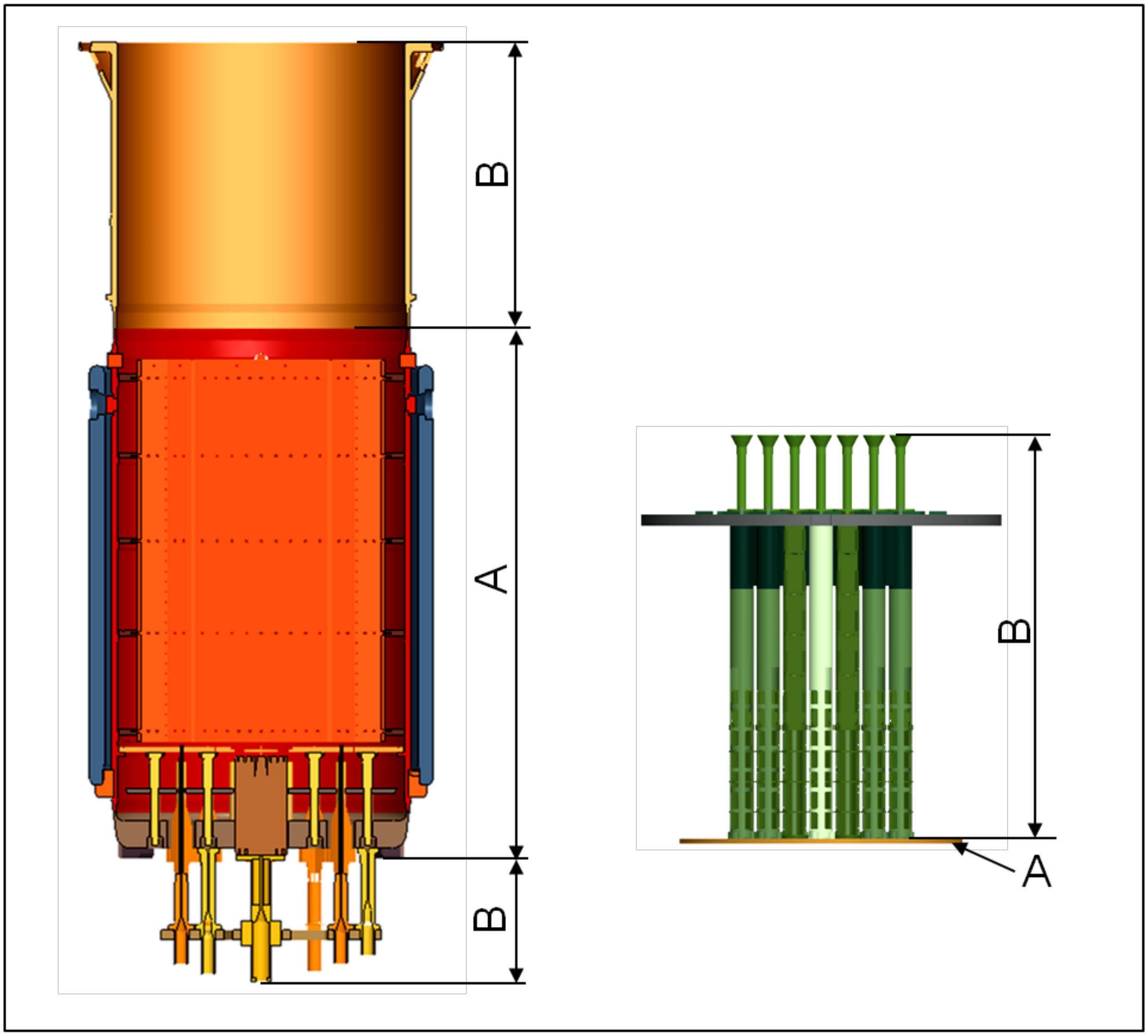

Fig. 1. Upper and Lower internals with waste categories (A=non-LILW and B=LILW)

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 the containers for non-LILW are so called MPC containers (Multi-Purpose Canisters). The containers are shown in Figure 2 below.

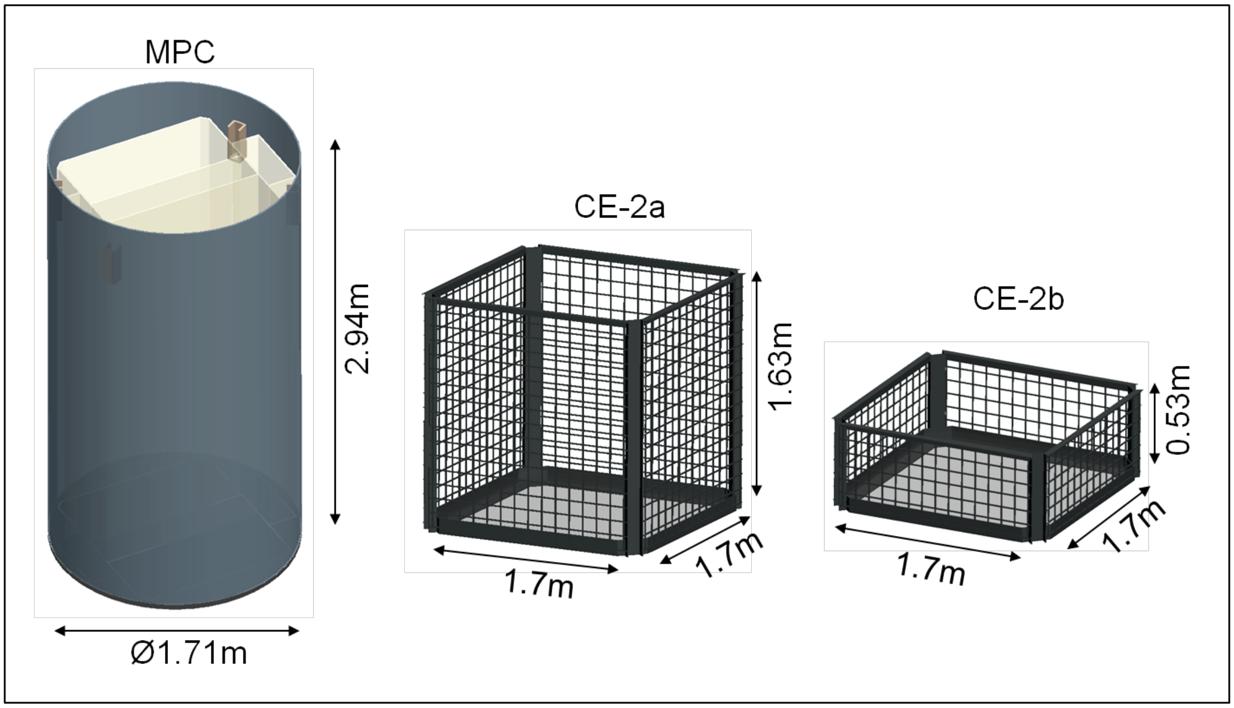

Fig. 2. Waste containers

DESIGN ACTIVITIES

As all segmentation projects, this project must be thoroughly planned together with the customer. The radiation level of the internals 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 year 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. One other key decision was to do the segmentation work in the spent fuel pool. To ensure underwater transfer of the internals, that required the demolition of the separation wall between the reactor cavity and spent fuel pool.

QUALIFICATION

The qualification was performed in Westinghouse test facility in Västerås where 1:1 scale mockups of chosen parts of the internals 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, all equipment was transported to site.

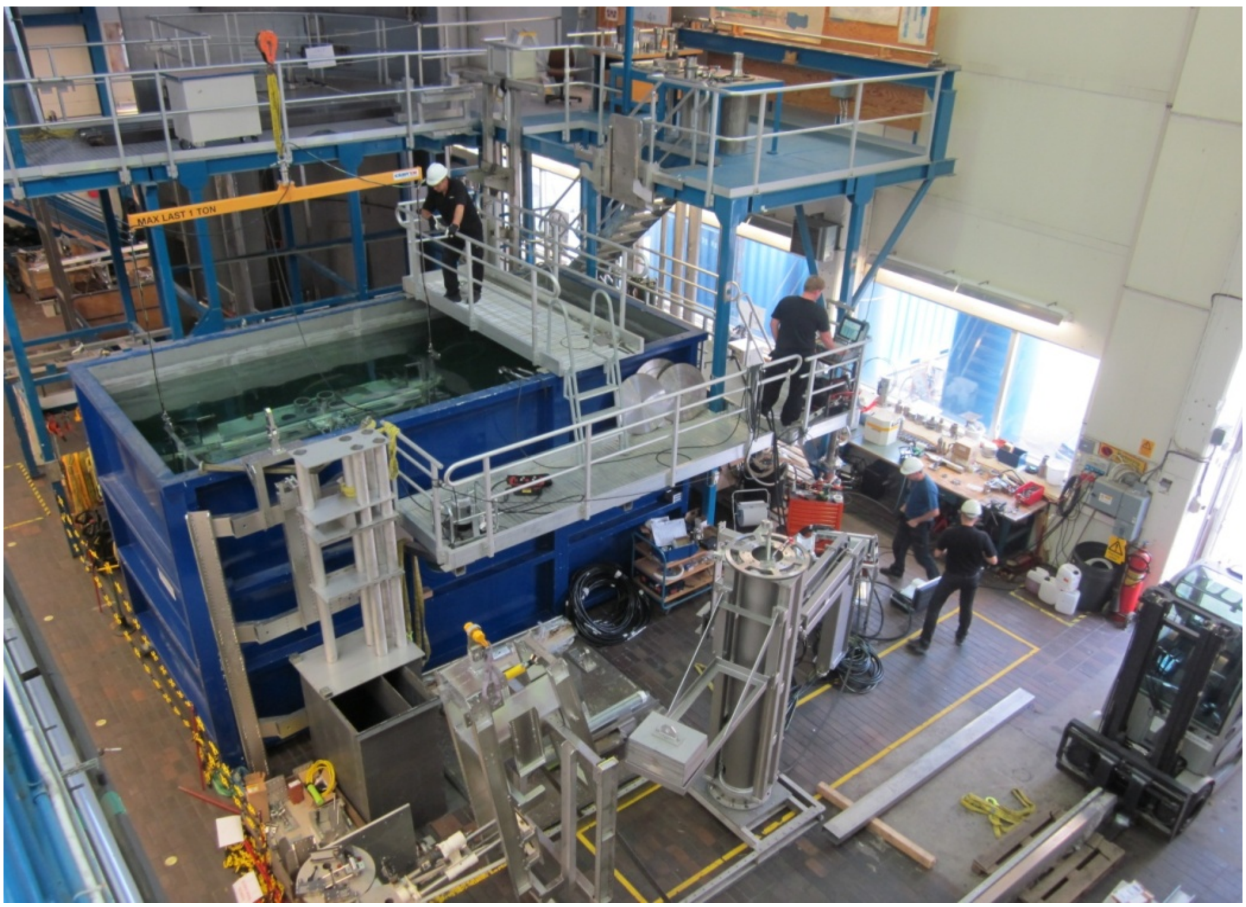

Fig. 3. Qualification in Västerås

PREPARATORY ACTIVITIES

A number of activities had to be performed before the actual cutting activities could start: e.g. cutting of the wall between the reactor cavity and the spent fuel pool, securing the pool integrity, characterizing the internals, retrieval of spent fuel racks, installing a new working bridge and cleaning of the pool floor and water. These activities were performed in the fall 2011 and beginning of 2012.

The sealing of the pool walls was a challenging task as the initial leakage was substantial and coming from all over the pool area. The floor of the reactor pool was therefore reinforced with a 15cm thick concrete layer whereas leakages in the wall were sealed by injecting sealant into all identified cavities and the whole surface was then painted with an impermeable paint. The leakages in the spent fuel pool steel liner had to be sealed under water because highly irradiated operational waste was stored in that pool which prevented draining of it. This operation was performed using divers.

Fig. 4. Diver performing leak tightening

CUTTING OF OPERATIONAL WASTE

The cutting and packing of the operational waste followed the preparatory works. A number of operational waste such as RCCA's, primary sources, secondary sources were cut with shearing tools and positioned into special designed canisters that was later put into the MPC containers along with the other high activated waste

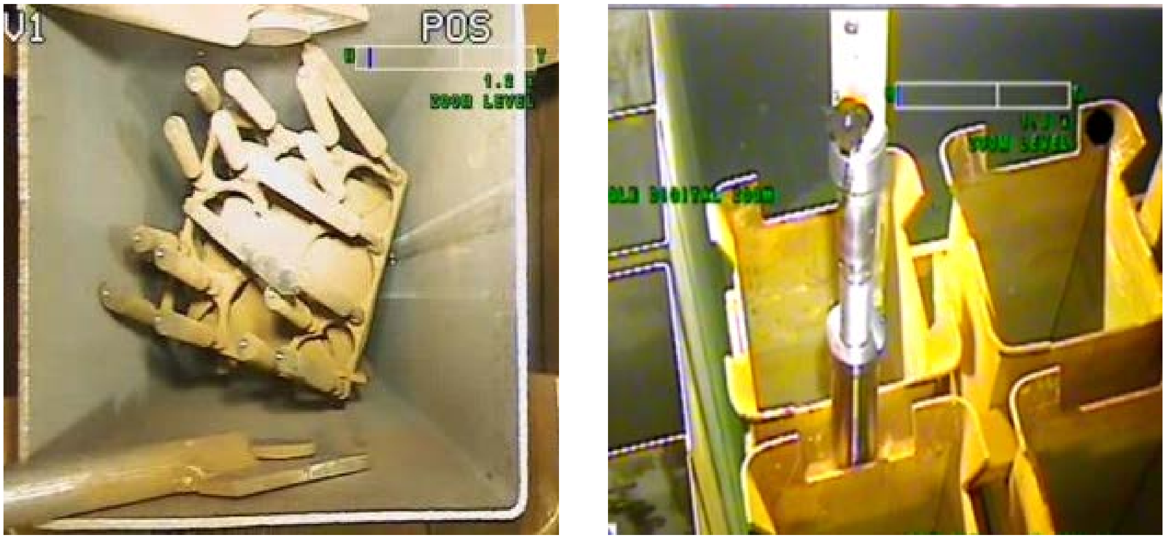

Fig. 5. Operational Waste

CUTTING OF UPPER INTERNALS

The next step in the project was to extract and position the upper internals into the spent fuel pool onto a turn table. The purpose of the turntable is to facilitate the cutting activities in the very crowded spent fuel pool. Once placed on the turntable, the upper internals were cut with a number of different disc cutting tools and shearing tools. The cut pieces were then packaged in dedicated baskets.

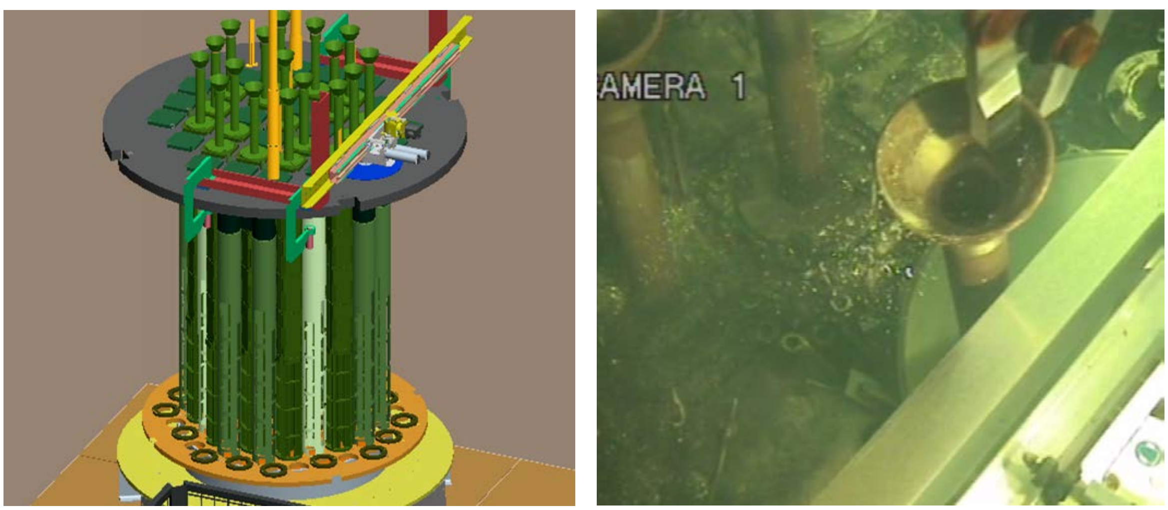

Fig. 6. Cutting of shroud tubes on the upper internals

CUTTING OF LOWER INTERNALS

Cutting of the lower internals started with the cutting of the upper core barrel which was segmented using a band saw on a center pillar. The cutting strategy was to cut a number of vertical cuts, drill a hole at the end of one cut, turn the blade 90 degrees, cut a 360 degree horizontal cut and removing the pieces that comes lose one by one.

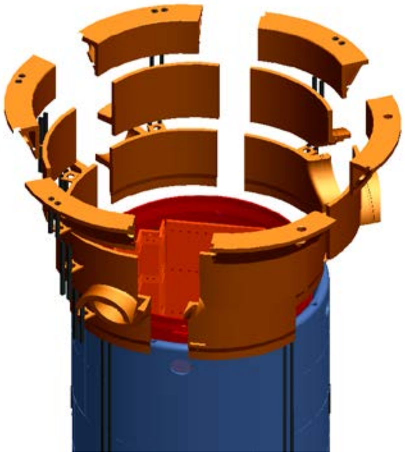
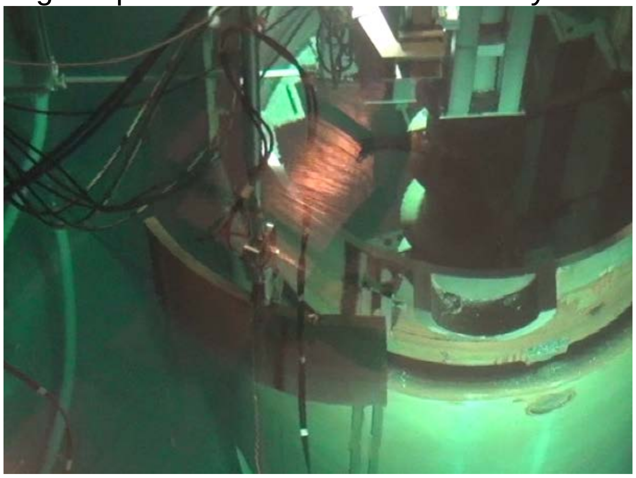

Fig. 7. Cutting of upper core barrel

Next step was to cut the 20 ton heavy thermal shield which was done using a specially designed disc cutting tool. The thermal shield was cut into eight big pieces leaving only a small ring in the lower part to be cut at a later stage.

The core region, including the highly irradiated baffle plates and formers was thereafter cut using the same strategy as was used for the upper core barrel. All pieces cut from the core region were placed in insert trays before later being positioned into the MPC containers. The lower part of the lower internals (plenum) was cut with a band saw as well as some different variants of disc cutting tools.

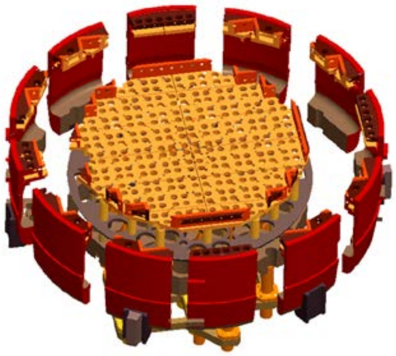


Fig. 8. Cutting of the plenum

PACKING OF WASTE

As it has been mentioned earlier in this paper, the cut internals were packed in different waste containers depending on the irradiation of the material. The low and intermediate level waste was packed and transported out of the pool continuously as the waste was produced. The high level waste was however packed in inserts which were stored in the reactor pool until all cutting activities were finalized. The inserts were then packed in the MPC containers and transported out from the pool. 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. 9. Packing of a CE-2B container

CLEANING OF POOL AND EQUIPMENT

A continuous activity in the segmentation project is to clean all tools that have been used. Cleaning was performed by rinsing the equipment with high pressure water, if needed the equipment was also wiped with decontamination fluid. Chips that have been produced during the cutting operations were picked up by the means of a scoop tool and finally with an underwater suction device. Westinghouse scope ended when the pool and all equipment were cleaned and all waste were 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.

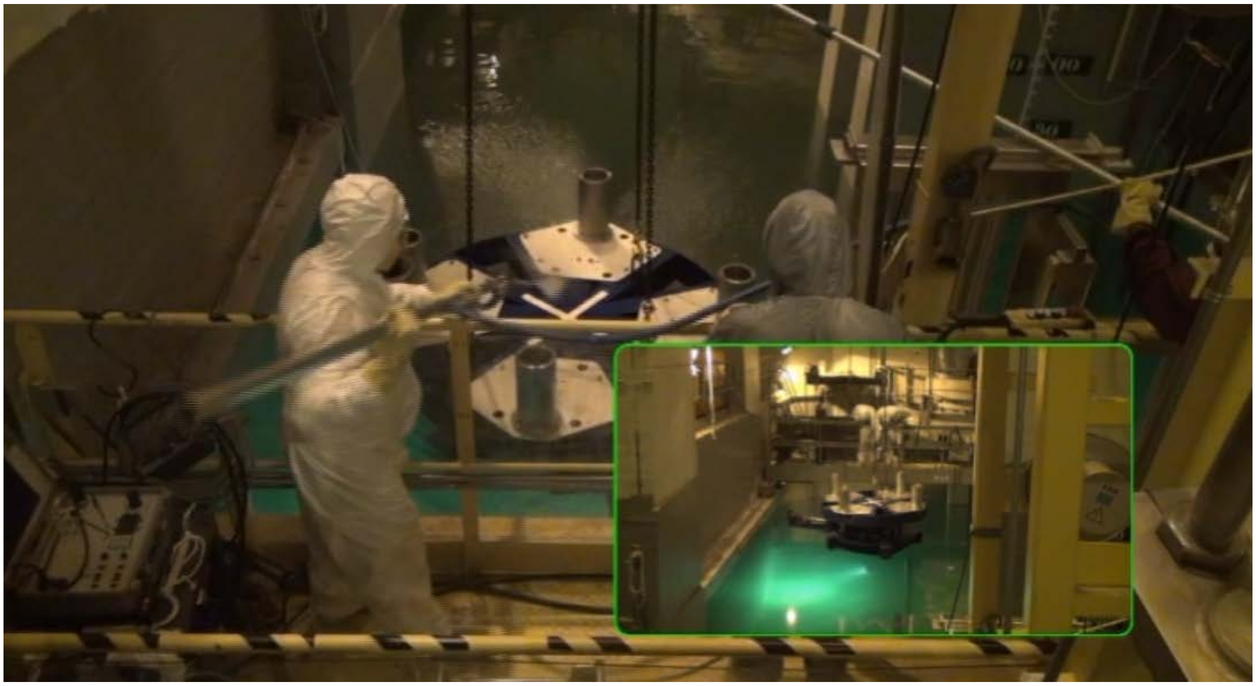

Fig. 10. Cleaning ongoing

CONCLUSION

Many lessons have been learned during the execution of the project which has been ongoing since the fall of 2010. The most important ones were as follows:

- Preparatory work is very time consuming – more work than anticipated.
- Many plant functions, such as compressed air and water were shut down, making the preparation more complicated
- The amount of debris (sludge, etc.) before the segmentation work really started was far more than anticipated
- An additional water filtration system has been needed to clean the debris from the initial state.
- Working with divers for the spent fuel pool liner sealing worked very well.
- Mechanical cutting worked very well for cutting internals
- The use of flexible tools that can be re-built at site has proved to be very valuable

These lessons learned together with past experiences that Westinghouse has accumulated gives us the skills necessary to successfully perform dismantling of reactor vessel internals, regardless of the reactor type and various plant conditions.
After completion of this successful project, Westinghouse got the award for segmenting the Jose Cabrera reactor vessel. Similar cutting tools and segmentation concepts will be used.