THE DECOMMISSIONING OF THE BR3 STEAM GENERATOR

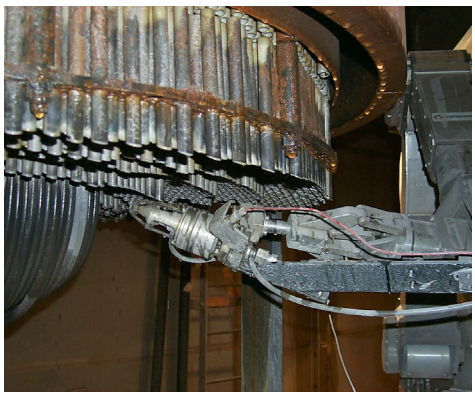
Background

A steam generator is a crucial component in a PWR (Pressurized Water Reactor). It is the crossing between the primary, contaminated, circuit and the secondary water-steam circuit. The heat from the primary reactor coolant loop is transferred to the secondary side in thousands of small tubes. Due to several problems in the material of those tubes, like SCC (Stress Corrosion Cracking), insufficient control in water chemistry, which can be the cause of tube leakage, more and more steam generators are replaced today. Only in Belgium, already 17 of them are replaced. The old 300 ton heavy SG's are stored at the 2 nuclear power plants of Doel and Tihange .

While it was foreseen in the BR3 strategy to dismantle the steam generator (only 30 ton), we took the opportunity to search for a complete package in the decommissioning of a steam generator. The complete management consists of a decontamination of the primary side followed by the complete dismantling. The first step, the decontamination with MEDOC® (water box + tube bundle) has already been achieved in 2002. It has led to an important DF (Decontamination Factor) between 100 and 1000 and an important dose rate reduction. This hard chemical decontamination process has been described earlier in the scientific report 2002 ("The BR3 steam generator decontamination with the MEDOC process" – M. Ponnet). The second step, the complete dismantling of the SG has been executed in 2005.

Objectives

With the BR3 SG, the main goal was to dismantle it in a safe way and to free release a maximum of material. We've used two cutting tools to perform the job: A HPWJC (High Pressure Water Jet Cutting) tool in combination with a hydraulic robot and a water cooled diamond cable. The last technique was done in close collaboration with the external company Husqvarna. It was important to have an idea of the performance, the efficiency of the cable and the quantity and the type of secondary waste.



Tube bundle cutting with HPWJ and the MAESTRO arm as a tool carrier

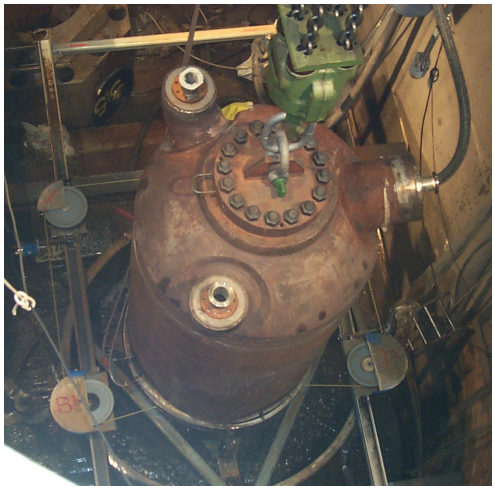
A HPWJC tool is an equipment which can cut material by means of water under very high pressure (380 Mpa). For cutting metal, additional abrasives are added to the water jet to increase its cutting power. These abrasives (Q = 450 g/min) and the used water (~ 4,5 l/min) are considered as secondary waste. In order to optimize the cutting parameters, with the result to find a good compromise between cutting time and production of waste, we did a lot of cold tests on simplified work pieces and mock ups. In parallel to these cold tests, we developed a two stage filtration system with a hydro cyclone filter and a cartridge filter in order to collect this secondary waste and to separate the water and the abrasives.

The second tool used was a diamond cable. This cable consists of a chain of diamond perles which was pushed against the outside wall of the steam generator. Due to the abrasive effect of those perles, material of different type and layers can be cut. Both techniques were used for the first time on our steam generator.

Principal results

The steam generator has been cut in slices of about 1000 mm length. The outside shell is completely free released with a minimal follow up treatment (sandblasting and grinding of the contaminated surfaces). The tube bundle and the waterbox including the tubeplate will be sent to a nuclear foundry. The total residual waste will be about 2 % of the initial mass.

In contrast with earlier HPWJ dismantling activities on the RPV (Reactor Pressure Vessel) and the pressurizer, the used abrasives show a rather low contamination, just above the free release limit between 0.27 Bq/g and 15 Bq/g. About 14 m³ water used for the cutting has been free released.



Diamond cable cutting on the BR3 SG

We did 3 cuts with the diamond cable in the lower part of the steam generator. Each cut was done through the outside and inside shell and the tube bundle in 1 pass. We collected 70 kg dry swarfs with an activity of about 3 Bq/g. This activity is clearly due to the residual contamination of the steam generator.
The HPWJC tool in combination with the hydraulic arm is a very flexible cutting tool for massive pieces, but not very efficient to dismantle a tube bundle. Therefore the test with the diamond cable was interesting and can be seen as a complementary tool besides the HPWJC.
The following scheme gives an overview of the final destination.

Future work

With the complete steam generator decommissioning, we showed that it is possible to treat those large components in a safe way, with an interesting dose reduction and a minimum of residual waste. This is interesting in prospect of all the steam generators (PWR, VVER) that are waiting for a further treatment.
For the future work at BR3, we will start the dismantling of the NST (Neutron Shield Tank). This component, which is the last large, even activated, component inside the reactor building, will be dismantled in 2006 using the HPWJC in combination with the hydraulic MAESTRO arm.

Main contact person

Luc Denissen, luc.denissen@sckcen.be

Main reference

P. Valenduc, E. Cantrel, L. Denissen, *The dismantling project of the BR3 reactor*, Conference SFEN – ENC 2005, Versailles, 12-16 Décembre 2005