

## THE REPLACEMENT OF THE ORPHEE REACTOR'S HOUSING CORE

(SUMMER 1997)

The research reactor Orphée built by the CEA at Saclay in the late seventies went first critical in december 1980. Since then the reactor has provided the neutron beams used by physicists on the experimental spectrometers located around the reactor. During the summer 1997 the reactor was stopped for a major refurbishment : the remplacement of the housing core located in a heavy water tank.

This housing core, a square tube of  $25 \times 25 \times 200 \text{ cm}^3$  is the backbone of the reactor as it contains the reactor core itself. It is the one barrier between the heavy water, from the tank, and the light water that cools the reactor core. The zircaloy 2 had been choosen for its characteristics both mechanical, close to those of the stainless steel, and physical (it does not interfere with the neutrons) to make the housing core and its 2 flanges. These two casted flanges are welded to both ends of the tube, and it is by them that the housing core is attached to the top and the bottom of the middle of the heavy water tank. The water tightness between the 2 types of water is done by two 0-ring metallic joints. The reactor core is supported by the grid core, located at the bottom of the housing core. The core is composed by eight fuel rods and one beryllium rod. So outside the tube there is the heavy water and inside it, there is the core itself cooldown by light water.

In reactor early life, year 1983, the metallic 0-ring upper joint, between the tank and the housing core, went to leak. So it has been replaced by a new one. This operation was done by removing the housing core from the heavy water tank and then the joint was changed by reputting it in its original place. The strain on the studs and nuts was increased to ensure the tighness of the system.

Meanwhile, it was obvious that the leak was due to the growth of the housing core that will, in the long run, lead to another leak. So it was decided to study the zircaloy growth by putting some samples inside the beryllium rod located in the middle of the reactor core itself. At the same time a new housing core was ordered.

The main difference between the two housing cores is that the new one is fitted at its top with a growth absorber made of a double stainless steel wall and flanges.

In the year 1995, it was foreseen, in the light of the study of the zircaloy, that the housing had to be changed by the turn of the century. It was then decided that it will be done in the summer 1997 to allow time to plan the operations. This planning was made by looking back in 1983 when the housing was first taken out to foresee the coming problems.

The main concerns were the four bottom studs and nuts as they had already given us troubles. It was decided to make some specific tools to destroy either the nut or, at worst possible case, the stud. The planning was done to start the refurbishment on the 15 july 1997.

The reactor was stopped on the 13, the core unloaded on the 14, and the heavy water replaced by light water on the 15. Before removing the housing core itself, several operations had to be done :

- i) Remove the bars that link the control rods and their mechanism,
- ii) Remove the rod trolley,
- iii) Remove the loading-unloading anti-fault grid,
- iv) Remove the core grid.

After that, it was possible to take out of the tank the housing core. The housing core was put in the canal to be disposed later. It was now possible to look inside the heavy water tank for an inspection done with a remote camera and also on the two 0-ring spans. It had shown that the two spans should be meticulously cleaned before we put back the new housing core.

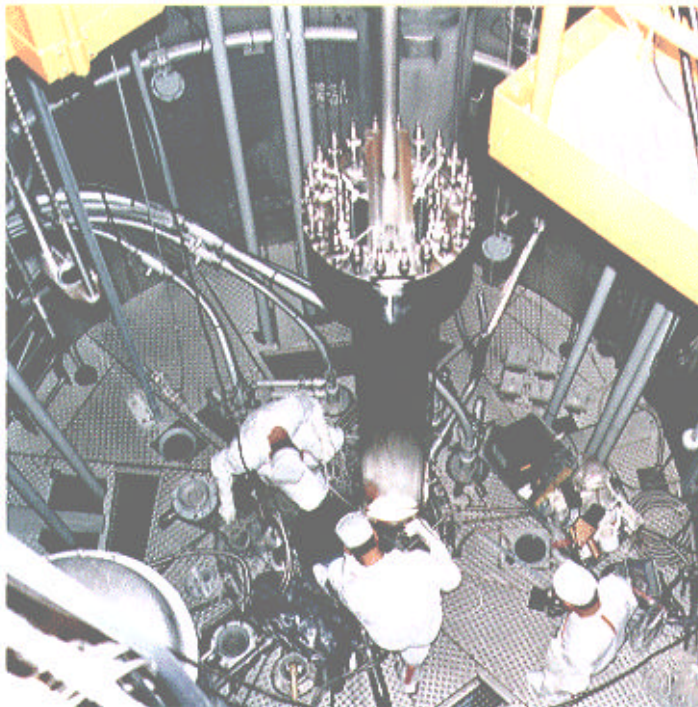
Through out these tasks, the new housing core and all its parts were put together on a mock-up tank for a final check before it was put in its real location, the heavy water tank.

After all the checks, both on the span ring, on the tank and on the new housing with all its parts, it was then decided to put the new housing in place. When it was in place two tasks were done. First the three 0-ring joints were tested for water tightness. There is one more joint, the one between the zircaloy flange and the stainless steel of the growth absorber device. As the test gave us satisfaction, all the other parts were put back into place.

When all the operations have been completed a mock up core was loaded in the new housing core for hydraulic tests. When completed, we asked the French Safety Authorities for the green light to start the reactor. The reactor was then loaded with the fuel rods. We had the go ahead green light to start on the 27 october 1997.



*Figure 1. Removal under water of the old housing core*



*Figure 2. Installation of the new housing core*

