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EBR-II—SEARCH FOR THE LOST SUBASSEMBLY*

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EBR-II--SEARCH FOR THE LOST SUBASSEMBLY

Experimental Breeder Reactor II (EBR-II) has been operating for nearly 20 years as part of the foundation of the U. S. Department of Energy's LMFBR development program.[1,2] During that time, the EBR-II fuel-handling system has performed extremely well, especially considering the conditions under which much of the system operates and the reliability required to maintain the high plant factor routinely demonstrated by EBR-II. Since EBR-II is a pool-type reactor, much of the fuel handling is done remotely within the sodium-filled primary tank at 371°C.

On November 29, 1982, experimental subassembly X-379 was being transferred from the in-tank subassembly storage basket to the reactor core using the manually operated fuel-transfer arm. The sensing devices in the transfer arm indicated to the operator that the subassembly was properly engaged by the transfer arm before the subassembly was removed from the storage basket. After the subassembly was removed from the basket, the transfer arm was rotated to the transfer point over the reactor vessel and directly under the core gripper, which is used to transfer subassemblies from the transfer arm to the reactor core. When the transfer arm was raised to engage the subassembly with the core gripper, the gripper sense rod indicated that no subassembly was present on the transfer arm. A recheck of the sense indications on the transfer arm verified that no subassembly was present. The storage basket was then checked using the transfer arm. The storage position that had

contained the subassembly was empty. This meant that the subassembly had dropped in the primary tank somewhere between the storage basket and the transfer point over the reactor vessel.

Since the location and position of the subassembly were unknown, several activities were initiated to develop the following: (1) a systematic search plan, (2) the methods and tools required for the search, and (3) a wide spectrum of retrieval methods. Additionally, full-sized mockups of sections of the reactor core, reactor vessel, and in-tank fuel-handling equipment were fabricated and integrated with an existing fuel-handling mockup. The first part of the search involved inserting a 9-m-long probe through a primary-tank nozzle near the storage basket position and down into a catcher at the bottom of the primary tank, which was installed as original equipment to catch a subassembly dropped from the transfer arm and position it for relatively easy retrieval. The probing tool, however, indicated there was nothing in the catcher. Work with the mockup indicated that the next most likely place would be on top of the reactor core. The easiest way to search this area was to move the transfer arm with a subassembly through the transfer path to the transfer point over the reactor vessel. To do this, however, the storage basket had to be moved. This could not be done until a search was made to ensure that the subassembly was not in the area near the basket. This was done by inserting a fairly simple probing tool with retractable arms through a nearby nozzle in the primary-tank cover. The subassembly was not found in this area of the primary tank, and the storage basket was safely lowered to provide access to the reactor vessel with the fuel transfer arm.

The transfer path was then searched using the transfer arm to carry a standard subassembly between the storage basket and the reactor vessel. Subassembly X-379 was contacted a few inches away from the transfer point over the reactor vessel. The core gripper was then removed from the small rotating plug to provide a direct access path through the gripper nozzle into the reactor-vessel area near the subassembly. A special probing and profiling tool was fabricated, inserted through the gripper nozzle, and used to determine accurately the position and location of the subassembly in a manner similar to a previous incident involving a damaged subassembly in the storage basket.[3] This information simplified the choice of a retrieval method. A simple snaring tool appeared to be feasible, and development and fabrication of such a tool was completed along with the preparation of a retrieval procedure. Initial checkout of the snaring tool resulted in some minor modifications to the tool and the procedure. After the changes were made, a complete "remote" dry-run retrieval was successfully demonstrated in the mockup. The tool was moved into the reactor building that same afternoon and inserted into the primary tank through the gripper nozzle. The subassembly was successfully retrieved on the first attempt on December 28 and returned to the in-tank fuel-handling equipment for transfer out of the primary tank to the fuel-examination facility.

Another special tool was then inserted through the gripper nozzle and used to search the drop area for damage to other subassemblies and reactor components that would prevent operation of the reactor. Nothing abnormal was detected.

The manual "feel" provided by the transfer arm and the other specially designed and built tools used greatly aided the search and retrieval efforts, as did the ability to listen to the contact of the tools with the dropped subassembly and with other installed primary-tank and reactor components by the use of high-temperature acoustic monitors that had been previously installed in test facilities in the reactor upper plenum.

The cause of the incident was apparently misalignment between the transfer arm and storage basket. These components were realigned and thoroughly checked out. The fuel-handling procedures were also expanded to provide additional checks to ensure that a subassembly is held securely during transfer.

The incident took less than a month to resolve and had relatively minor impact on plant operating capacity, because during the activities associated with X-379, several major and minor maintenance activities were completed that were originally scheduled for the March 1983 shutdown. This allowed the March shutdown to be shortened considerably.

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1 L. J. Koch, et al., "Hazards Summary Report, EBR-II," ANL-5719, Argonne National Laboratory (May 1957).

2 L. J. Koch et al., "Addendum to Hazards Summary Report, EBR-II," ANL-5719 (Addendum), Argonne National Laboratory (June 1962).

3 R. W. King and E. C. Filewicz, "Retrieval of Damaged Subassembly from Experimental Breeder Reactor II Primary Tank," Nuclear Technology, Vol. 52, pp. 32-42 (January 1981).