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OPERATIONAL EXPERIENCES IN MOX FUEL FABRICATION FOR ADVANCED THERMAL REACTOR "FUGEN"

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In 1966, the Japan Nuclear Cycle Development Institute, JNC, has started development of Advanced Thermal Reactor, "Fugen", adopting heavy water moderating and light water cooling system. The Fugen was expected as a bridge between Light Water Reactor, LWR and Fast Breeder Reactor, FBR, because ATR could supply higher amount of plutonium for FBR than LWR. The construction of Fugen started in December 1970 and its first criticality was achieved in March 1978. The Fugen fuel assembly has a unique cylindrical shape and consists of three layers of fuel pins. The numbers of fuel pins in each layer are 4, 8 and 16 from inner layer. The pellets with same plutonium content are loaded in the inner and middle layers pins and the other pellets with higher plutonium content are loaded in the outer layer pins. Each fuel pins has aluminum dioxide insulator pellets on the both sides of MOX pellets to make On Power Refueling possible during reactor operation. The fuel assembly for Fugen is shown in Fig. 1.

In parallel with development of the reactor, the JNC started development of MOX fuel fabrication technology at the Plutonium Fuel Development Facility, PFDF, constructed by the design of NUMEC, USA company, in 1966. Based on the experiences concerning plutonium handling and test fuel fabrications in the PFDF, the JNC designed and constructed the Plutonium Fuel Fabrication Facility, PFFF, containing Fugen fuel fabrication line (hereinafter referred to as ATR line) in 1971. The annual fabrication capability of ATR line in PFFF is about 10 ton of MOX.

The PFFF ATR line was designed to fabricate MOX fuel in semi-automated operation by using reactor grade plutonium in proto-typical scale for commercial use. The fuel fabrication can be carried out through the control panel located beside the glove box and process equipment by operators from weighing to fuel assembling. The JNC began to utilize the standardized giant size glove boxes, 2.5m x lm x 6m, in the PFFF to restrain the initial construction cost. Each glove box is connected to the transfer tunnel at its end and nuclear material is transferred through this tunnel between glove boxes along fuel fabrication process.

The PFFF ATR line has started its operation with MOX fuel fabrication for the Deuterium Critical Assembly, DCA, in 1971 with 30 kg MOX/day of fabrication capability. Total amount of MOX fuel fabricated for DCA was 9.1 t MOX. After DCA fuel fabrication, the ATR line was improved its production capability up to 50 kg MOX/day prepared for Fugen fuel fabrication in 1974. The MOX fuel fabrication for Fugen initial load fuel was completed in 1978. Total amount of MOX fuel for Fugen initial core was 17.6 t MOX (100 fuel assemblies). The accumulated MOX fuel fabricated for Fugen reached to 126 t MOX, 683 fuel assemblies, as of March 1998. The amount of MOX fuel fabricated in the ATR line is shown in Fig. 2. Now, MOX pellets for the 29th reload fuel is being fabricated.

Through these 25 years experiences, the ATR line has demonstrated MOX fuel fabrication in engineering scale with high quality having enough margins for fuel specifications. With regard to the MOX handling technology, the ATR line has adopted dry process except grinding and it is the indispensable technology for current MOX fuel facility in large scale. Furthermore, the MOX pellet for Fugen is a high density solid pellet with 14.4 mm in diameter and these specifications are closed to those for BWR pellet. Therefore, it can be recognized that the technology to fabricate MOX pellets similar to BWR fuel specifications has been demonstrated by JNC through Fugen fuel fabrication.

Up to now, any failure has never been observed in all products of ATR line including 683 fuel assemblies loaded into Fugen. In the ATR line, various kinds of plutonium recovered by JNC as well as foreign countries have been utilized as a feed material to fabricate MOX fuel for Fugen. It was one

of the epochs in the ATR line to fabricate Fugen fuel by the utilization of plutonium recovered from Fugen spent fuel in 1987 with closing the fuel cycle through Fugen.

On the basis of these experiences, the JNC designed and obtained a license for new MOX fuel production facility in commercial scale for the demonstration ATR. However, this project was cancelled by the decision of Japan Atomic Energy Committee in 1995. We believe that the experiences obtained through Fugen fuel fabrication for these 25 years and this capability of designing and obtaining a license for a large scale MOX facility can be alive in the future use of plutonium in LWRS.

This paper discusses the summary of Fugen MOX fuel fabrication for this quarter century in JNC.

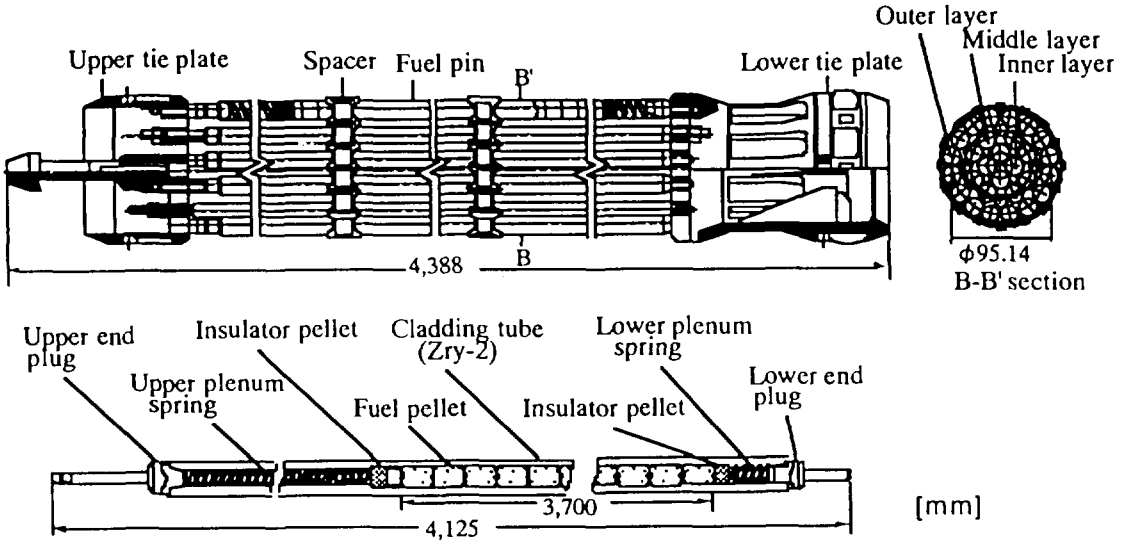

Fig. 1. Fugen fuel assembly

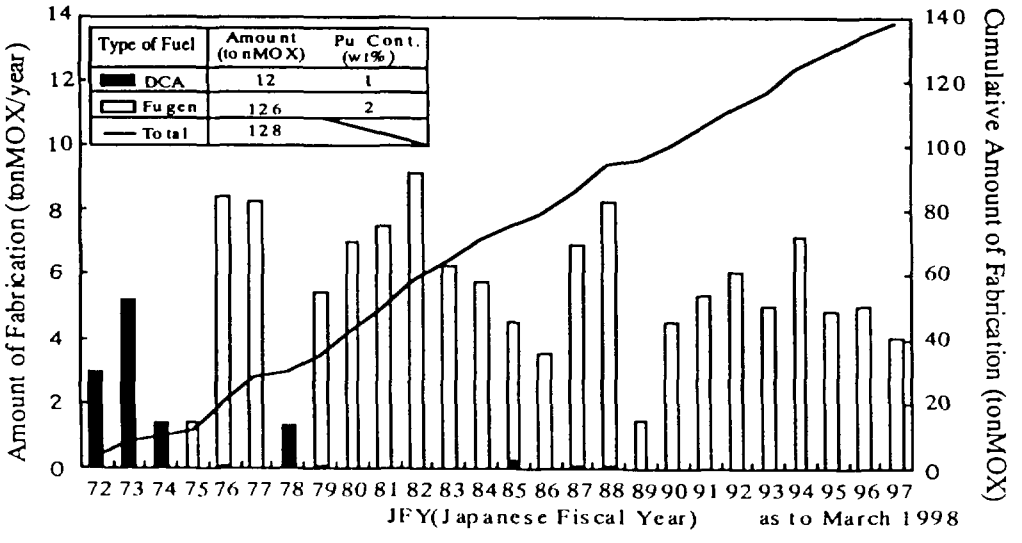

Fig. 2. The amount of MOX fuel fabricated in the ATR line