PRESENT STATUS OF JMTR SPENT FUEL SHIPMENT

Masataka Miyazawa, Masao Watanabe, Makoto Yokokawa,
Hiroshi Sato, Haruhiko Ito
Japan Atomic Energy Research Institute
Oarai-machi Ibaraki-ken, Japan

ABSTRACT

The Japan Atomic Energy Research Institute (JAERI) has been consistently making the enrichment reduction of reactor fuels in cooperation with RERTR Program and FRR SNF Acceptance Program both conducted along with the U.S. Nuclear Non-Proliferation Policy and JMTR, 50 MW test reactor in Oarai Research Establishment, has achieved core conversion, from its initial 93% enriched UAl alloy to 45% enriched uranium-aluminide fuel, and then to the current 19.8 % enriched uranium-silicide fuel.
In order to return all of JMTR spent fuels, to be discharged from the reactor by May 12, 2006, to the U.S.A. by May 12, 2009, JAERI is planning the transportation schedule based on one shipment per year. The sixth shipment of spent fuels to U.S. was carried out as scheduled this year, where the total number of fuels shipped amounts to 651 elements. All of the UAl alloy elements have so far been shipped and now shipments of 45% enriched uranium-aluminide type fuels are in progress. Thus far the JMTR SFs have been transported on schedule. From 2003 onward are scheduled more then 850 elements to be shipped. In this paper, we describe our activities on the transportation in general and the schedule for the SFs shipments.

INTRODUCTION

JMTR is a light water cooled-and-moderated tank type test reactor with 50MW thermal output. The first criticality was achieved in 1968 and has now attained 147 cycles of operation by Oct. 2002.

JMTR has been positively taking part in RERTR. The enrichment of fuel was first reduced In 1991 from 93%(hereinafter referred to as“HEU”) to 45 %(hereinafter referred to as“MEU”), and then in 1994 to less than 20 % (hereinafter referred to as“LEU”). In 2001 operation license was

updated to improve the maximum burn-up limit of the reactor fuel from 50% to 60% with increase of fuel numbers in the core. These processes have brought about a variety in enrichment, fuel-core material and burn-up among the spent fuels.

At the early stage, the high-enriched spent fuels (hereinafter referred to as "HEU SFs") were delivered for reprocessing mainly to the U.S.A., once to U.K. and France. The total number of 1547 elements was reprocessed by 17 shipments. In 1989 the shipment to U.S.A. was suspended due to US policy modification on the reprocessing. The number of spent fuel elements (hereinafter referred to as "SFs") which were stored in the facility, consisting of HEU, MEU and LEU SFs, reached 934 at maximum, approaching to the capacity limit. After a new FRR SNF Acceptance Program (hereinafter referred to as "Acceptance Program") was resumed in 1996, a preparation for the SFs shipment soon started and in 1997 the first shipment took place. The Shipment is currently taking place once a year, totaling 651 elements by the 6th delivery of this year. Transports under new Acceptance Program have been carried out on schedule. General view on the transportation and the schedule of SFs shipments are described in this report.

JMTR Fuel Management

The fuel elements used in JMTR are modified ETR type of which a standard fuel has 19 fuel plates and a fuel follower has 16. The outlines of fuel elements are given in Fig.1 and Table 1. The operation of the reactor from 1994 to 2002 generated 587 elements of SFs. The average burn-up of SFs is less than 43%.

The MEU SFs and LEU SFs are currently stored in the racks made of aluminum alloy placed in the spent fuel pond. The pool water is purified and so controlled that it maintains electric conductivity of less than 2μS/cm and pH of 5.5～7.0. There has been no release of FP from fuels due to corrosion of cladding material or any other reason during the period of storage so far.

About 2700 fuel elements were irradiated in the JMTR since the first criticality, and no failure have seen both in reactor operation and in SF storage. It can be said that the fuel management in the JMTR have been adequately performed.

ANNUAL SHIPMENT

Preparations for Shipment

Main preparations for the shipment performed in the JMTR facility include periodical

maintenance of the cask, cutting and loading of fuels, and pre-shipment test. In parallel with these, an application for the approval of each shipment needs to be submitted to the Authorities concerned. Entire processes for the shipment are shown in Fig.2.
Cutting of fuels means that a handle and adaptors of each SF are cut and removed so that SFs can be accommodated to the loading into the transportation cask. The cutting work with cutting machine is performed under water at 6m depth in the spent fuel pond. The present machine was fabricated with the design to improve the efficiency of cutting processes.

Four casks of B(U)F type, JMS-87Y-18.5T, prepared in 1988, are now in use for the shipment. These casks have already licensed by the domestic Authorities concerned, according to the 1996 Edition of Regulations for the Safe Transport of Radioactive Material and an application for the multilateral approval will be filed soon to the relevant countries, U.S.A. and U.K.. The schematic drawing of the cask is given in Fig.3. It weighs 18.5 tons and can contain 30 fuel elements of ETR-type fuel.

The SFs are loaded manually one by one using tongs under water at 6 m depth, with measurement of 1/M (Inverse Multiplication) factor at each addition of the element for the confirmation of sub-criticality. The longest under water storage period of the fuels to be shipped is 12 years. Sipping tests after loading provides the concentration of Cs-137 of around 10^{-3}～10^{-4} Bq/cm^3, assuring integrity of those fuels.

Transport by Vehicle and Vessel

In the past, the particular vehicles for the transport were used on the requirements for the weight and width of vehicle by the Traffic Regulations, with the specified speed and under conditions of night transport. Last year, however, owing to the moderation of the Traffic Regulations, the SFs were transported by general-use vehicles with the twist lock device for a 20 ft ISO container, and through the route including the express way. Further, working efficiency of the cask loading to the vessel was much improved.

After combined with shipment batches from JRR-3, JMTR SFs are delivered by the vessel for exclusive use of INF- class on IMO code. Such arrangement contributes to improved receipt conditions at the Charleston port, U.S.A., and a reduction of the cost incurred.

SHIPMENT SCHEDULE

JMTR SFs

JAERI is going to ship more than 850 elements of SFs of JMTR before the US Acceptance Program expires in 2009. The present status of shipment following to the category of the enrichment is as follows,

HEU SFs : 81 elements completed by 1998

MEU SFs: 570 elements completed by 2002

155 elements expected by 2004

LEU SFs: Shipped following MEU

More than 700 elements of LEU SFs are anticipated to be generated by 2006. To achieve the shipment of these SFs during prescribed period, the number of SFs to be shipped a year need to be increased. In consideration of the vessel arrangement, turn-around period, preparation period, obtaining license and the cost, it has been concluded to increase the number of the cask per shipment from current 4 to 6, possibly from the shipment in 2005. It is under consideration to add 2 more casks of the same type of JAERI's by lease. The experience learned over past six years will be certainly provide advantages on considered the vessel arrangement, obtaining license and cost, that are critical paths for future shipment.

JMTRC SFs

JMTRC was a pool-type critical facility as a nuclear mock up of JMTR with the maximum thermal output of 100W and was dismantled in 1996. JMTRC SFs constitute of standard fuels and follower fuels, the dimension and form of which are almost the same as those of JMTR fuels. Some of the fuels (experimental fuel) are so constructed that fuel plates are removable.

Since JMTRC fuels included experimental fuels, several kinds of special fillers were manufactured to fix the elements in the basket of the cask. A cutting work of JMTRC has fuels completed this summer and visual inspection after cutting has identified no failure among fuels. JAERI is proceeding with application for license regarding the transportation cask. JMTRC SFs are already registered in the Acceptance Program. The delivery will be started as soon as possible in compliance with the Acceptance Program.

CONCLUSION

JAERI has shipped 6 campaigns of SFs to U.S.A. since 1997 and scheduled to continue until 2008. In near future, JMTRC fuels will be included in the program. International shipment depends on the budget assigned and requires large human resources as well as the time for it. In consideration of the recent social circumstances, the shipment schedule may face the more severe situation, which might sometime possibly enforce the delay of shipment schedule.

JAERI, as a consigner, needs to make an effort for safe-and-improved shipment with the closer contacts to the Authorities concerned and other parties.

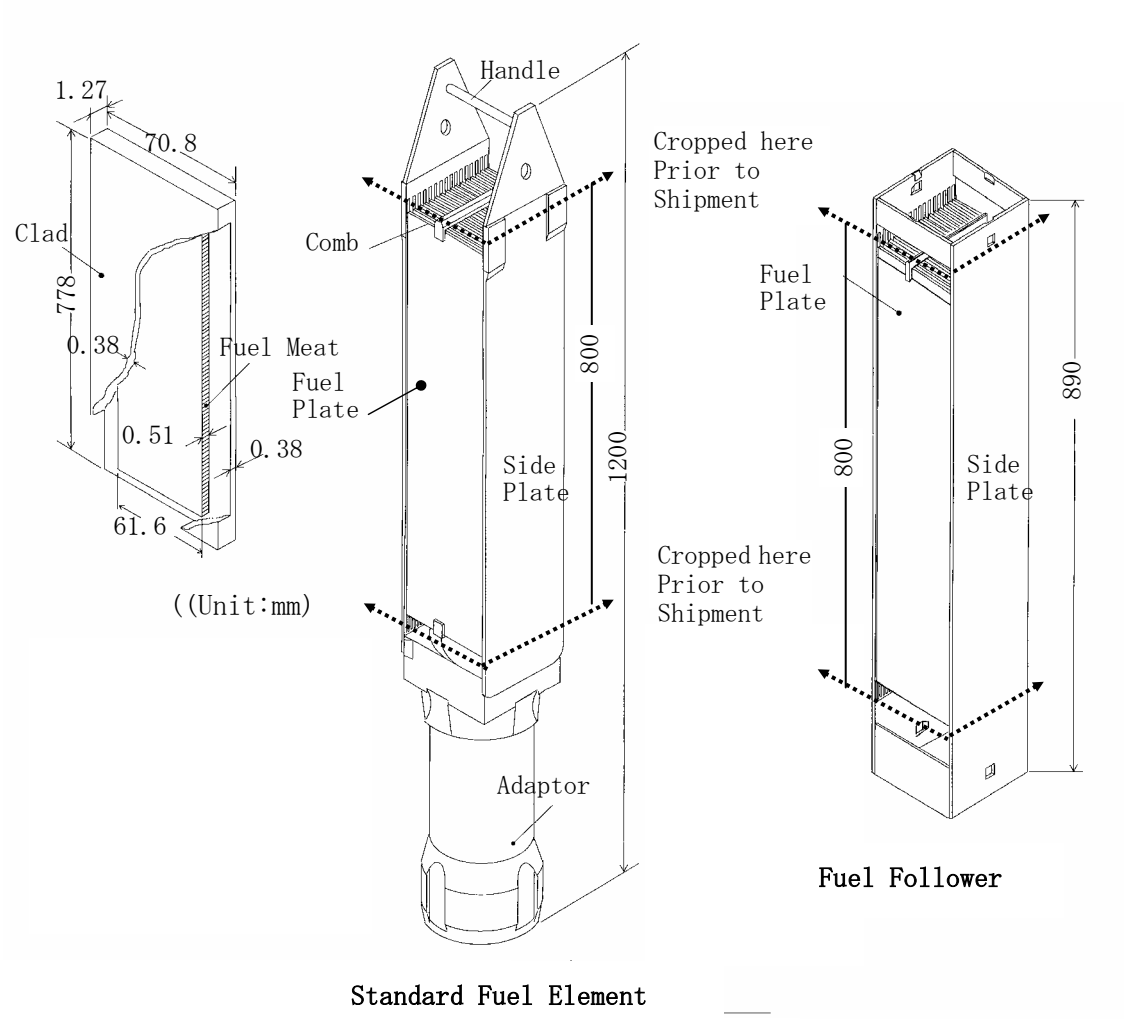

Fig.1 Schematic Illustration of JMTR Fuel Elements

Table 1 Fuel Element Configuration

	MEU Fuel Element		LEU Fuel Element	
Element Type	Standard	Follower	Standard	Follower
Fuel Meat	UAlx-Al Dispersion Alloy		U_3Si_2-Al Dispersion Alloy	
U-235 Enrichment (%)	45		19.75	
Initial U-235 Content (g)	310	205	410	275
Maximum Burn-up (%)	40		LEU Core : 50 Improved LEU Core: 60	
Number of Fuel Plate	19	16	19	16
Plate Thickness (mm)	1.27		1.27	
Fuel Meat Thickness (mm)	0.50		0.51	

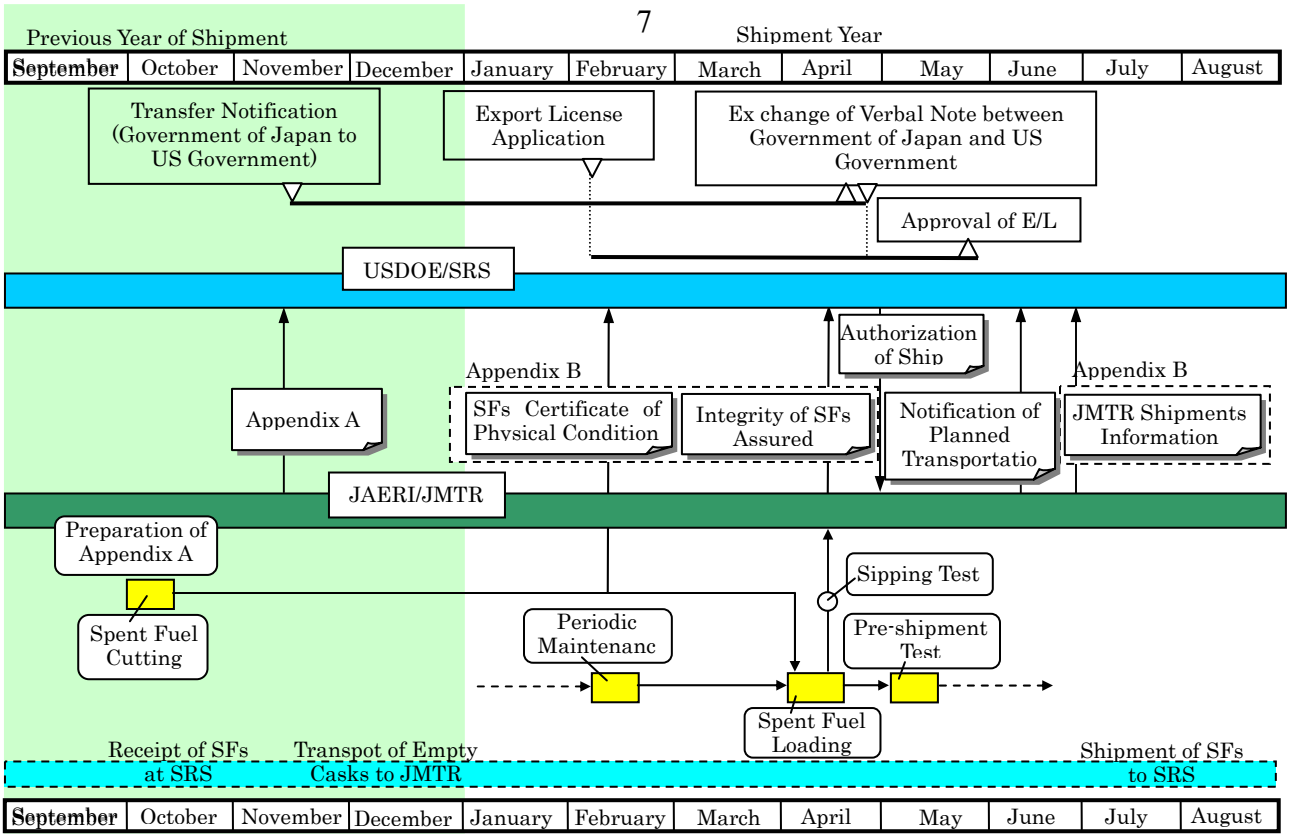

Fig.2 Typical Working Schedule of JMTR Spent Fuel Shipment

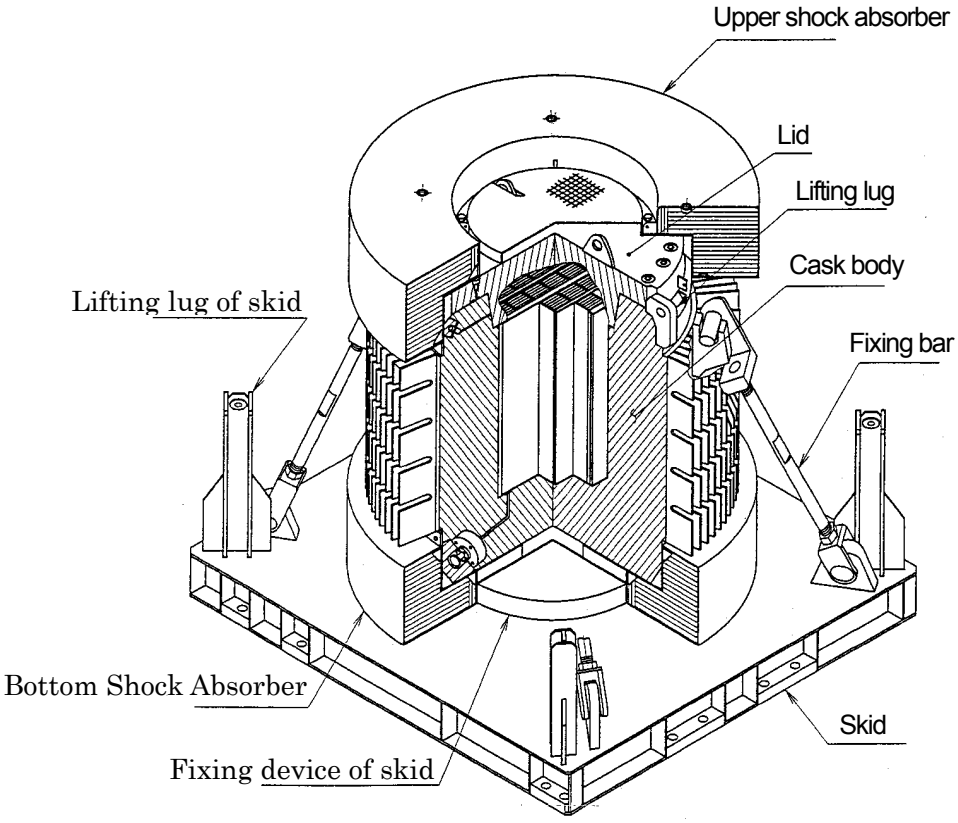

Fig.3 JMS-87Y-18.5T Cask in Transportation Configuration