DISMANTLING OF GLOVEBOXES FOR MOX FUEL FABRICATION BY A GLOVEBOX DISMANTLING FACILITY

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ABSTRACT

The Nuclear Cycle Development Institute (JNC) installed a glovebox dismantling facility (GBDF) in the Plutonium Fuel Production Facility (PFPF) of the Tokai works. The purpose of GBDF is to dismantle after-service gloveboxes for the MOX pellet fabrication process in PFPF (GBMPs) for safely storing and recovering the hold-up MOX powder from GBMPs. GBDF has a function of a glovebox for preventing scattering radioactive nuclides and is used for dismantling after-service gloveboxes repeatedly for decreasing the quantity of secondary wastes. Remote-controlled devices such as an arm-type robot, and plasma arc cutting systems are installed in it for the purposes of decreasing irradiation dose and increasing work efficiency respectively. Following items are considered as merits for the application of remote-controlled devices to the dismantling works in comparison with the ordinary dismantling method,

- -Improving working conditions (no capability of injury and inhalation contamination area)
- -Decreasing irradiation dose of workers
- -Decreasing generation of secondary wastes
- -Decreasing personal cost

The remote-controlled method was applied to constantly repeated works, and simple and long-time works. Approximately 20% of whole dismantling works were performed by remote-controlled devices. After-service GBMPs were dismantled safely and successfully by using GBDF. It was confirmed that the remote-controlled devices were useful for dismantling after-service GBMPs from the viewpoint of safety and cost reduction. It is expected that the GB dismantling method by using GBDF will be more economical than the ordinary dismantling method with consideration of increasing the fraction of the remote-controlled dismantling.

PURPOSE AND CONCEPTION OF GBDF

The Nuclear Cycle Development Institute (JNC) has been producing mixed oxide (MOX) fuels for FBR MONJU and JOYO in the Plutonium Fuel Production Facility (PFPF) of the Tokai works. This facility has remote-controlled and automated fuel fabrication systems for the purpose of demonstrating the industrial production of the MOX fuel. The accumulation of hold-up nuclear materials in the MOX pellet fabrication process appeared as a significant issue for PFPF as a large-scale MOX plant in 1994. Eight gloveboxes for the MOX pellet fabrication process in PFPF (GBMPs) have been replaced to new ones since 1996 because of introducing the improved automated MOX pellet fabrication system with a powder recovery system to prevent scattering the MOX powder. In general the hold-up nuclear materials are recovered from the after-service glovebox by the glove work from the viewpoint of accounting. Then it is dismantled in an in-situ temporary enclosure (greenhouse) from the viewpoint of safely storing for long time. An automatic equipment in GBMP is composed of complicated fabrication devices, devices for transferring nuclear material, and control units, which are installed almost of the inner space of GBMP. Besides, the quantity of the hold-up MOX powder in the after-service GBMP had been approximately 1 kg in maximum. Therefore, it was very hard to clean out the inner surface of the after-service GBMP and the inside of equipment, and scrape up the MOX powder in the after-service GBMP through gloves under narrow circumstances. It was also necessary to keep the more durable containment than that of the greenhouse for dismantling the after-service GBMP in which the hold-up MOX powder was still left. Moreover, it was predicted that if the after-service GBMP were dismantled by the ordinary dismantling method with the greenhouse, the irradiation dose of workers was increased extremely. The purpose of a glovebox dismantling facility (GBDF) is to dismantle the after-service GBMPs for safely storing and recovering the hold-up MOX powder from the after-service GBMPs. Basic conceptions of GBDF are as follows,

- Preventing scattering radioactive nuclides
  GBDF has a function of glovebox (GB). The level of the internal pressure is kept about 300Pa in gage pressure negative to the surrounding room pressure.
- Decreasing the irradiation dose of workers
  Remote-controlled devices are installed in GBDF for decreasing the irradiation dose of workers.
- Maintaining a durable structure
  GBDF has an aseismatic structure equivalent to that of GB.
- Decreasing the quantity of secondary wastes
  GBDF is installed at a specific place in PFPF and used for GB dismantling works repeatedly.

OUTLINE OF GBDF

The outline of GBDF is shown in Fig1. This facility is composed of a dismantling chamber (10mL x 5mW x 5mH), two-sets of the contamination-control system for workers with airline suits (2.5mL x 2mW x 2.5mH), a ventilation system, and a continuos monitoring system of airborne radioactive density in GBDF. The dismantling chamber and contamination-control systems are reinforced by six millimeters stainless frames at intervals of two meters as the aseismatic structure. The dismantling chamber has an entrance for loading GB to be dismantled in GBDF and a port for loading out cut fragments and secondary wastes. The dismantling chamber is divided of area I for dismantling and rough cutting, and area II for cutting in small pieces, packing, and loading out. A draft chamber for cutting work and a dust collector for preventing scattering dust including the MOX powder are installed in the dismantling chamber for the purpose of controlling airborne radioactive density. An arm-type robot and three manipulators are installed in it for the purpose of decreasing irradiation dose. Two plasma arc cutting systems and two cranes are also installed in it for the purpose of increasing work efficiency. Only parts of plasma torches and lines for electric and air of the devices are equipped in it from a viewpoint of decreasing secondary wastes. The ventilation system of GBDF has a roll of keeping 25mm to 35mm water-column negative pressure with respect to the surrounding room pressure for the dismantling chamber and the contamination-control systems. The ventilated air flows from the contamination control systems to the dismantling chamber. The direction of the airflow is reverse to the leaving direction of workers because of preventing scattering radioactive particles. Two sets of HEPA filters are equipped as a filtration of GBDF. A pre-filter is also equipped in the dismantling chamber because of preventing HEPA filters from choking by cutting powder and chips. There is a monitoring system to observe the dismantling work and instruct workers from outside of GBDF, which is composed of remote-controlled cameras, screens, and wireless communication devices. Eight windows of acrylic plates are mounted on the walls of the dismantling chamber and the contamination-control systems for direct observation. GBDF was installed in the basement floor of PFPF in 1996.

SEPARATION AND TRANSFER OF GB IN PFPF

GBMPs are standardized as having $9m^3$ volume (3mL x 3mH x 1mW) and the stainless steel body with 6mm thickness. The weight of GBMP is approximately 6,000kg in maximum. Each GBMP is connected to the glovebox for transferring nuclear materials (GBTM) by a connection tube with 500mm diameter. The ventilation of GBMP is performed through this connection tube by the ventilation system of GBTM. The after–service GBMP is separated completely from GBTM and transferred from the process room on the first floor to GBDF on the basement floor by following procedures.

-Shutting two flanges of GBMP and the connection tube by an isolation plug with two closing plates
-Separating GBMP from GBTM at the flange of the connection tube
-Setting casters under the bottom frame of GB
GBMP is transferred smoothly by man`s power.
-Transferring it from the process room to the corridor through the removable wall
-Transferring it to a loading hatch and lowering it to the basement floor
-Transferring it to GBDF through the corridor

DISMANTLING PROCEDURES IN GBDF

The procedures of dismantling GB in GBDF are as follows,

-Loading GB to be dismantled in GBDF
GB to be dismantled is loaded in GBDF by a bag-in method through the entrance. After that, a vinyl bag for the bag-in method is removed from GB. Then GB is fixed on the floor of area I in the dismantling chamber.
-Dismantling works in area I (see Fig.2)
Acrylic panels are removed from GB by unfastening screws and cut in nine pieces. The ceiling, side plates, bottom plate, and beam structures of the GB body are cut roughly. Equipment is removed from GB.
-Dismantling works in area II
Rough fragments of the GB body including beam structures, and removed equipment is cut in small pieces in the draft chamber for cutting work. The cut pieces and secondary wastes are packed and loaded out from GBDF through the port by a bag-out method.

The plasma arc cutting system is used for heavy cutting works such as a cutting work of the GB body and equipment in GB because of high performance. The cutting works for pipes and non-metal parts such as acryle panels are done by mechanical tools (rotary band saw, nibbler, etc.). The dismantling work is carried out by two kinds of dismantling method. One is an ordinary method by the workers with the airline suits, and the other one is a remote-controlled method in which the arm-type robot and manipulators are used.

APPLICATION OF REMOTE-CONTROLLED DEVICES

Following items are considered as merits of the remote-controlled dismantling method in comparison with the ordinary dismantling method,

-Improving working conditions (no capability of injury and inhalation in contamination area)
-Decreasing irradiation dose of workers

-Decreasing generation of secondary wastes
-Decreasing personal cost

The remote-controlled method is applied to constantly repeated works and simple and long-time works, for example, unfastening of one-size and many screws, and cutting of long and flat plate. Some kinds of work in the whole dismantling works were performed by using the arm-type robot and manipulators. These are,

-Cutting a vinyl bag of the bag-in method for removing it from GB
-Removing the panels from the GB body by unfastening fifty-six bolts
-Removing glove ports from the panel by unfastening sixteen bolts
-Cutting panels by the chip saw
-Cutting the GB body by the plasma arc cutting system or the chip saw (see Fig.3)

EXPERIENCES OF DISMANTLING GB IN GBDF

Eight GBMPs were dismantled safely and successfully in GBDF from 1996 to 2000. The total amount of volume for the dismantled GBs is $72m^3$. The total amount of workdays for dismantling one GB was fifty to hundred days, which were mainly depended on the quantity of the hold-up MOX powder in GB. The numbers of average workdays for the separation and the transfer were fifteen days and two days respectively. Approximately hundred-seventy drums per one GB including seventy drums of the secondary wastes were generated as radioactive wastes. Approximately 20% dismantling work to the whole dismantling works were performed successfully by using the remote-controlled devices.

COMPARISON OF GB DISMANTLING WORKS

The GB dismantling work by using GBDF (DWDF) was compared with the ordinary dismantling work with the greenhouse (DWOM) from the viewpoint of irradiation dose, generation of secondary wastes and personal cost (see Fig.4). 20% remote-controlled dismantling works in DWDF was considered in this comparison. The results for DWDF in comparison with DWOM are,

-The average irradiation dose per man and per GB was decreased up to approximately 57%. The reasons of this reduction are the reduction of twelve dismantling workdays with the airline suits by the application of the remote-controlled devices and the difference in the effect of irradiation protection to the workers at the outside of the dismantling work area.
-The generation of secondary wastes was decreased up to approximately 76% because of the reduction of materials used for the greenhouse and twelve dismantling workdays with the airline suits.
-The personal cost was decreased up to approximately 65% because of the application of the remote-controlled devices and the reduction of twelve dismantling workdays with the airline suits.

The fraction of the remote-controlled dismantling works to the whole dismantling works will be increased up to 40 to 50% by improving the tools and procedures in future. It is expected that DWDF will be more economical than DWOM in comparison of the cost of GB dismantling works for the replacement of GBMPs and the decommissioning of PFPF. The costs of GBDF, the maintenance, and a replacement of the remote-controlled devices are included in this estimation.

CONCLUSIONS

1. The after-service GBMPs were dismantled safely and successfully by using GBDF.
2. It was confirmed that the remote-controlled devices were useful for dismantling the after-service GBMPs from the viewpoint of safety and cost reduction.
3. It is expected that the GB dismantling method by using GBDF will be more economical than the ordinary dismantling method with consideration of increasing the fraction of the remote-controlled dismantling.