

DECONTAMINATION OF HOTCELL 02/03 FACILITIES IN RADIOMETALURGY INSTALLATIONS

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ABSTRACT

NATIONAL NUCLEAR ENERGY AGENCY (BATAN) has hot cell facility to support the activities of the nuclear fuel technology development in Indonesia. At the present, hot cell condition is needed to revitalize, the test equipment needs repair and replacement with new test machines. Test equipment that is damage and unable to repair will be removed from the hot cell. For test equipment repair and replacement with new test equipment and also to remove the damage equipments, one must get into the hot cell. It is necessary for the decontamination of hot cell. In this paper, we will describe hot cell facility, and explain the the hot cell decontmination technique with some obstacles encountered in the decontamination. These obstacle include the limited facilities and infrastructure required to carry out decontamination in the hot cell. Meanwhile, there are contaminants in the hot cells caused by post-irradiation examination of oxide and silicide fuel, as well as post-irradiation testing for low enriched uranium targets foil for producing Mo-99. There for the hotcell facility must be decontaminated. Steps of decontamination hotcell are identification and mapping of radiation level in hot cell, waste clasification of nuclear fuel and contaminated materials, remote decontamination by manipulator and then all waste would be tranfered to interm storage facility.

Keywords : hotcell, decontamination, remote handling, and manipulator

INTRODUCTION

Centre for nuclear fuel technology (PTBBN) has two instalation, one is radiometallurgy installation. RMI has hotcell that consisting of 3 concrete cell and 9 steel cell as shomn figure 1. Hotcell 01 for reception and temporary storage of nuclear fuel to be tested, hotcell 02 for visual inspection, dismantling and cutting fuel elemens for destructive test sampling and hotcell 03 for non destructive testing.

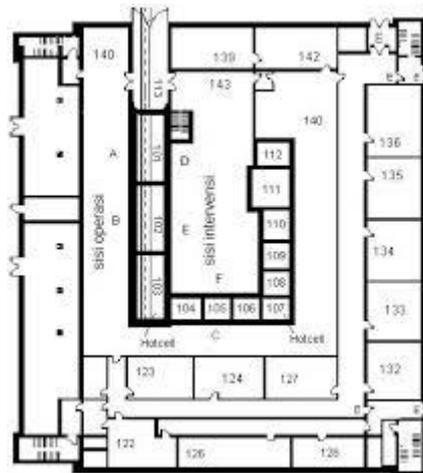


Figure 1. Layout of Radiometallurgy Installation

Testing in hot cell can be conducted for nuclear fuel element of Material Test Reactor, Pressurized Heavy Water (PHWR), Light Water Reactors (LWR) and structural materials such as plate of $AlMg_2$, $AlMgSi$ dan zircalloy tube. Hotcell in IRM was used to performe post irradiation examination of the oxide fuel (U_3O_8) and silicide fuel (U_3Si_2-Al) since 1995¹. The hotcell was also used for testing of Low Enriched Uranium foil target (LEU foil target). Dismantling of fuel plate and LEU foil target in concrete cell had been carried out resulting very high contamination of radioactive materials. Due to high radiation exposure in the concrete cell, most of the equipment, electrical cables and several manipulator sleve arm become damage². Test equipment that is damage and unable to repair will be removed from the hot cell. For test equipment repair and replacement with new test equipment and also to remove the damage equipments, one must get into the hot cell. It is necessary for the decontamination of hot cell. Slave arm manipulators in hotcell 02/03 ware replaced with new manipulator in 2013. They can be used to handle spent fuel and radioactive waste both in hotcell 02 and 03. Manipulators that replace are 3 units in hotcel 02 and 2 units in hotcel 03^{3,4}. Figure 2 shown before and after replacement of manipulator in hotcel 02/03.

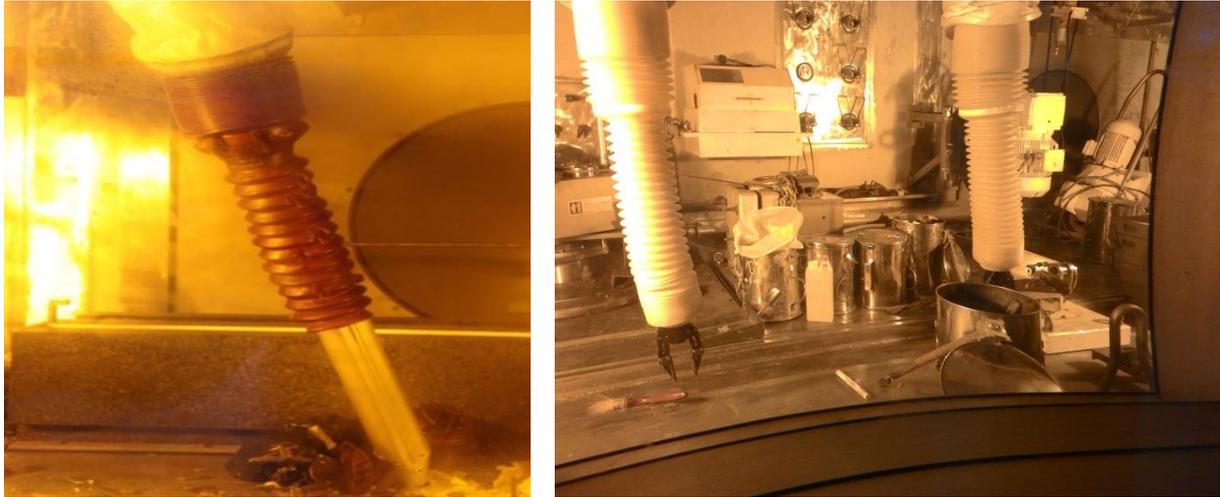


Figure 2. Manipulator in hotcel 02/03 before and after replacement

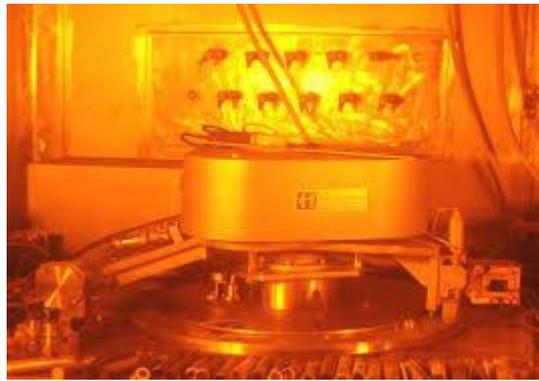


Figure 3. Some equipment will be repaired and replaced

In this paper, we will describe hot cell facility, and explain the the hot cell decontamination technique with some obstacles encountered in the decontamination. The purpose of this activity is to reduce the level of radiation exposure and contamination in hotcell 02 and 03 up to a certain level so that personnel can get into hotcell for repair of equipment such as a barrel lifting device and other equipment that NDT tool in the form of gamma scanning, radiography, ultra sonic tester etc. Equipment will be repair and replace such as barrel double lid, dismantling machine and NDT equipment shown in figure 3

EXPERIMENTAL

Decontamination technique was done mechanically using manipulator. Scope of the activity includes tools preparation, contaminant α/β mapping and decontamination. At first, spent fuel and contaminated materials were classified and collected in difference cans.

Nuclear fuel plates after post irradiation testing were collected and put into container as figure 4.

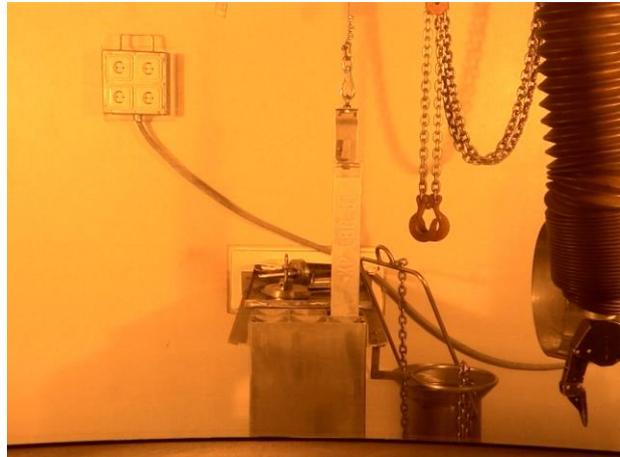
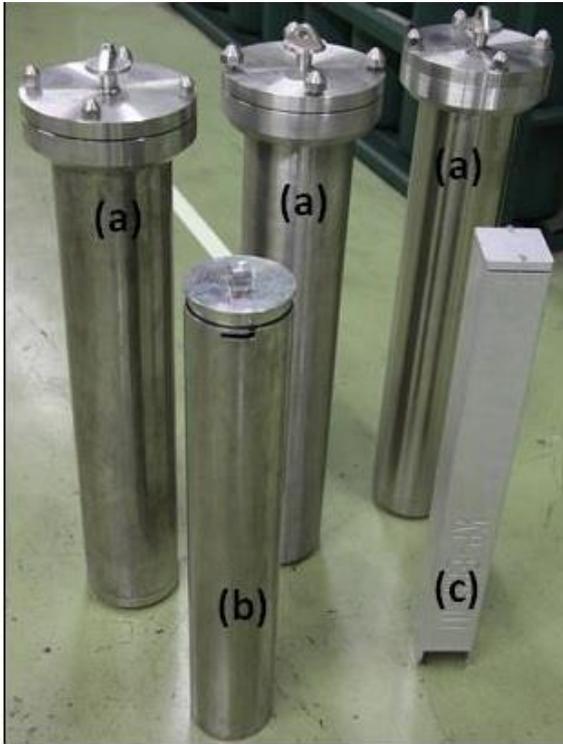


Figure 4. Container for spent fuel plate and LEU foil target³¹

Waste piece of of LEU foil target put into cylinder container and transfer to HC 01 for temporary. Meanwhile, for contaminated solid materials plated put into stainless steel cylinder cans as figure 5, the cans were take out through wall plug 03 and transferred to temporary waste storage in 013.



Figure 5. Cans for contaminated waste materials

Preparation steps include preparation of decontamination personnel and their work equipment (film badge, ring badge, TLD, pocket dosimetry), decontamination clothes, and full face respirator for personnel intervention in isolating room¹¹. Decontamination were done by remote handling using manipulator. Some particles and chips on the floor were collected and put into storage using scoop and brush. The floor of hotcell was swept using dry cloth continually until beta contaminated level under dose limit. After that, decontamination will be continued with wet decontamination. Cloth or paper drabble with radoowash or acetone and then wet cloth swabed into surface of floor and equipment. Wet decontamination expected to desperated dust or particles on the floor. After that, radioactivity of beta was measured to determine the difference before and after decontamination.

RESULT AND DISCUSSION

Contamination mapping

The aims of decontamination in hotcell 02/03 are to repair and replace some equipment so they can be used for handle waste and post irradiation examination. Before we conduct decontamination, we should be map radioactivity level. Preparation stage is very important. Mapping of radioactive level related to the history of hotcell utility. Mapping of radioactive level or contaminant exactly will provide effective results for the decontamination process. Mapping surface contamination level in hotcell 03 has been done at several position that showed in figure 6.

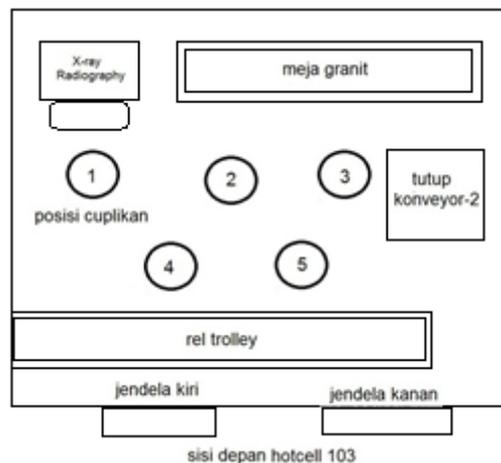
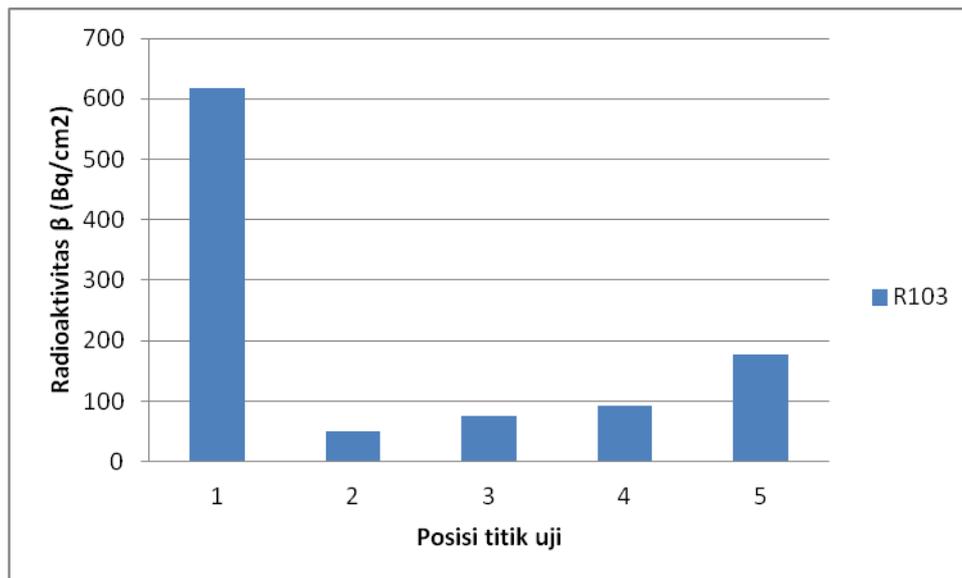


Figure 6. Sampling position for smear test in hotcell 03⁵¹



Gambar 7. Mapping of radioactivity contaminant in hotcell 03⁵¹

The results of mapping surface contamination levels in hotcell 03 have showned in figure 7. Contamination of beta is highest at 617,97 ± 2,76) Bq/cm2 in position 1⁵¹. High radioactivity level in hotcell 03 caused by several activity such as dismantling and cutting of nuclear fuel element, post irradiation examination fuel of U₃Si₂-Al with density of 2,98 grU/cm³.

Decontamination

After manipulators in hotcel 02 and 03 have repaired, so that waste in hotcell 02 and 03 could be manage by remote handling using manipulator. Decontamination is define as the removal of contamination from areas or surfaces of facilities or equipment by washing, heating, chemical or electrochemical action, or mechanical cleaning⁶¹. Decontamination has done mechanically by manipulator. Mechanical decontamnation can be classified into two method, namely surface cleaning and surface removal⁷¹. Surface cleaning method was chosen because it is very effective of decontamination for wide surface, and contaminated materials don't react with surface of floor and equipment. Types of contaminant in hotcell 02/03 are spent fuel plate, LEU foil target tube, visible debris and coarse dust. Its contaminants don't react with surface of floor and equipment so that the surface cleaning is realatively easy. Condition of hotcell 03 before decontamination shown in figure 8. Tools for surface cleaning are choven, brush and cloth that handle with manipulator. Firstly, decontamination was done at position of highest radioactive level based on mapping of radioactivity level.

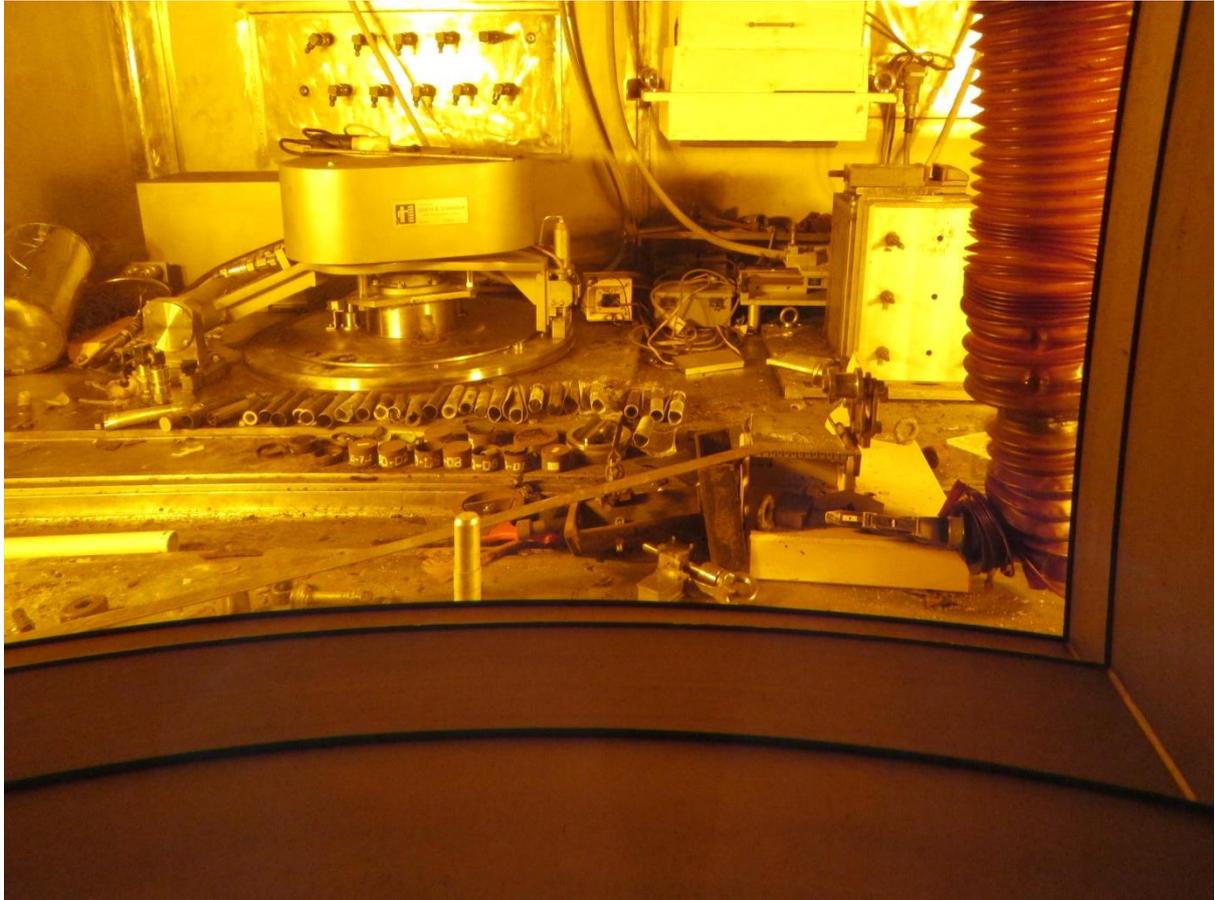


Figure 8. Condition of hotcell 02/03 before decontamination

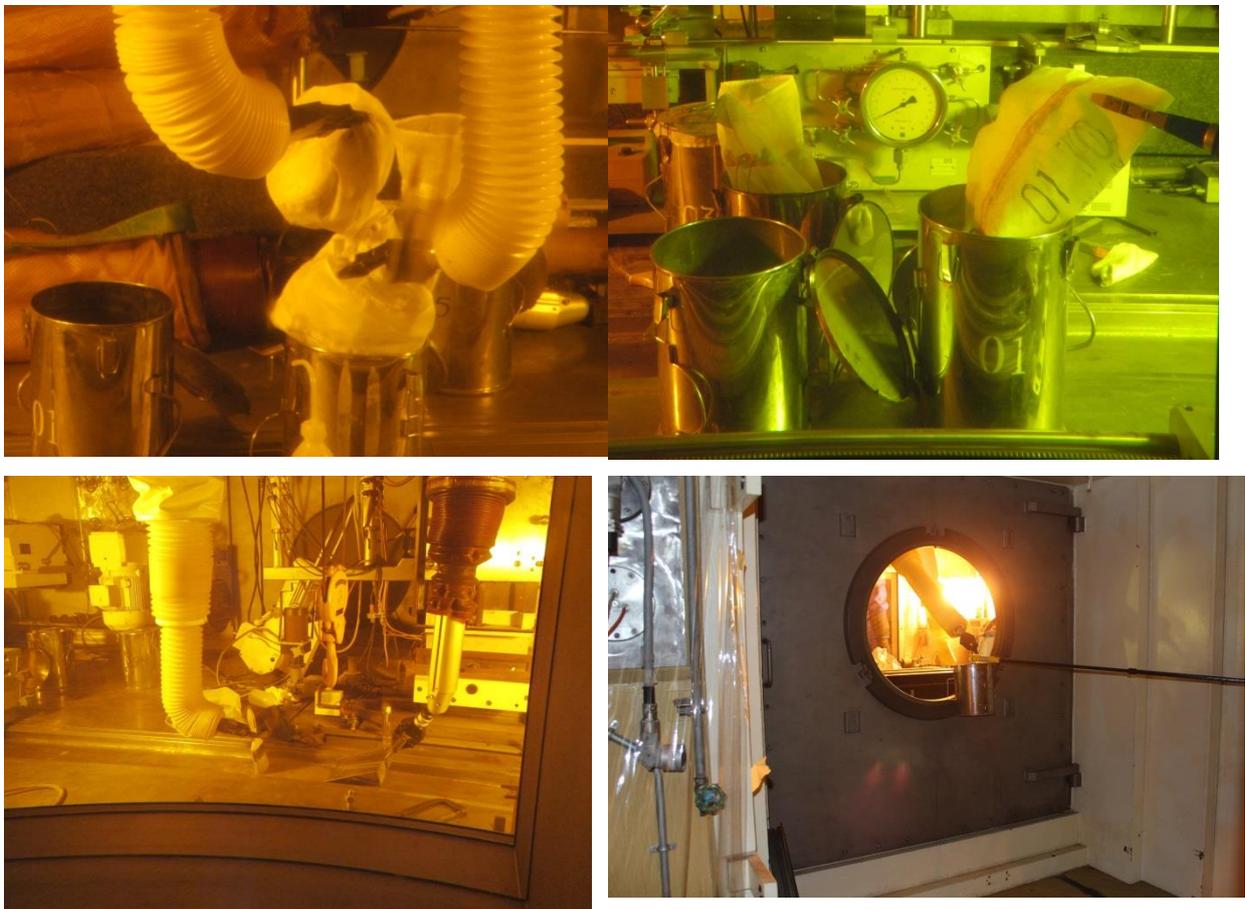
At first, spent fuel plate and LEU foil target were collected and put into inner container that made from stainless steel. After that containers transferred to hotcel 01. Figure 9 is activity to collect spent fuel or Mo-foil target and put into containers.



Figure 9. spent fuel plate put into containers by manipulator

For contaminated materials, cans will used to as waste container. At this stage, the handling of spent fuel and other contaminated material using manipulator was done carrefully.

Operators who have high skill to operate the manipulator. Piece of spent nuclear fuel put into cans gradually by sleeve arm manipulator. If cans were full, those cans would be transferred to hotcell 01. After initial decontamination or transfer spent fuel from hotcell 02/03 has finished then we carried out decontamination of contaminated materials. Decontamination efforts began by using “dry” methods with in-cell manipulators to concentrate on visible dirt and debris (figure 10). Dry decontamination methods were chosen because they are effective at gross decontamination while generating only limited amounts of secondary wastes^{7,8]}. The goal for this initial stage of decontamination was to collect all visible debris and eliminate any identifiable “hot spots.” Operators “dry” wiped all accessible hot cell surfaces. After collecting visible dirt and debris by choven and then floor surface and equipments is wiped using a cloth that has given radiowash.



Gambar 10. Decontamination process in hotcell 02/03 by manipulator

Contaminated materials such as particle, debris and other contaminants have been removed from the floor of the hot cell or from the surface of equipment using a manipulator equipped with tools such as a chisel and cotton waste or cloth. While, fine particulate is removed by a wet cloth. Decontamination is done by rubbing the surface of the floor using a cleaning cloth that has been soaked

with radiowash or acetone. In this way, the contaminant on the surface is expected to be drawn by a dump cloth so that the level of contaminant is reduced. Figure 11 is condition of hotcell after decontamination. Floor surface have cleared of particle, visible debris, piece of spent fuel plate and others contaminated materials.



Figure 11. Hotcell 03 after mechanical decontamination (dry and wet)

Spent fuel plates have transferred to hotcell 01, while contaminated materials were taken out through wall plug 103 and transferred to temporary waste storage in 013. In this paper, Dose rate and radioactivity α/β not be measured yet completely in hotcell 03, because there are obstacles such as any solid waste didn't take out from hotcell 03. Some radioactive waste that results from hotcell 03 were transferred to Centre for Radioactive Waste Technology (PTLR) in 2014, other still in interim storage of PTBBN. Solid radioactive waste resulting from hotcell 03 were transferred to PTLR is 8 drums (@ 200 liters) with highest exposure at about 4600 $\mu\text{Sv}/\text{hours}^{\text{91}}$. Radioactive waste stored in PTBBN have dose rate at about 20000 $\mu\text{Sv}/\text{hours}$. Its radiation level is very high. Container for solid waste should be shielded with Pb plate in several layers to decrease the radioactivity level. There are obstacles for management and disposal of waste because barrel lifting device and other equipment still broken and not yet repaired. Based on the procedure, the movement of solid waste should be used barrel lifting equipment device in R 02 and the maximal exposure of radioactive waste that sent to PTLR was 250 $\mu\text{Sv}/\text{hour}$.

CONCLUSIONS

The method of hotcell 02 & 03 decontamination was done mechanically by wet and dry method using manipulator. Decontamination technique was done by cleaning the surface of floor, because the floor was relatively flat and not damaged. Decontamination was done continually and gradually until the floor and hotcell equipment clean. Mechanical

decontamination produced dust or fly particle that effect contamination on other surface but If remote handling was done carefully and gradually by dry and wet method, the possibility could be avoided. After decontamination, the overall condition of hotcell 02 and 03 in clean condition with relatively low contamination. Spent nuclear material and the Mo-foil targets have been separated and moved to R 01 so that the radiation exposure around the area is relatively lower. Meanwhile the solid waste was removed and sent to a temporary waste storage facility in PTBBN. Several solid waste containers have not taken out from hotcell 03 because of the very high exposure. Solid waste that produced from decontamination hotcell 03 had exposure more than 2400 to 20,000 $\mu\text{Sv}/\text{hour}$ while the permitted limit for delivery to PTLR about 250 $\mu\text{Sv}/\text{hour}$ ^{8]}. So it should be an effort to decrease the radiation exposure with wrapping the waste container using Pb plate up to a certain thickness. Visually the surface condition of the floor and test equipment in hotcell quite clean, it indicated that the level of contamination and exposure considerably decreased, but the measurement of contamination must be more detailed and thorough, especially on narrow and angled parts to made sure the condition in hotcell 02 and 03 were free of contamination and low exposure γ radiation, so that personnel of repairment and tool replacement were allowed to entered into hotcell.

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