Radiological Safety Considerations and 20 years Operational Health Physics Experience in Hot Cell Operations at Radio Chemistry Laboratory

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1. Introduction

The hot cell facility at Radio Chemistry Laboratory (RCL) consists of 5 cells in a row, operating area, isolation area; mock up area, decontamination and active maintenance area. Operations involving high radioactive handling is performed in Hot cells by remote handling systems like master slave manipulators. These hot cells are designed to handle activities up to 370 TBq of Co-60. Radiation shielding is provided by 1500 mm thick ordinary concrete (density 2.4 g/cm^3) in the front and rear faces and inter cell walls are 900 mm thick high density concrete (3.5 g/cm^3). The shielding is adequate to handle one bundle of MAPS fuel with a burn up of 10000 MWd/t or one subassembly of FBTR fuel with burn up of 150GWd/t. The design specification of the cells is such that the dose level in the operating are is less than 1μSv/h during the handling of the radioactive materials within the maximum design specifications. The supplied air to the cells 1-5 is exhausted through HEPA filters located back side of the cells and goes through a damper pit from the isolation rooms. A negative pressure of 20 to 25 mm of WC is maintained for cells 1&5 and in the boxes cells 2, 3 &4 is at negative pressure of 40-50mm of WC with 30 air changes per hour. The most important few operations at hot cells for last twenty years were taken for presentation and their radiological safety aspects are depicted in this paper.

2.Radiological Safety

To ensure the safety of the personnel working in the Hot Cell areas on routine basis, a comprehensive radiation hazard control plan was implemented, which consists of evaluation of both external and internal radiation exposures. The control of exposures was implemented using air monitoring, area monitoring, personal monitoring and contamination control. Air monitoring is carried out using installed continuous air monitors and spot air sample analysis on daily basis. Radiation survey was carried out ion to assess the potential risk of external exposures to the workers. External exposure control is carried out using personal monitoring (using TLD's and DRD's) devices. Contamination control is achieved by zoning of areas in the hot cell area and ventilation systems. Internal dose assessment was carried out by sending individuals to whole body counting and Bio assay analysis periodically. Safe working procedures were formulated by implementing Radiological work permits for special operations which ensures the adequate administrative control of the work. The envisaged major maintenance jobs associated with hot cell are replacement of HEPA filters of the cells, removal of containment boxes and replacement of in-cell components on failure other than experimental studies. The first two operations do not need entry to the cell where as the repair of some experimental assemblies requires man entry to cell. Man entry to cell is carried out from the isolation area for maintenance jobs and these jobs would be taken up only after the area is declared free of floor and airborne contamination and under strict administrative control by RWP.

3.0 Health physics experience during the major Hot Cell operations

Since collective effective dose in a plant is an instrument for optimization for comparing radiological technologies and protection procedures, it gives an idea of adherence to the Radiation Protection Procedures.

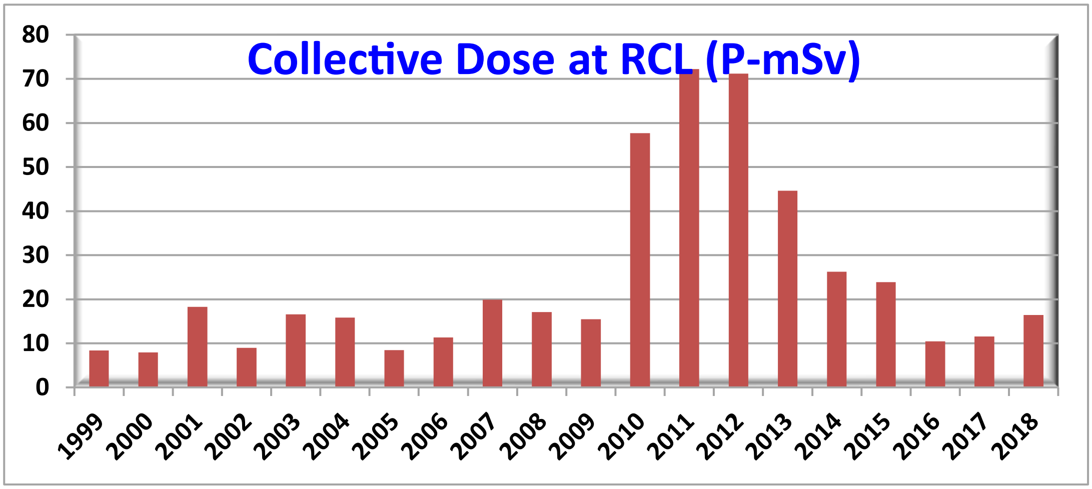


Figure 1. shows the collective dose for RCL for last past 20 years

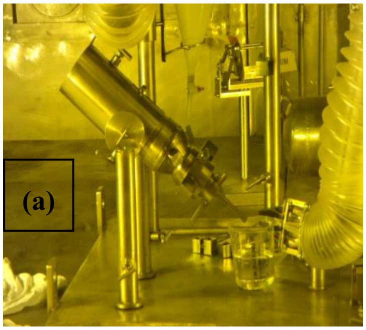
From Fig.1, it is observed that the collective dose was 60-75 PmSv during period 2010-2012. This is due to the mixer settler run carried out at Glove Box (MSGB1environment in H-6 lab. The separation and stripping with sample collections using simulated solution with Pu and Uranium is carried out in the run. Hence, a higher personnel dose consumption was envisaged for mixer-settler runs with actual dissolver solution. Hence, installation of mixer settler runs with HLW solution inside cell 5 was planned and executed.

The first man entry to cell 5 is performed for providing experimental accessories for the installation of mixer settler and for alignment of flange associated with ETP inside cell 5. Cell was cleaned for transferable contamination prior to man entry to the cell and dose rate at the work place inside cell was 1.0 mSv/hr. Air borne activity was found to be less than one DAC of Pu-239. Effective external dose consumed during the installation was 0.5 miSv/h. Few years later, another man-entry was carried out to cell 5 for installation of 16-stage ejector mixer settler set up for extraction of lanthanides. Radiation field maximum measured was 1.0 mSv/h (max) near the old materials stored. . In both the cell entry operations, Full cover-all, double surgical gloves and shoe coves, Self Contained Breathing Apparatus, TLD, and DRD were recommended as personnel radiation protection equipments. Dose expenditure during the cell entry operations was 1.01 PmSv.

Transfer of Materials like Fuel pin clad, FBTR irradiated fuel pins and cut sections in the hot cell and high level waste solutions (3L) and Sr-90/Y-90 solutions are other significant hotcell operations that had potential personal exposure. The irradiated fuel pins from FBTR were received in alpha leak tight stainless steel La calhene container in a shielded cask. Transfer of material was carried out by properly aligning the cask to the cell shielding block whose shutter can be opened and the material can be taken inside the cell. Some of the most important hot cell operations and transfer operations for last twenty years are listed in Table.1.

Table 1. Some of the important Work description

Decontamination & maintenance of 3 MSM; Removal of ^{137}Cs from MAPS fuel in cell 1
Dissolution of FBTR irradiated fuel pellet in concentrated acid
Receipt, posting and examination of MAPS pressure tube in Cell 1; Receipt and storage of chopped FBTR Fuel pins in cell 4; Fuel pin puncturing device and testing of the same.
Dissolution of the cut section of the fuel pellet; Receipt of RDL dissolver solution
Receipt of irradiated Y-88 pellets, Sr-89 solution separation and Extraction FBTR fuel pins
MOX fuel solution; Transport of Fuel pin clad to RML



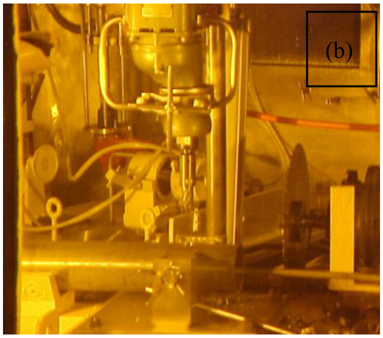


Figure 2. (a) Sr separation in cell 1 (b) Pressure tube examination and trepanning

4.0 Conclusion

Effective HP surveillances were provided for minimizing the plant-dose to considerable extent without any untoward over exposure cases for last 20 years. None of the occupational workers of MC&MFCG was received an effective dose limit (20mSv) recommended by AERB in any single year during last 20 years. Over all fractional dose contribution incurred due to hot cell operations to the total cumulative collective dose of RCL was estimated to be 0.42%.

References:

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