RADIATION PROTECTION ASPECTS IN DECOMMISSIONING OF A FUEL REPROCESSING PLANT

P. Kotrappa, P.P. Joshi, Health Physics Division;
T.K. Theyyunni, B.M. Sidhwa and M.N. Nadkarni, Fuel Reprocessing Division, Bhabha Atomic Research Centre, Trombay, Bombay - 400 085, INDIA.

INTRODUCTION

The Fuel Reprocessing Plant at Trombay (1) was designed as a pilot plant to develop the technology of chemical processing of irradiated nuclear fuel. The chemical process employed was a Purex type, solvent extraction process. The aluminium clad natural uranium fuel from the CIRUS reactor was successfully processed in this Plant (2).

After a long period of operation, it was decided to carry out a partial decommissioning of this plant with a view to modifying the plant to increase its capacity, to improve the safety features and to extend its useful life. Any major modifications of a nuclear chemical plant require massive decontamination and decommissioning efforts to permit easy and unrestricted entry of personnel for the new installation work.

In the case of the Trombay Fuel Reprocessing Plant, these jobs have been successfully carried out. Salient features of these efforts have already been described (3). The purpose of the present paper is to provide information on the radiation protection aspects of such an operation.

DISMANTLING AND REMOVAL OF PROCESS EQUIPMENT

The recoverable nuclear materials from the vessels and columns were removed by repeated rinsings. The internal decontamination campaign for these was then started.

Initial radiation surveys were carried out by lowering wide range (5 rems) self reading dosimeters attached to long thin rods or strings. After several washings, the radiation levels on the equipments were reduced to levels below 250 mr/hr. There were spots of much higher levels which could be located only after entering the cells. These latter surveys were carried out by using wide range dose measureing instruments with extendable arms (upto 4 meters). The dismantling of the equipments and piping was done by electric arc cutting. The heavy equipments were lifted by a crane through the cell top plug openings and stored in a previously unused cell.

When the dissolver off-gas filter was disconnected from the suction side, the gamma radiation levels in front of the flanged openings were unexpectedly higher (nearly 10 times) than the gamma dose rates on the body of the S.S. container of the filter. This was due to bremstrahlung low energy X-rays, which could be easily shielded by a metal cap. If not anticipated or measured such high radiation through the flanged opening can cause excessive exposures.

Beta radiation dose rates were also contributing to the workers exposures. Due to spills of hold up liquids from cut pipes or contaminated stagings and walls, high beta dose rates 30 to 50 times the gamma dose rates were observed. The beta dose rate levels were measured with a small ionization chamber type instrument. Its response was calibrated using an extrapolation chamber. For the immediate estimation of the beta doses received by the workers, use was made of a pair of dosimeters, one of which was shielded from beta rays by means of a S.S. tube. The difference in the readings of the two dosimeters was used to estimate the beta ray doses. This procedure was also calibrated for dosimetry of beta rays from aged fission products, using an extrapolation chamber.

Each worker was provided with a full set of protective equipments consisting of undergarments, coverall, ventilated one piece plastic suit covering the body from the toes to the neck, skull cap, transparent plastic hood covering the entire head and face, two pairs of rubber hand gloves and ankle high rubber gum boots. Each worker used a supplied air positive pressure respirator connected to a compressed air supply station by a 10 to 20 meters long rubber pressure hose. With this protective gear, a worker could carry out his assigned jobs only upto 30 minutes. The heat stress and excessive sweating caused fatigue and exhaustion. In the initial stages the high radiation levels set limits on working time to less than 5 minutes.

DECONTAMINATION OF CELLS AND OTHER AREAS

A large effort was spent on the decontamination of cell interiors and adjacent areas such as dilution cells, rod storage bay, tunnels in the sampling gallery, the cubicles housing the service pumps and the plutonium processing areas.

By mopping and hosing withhigh pressure water much of the removable contamination was removed. Fixed contamination on the walls and floors had to be removed by pneumatic drilling. To prevent spread of contamination due to airborne dust or by liquids, only small areas were fully decontaminated and reclamied at a time. During drilling of concrete surfaces water spraying of the spot being removed, helped in limiting the amount of airborne dust. All the drilled surfaces were refilled with fresh concrete and all surfaces were given a fresh coat of paint.

MANAGEMENT OF RADIOACTIVE WASTES

The liquid wastes generated during the internal decontamination of the process equipments were concentrated by evaporation and transferred to the underground storage tanks.

During the dismantling operations, the unusable items and a large quantity of metal scrap produced were put in drums and sent as active waste for burial. Large unwieldy items were decontaminated to an extent permitting their cutting and handling. The drums were moved by crane and put in the shielded transport containers.

During the decontamination work of the cells and other areas, large amounts of solid and liquid wastes were generated. The solid waste consisted of cotton mops and rags, concrete rubble, small size metallic scrap and polythene and rubber items. These were packed in plastic bags. For safe transport the bags were put in drums which were transported to the disposal site and brought back for reuse. The liquid wastes were put in plastic carboys which were again put in secondary metal containers before shipment for immobilization and burial. The organic liquid waste from one cell was sent for disposal in a S.S. tank in a single lot.

Many of the operations gave rise to airborne radioactivity. The normal plant ventilation and filtration system could adequately handle these situations. A meticulous record was maintained on the release of activity through the stack.

Table 1 gives the volumes of solid and liquid wastes and activities released through the stack.

TABLE 1. Discharges during Decommissioning

Solid Wastes						Liquid Wastes				Stack Release	
Bags (M^3)			Drums (M^3)			Inorganic (M^3)			Organic (M^3)	Alpha mCi	Beta mCi
L	M	H	L	M	H	L	M	H			
800	5	86	278	64	170	2.2	0.3	0.03	2.7	25.4	614

L = Low active (less than 200 mr/hr); M = Middle active (200 to 1000 mr/hr); H = High active (greater than 1000 mr/hr).

CONTROL AND MEASUREMENT OF RADIATION DOSE TO WORKERS

Each day's work was planned through a system of special work permits requiring details of (i) work to be done; (ii) radiation surveys of the area; (iii) the authorised dose to the workers; and (iv) the protective wears and dosimetry systems to be worn and such other relevant information.

Normally a standard film badge, a self reading dosimeter, a self reading dosimeter with a beta shield (1.5 mm S.S. sleeve) were worn on the chest. In special cases additional film badges were used on wrists and feet. In most of the cases workers were exposed to significant beta doses. These were taken into account by adding 1/6th of the beta dose to the gamma dose and calling the sum as the whole body dose. Even though such addition was not required by the I.C.R.P. recommendation (I.C.R.P. 26) gives a factor of 1/16 as the weighting factor for skin exposure.

The total dose commitment for this work was around 3000 man-rems. Out of this nearly 1000 man-rems were due to dose from beta radiation exposure. (This means that the total beta dose was 6000 beta man-rems).

A shadow shield whole body counter was available full time for this job. Workers were scanned for internally deposited radioactivity within a week after their job. A plutonium lung counter was also available for estimation of chest burdens of plutonium. All the workers were subjected to bioassay procedures for body burden estimation of fission products, plutonium and uranium.

CONCLUDING REMARKS

The work was completed safely by using relatively simple but fully reliable protective wears. The entire job was done by the staff normally associated with the operation of the plant. This aspect contributed significantly in the management and control of personnel exposures. Good planning and supervision of the radiation work during all the phases resulted in keeping the external doses to individuals below the annual limit of 5000 millirems. There was no case of any internal contamination resulting in a dose commitment in excess of 10% of the annual limit. General industrial safety precautions must also be followed in such jobs in which compressed air, scaffoldings and ladders, slippery surfaces, harmful chemicals, sharp objects and a host of other lurking causes may lead to serious injury.

A job of this type looks staggering in the initial stage. A large responsibility rests on the health physicists in building up the confidence of the radiation workers in the efficacy of safety measures and dose control methods. We were fortunate in having a band of dedicated workers who took to the task in a sincere and very cooperative manner. Our experience shows that decommissioning of nuclear chemical plants can safely be carried out using the presently available technical facilities and scrupulously following the principles and procedures of Health Physics.

ACKNOWLEDGEMENTS

We thank Shri A.N. Prasad and Shri S.D. Soman for encouragement and helpful advice.

REFERENCES

1. Sethna H.N. and Srinivasan N. (1964) : Fuel Reprocessing Plant at Trombay - Paper presented at the Third U.N. International Conference on the Peaceful Uses of Atomic Energy; GENEVA.
2. Prasad A.N. and Kumar S.V. (1977) : Indian Experience in Fuel Reprocessing - Paper presented at the International Conference on Nuclear Power and Its Fuel Cycle; SALZBURG.
3. Rao M.K. (1978) : Decommissioning Aspects in a Nuclear Chemical Plant - Paper presented at the International Symposium on the Decommissioning of Nuclear Facilities; VIENNA.