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RADIATION PROTECTION PROCEDURES FOR THE DISMANTLING AND DECONTAMINATION OF NUCLEAR FACILITY

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ABSTRACT

This work presents the operational procedures and conditions to ensure the required level of protection and safety during the dismantling and decontamination of a natural uranium purification facility at IPEN-CNEN/SP. The facility was designed for chemical processing of natural uranium, aiming to obtain the uranyl nitrate, nuclear-grade. Afterwards, the installation operated in treatment and washing of thorium sulfate and thorium oxycarbonate dissolution, to get thorium nitrate as final product. A global evaluation of the potential exposure situation was carried out by radioprotection team in order to carry out the operations planned. For the facility dismantling, was established both measures to control the radiation exposure at workplace and individual monitoring of workers. A combination of physical, chemical and mechanical methods was used in the decontamination procedure applied in this unit. Concerning the internal operation procedures of IPEN-CNEN/SP, the radioactive waste control, the transport of the radioactive materials and authorization of use of decontaminated equipment were also subject of study.

1. INTRODUCTION

Effective work management involving radiation exposures is necessary to be managed and planned from the perspective of the specific task, considering the radiological conditions. For this purpose was established a work schedule by radioprotection team to deal the operational procedures about the dismantling and decontamination of a nuclear facility of Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP.

The historical records indicate that the facility was used for production of the uranyl nitrate and thorium nitrate as end product. In general during the process of dismantling and decontamination of a facility there is solid waste generation.

Activities related to cessation of operations must be monitored, controlled or prepared, in case for a new operation. The radioprotection team was responsible to carry out the operational procedures set up in compliance with the regulations well established and to apply experience and lessons learned to the development of this job [1-3].

This study is intended to provide consolidated experience and guidance to those planning, managing and performing the dismantling and decontamination activities in research reactors,

reprocessing plants and other nuclear or radioactive facilities. The study may be of use to those involved in the nuclear regulatory field, when reviewing plans, carrying out inspection activities and confirming satisfactory completion and it will also be helpful to those carrying out large scale maintenance activities on operational nuclear or radioactive installations.

The focus of this study is particularly on dismantling and decontamination operations carried out by radioprotection team. However, the management of materials/waste, measurements direct or indirect is also an essential part of the monitoring program applied.

2. METHODOLOGY

2.1 Preliminary Analysis

The radioprotection team inspected the area of pilot unity of uranium purification, and analyzed in detail the radiometric and operational records. The aim was to identify the structural needs, available resources, preliminary schedule and existing radioactive materials in the area.

The Fig. 1, shows the facility area, where the preliminary radiological characterization, with materials and components, was considered.

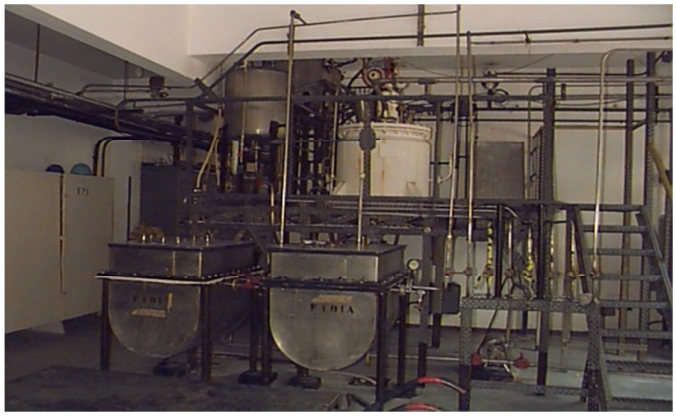

Figure 1. View inside of the facility.

From this preliminary analysis it was possible to identify radioactive materials of uranium and thorium and to establish the following radioprotection procedures for handling:

- The equipments and pieces considered as disposable were monitored, classified and segregated as radioactive waste.

- The equipments and pieces considered reusable in future processes were monitored, classified, segregated, packaged, labeled, transported and stored. Depending on the needs of its reutilization, it could be submitted to surface decontamination process.

- Before a site, equipments and parts may be released for unrestricted use, a survey shall be performed to demonstrate that the end point conditions, as established by the regulatory body, have been met [1,3].

2.2 Training of Staff

In training the application of basic concepts of radioprotection was discussed, the correct use of personal protective equipment, PPE, and also took into account the occupational experience of the two workgroups. The training was required to ensure that all persons involved in operations (installation workers and radiation protection staff) were qualified for the tasks of dismantling and decontamination.

2.3 Preparation of Workplaces

For the implementation of this operation, it was established procedures to comply with the physical and radiological security requirements. This preparation included the evaluation of structural condition, as availability of electrical power, water supply, drums and tanks for effluent storage, adequate venting systems, definition of access control, places for decontamination and temporary storage of contaminated materials [4-6].

The radioprotection team established that:

- Reuse of drums and tanks that appear to be in good condition, in immersion methods of decontamination into chemical solution.
- Installation of the mobile ultrasound equipment. This equipment consist in two tanks of 100 Liters, temperature control system, gases cooling, effluent sampling and mechanical stirring pump. It can be used for simultaneous processes of surface decontamination. This suggestion was based in a study of combination and application of methodologies of decontamination in different kinds of contaminated surfaces, comprising various radionuclides used in IPEN-CNEN/SP over the years.
- During the dismantling operation, the decontamination of pieces, small and medium equipment were performed.
- Rigid control of occupational radiation protection, considering the execution of routine tasks of monitoring, signaling, area isolation, instruction and correct use of personal protective equipment (PPE), control and release of radioactive waste [.

2.4 Radiological Survey for the Control of Occupational Radiation Doses

A constant radiological survey was performed, before, during and after the dismantling operations. The principal objective was to establish a control of occupational radiation doses, according to workplace conditions, classification area, surface contamination, choice of spots of radiological control, definition of places to carry out the segregation procedures, decontamination and temporary storage of equipment, radioactive waste. The operational monitoring program included both assessment of workplace conditions and individual exposures [7], as described below:

- Direct and indirect monitoring of surface contamination;
- Monitoring of external radiation, using portable monitors to control of occupational doses;
- Air contamination monitoring by filters;
- Collection of liquid samples to determine the radioactive particles concentration;
- External and internal individual monitoring of workers.

2.4 Dismantling, Monitoring and Segregation

Planned requirements of occupational radiation protection were followed. The workforce was divided in two groups in work shift system. The adopted proceedings by radioprotection team were:

1) Demarcation and delimitation of operational areas, to avoid access of unauthorized people;
2) Isolating of floor at predetermined places, for the segregation and decontamination of equipment, using plastic tarp over the floor, in order to avoid possible contamination of adjacent areas;
3) Monitoring, segregation and moving of equipment, pieces, drums and metallic boxes containing radioactive waste;
4) The monitored materials considered non-contaminated were separated and stored for reutilization ;
5) The contaminated materials (equipment and pieces) that would be submitted to surface decontamination process were separated according to its size and contamination levels;
6) The radioactive waste was conditioned in drums, containers and bags.

The Fig. 3 shows the job of monitoring, segregation of equipment and materials during the dismantling operation.

Figure 3. Monitoring, segregation of equipment and materials.

2.5 Surface Decontamination

2.5.1 Pieces and equipment surfaces

The Fig. 4a and 4b present the ultrasound equipment and the tank used for the decontamination of equipment, pieces and materials.

Figure 4a and 4b ultrasound equipment and the tank used for the decontamination process.

3. RESULTS AND DISCUSSION

The professional experience of two workgroups was essential and acquired during years of operational handling of radioactive materials, as well in attendance in radiological emergencies.

The first phase of dismantling operations was to collect physical and radiological information about the facility. This data set then forms the basis for determining the plans for decontamination and dismantling, radiological protection procedures for the workers, public, environment and waste.

3.1 Assessment of the data by Radioprotection

According to data of monitoring obtained in equipment, pieces and superficies of the facility, the values doses ranged from 1.2 µSv/h to 80.0 µSv/h.

The evaluation of methods employed for radioactive surface decontamination of pieces and equipment was specific for the type of material. The results obtained by use of conventional processes of decontamination as aspiration, friction, abrasion, mechanical removal of pieces or parts of equipment with water or by chemical solutions, were of 30 to 70% of efficiency to contamination removal. The combined use of methods for decontamination, as chemical solutions with mechanical process for removal of the contamination had efficiencies between 40 to 95%.

The surface contamination analysis obtained in pieces surfaces, floor, equipment and various materials varied from 1.65 $Bq.cm^{-2}$ to 72.0 $Bq.cm^{-2}$. These measurements were performed by direct monitoring methods with a detector probe. Indirect method from wipe test, using a filter paper of 5 cm diameter, was also carried out. This filter paper was wiped an area of

100 cm^2 of the surface, and taken to counting in by one minute. The equipment used was scintillators counters Eberline, model SAC-4 and BC-4.

The Tables 1 and 2 show the monitoring spots its description, the doses values rate and activities concentrations obtained before and after the operation.

Table 1. Doses values before and after decontamination processes

Spots	Description	Dose rate (µSv / h)	Dose rate (µSv / h)
A	Access point	1.2	0.7
B	Facility center 1	2.4	0.5
C	Facility center 2	2.8	0.6
D	Sink	1.6	0.25
E	Corridor 1	2.2	0.5
F	Corridor 2	2.0	0.4
G	Facility center	3.6	0.5
H	Fume hood 1	11.0	0.3
I	Fume hood 2	80.0	0.4
J	Exit point	1.2	0.4

Table 2. Activities concentrations values before and after surface decontamination processes

Spots	Description	Activity concentration (Bq / cm^2)	Activity concentration (Bq / cm^2)
A	Access point	2.65	0.30
B	Facility Center 1	15.6	0.42
C	Facility Center 2	18.5	0.30
D	Sink	5.45	0.23
E	Corridor 1	6.08	0.24
F	Corridor 2	4.85	0.22
G	Facility center	15.3	0.35
H	Fume hood 1	5.90	0.36
I	Fume hood 2	72.0	0.42
J	Exit point	1.65	0.20

4. CONCLUSIONS

The experience acquired with this planned operation, it was possible to improve the radioprotection procedures applied with relative success to dismantling and decontamination

techniques for decommissioning purpose of Radioactive and Nuclear Facilities. The activities performed by working group are in compliance with national and international standards.

Another aspect which was taken into account concerning the dose uptake during the dismantling and decontamination processes. The doses were calculated as external and internal exposure of the workers and the results showed that are in complying with the regulatory requirement for accomplishing the required work with resultant worker radiation exposures maintained as low as reasonably achievable (ALARA).

In general, the study represents an overview of the state-of-the-art in the area based on different reports to which participants have contributed in a substantial way for future decommissioning process.

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