Radioprotection Planned Operation to Deactivate an Old Fabrication Plant of UO_2 Pellets in IPEN – CNEN/SP to Perform Decommissioning

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Abstract. In this work, the steps adopted in the operation planned for the deactivation and decommissioning of the previous plant (building 24), to manufacture the tablets of dioxide of Uranium of the Nuclear and Energy Research Institute, IPEN - CNEN/SP are shown, with decomissioning aims. This operation involved the planning, training the operators of the installation, radiometric analysis of the workstations and surveys for monitoring external radiation, contaminated surfaces and air contamination . The training involved the procedures for the manipulation of radioactive materials, decontamination of surfaces, segregation of materials and practical procedures for monitoring the individual surface body contamination, footwear and clothes. Procedures for the transport of radioactive materials had also been established, relative to the internal rules of the installation; provisory confinement of wastes; effluent, riddance of materials and finding areas free of contamination.

KEYWORDS: Radiological Protection, Planned Operation, Transport of radioactive Material, Monitoring, decontamination, and decommissioning.

1. Introduction

The Metallurgic Processes Division of the Nuclear and Energy Research Institute, IPEN - CNEN/SP, is one of the oldest divisions of this institution, who operates with radioactive material, being very well helped by for the radioprotection group. On the basis of acquired experience in the 1960 decade, dealing with enrichment uranium hexafluoride (UF_6) in ammonium uranyl tricarbonate (TCAU), targeting the production of tablets of uranium dioxide of (UO_2) used as nuclear fuel in the reactor IPEN-MB01, built in 1984 only with Brazilian technology, the unit of UO_2 tablets production was projected and the first operational tests was initiated in 1985. The chemical transformation of the TCAU in UO_2 in a static and a fluid bed was developed, achieving a high homogeneity UO_2 powder.

Until 1988, there was produced about four tons of UO2 tablets, and among then, 43.000 tablets was manufactured with uranium enriched about 4% in weight of ^{235}U. Since 1989, all technology and experience acquired for the IPEN - CNEN/SP in the enrichment uranium of the UF_6 and manufacture of the fuel (the basis of the UO_2) was transferred to the Nuclear Materials laboratory of the Navy Technical Center, located in the Aramar at São Paulo State.

The research made by this laboratory with the decisive support of IPEN - CNEN/SP technicians had resulted in very important technological developments for the Country, due to starting of the UO2 Manufacture Tablets Plant, located in the Nuclear Fuel Center at IPEN - CNEN/SP. Since 1993, due to the transference of the technology of manufacture of the fuel (based on UO_2), to the CTM-Aramar, the IPEN - CNEN/SP, it finishes its activities related to this fuel technology.

In the 2006 year, it was decided for the deactivation of UO_2 Tablets facility Unit. Studies aiming at to introduce changes in the radioactive materials manufacturing process, to another technological processes that did not involve these kind of materials, had lead the need of decomissioning of this nuclear installation and the further rebuilding of its facility.

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Previously, for these matters, it would be necessary to introduce the disassembly of all operational system, with the safe transport of the internal contaminated equipment, to a safe save area located in the dependencies of IPEN - CNEN/SP, where it stays until it could be possibly used in others processes involving radioactive material.

It would be also necessary to effect the decontamination of the surfaces, the ground floor and walls, that would work as a initial standard of the basics procedures for the decomissioning of this facility.

In such a way, the requirements of occupational radiation protection in this facility had included the previous evaluation of the external radiation levels, surfaces and environmental air contamination, studies for improvement of the facility shields, control of staff assessment, structural areas conditions through the point of view of physical and radiological security. These evaluations had been made in the 2006 year, following the Brazilians and international standards [1, 2, 3, 4 and 5]. So, it was considered during 2006 year, measures for safe using of unsealed source.

2. Operation Planning

In this phase, it was foreseen and evaluated all the disassembly phases the of the operational system, internal transportation of the radioactive material and equipment and surfaces decontamination, as well theirs associate risks. There was also elaborated the procedures, the physical safety and radiological standards, the chemicals reagents and the equipment to be used in this job.

2.1 Training

During February's 2007, a practical and theoretical radiation protection proceedings training was given to the operators of the facility approaching of radiation protection in order to achieve proper techniques to manipulation, segregation, decontamination and transport of radioactive materials, as well as the individual monitoring of the clothing and footwear and exterior radioactive body contamination.

2.2 Analysis of the contaminated places

Initially For the implementation of this operation, it was necessary to made a detailed inventory of the materials and equipment in order to evaluate the maximum amounts of existing uranium, its physical and chemical forms, shields, places, wastes, effluent, exposition, values and radioactive contamination. So far, the following conditions had been identified to be assumed:

Facility: it was verified that the structural conditions , appropriate passage points of workers as well as dressings room for personal areas hygiene are according with standards requirements of the to the, by the radiological standards, showing enough conditions for the equipment, parts and operational system disassembly, packing, labeling and transport.

Individuals Occupationally Exposure (IOE) involved: from January's 2006 to 2007's May, there was made surveys of the attributions, responsibilities and analyzed the reports of individual monitoring in order to evaluate the radiation doses that could be exposed by the individuals in the usual work conditions. It was verified that the IOEs involved would be in compliance with the legal standards, established in [4].

2.3 Radiometric measurements

From January's 2006 to June's 2007 there was made radiometric surveys to verify the radiological safety conditions at the along all the operations process. This phase involved the monitoring of the contaminated surfaces by indirect methods, monitoring the external radiation analysis and evaluation, monitoring of the uranium concentration in the air and effluent. It was also necessary the elaboration of sketches of the original plant, control to for monitoring the external and surface radiation contamination, that described carefully the monitoring check points.

Figure 1: Placement for the radiometric check points in building 24.

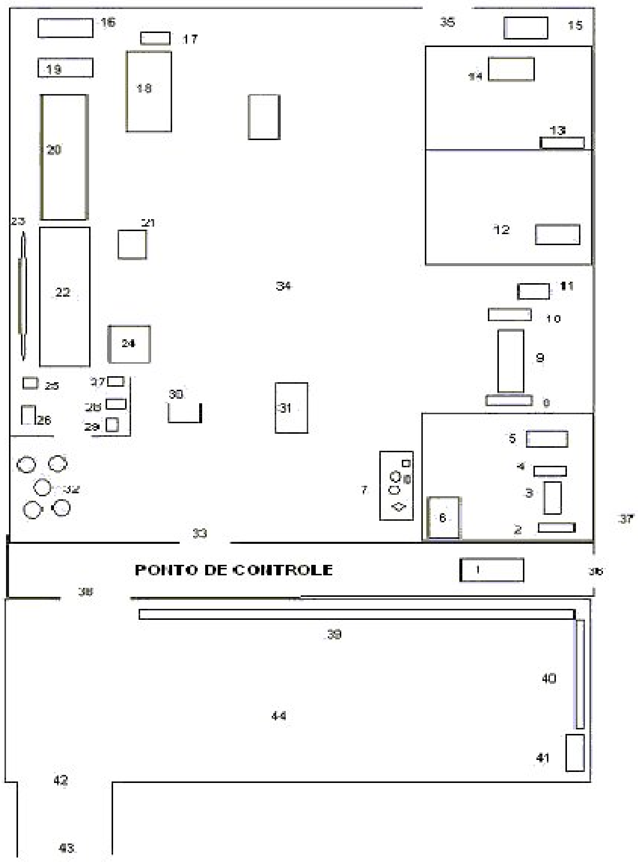

Figure. 2: In this picture there are, respectively, the monitoring, the disassembly, the packing and labeling of materials in the building 24, and finally the transportion and the installation of this planned operation.

Table 1: Average Dose levels of the external radiation and surface contamination in building (24) parts, equipment and floor, before the operational systems and installation disassembly.

Quantity	Description	Dose Rate (μSv / h)	Surface contamination (Bq / cm^2)
243	small size materials	8.3	28.6
88	average size materials	10.6	32.1
54	small size Equipment	8.2	29.2
87	average size Equipment	15.3	47.6
37	great size Equipment	22.4	82.7
370m^2	Synthetic floor	10.4	30.6
370 m^2	concrete Floor	2.1	7.8

Table 2: Average Dose levels of some parts, equipment and floor of the building (24), external and surface contamination due to radiation after being submitted to a processes of decontamination during the disassembly of the operational systems of the facility.

Quantity	Description	Dose Rate (μSv / h)	Surface contamination (Bq / cm^2)
25	small size materials	2.4	1.1
10	average size materials	2.5	1.3
12	small size Equipment	2.4	1.2
03	average size Equipment	2.2	1.1
01	great size Equipment	2.0	1.1
370 m^2	concrete Floor	1.5	0.7

2.4. Methods and proceedings

2.4.1. Methods

This stage involved the labeling of the controlled area [6], as well as the monitoring, segregation and internal transport of contaminated radioactive and material wastes for specific areas of IPEN - CNEN/SP. There were also defined the specific proceedings of the need of being decontaminated, for instance, small pieces of parts, equipments, ground floor and walls, which has some radioactive contamination that could be exchanged, according to the rules of radiological safety standards established previously in the operation planning and during the training period of the operators. The decontamination methods used were specific for each kind of material. Generally, physical and/or chemical methods was applied, starting from the most moderate to the most aggressive methods. To removal of the change contamination, methods of dry suction of the powder contamination was applied, for instance, the use of dust vacuum cleaners with efficient filters. After that, humid methods was used, like cotton or humidified cloths, with specific solutions (detergents) which behave as oil and fats removal. Only after these initial methods proved to be inefficacious, due to the adhesion to the surfaces, there was used more aggressive methods. For instance, the use of solutions make with acid citric. These solutions behave as agents to removal the fixed contamination.

2.4.2. Proceedings

As said in the previous paragraphs, it was adopted the following sequence of standard Proceedings for the disassembly of the facility and decontamination of some kinds of surfaces:

1. Clothing Adequacy of the IOEs with the proper clothing and furnishing individual protection equipment to each specific task;
2. Establishing areas, initial selection, packing and labeling of parts and contaminated equipment, by direct and indirect radiation monitoring;
3. Definition and application of the superficial decontamination methodology, as well as the chemical reagents;
4. Disassembly and application of specific treatments in parts and equipment not resistant to the water damage;
5. At the ending of the decontamination cycle, there where made a new radiometric monitoring, and after the surfaces being considered free of contamination, there was issued a certified the decontaminated;
6. Monitoring and control of the equipment and materials that shows residual contamination, packed and labeled towards a provisory area;
7. The solid wastes and effluent resultants of the decontamination procedures received specific treatment from the radioprotection group;
8. At the ending of day, there was proceeded the removal of clothing, individual safety equipment and equipment of the IOEs under supervision of the radioprotection monitoring team.

2.5. Analysis of the results

In the presentation of the results of the radiometric measurements measures above, is possible to say that:

1. There were used Geiger-Muller, detectors for the evaluation of the equivalent dose rate, where it was found 1.5 µSv/h as back ground radiation, and was adopted the. According to the obtained results and to the interpretation of the nowadays standards, it was evidenced that the doses in these places would be, for extrapolation for the period of one year, below the register level.
2. The evaluation of the contaminated surfaces was made by the method of indirect analysis, called smears tests, where discs of absorbent paper with 5 cm of diameter was been rubbed in surfaces up to 100 cm^2 and taken to be measured for 1 minute with scintillation detector zinc sulphato actived silver type, mark Ludlum, model 2000-Scaler, and the contamination was calculated in Bq/cm^2; reaching the value of 82.7.
3. The air contamination was made by method of indirect analysis, evaluating specific filters connected to a Eberline type model RAS-1 vacuum pump, submitted to a 25 l/min air flow, during a 3 hours period (minimum). These samples was sent to the IPEN - CNEN/SP environmental radiometry group, and it was not noticed no dangerous concentration of the uranium.
4. In the worker's radiotoxicologic analysis of the urine samplings, before and after the work, it was not shown contamination of radioactive material.

3. Conclusions

According to the previously studies and the experience acquired in this planned operation, it was possible to elaborate a basic procedure of disassembly of operational systems, and practical of radiation protection adequate to surfaces decontamination, suitable to installations where unsealed sources of ionizing radiation are handling, with decomissioning intentions, according to international and national standards [1,2,3,4,5,6 and 7]. This experience shows that the practical of decomissioning according to the radiation protection criteria, benefits the IOEs, individuals the public and the environment.

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