WM’07 Conference, February 25 – March 1, 2007, Tucson, AZ

Waste Management of the Clean-Up Process at IFIN-HH, Bucharest-Magurele Site

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ABSTRACT

Before any decommissioning activities begin, the clean-up of reactor main areas it’s an important item in the work of facility preparations for radiological characterization
During the clean-up process and important amount of radioactive and non-radioactive materials was aquired being appropriate for treatment and further storage or excemt from regulatory control and then reused or recycled. The present paper describes the results obtained in the waste management of the clean-up process prior of beginning of any decommissioning activities.

INTRODUCTION

The WWR-S reactor is a light-water-cooled-moderated-and-reflected, heterogeneous, thermal reactor at National Institute of Research & Development for Physics and Nuclear Engineering “Horia Hulubei” (IFIN-HH). The WWR-S research reactor from IFIN-HH Magurele was commissioned in 1957 and it was shutdown in 1997. The facility is a tank type Russian origin research reactor used mainly for radioisotope production and for applied and fundamental research performed in the institute.
The main objectives of the reactor was to provide neutron flux levels of medium intensity for research and development experiments in the field of condensed matter physics, biology, medicine, and agricultural as well for neutron activation, neutron measurements and calibrations, and radioisotope production.
Its final shut down was in December 19, 1997. All of the fuel (36% U^{235}) from the active core was removed and stored in the cooling pond. No major modifications or improvements were made during the 40 years of service to the essential parts of the reactor [1], respective to the primary cooling system, reactor vessel, active core and electronic systems.
There have been no incidents or accidents, or any other event that would have a hazardous impact on the personnel, public and the environment.
Exploitation of the reactor about 40 years without any kind of modernization exceeded the average time estimated for the safe functioning of a nuclear facility.
Therefore, the IFIN-HH Board of Directors decided that starting with December 31, 1997 the reactor would be permanently shut down, the nuclear fuel from the active core will be stored in the cooling pond and it should be taken all necessary measures for permanent surveillance of the reactor and fuel, in accordance with the national [2,3] and international regulations [4,5,6].
The Romanian Government considered that the decision of IFIN-HH is grounded and as a consequence, in the *Monitorul Oficial* No. 311 from May 10, 2002 it is published the Romanian Government decision of final shutdown for the decommissioning of the WWR-S Nuclear Reactor for research and radioisotope production, owned and operated by IFIN-HH.
The decommissioning of the WWR-S reactor of IFIN-HH will be accomplished through a process including three successive stages. This process corresponds for the method entitled by NRC as the DECON – immediate decommissioning method – after an authorized period of preservation.
DECON is a decommissioning method in which equipments, buildings and parts from installation and from reactor site which contain radioactive inventory are removed or decontaminated to a level which allow that reactor site be discharged for un-restriction use/restored till “GREEN FIELD” level. Because

DECON operations will be finished in several years after reactor stopping workers exposure to radiations will be, generally, higher than for methods which use time decrease and have as consequence delay of works.

THE CLEAN-UP PROCESS

This work is performed under Work Order #2 & 3, BOA 3J-00201 U. S. DOE.
The first step in order to be ready to start the decommissioning process is the Clean-Up Plan implementation.
The Clean Up Plan is a summary list of the materials, equipments, instruments and shielding objects located in the reactor hall, around reactor (and generally in the rooms of interest), and numbers of samples and surveys required for adequate characterization of the objects, to meet the stated goals.
For each object in the list, the specific types and numbers of measurements are defined.
The clean up shall consist of implementation of the specific procedures consisting in preparations, sampling, surveys and objects removal enumerated in the plan. Specific procedures for free release were issued and implemented in order to be able to remove an important amount of materials around reactor block. The clean-up activities represent the approach and process to be used for further free release of materials (not associated with reactor components).
One of the most important goal of the clean-up is to reduce the amount of equipments and objects present on the site by unrestricted release of the materials (which satisfies release criteria) that might be salvaged or recycled in order to minimize the volume of radioactive waste.
After clean-up implementation, much more space will be available and much more accessibility will be gained for characterization work.
The work areas are:

1. The Reactor Hall, where shielding, research equipment and instrumentation will be removed
2. Rooms where depleted uranium was processed
3. The storage for the radiation sources
4. The hot cells, where high radioactive waste will be removed
5. Other areas in the building where radiochemical research laboratories were in use

The clean-up are conducted in accordance with written procedures approved for use by the National Commission for Nuclear Activities Control (CNCAN) to ensure quality and public safety. Procedures are controlled and implemented to ensure that operations are performed in a safe and technically correct manner. If applicable, decontamination will proceed until the residual contamination that is distinguishable from background is below clearance levels.
After decontamination, a final status survey will be conducted to verify that decontamination has been completed and that all objects accomplish the criteria for free release.
Before any gamma spectroscopy analyses are performed, all the samples and objects are rigorously scanned to determine any contaminated or activated area.
The laboratory performing the analysis on the samples and smears will perform gross alpha/beta and gamma spectroscopy analyses on all samples, which are submitted for radionuclide characterization. Where alpha contamination is found, the laboratory will perform an alpha spectroscopy analysis to determine the alpha emitting radionuclides. Where beta activity is observed, the gamma spectroscopy results will be compared to the gross beta results. This is done to screen the sample to determine if further beta characterization is necessary
Where beta activity is detected with no associated gamma activity, samples will be analyzed to determine the activity concentration of the following beta emitting radionuclides:
^{3}H, ^{14}C, ^{36}Cl, ^{99}Tc, ^{63}Ni, ^{55}Fe, ^{90}Sr, and ^{90}Y.
Analyses for low energy beta emitting radionuclides will also be done if there is process knowledge that these radionuclides may be present.
The work is organized for teams of 3-4 operators, with one team leader.
The activities start in reactor hall having the main goal, as a first step, to remove the shielding from the beam tubes.
All physical hazards at the site were identified and removed or marked as appropriate.

The shielding consists in metallic tanks filled with water, paraffin, concrete and lead bricks. All this objects exists in large quantities in reactor area.
Only a small part of the lead bricks remain temporary for further needs. The water from the tanks was sampled and analyzed in order to identify radionuclides and determine activity concentration. After receiving the measurement certificate and CNCAN permission, the entire water amount from shielding tanks was released to the sewerage. The empty tanks were cut off in two pieces, smeared, analyzed and after that released for free recycling.
The same situation occurs in the case of paraffin and concrete bricks. After receiving the analysis certificate and obtaining permission from CNCAN, the whole amount of paraffin and concrete bricks where prepared for shipment to ICN Pitesti, 130 km far from Bucharest.
After complete objects removal from reactor hall the ongoing operations are moved to other spaces where clean up is needed to be performed. At the moment all these operations are in progress and effort are focused to complete release of instruments and equipment's (see Fig. 1 and Fig. 2).

Fig. 1. Realease of the instruments.

Fig. 2. Realease of the equipment.

Another places of special interest for clean-up activities are the hot cells. Here exists an important number of aluminum containers and capsules used for irradiation of different types of isotopes. All these waste are higly active and their removal require special attention and special procedures in accordance with the Romanian norms and regulations [7-10]. Depending on size and material, the waste should be selected before are taken out from the hot cells in order to facilitate the radiological characterization and adequate package. The content of every package is strictly registered in the document of the department of radioactive waste (see Table I).

Table I. List of packages with their contents.

No.	Package code	Package Mass [Kg]	Volume [m^3]	Dose rate [μSv/h]	Material	Radionuclide	Activity [Bq]	Description	Package protection
1	R-2	43	0.15	3	Al, Fe	C-137; Co-60; U-234; U-235;	21743	Al tray	No protection
2						C-137; Co-60; Eu-152; Eu-154;	27929	Al pipe	
3						C-137; Co-60;	1217	Fe sample	
4						Co-60	339	Al sample	
5	R-4	42	0.16	1.2	Al, Cd, Fe	C-137; Sb-125; Co-60;	101	Al sample	No protection

						Eu-152			
6						C-137; Co-60; Eu-152; Eu-154;	25	Al cylinder	
7						C-137; Co-60; Eu-152; Eu-154;	2878	Plastic	
8						Co-60; Am-241	15	Brass screw	
9						Co-60; Eu-152	57525	Al, Fe cylinders	
10						C-137; Co-60; Eu-152; Eu-154;	5595	Al pipe	

After segregation and characterization the waste is put into 220 liters drums (see Fig. 3) and send to Radioactive Waste Management Department (DMDR) of the institute (see Fig. 4). Here, the waste is treated and packed in 220 liters drums and sent to Baita Bihor repository for final storage or kept on the site for interim storage as accordingly.

Fig. 3. Package with waste.

Fig. 4. Wastes are send to DMDR.

RESULTS

As immediate effect of materials removal) non-associated with reactor components, an important area has been released to allow beginning of characterization activities.

An important amount of shielding (concrete and paraffin bricks) was send to be reused at another nuclear facility. Metallic water tanks were cut and release for free recycling by melting and after that reused for other purposes. Only lead bricks were kept for further needs of the department or institute.

An importand free space was gained inside the hot cells, allowing radiological characterization of these components to be performed. After decontamination process and performing measurements, an important amount of data will be available to estimate the amount of waste resulted from the decommissioning of these components.

Respecting ALARA principle, the minimization of the radioactive waste volume can be achieved in the same time with protecting workers, people and the environment.

The Decommissioning Plan [11] contains further details regarding the ALARA program and health physics program that will be in effect during characterization and D&D of the WWR-S reactor.

CONCLUSIONS

Using radiological measurement equipment, knowing the exempt and clearance levels, the team is selecting, transporting and storing the materials in the pre-determined areas which were coded and registered for the management of radiological inventory, for materials temporary storage or for the verifications. The objectives have been defined around the goal of the minimization of quantities of radioactive waste and reuse, sending to the land field, when clearance level is demonstrated.

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