DETAILED RADIOLOGICAL CHARACTERIZATION PLAN OF VVR-S BUCHAREST-MAGURELE NUCLEAR REACTOR

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Content of Characterization Plan

The Characterization Plan contains the chapters:

1. GENERAL
2. FACILITY OPERATION HISTORY
3. IDENTIFICATION OF POTENTIAL CONTAMINATION SOURCES AND LOCATIONS
4. RADIOLOGICAL CHARACTERIZATION
5. HEALTH AND SAFETY PROVISIONS
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Introduction (1/2)

- The detailed radiological characterization plan is a support document for decommissioning project of the VVR-S Magurele nuclear reactor;
- This plan provides guidance and direction, concerning radiological characterization, necessary for implementing and executing the processes set forth in the Decommissioning Plan (DP);
- The characterization activities described in this plan will be implemented and performed prior to decontamination of reactor rooms, structures and environmental areas;
- The characterization plan was made by the staff of the Nuclear Reactor Decommissioning Department – **DDR.**

Introduction (2/2)

For the implementation of radiological characterization plan and of clean-up activities the following points are considered:

- Analysis of the historical information (data and previous radiological characterizations);
- Facility description, site location and environmental assessments of the decommissioning area;
- Define clear the purpose of the radiological characterization in order to acquire information necessary for preparing the cost estimates and the risks involved in clean-up and decommissioning activities as well as the amounts and the categories of waste arising from these activities.

Objective

The specific objectives of radiological characterization are to collect information useful in:

- Preparing a Decommissioning Plan;
- Planning the level of protection required to protect workers, the public, and the environment during decommissioning;
- Estimating the collective radiation dose to workers during the D&D;
- Estimating the costs for decommissioning;
- Estimating the amount of material that satisfies release criteria and that are radioactive waste.

Operation of VVR-S

- The reactor was designed to provide experimental activities for research and radioisotopes production in a thermal neutron flux of max. $2x10^{13}$ n/cm^{2}sec, at an operating power level of 2 MW.
- The Construction of the VVR-S Nuclear Reactor began in 1955 and criticality was attained on July 29, 1957 with a fuel loading of 4.5 kg of ^{235}U. Its last shut down was on July 1997. All of the fuel (10% ^{235}U until 1984, and 36% ^{235}U after this date) was removed from reactor core to the Cooling Pond (Reactor Hall) and the basins of Spent Nuclear Fuel Storage (Building No. 20).
- The facility operated 113467 h at a power of 2 MW and 2000 h at a power of 3.0-3.5 MW. The total thermal energy produced was 9510 MWd.
- In 2002, the Romanian Government approved the final shutdown of the VVR-S reactor and its decommissioning.

The Owner of VVR-S

- National Institute for Research & Development for Physics and Nuclear Engineering - Horia Hulubei (IFIN-HH) is a state institution that is subordinated to The Ministry of Education and Research. The main activity is Research & Development - fundamental and applied research, technological development, activities and services in the field of physics and nuclear engineering.
- VVR-S Nuclear Reactor for Research and Radioisotope Production is a public property under the licensed administration of IFIN-HH.

The Preservation License

The work for characterization survey was performed under the Preservation License issued by Regulatory Body (CNCAN) within the following limits and conditions:

•It is forbidden the charging of the reactor core with nuclear fuel.

•As concerns the reactor itself, the limits and technical conditions applicable for its preservation in compliance with the operation and maintenance instructions have to be taken into consideration.

•As regards the Cooling Ponds and Spent Nuclear Fuel Storage (DCNU), the limits and the applicable technical conditions specified in the Final Safety Reports have to be taken into consideration.

Decommissioning Area

- Decommissioning activities of VVR-S Nuclear Reactor will take place on a 7500 m^2 surface. Almost half of this surface, around 3400m^2, is occupied with buildings (main buildings incorporates reactor building (hall and basement) and laboratories building (85 rooms)), metallic structures for material storage, underground emplacement and pipes.
- The decommissioning project of VVR-S Nuclear Reactor takes into account buildings with activated or contaminated structures, including those in which nuclear spent fuel or radioactive waste arising from operational period are stored.

History of Activities

At radiological characterization survey were considered:

- Events recorded during operation (major events and minor events);
- History of the radioisotope production;
- Authorization history;
- Modifications/Retrievals.

Potential Contamination Sources and Locations (1/2)

The information provided is based on records and the relevant documentation existing in the operating period of VVR-S nuclear reactor.

After the shut-down of the VVR-S reactor the radioactive inventory consists of the waste resulted from the reactor's operating activity.

- Devices used for standardization and calibration
- Spent fuel (evidence under nuclear guaranties)
- Activated components of the reactor resulted from the operating period
- Contaminated components of the reactor resulted from the operating period
- Activated components of reactor resulted from some modifications (unessential)
- Waste (solid, liquid, gaseous and effluents)
- Contamination resulted from handling errors
- Sources resulted from research activities
- Sources used for standardization and calibration or for other departments' experiments
- Activated installations and equipment
- Waste activated by irradiation

Potential Contamination Sources and Locations (2/2)

Between 1995–2003, a preliminary radiological characterization of the main building was made for the following objectives:

•Radiological risk assessment, distribution and quantification. Data used for designing the decommissioning activities will be obtained through radiological characterization. The measurement method was used in order to identify the external exposure and contamination.

•In all supervised areas the gamma and neutrons radiation field was measured with portable instruments. The contamination was established directly with portable instruments to identify the equipment and the contaminated/activated areas.

•To elaborate specific documents in compliance with the international agreements and contracts issued between 1994 and 2000 (PH 4.01/94 and ROM09/017).

•All the measurements' results that had showed values greater than the local radiation background were taken into consideration.

Building Characterization (1/4)

Inside the Laboratories Building were measured the followings:

- Dose equivalent and ambient dose equivalent for gamma and neutron radiation field;
- Contamination level.

The level of surfaces' contamination was identified through direct measurements made at 1 cm up to surface (paving, walls, furniture and equipment) through continuous scanning of all the surfaces mentioned above. The measurements were made with the instruments from operation period of the reactor.

Forty rooms were considered to be clean.

Other rooms had contaminated/activated sources and objects and after evacuation of objects and sources were considered clean.

Other rooms had alpha and beta contamination of the construction surfaces as well as of the objects or contaminated/activated sources inside these rooms. Clean-up activities were considered (decontamination and evacuation).

Building Characterization (2/4)

Inside the reactor hall, with ventilation operating and in normal temperature and humidity conditions, there were measured the followings:

•Dose equivalent and ambient dose equivalent for gamma and neutron radiation field;

•Contamination level.

Was found alpha and beta contamination of the construction surfaces as well as of the objects or contaminated/activated sources inside these rooms.

In some rooms there is radioactive waste resulting from radiochemistry production activities. There were not made any measurements in these rooms.

Building Characterization (3/4)

The rooms in the main building have an insignificant radiological risk, excepting the following rooms from the basement:

•rooms 43÷47: natural uranium processing workshops (no access for personnel);

•rooms 49 and 50: silicon and chemistry laboratories;

•hot cells which contain sources, waste etc. resulting from radiopharmaceutical production and experiments;

•corridor 17 behind the hot cells where sources and contaminated devices used for hot cells' operating can be found,;

•room 18 which contains components for mechanical hands and other devices, all contaminated;

•rooms 30, 31 and 101.

Building Characterization (4/4)

There are no radiological measurements for:

- Technological ventilation;
- Spent Nuclear Fuel Storage;
- Metallic construction for materials' storage;
- Underground arrangement containing the 30 m^3 tank for contaminated water;
- Underground sewerage for ventilation and radioactive liquids pipes of the nuclear reactor.

Contaminated/ Activated Systems and Equipment

List of places where contaminated or activated systems can be found:

- Reactor Block
- Fuel Storage
- Hot cells
- Primary Circuit
- Technological Systems
- Instrumentation System
- Dosimeter Control Systems
- Biological Shielding
- Underground arrangement containing the 30 m^3 tank
- Spent Nuclear Fuel Storage (SNFS)
- Ventilation and Conditioning Systems

Sampling of Environment (1/2)

The Nuclear Reactor VVR-S was built on agricultural land. Around the facility an exclusion area for civil buildings was created by forestation.

The annual measurements program for radioactivity level surveillance of the environment aims to identify the activity:

- of the emission source;
- in the underground water;
- in the sediments on the soil.

Sampling of Environment (2/2)

The sampling of environment method in the radiological characterization process has followed the provisions of the MAPN order, no.184/1997 for:

- Soil sampling - depth sampling and surface soil sampling;
- Water sampling - surface water sampling;
  - underground water sampling.

Preliminary Operations for Characterization

Before starting surveying activities–scanning, sampling-the following activities must be performed:

•All the materials, equipment and non nuclear structures from the facilities will be removed (as much as possible);

•The alarm systems (radiations, fire, flood, unauthorized access etc.) will be verified and tested in order to see if they are operational;

•The crane will be inspected and tested;

•The burnt bulbs in the working areas will be replaced;

•All the equipment from the reactor's platform will be removed;

•All the outdoors in the reactor block will be blocked;

•Clear at least a 2 m area around the reactor;

•All the objects placed on the spent fuel cooling pond will be removed.

Activation Products

- **The main activation products found when the reactor was shut down:**
- ^{55}Fe, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{39}Ar, ^{94}Nb in cast iron and iron;
- ^{3}H, ^{14}C, ^{41}Ca, ^{55}Fe, ^{60}Co, ^{152}Eu, ^{154}Eu in concrete;
- ^{3}H, ^{14}C, ^{152}Eu, ^{154}Eu, in graphite.

Equipment for Characterization

Equipment procurement:

- Portable spectrometer NOMAD plus – Berthold AIV;
- Contamination monitoring equipment SMART 2000-Eberline;
- Survey-meter RO-07-Eberline;
- Aspirator with HEPA- NILFISK filter;
- Equipment for concrete scarifying of the building wall, floor;
- Equipment for cutting and drilling (Mechanical saw HILTI WSR 1200-PE, Diamond drill equipment for concrete core extraction - DD200 , Device for sampling through stamping, type TRUMPH Nibbler N-1000-0 , Discs for smears sampling).

THANK YOU FOR YOUR ATTENTION