Annex 11

# RADIOLOGICAL MONITORING

## 1. Radioactive emissions monitoring

### *1.1. Radioactive effluents*

By design and construction, VVR-S NR and DCNU are provided with a technological ventilation system which absorbs the air from the technological spaces and exhaust it into the atmosphere through the 40 m stack of the technological ventilation. Before the exhaust to the stack, DCNU ventilation system passes the air absorbed from the repository spaces through HEPA filters, for entrapping the aerosols.

Also by design and construction, potentially radioactive liquids are not released into the environment. In case of necessity, these liquids are directed through a collection system to the 30 $m^3$ buffer tank of the nuclear reactor. From this tank, liquids can be transferred in two 300 $m^3$ tanks belonging to the Radioactive Waste Treatment Plant, IFIN-HH. Therefore, NR and DCNU operation does not generate liquid radioactive effluents to the environment.

### *1.2. Emission routes*

Liquid effluents from the nuclear units within IFIN-HH are discharged into Ciorogarla River. Gaseous effluents from DCNU and VVR-S NR are released through the 40 m stack.

### *1.3. Radioactive emissions monitoring systems*

Liquid effluents releases are controlled by careful operation in accordance with the operation procedures. The operation characteristics are carefully monitored, in order to have the warranty that the systems are functioning according to the project.

Nuclear reactor dosimetry system monitors the gaseous effluents released through the 40 m exhaust stack by sampling air from the base of the stack. In the sampling area are cumulated both the exhausted air from the reactor technological ventilation system and the one from DCNU.

Monitoring of gaseous emissions at NR stack is made by the sampling system (room 15A and 15B - reactor) according to the provisions of the procedure **"Filters for measuring aerosols activity and radioactive iodine"**, **code: PL-DDR-502**, applicable revision.

The assessment of aerosols evacuations from the technological ventilation stack is made using the following system: 20 l ionization chamber no. 2 and KAKTUS dosimetry system. Filters measurement is performed by the Department of Life and Environmental Physics within IFIN-HH, and the values of volumetric radioactivity of gaseous effluents (iodine and aerosols) are given according to the provisions of the procedure **"Gaseous effluents radioactivity monitoring"**, **code: PC-DDR-502**, applicable revision.

### *1.4. Radioactive emissions monitoring program*

Since liquid effluents are not directly released from VVR-S NR and DCNU, liquid emissions monitoring to the environment is made for the entire platform, according to **"Monitoring program of radioactive emissions from nuclear and radiological installations within IFIN-HH"**.

According to **"Reports on the environmental radioactivity in IFIN-HH influence area"**, drawn up by The Department of Life and Environmental Sciences, water samples from river discharge channels and decanter are taken daily and global beta and gamma activities are determined.

Gamma spectrometry analyses are performed yearly or when the global gamma activity of a sample is higher or near the allowed limits.

Monthly, water samples are taken from sewerage and rain waters and global beta and gamma activity are analyzed. Gamma spectrometry measurements are also performed yearly, in the same conditions as industrial waters.

According to the provisions of procedure "Gaseous effluents radioactivity monitoring", code: PC-DDR-502, applicable revision, aerosols evacuations are assessed bi-monthly and registered on dosimetry measurements data sheets.

## 2. Personnel radiological monitoring

### *2.1. Zoning of work areas*

Within work areas with radiological risk from IFIN-HH perimeter, radiological zoning is made according to the provisions of procedure with code: AC-PL-RAPSEN-09, applicable revision, as follows:

***Defining the areas***: In areas with no risk of contamination, designated areas will be defined as: ambient equivalent dose rate at the "border" of the area. The values of the H*(d) rate are calculated so that persons exposed during a year should cumulate a dose value representing a fraction of the annual limit L (1mSv/year dose limit for population). In the case of this contamination, areas are limited depending on the derived limit air concentration, DLAC.

***Classification of professionally exposed personnel***

Category A: personnel directly affected by exposure to ionizing radiation, who in normal activity conditions are likely to exceed 1/3 from the annual limit (20 mSv/year).

Category B: personnel indirectly affected by exposure to ionizing radiation, who in normal conditions of activity cannot exceed 1/3 from the annual limit (20 mSv/year).

Category NA: unaffected personnel; those who in normal conditions of activity have their work place in unregulated areas and normally are not exposed to more than the annual limit for population (1 mSv/year).

Access of personnel to radiological areas is regulated by the procedure code: **AC-PL-RAPSEN-09**, applicable revision. The responsibility for radiological zoning design belongs to the Radiological Safety Responsible of the department.

### *2.2. Radiological monitoring of work areas*

Area monitoring is made according to the provisions of procedure **AC-PL-RAPSEN-16**, applicable revision.

Area monitoring is made during the deployment of operations, taking into account the following aspects:

- if during the activities the radiation fields remain constant, preliminary monitoring is sufficient;
- monitoring before each series of operations is recommended;
- continuous measurements are necessary during the operation;
- if the operations influence ambient dose equivalent rate or if radiation fields are variable;
- 2 types of instruments are necessary if there is beta contribution in mixed fields and the ratio of ambient dose equivalent rate of beta and gamma radiation substantially modifies at operations minor changes.

Radiation fields and surfaces contamination monitoring are made according to the procedure **AC-PL-RAPSEN-02** and **AC-PL-RAPSEN-03** respectively, applicable revisions.

Radiological monitoring is made using both stable and mobile equipment.

For monitoring gamma radiations field, measurement circuits with continuous indication during the operations and possibility of local, optical and acoustical signaling the dose rate predetermined threshold are used.

Except the stable dosimetry equipment for measuring the contamination of objects surfaces or persons, and also for measuring the dose rate, BERTHOLD UMo LB 123 handheld contamination monitor, provided with three probes for measuring the contamination (α-β LB 6358G detector, α-β LB 6358GP detector and β-γ LB 6357 detector) and a proportional counter tube for measuring the dose and dose rate.

### *2.3. External exposure control of professionally exposed workers*

According to the provisions of procedure "Individual dosimetry monitoring", code: **PC-DDR-500**, applicable revision, individual dosimetry monitoring of professionally exposed personnel within DDR is made according to the records resulted from TLD readings which will be given the working personnel.

Reading is performed periodically, by an authorized dosimetry body, according to norms in force and a dosimetry bulletin will be issued. Centralized records of the dose received by professionally exposed personnel are kept by the radioprotection responsible.

Outside the dosimetry cassettes, individual dosimetry control of professionally exposed personnel at DCNU is also made with direct reading individual dosimeters.

At IFIN-HH are applied the provisions of the procedure **"Recording the results in photo-dosimetry monitoring and reporting"**, code: **AC-PL-DFVM-03**, applicable revision.

### *2.4. Internal contamination control of professionally exposed workers*

If during handling or in any other moment rises the suspicion of personnel internal contamination, internal contamination control of potentially contaminated persons is performed by an authorized laboratory which will specify the individual commitment dose due to internal contamination.

At IFIN-HH are applied the provisions of the procedure "Radioactive internal contamination and intake monitoring procedure", code: **AC-PL-DFVM-11**, applicable procedure.

### *2.5. Estimation of doses received by professionally exposed workers*

Estimation of doses received by professionally exposed workers is made according to **"Annual individual dose estimation procedure"**, code: **AC-PL-RAPSEN-01**, applicable revision.

## 3. Environmental radioactivity monitoring

The radiological impact of the activities at VVR-S NR and DCNU on the environment is assessed at IFIN-HH by monitoring the environment according to "Environmental radioactivity monitoring program in the vicinity of nuclear and radiological installations from IFIN-HH".

The main elements of the environmental monitoring program include:

(a) the basic concept for routine monitoring and special studies correlated with radioactive releases from nuclear installations;

(b) details about the environmental monitoring locations, sampling paths, analytical measurements which must be performed and sampling frequency;

(c) procedures for laboratory analysis, including equipment calibration;

(d) annual reporting of environmental monitoring program results and estimation of the commitment dose to the institute managing staff and the regulatory bodies.

The results of all analytical measurements performed are documented as records according to the national legislation provisions.

The major objectives of the monitoring program are:

- verification of the radioactive emission monitoring program results and associated models in order to check the protections supplied by the employed models;
- supply of required data for the assessment of current or potential doses to the critical group members, resulted from the decommissioning activity;
- detection of any unexpected modification of the radioactivity concentrations and the evaluation of the long-term trends of the radioactivity levels in the environment as a result of the radionuclide releases to the environment;
- supply of information to the public.

These objectives are in accordance with provisions NSR-22 [4].

### 3.1. Environmental radioactivity monitoring program

The environmental radioactivity monitoring program is established depending on the emissions during normal operation or after an accident, the metrology of Magurele area and significant exposure paths.

***Environmental sampling points***

In table 1 are presented the monitoring locations as well as the types of samples.

**Table 1**. Monitoring locations and types of samples

| **Place of Sampling** | **Types of samples** | **Sector** |
|---|---|---|
| Reactor channel 1 | Water, sediment, spontaneous vegetation, uncultivated soil | S |
| IFA Channel 2 | Water uncultivated soil, spontaneous vegetation | S-SW |
| Ciorogarla river-upstream from the IFA channel | Surface water, sediment | SW |
| Ciorogarla river-downstream from the reactor channel | Surface water, sediment | S |
| ICAB Station | Waste water, sediment | S-SW |
| IFIN Group I-distribution network | Drinking water | NW |
| IFA Group II-distribution network | Drinking water | W-SW |
| Wells from Magurele | Underground water, near reactor channel | S |
| | Underground water, to south from group II IFA | SW |
| Monitoring draw wells IFIN-HH | Underground water from the back of DMDR | E |
| Forest- Waste station | Uncultivated soil, spontaneous vegetation | W |
| High voltage station | Uncultivated soil , spontaneous vegetation | W-NW |
| Pumping station | Uncultivated soil , spontaneous vegetation | NW |
| Decanter waste-manage (area IFIN-HH) | Water evacuated from IFIN-HH to IFA channel | |
| DFVM (IFIN-HH area) | Air | W |
| Meteorological tower (IFIN-HH area) | Atmospheric depositions | W |

| | | |
|---|---|---|
| Helen (IFIN-HH area) | Uncultivated soil, spontaneous vegetation | W |
| Machine shop (IFIN-HH area ) | Uncultivated soil, spontaneous vegetation | W |
| Reactor lawn (IFIN-HH area ) | Uncultivated soil, spontaneous vegetation | W |
| Bucharest (baseline) | Uncultivated soil, spontaneous vegetation | E-NE |
| Around the discharge channels | Vegetables, cereals, milk | S |

***Frequency of sampling***

Frequency of sampling and measurements are presented in Table 2

**Table 2**. Monitoring frequencies

| **Monitored Environmental factor** | **Frequency of sampling** | **Measurement points** | **Types of analysis** | **Frequency of analysis** |
|---|---|---|---|---|
| Water from river discharge channels | daily | 2 | Global Beta and Gamma Activity<br>Gamma Spectrometry * | daily<br>yearly |
| Water decanter | | 1 | | |
| Surface water (river) | daily | 2 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | daily<br>yearly |
| Underground water (village) | monthly | 2 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | monthly |
| Waste and pluvial water | | 1 | | yearly |
| Drinking water | monthly | 2 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | monthly<br>yearly |
| River and sewerage sediment | every 2 months | 4 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | once at 2 months<br>yearly |
| Aerosols | bi-monthly | 1 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | Bi-monthly<br>yearly |
| Atmospheric depositions | acc. to the procedure | 1 | Global Beta Activity<br>Gamma Spectrometry* | monthly<br>yearly |
| Uncultivated soil | monthly | 9 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | monthly<br>yearly |
| Spontaneous vegetation | biannual | 9 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | biannual<br>yearly |

| | | | | |
|---|---|---|---|---|
| Crops | yearly | 5 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | <br><br>yearly |
| Milk (cow) | quarterly | 1 | Global Beta and Gamma Activity<br>Gamma Spectrometry* | quarterly<br><br>yearly |

*Gamma spectrometry measurements are made if global gamma activity of a sample is higher or near the maximum allowed levels on samples cumulated yearly.

***Monitoring systems***

The equipment used in the environment radioactivity measurement activities is:

- equipment for global gamma and beta activity measurements, with type AB-S-28 gas current: background 6-7 pulses/minute and detection efficiency 22 % for an extended sources 90(Sr-Y) (Φ=49 mm) and 0.16 Bq/l minim detectable activity;
- type NE-RS-5 automatic beta equipment: background 3-4 pulses/minute and detection efficiency 26 % for an extended sources (Φ=23 mm) of 90(Sr-Y) and 0.13 Bq/l minim detectable activity;
- equipment for gamma spectrometry measurements with Ge(Li), detector, resolution about 2 keV- 1332 keV and relative efficiency 15 %;
- automatic gamma equipment with NaI (Tl) crystal with well: background about 440 pulses/minute and detection efficiency about 0.24 Bq/l.

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