RADIATION MONITORING PROGRAM AT NUCLEAR SCIENTIFIC EXPERIMENTAL AND EDUCATIONAL CENTER - IRT-SOFIA

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Abstract

Ensuring minimal risk of personnel exposure without exceeding the dose limits is the main task of the General Program for Radiation Monitoring of Nuclear Scientific Experimental and Education Centre (NSEEC) with research reactor IRT. Since 2006 the IRT-Sofia is equipped with a new and modern Radiation Monitoring System (RMS). All RMS detectors are connected to the server RAMSYS. They have online (real-time) visualization in two workstations with RAMVISION software.

The RMS allows the implementation of technological and environmental monitoring at the nuclear facility site. Environmental monitoring with the RMS external system includes monitoring of dose rate; alpha and beta activity; radon activity; Po-218, Po-214, Po-212 activity; gamma control of vehicles. Technological control of reactor gases includes: Alpha beta particulate monitor; Iodine monitor; Noble gases monitor; Stack flow monitor.

The General Program based on the radiation monitoring system allows real-time monitoring and control of radiation parameters in the controlled area and provides for a high level of radiation protection of IRT staff and users of its facilities. This paper presents the technical and functional parameters of the radiation monitoring system and radiation protection activities within the restricted zone in IRT facilities.

Introduction

Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in science, medicine, industry, and agriculture. The radiation risks to workers, the public and the environment that may arise from these applications have to be assessed and, if necessary, organizational and technical measures for radiation protection have to be developed and implemented in depth.

Radiationsafety in allactivities at theIRT-Sofia premises and facilities (regular maintenance and refurbishment works; work withsourcesof ionizingradiation)is secured in the General

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Program (GP) by comprising a set oftechnical and organizationalresources andactivities related to theimplementation of theALARA principle. The main objectiveof the GP for radiation protection at NSEEC is to createconditions so that theradiation exposureof the staffis kept at a reasonably achievable level, which is lower than the limits set in regulations [1, 2]. The GP takes into account the resources of the modern Radiation Monitoring System (RMS) for environmental and technological monitoring of IRT-Sofia delivered in the frames of the BUL/04/14 “Refurbishment of Research Reactor” 2005-2010 Project supported financially by the PHARE program in 2006. The research reactor IRT-Sofia is under major reconstruction and the GP performance was proved successful during the execution of the partial dismantling of reactor components and shipping of spent fuel.

Basic characteristics of RMS

The detector units of the RMS are placed in control posts distributed on the site (Figure 1). Environmentalmonitoring via the RMSexternal systeminvolves: monitoring of gamma dose rate, alpha and beta activity, radon activity, Po-218, Po-214, Po-212 activity; gamma control of vehicles. Technological control of gaseous effluents includes alpha beta particulate monitor, Iodine monitor, noble gases monitor and stack flow monitor.

Figure 1. Scheme of radiation monitoring stations in IRT-Sofia

Gammabackground is measuredcontinuouslyin all sixcontrol stations using gamma radiation monitorsGIM-204 mountedtwo metersabove the ground (Figure 2). All gamma monitorsare connectedand are part ofRMS (Figure 3). The GIM-204 employs a silicon detector and operates in the range(IEC 60532) from 10^{-6} to 10 Sv/h for energies ranging from 60 keV to 3 MeV.

Figure 2. Gamma monitor GIM 204

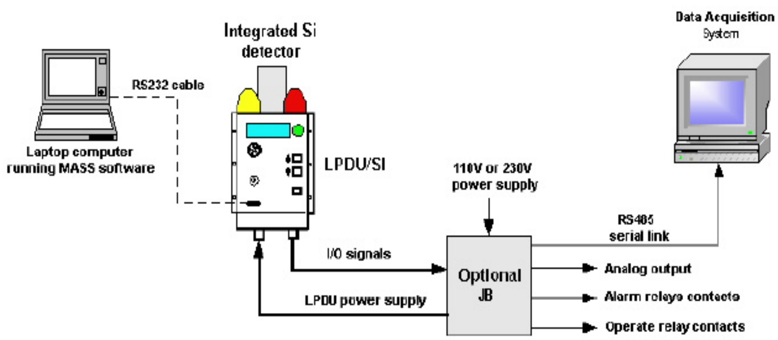

Figure 3. Principal scheme for connection with gamma monitor GIM 204

Three aerosol monitors ABPM 201L are located in threepoints selected according to the wind rose at the site. The ABPM 201L (Dual large area silicon detector; MILIPORE filter FSLW2) measures alpha, beta and gamma radiation. Typical energy windows are: 2 - 10 MeV for alpha, 80 keV to 2.5 MeV for beta, and 80 keV to 2.5 MeV for gamma, typical energy range: alpha 10^{-2} to $3.7x10^{6}$ Bq/m^{3}, beta 1.0 to $3.7x10^{6}$ Bq/m^{3}.

The monitoring of the restricted zone in reactor hall to this moment includes two personal whole-body contamination monitors, mobile alpha beta particulate monitors and mobile noble gas monitors (Figure 4). The mobile monitors may be connected to a laptop and the data from the measurements can be visualized in respect to the particular needs by using the possibilities offered by the RAMVISION software. All the detectors of the RMS have connection with a RAMSYS server. They have online (real –time) visualization in two workstations with RAMVISION software (Figure 5).

Figure 4. Mobile ABPM 203 M and NGM 209 M

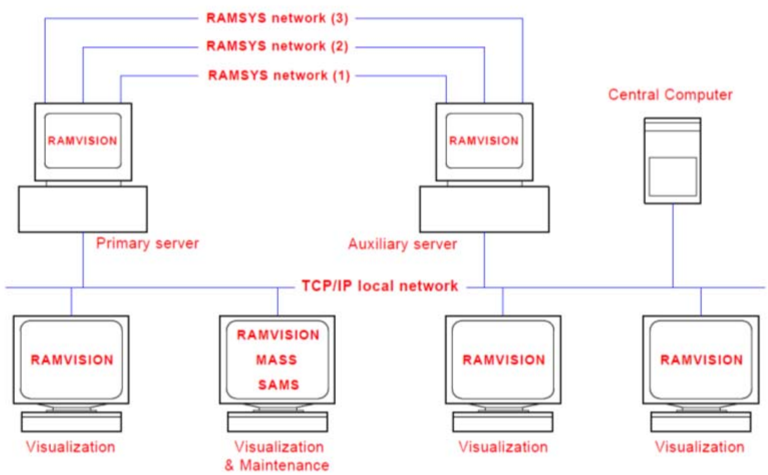

Figure 5. Scheme of RMS structure

Monitoring of gaseous effluents is done by a PING SYSTEM (Figure 6) which includes: alpha-beta particulate monitor ABPM 201 L, Iodine monitor IM 201L, Noble Gas monitor NGM 204, and Ultrasonic flow rate sensor.

The monitor NGM 204 (dual large area Si; sampling chamber 300 ml) detects β and γ radiation. Typical energy windows: β 80 keV to 2.5 MeV, γ 80 keV to 2.5 MeV. Typical measurement range: ^{85}Kr 3.7x10^{+4} to 7.4x10^{+13} Bq/m^3; ^{133}Xe 3.7x10^{+4} to 3.7x10^{+12} Bq/m^3.

The monitor IM 201L (1$^{1/4}$"x1" NaI (Tl) scintillator +PMT, Iodine cartridge: 57.7 mm) detects γ radiation in energy range 100 keV to 3 MeV. Typical energy windows: 314 - 414 keV (^{131}I, E_γ 364.5 keV); 1024 channels spectrum. Typical measurement range: 3.7 to 3.7x10^{+6} Bq/m^3.

Figure 6. PING monitoring system

The RM Program of the NSEEC - IRT-Sofia at the Institute for Nuclear Research and Nuclear Energy of the Bulgarian academy of sciences includes the following sections: a) Identification of relevant safety criteria; b) Operational limits and conditions; c) Preliminary analysis of abnormal events and incidents; d) Assessment of potential consequences.

Results

All the measurements (gamma background, aerosol activity) in the observed zone of the NSEEC site demonstrate that before, during the preparations for shipment of spent nuclear fuel (SNF), in the course of the partial dismantling of IRT components and after all other operations and occupation of personnel related with radioactive waste treatments and interim disposal, the gamma background did never exceed the normal level. Figures 7 and 8 illustrate that during the SNF removal from the site the controlled parameters levels were well below the national regulation limits, even in the reactor hall where the works took place.

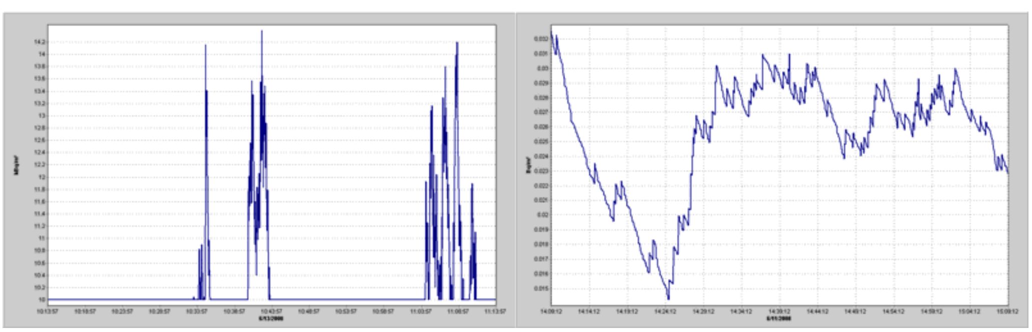

Figure 7. Gas (left panel) and Alpha (right panel) activity in Reactor hall during SNF shipments

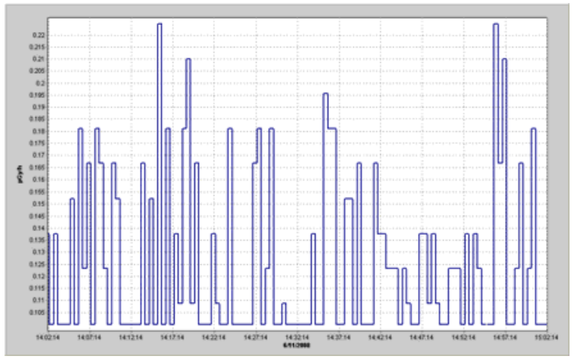

Figure 8. Gamma Dose rate in Reactor Hall during SNF shipments

The results from the measurements from the control posts at the research reactor site are transmitted daily to the National Regulatory Agency and from the beginning of January 2011 they are submitted also to the Executive Environment Agency of the Ministry of Environment and Water of Bulgaria.

Conclusion

The automated radiation monitoring system provides for early detection of abnormal radiological incidents and accidents. Integrating this system into the national system for continuous monitoring of the environment will be of help for a quick assessment of the radiological status at the NSEEC site in Sofia and in taking adequate management decisions.

References

1. Regulation on Basic Norms of Radiation Protection (BNRP), 2004.
2. Safety Standards of the Nuclear Safety Standards Commission (KTA), Monitoring the Discharge of Radioactive Substances from Research Reactors, KTA 1507 (06/98), 1998.
3. Environmental Impact Assessment (EIA)Report forinvestment project"Reconstruction andconversionof the research reactorIRT-2000 forits transformation intocivil typereactor withlow power(200kW)and furtherapplication in medicine(neutron therapy)" - Sofia, 2009.