



## **Radiation Safety Ensuring and Environment Protection dealing with Radioactive Waste Management in the System of the Special Plants "Radon"**

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Wide production and use of ionising radiation sources inevitably entail production of considerable amount of radioactive waste. Reliable isolation of radioactive wastes from the biosphere for all the period of their potential hazard is the major task in the common problem concerning radioactive substances management. With this purpose at territory of the Russian Federation 16 regional special plants dealing with radioactive wastes management are functioned.

Long-term activity of the special plants "Radon" was arranged according to the territorial principle with a system of regional service of plants, irrespective of their departmental membership. As the practice showed, the activity of the centralised system special plants "Radon" has justified itself. The main function of special plants "Radon" is its systematic work on the centralised radioactive waste collection, transportation and burial. This work is carried out in tight contact with the Administrations of the territories, which enterprises are served by the concrete plant. Each of them serves definite region, as well as several adjacent ones. Two of them, the Murmansk and Grozno plants, are closed. The plants fulfil radioactive waste collection, transportation, storage and burial, as well as radiation monitoring at all the stages of wastes management. At the MosNPO "Radon" and the Leningrad special plant "Radon" the systems for harmless radioactive waste rendering and reprocessing are created, the separate elements of which are also used at some other special plants. The majority of plants does not accomplish radioactive waste reprocessing. Special plants serve the research & development centres, medical entities, industrial enterprises which use ionising sources and radioactive substances, and accept for final disposal the wastes produced as a result of recultivation of distorted grounds and decontamination of building constructions, exposed to radioactive contamination.

### **1. Characterisation of entering radioactive wastes**

The plants are intended for acceptance of solid radioactive wastes (SRW) and liquid radioactive wastes (LRW) of low and medium levels of activity for reprocessing and final disposal. radioactive waste classification by activity levels is shown in Table 1. SRW are divided into burnt, pressed, and non-reprocessed ones. LRW are divided into non-combustible and combustible. Storage facilities for SRW burial are intended for radioactive waste, non-reprocessed and reprocessed ones, by the methods of incineration, compacting, bitumen-impregnating with the subsequent inclusion them into matrix material on the basis of cement solution.

Table 1. Radioactive waste classification according to activity levels

Level of activity	Specific or volumetric activity		
	Liquid, Bq/l	Solid, Bq/l	
		Alpha-radioactive	Beta - radioactive
Low-level	Up to $3,7\delta 10^5$	$7,4\delta 10^3 \dots 3,7\delta 10^5$	$7,4\delta 10^4 \dots 3,7\delta 10^6$
Medium-level	$3,7\delta 10^5 \dots 3,7\delta 10^{10}$	$3,7\delta 10^5 \dots 3,7\delta 10^8$	$3,7\delta 10^6 \dots 3,7\delta 10^9$

## 2. Radioactive waste storage facilities construction.

Storage is carried out in the shallow land-based facilities representing a reinforced concrete hydroisolated rectangular reservoir of 5,000 cubic m volume. After filling in a reservoir up to the full capacity its conservation is carried out. Monolithic radioactive waste are coated with concrete layer of 0.5 m thickness, then they are covered by hydroisolating bed of asphalt of 0.1 m thickness and rolled in by clay soil. The thickness of rolling layer is selected depending on a depth of seasonal freezing in order to eliminate impact of freezing and through-thawing processes on cement stone. Spent ionising radiation sources are buried in the shallow land-based storage facilities of well type (canyons) with the use of metallic matrix. At greater number of special plants the burial of LRW is not carried out owing to lack of installations for radioactive waste reprocessing.

## 3. Preparation of radioactive wastes for burial.

From clients special plants accept the wastes sorted correspondingly to the indications, explained in part 1, for final disposal. With the purpose of reducing waste volume and/or transformation it into a phase which ensures safety of burials, its reprocessing is carried out. At MosNPO "Radon" and LSP "Radon" radioactive waste reprocessing is carried out as follows:

- Compacting;
- Incineration;
- Cementation;
- Bitumen-impregnating.

As an intermediate one the method of LRW concentrating is used, the works on its vitrifying are carried on. Quality of reprocessing is controlled by the evaluation of alkalinity factor, mechanical strength, thermal samples stability of the wastes prepared for burial.

## 4. Selection of a site for special plant's location.

According to the requirements of regulations /the normative - engineering documents (NTD)/ a site for special plants 's location should be outside of a territory of the perspective development of settlements, suburban zones used for rest and treatment of the population. Boundaries of the site should be fixed at the distance not less than 500 m from the surface of reservoirs and locations of underground water intakes, on non-flooded and non-swamped area, combined from the ground surface by dry loose sedimentary strata of 20 m thickness and more. The minimum depth of ground water table should be not less than 4 m from a container's bottom. When building some special plants the requirements were partially violated, and special plants were located in the outskirts of towns, nearby to farmlands, at the territories of reserves.

## 5. Organisation of radiation safety service at plant.

At all the special plants radiation safety services (SRB) provided with the necessary devices and equipment were established. Main objectives and functions of SRB are the following:

- Monitoring radiation state parameters (RO);
- Control of realisation of the requirements of norms, rules, operating instructions, and other operating regulations in ensuring radiation safety;
- Issue of permissions for carrying out the radiation hazardous works;
- Involvement in the work dealing with the staff's training and examinations in the field of radiation safety (RS);
- Involvement in development, organisation and fulfilment of the measures aimed at reduction of radiation impact;
- RO forecasting at possible accidents, participation in development of emergency action plans, RO parameters monitoring in case of an accident rise.

#### **6. Division of special plants territory into zones.**

special plants 's site and the adjacent territories are divided into 3 zones: strict mode zone (SMZ), sanitary-protective zone (SPZ) and zone of observation (ZO). Containers for radioactive waste burial, premises for radioactive waste segregation, radioactive waste reprocessing installations, decontamination sites, radiation measurement and monitoring laboratories are located in SMZ. The works carried out in SMZ depending on nuclide radiotoxicity and its activity at a working place are divided into 3 classes. The principle of premises' division into 3 zones depending on a degree of possible radioactive contamination is put into the layout basis of the premises intended for carrying out the class 1 works. Radiation monitoring is carried out in SMZ, the works are fulfilled in accordance with special permissions. Radiation monitoring is conducted in SPZ, as well as restriction mode on the use of earth in the agricultural purposes is carried out there. Location of inhabited buildings, children's and medical entities, industrial infrastructures not concerning the special plants activity is prohibited in SPZ. Radiation monitoring is carried out in ZO.

#### **7. Realisation of radiation monitoring.**

Radiation monitoring is carried out in the following directions:

- Measuring specific or/and volumetric radioactive waste alpha and beta - activity or gamma-radiation dose rate, neutron radiation or neutron flow density from the surfaces of radioactive waste packages;
- Measuring volumetric activity of gases, air aerosols of industrial premises, effluents in the atmosphere, free air, radioactive fallout density;
- Measuring volumetric activity of sewage, underground waters, waters of near-surface pipelines;
- Measuring volumetric activity of soil, grounds underlying radioactive waste storage facilities, ground deposits, vegetation and forages of local production, hydrobionts of open reservoirs;
- Definition of alpha and beta contamination levels of the surfaces of premises, equipment, transportation means, territory, roads;
- Definition of contamination levels of individual protection means by alpha -and beta-active substances, as well as of the dermal integument and personal clothes of the staff;
- Definition of an individual dose of external exposure, radionuclides content in the man's organism;
- Definition of radionuclides composition of the measuring objects.

### **8. Accident preventing and elimination of its consequences.**

Emergency instructions have been developed at special plants, in which it is defined, that the reasons of accidents may be violations in technological mode operation of radioactive waste reprocessing facilities, violations of leaktightness of packages with radioactive substances, separate elements of technological installations, special truck bodies, fallout of sources from protective devices or containers, violation of leaktightness of radioactive waste storage facilities, violation of ventilation work, etc. For liquidation of radiation accidents at special plants there have been established the permanently operating and correspondingly trained emergency teams provided with the emergency sets which include radiometric and dosimetric instruments, warning signs and barriers, individual protective means, means for liquidation of abnormal contamination and decontamination solutions. For prospecting the centres of radioactive contamination and monitoring the decontamination results an auto radiometric laboratory is attached to the emergency group. Quality of transport packing sets is confirmed by a certificate - permission. For the safety-related equipment the regulations for verification, repairing, preventive maintenance are set, backup of the significant elements is stipulated. When implementing the radiation hazardous works the emergency signalling and blocking systems are involved. Emergency drills are regularly conducted with the personnel.

### **9. Training, preparation and access of the staff for the radiation hazardous works.**

The engineers and workers who have taken a training course and passed an examination in radiation safety, are occupied at the radiation hazardous sites. The examinations are carried out under special programmes annually, the instructing - ones per three months. The radiation hazardous works are carried out according to access-orders under the RS service supervision.

### **10. Sanitary treatment of the staff and equipment decontamination.**

Sanitary inspection rooms and sanitary sluices for treatment of the staff are equipped at special plants. Separate industrial sites furnished with decontamination solutions and installations are foreseen for conducting decontamination of special trucks and equipment.

## **Separate problems of the special plants "Radon" state.**

Non-fulfilment by the Government of the Russian Federation of the commitments concerning activity financing of the radiation hazardous productions and plants everywhere results in aggravation of RS state at the plants. Partial financing of special plants "Radon" at the expense of the regional budgets (budgets means of the subjects of the Federation), the ecological funds and enterprises is enough only for the existence, but not for reconstruction of the plants and for resolution of the tasks concerning radioactive waste management. So, free volume of the storage facilities of the Leningrad special plants "Radon" which serves all the Northwest region of Russia, compounds hardly more than 1,000  $\text{t}^3$ . At the average annual inflow of 600  $\text{t}^3$  solid radioactive waste for burial, even in view of its simultaneous reprocessing in amounts of about 400  $\text{t}^3$ , the acceptance of wastes can be ceased in 1999.

Rather intense problem concerning radioactive waste management remains in the North-European District because of the Murmansk special plants "Radon" closure. The conditions for radioactive waste storage at the plant continue to remain potentially dangerous. As the result of measures, accepted by the Kola Inspection, radioactive waste accumulation at the plants and in the organizations in the Murmansk region is suspended at the expense of increasing acceptance of volumes for final disposal by five plants which have radioactive waste special

storage facilities (Kola NPP, Murmansk Shipping Company, RTP "Atomflot", SRZ "Nerpa", IHTREMC KNTs RAN). Besides, the Leningrad special plants "Radon" through the AOZT "Spetsavtomatika", operating in the Murmansk region, is involved in the final disposal of low-level sources. The Leningrad special plants "Radon" was forced to accept radioactive waste also from the enterprises of the Arkhangelsk region. But for the Leningrad special plant the cardinal problem affecting radiation safety aspects for all the Northwest region of Russia, is connected with exhaustion of the reserve volumes for solid radioactive waste acceptance. It is necessary to mention the **separate class** of radioactive wastes storing at the plants. These are the **spent sources of ionising radiation**. The radioactivity of one source reaches (can reach) thousands Ci. At present their burial is carried out in shallow land-based storage facilities of the well type. In 1997 the selective inspection of the existing similar storage's at special plants "Radon" showed seriousness of the problem regarding reliability of spent sources burial.

*The principal conclusion* of the conducted measuring inspection states that it is necessary to **stop the burial** of ionising sources containing radionuclides with the **half-life more than 30 years**, in storage facilities of the well type. The existing storages are not able to provide for safe storage of such sources for all the period of their potential hazard. At the same time, the storages are not adjusted for extraction of such sources from them in the future. The spent sources containing long-lived nuclides are necessary to store temporarily (until the completion of a new process engineering) in transport containers in separate section of solid wastes storage facility.

With the purpose of solution of this problem Gosatomnadzor of Russia jointly with the Moscow NPO "Radon" continued the inspection programme of the well type special storage facilities at five special plants (the programme was approved on 03.04.98) in 1998. The inspection of special storage facilities in 1995-1997 allowed to elaborate the recommendations for their further operation with the purpose of safety assurance of the staff, population and protection of the environment. The Managers of the plants have been familiarised with the recommendations for practical fulfilment. In 1997 analysis of radiation state parameters for radioactive waste burial at special plants "Radon" showed, that the exposure dose rate at the working places, the average annual volumetric activity of radionuclides in the air, water, soil, the level of surfaces' contamination in the premises did not exceed the permissible values and the acceptable levels established by the regional Gossanepidnadzor bodies.