

**FEDERAL ENVIRONMENTAL, INDUSTRIAL AND NUCLEAR SUPERVISION SERVICE  
OF RUSSIA**

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**FEDERAL STANDARDS AND RULES  
IN THE FIELD OF USE OF ATOMIC ENERGY**

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**Safety of Radioactive Waste Management. General Provisions**

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**Safety of Radioactive Waste Management. General Provisions  
Federal Environmental, Industrial and Nuclear Supervision Service of Russia**

**Moscow, 2004**

These federal standards and rules "Radioactive Waste Management Safety. General Provisions" establish objectives and principles as well as general requirements to radioactive waste management safety. The regulatory document is issued for the first time\*.

It has been developed basing on the legal acts and regulatory documents of the Russian Federation, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, federal standards and rules in the field of the use of atomic energy, radiation safety standards etc., and the IAEA recommendations Safety Series No 111-F "The Principles of Radioactive Waste Management" and No WS-G-1.2 "Management of Radioactive Waste from Mining and Milling of Ores".

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**List of abbreviations**

<b>GRW</b>	- Gaseous Radioactive Waste
<b>IL</b>	- Intervention Level
<b>LRW</b>	- Liquid Radioactive Waste
<b>LRW DDS</b>	- Liquid Radioactive Waste Deep Disposal Site
<b>MPD</b>	- Maximum Permissible Discharge
<b>MPR</b>	- Maximum Permissible Release
<b>MSSA</b>	- Maximum Significant Specific Activity
<b>NF</b>	- Nuclear Facility
<b>PD</b>	- Permissible Discharge
<b>PR</b>	- Permissible Release
<b>PVA<sub>pub</sub></b>	- Permissible Average Annual Volumetric Activity
<b>RW</b>	- Radioactive Waste
<b>RWDF</b>	- Radioactive Waste Disposal Facility
<b>SCR</b>	- Self-sustained Chain Reaction
<b>SRW</b>	- Solid Radioactive Waste

## Basic terms and definitions

**Gaseous radioactive waste management** shall mean activities related to GRW collection, hold-up, filtration, sorption (reprocessing).

**Liquid (solid) radioactive waste conditioning** shall mean RW conversion to the forms suitable for safe storage, and (or) transportation, and (or) disposal. Conditioning may include conversion of LRW (SRW) to a stable form, enclosure of LRW (SRW) in containers, operations to produce RW packages.

**Liquid radioactive waste deep disposal site (LRW DDS)** shall mean the natural and engineering system located within the territory determined by the design and designed for LRW disposal which includes a part of the bowels – intake beds (reservoir-bed) located within a mining lease, and the complex of near-surface and underground structures, systems and equipment required for LRW management.

**Liquid radioactive waste disposal** shall mean LRW emplacement in deep reservoir-beds at the depth of several hundreds of meters within the boundaries of the mining lease by injection through bore wells without intent of further retrieval.

**Liquid (solid) radioactive waste management** shall mean activities related to LRW (SLW) collection, transportation, reprocessing, conditioning, storage and (or) disposal.

**LRW reprocessing** shall mean process operations to reduce volume, change aggregate state and (or) physical and chemical properties of LRW.

**Maximum permissible discharge** shall mean the standard of the permitted for NF radionuclide discharge by drain waters into the environment over a calendar year, which is calculated basing on the quote established for NF liquid radioactive waste.

**Maximum permissible release** shall mean the standard of the permitted for NF radionuclide release into the environment over a calendar year, which is calculated basing on the quote established for NF releases.

**Near-surface disposal of radioactive waste** shall mean the disposal of RW in the structures located on the ground surface or at depths of several dozens of meters.

**Nuclear facility (within the frames of this document)** shall mean the nuclear installation, radiation source, nuclear materials storage facility, radioactive substances storage facility, radioactive waste storage facility intended for storage of radioactive waste, radioactive waste storage facility intended for radioactive waste disposal (radioactive waste disposal facility).

**Open-air reservoir–LRW storage** shall mean an open-air stationary structure intended for collection and storage of low and intermediate level liquid waste and located within the territory specified in the NF design.

**Period of potential radioactive waste hazard** shall mean the period after which the specific activity of radionuclides contained in RW will be decreased up to the values that allow to exempt RW from the existing Radiation Safety Standards.

**Permissible discharge** shall mean the standard of the permitted for NF radionuclide discharge by drain waters into the environment over a calendar year taking account of the optimization principle.

**Permissible release** shall mean the standard of the permitted for NF radionuclide release into the environment over a calendar year taking account of the optimization principle.

**Physical barrier** shall mean the obstacle on the way of ionizing radiation propagation and radionuclide migration into the environment.

**Radioactive waste** shall mean the substances in any aggregate state, materials, products, equipment, items of biological origin, radionuclide sources, contaminated environmental items, contaminated soil, which can not be used further and where radionuclide content exceeds the levels established by the radiation safety standards.

**Radioactive waste generated during mining and processing of radioactive ores and other natural resources** represents further unusable rock, ores and ore dressing and leaching waste, slam, contaminated materials and equipment, process solutions and contaminated soil where radionuclide content exceeds levels established by radiation safety standards, which have been excavated and placed in tail storage facilities.

**Radioactive waste collection** shall mean RW consolidation in locations specially designated and equipped.

**Radioactive waste container** shall mean a vessel (a component of the package) used for RW collection and (or) transportation and (or) storage and (or) disposal of.

**Radioactive waste disposal** shall mean the safe emplacement of radioactive waste without an intention of further retrieval.

**Radioactive waste disposal acceptance criteria** shall mean RW characteristics to be met by RW after collection, reprocessing, storage and conditioning.

**Radioactive waste disposal facility** shall mean the stationary facility (facilities) and (or) structure (structures) designed for disposal of radioactive waste, located within the territory specified in the design and fitted with a complex of structures, systems and equipment for RW disposal.

**RWDF (LRW DDS) closure** shall mean the activity implemented after RW has been emplaced in the RWDF (LRW DDS) and targeted to bring the RWDF (LRW DDS) to the state, which will remain safe during the period of potential hazard of RW emplaced in the RWDF (LRW DDS).

**Radioactive waste disposal in deep geological formations (deep geological isolation)** shall mean the disposal of RW in the structures located at depths of several hundreds of meters without an intention of their further retrieval.

**Radioactive waste disposal system** shall mean the combination of natural geological formation, RWDF (LRW DDS) structures and disposed RW.

**Radioactive waste disposal system safety** shall mean the capability of the RW disposal system to limit radiation impact on population to levels established by the radiation safety standards during the whole period of potential RW hazard.

**Radioactive waste storage** shall mean temporary emplacement of RW in vessels (storage facilities) ensuring radiation protection and RW isolation with intention of RW further retrieval.

**Radioactive waste storage facility** shall mean the stationary facility (structure) designed for storage of radioactive waste, located within the territory specified in the design and fitted with systems and equipment for RW management.

**Solid radioactive waste reprocessing** shall mean the process operations to change the form and reduce the volume of SRW.

**Safety in radioactive waste management** shall mean a level of protection of the employees (personnel), population and the environment against the impermissible radiation impact during RW management.

**Tail storage facility** shall mean an open-air stationary structure intended for collection and storage of low level liquid and solid waste and located within the territory specified in the NF design.

This document includes other terms and definitions contained in the federal standards and rules in the field of the use of atomic energy.

## 1. Purpose and scope of applicability

1.1. This document "Radioactive Waste Management Safety. General Provisions" is developed basing on the Federal Laws "On the Use of Atomic Energy", "On Radiation Safety of Population", federal standards and rules in the field of use of atomic energy.

1.2. This document establishes the objectives, principles and general requirements to safety ensurance during radioactive waste management.

## 2. Safety objectives of radioactive waste management

Safety objectives of radioactive waste management shall be:

the ensurance of reliable protection of the employees (personnel) and population during RW management against the radiation impact exceeding the levels established by the radiation safety standards;

the ensurance of LWR and SRW reliable isolation from the environment, protection of present and future generations and biological resources against radiation impact in excess of the limits set forth by the radiation safety standards;

the prevention of releases (discharges) during radioactive waste management into the environment in quantities exceeding maximum permissible releases (discharges).

## 3. Safety principles of radioactive waste management

3.1. The following principles shall be complied with during RW management:

maintaining of the acceptable level of protection of the employees (personnel) and population against the RW adverse radiation effects in accordance with principles of justification, standardization and optimization (the principle of human health protection);

maintaining of the acceptable level of environmental protection against RW adverse radiation effects (the principle of environmental protection);

taking account of interconnection between RW generation stages and RW management stages (the principle of interdependence of RW generation and management stages);

predicted exposure levels for future generations conditioned by RW disposal shall not exceed permissible exposure levels for population set forth by the existing regulatory documents (the principle of protection of future generations);

avoidance of an undue burden to future generations resulted in necessity to ensure safety in RW management (the principle of not imposing of undue burden on future generations);

RW generation and accumulation shall be kept at a minimum practicably achievable level (the principle of control of RW generation and accumulation);

prevention of accidents followed by radiation consequences and mitigation of their possible consequences in case of their initiation.

## 4. General safety requirements to radioactive waste management

4.1. According to its state of aggregation RW shall be categorized as liquid, solid and gaseous.

4.2. Liquid radioactive waste includes organic and inorganic liquids, pulps, sludge, emulsion and suspension, which are not subject to further use. Their specific radionuclide activity exceeds intervention level values set forth by the radiation safety standards by more than 10 times.

4.3. Solid radioactive waste includes substances in solid state, materials, products, equipment, items of biological origin, radionuclide sources, contaminated items of external environment, soil, solidified liquid waste, which are not subject to further use. Their specific radionuclide activity exceeds MSSA values set forth by the radiation safety standards; and in case of unknown radionuclide composition specific activity value exceeds 100 kBq/kg – for beta-radiation sources, 10 kBq/kg – for alpha-radiation sources, 1 kBq/kg – for transuranium radionuclides.

4.4. Gaseous radioactive waste includes radioactive gases and aerosols, which are not subject to further use and are generated during the production processes. Their volumetric activity exceeds  $PVA_{pub}$  values indicated in the radiation safety standards.

4.5. Attribution of waste to the radioactive ones, LRW and SRW classification in terms of specific activity and radionuclide composition by categories (low, intermediate, high level RW), SRW classification based on surface radioactive contamination and gamma-radiation dose rate at the distance of 1 meter from the surface shall be carried out in accordance with criteria set forth in radiation safety standards and rules.

4.6. RW shall be collected and sorted out at the places where RW is generated, separately from non-radioactive waste, taking account of:

- RW state of aggregation;
- RW category;
- RW amount;
- RW physical and chemical properties;
- half-life of radionuclides contained in RW (less than 15 days, more than 15 days);
- RW explosion and fire hazard;
- techniques for further RW management.

4.7. In accordance with requirements of the existing regulatory documents, for buildings, structures, premises, systems (components) related to RW management the NF design shall include the following:

- classification of buildings and premises important for safety by safety classes;
- classification of buildings, structures, systems and components in terms of seismic stability;
- classification of systems (components) in terms of the purpose, impact to safety and type of safety functions performed by them;
- classification of equipment and pipelines by quality groups;
- a list of buildings, structures, systems and components subject to analysis of their resistance against natural and man-induced impacts;
- categorization of premises in terms of explosion and fire hazard.

4.8. RW management safety shall be ensured through the use of physical barriers system on the path of ionizing radiation propagation and radioactive substances release into the environment. Number and purpose of the barriers shall be determined and justified in the NF design.

4.9. The NF design and operating documentation shall contain specific technical solutions and organizational measures targeted to ensure safety during management of each RW category, including:

- RW minimization in terms of RW activity value, mass (volume);
- LRW and SRW collection and (or) reprocessing and (or) conditioning and (or) storage, including RW generated during NF decommissioning;
- GRW hold-up and (or) clean-up;
- techniques and means of radiation and process monitoring;
- prevention of radionuclide releases (discharges) exceeding maximum permissible ones;
- safe RW transportation on NF site and (or) to RW disposal sites;
- prevention of SCR initiation during management of RW containing nuclear hazardous fissile nuclides;
- RW physical protection, accounting and control.

4.10. Management of RW of different categories (low, intermediate and high level) and non-radioactive waste shall be implemented in separate NF systems.

4.11. The NF design and operating documentation shall include data on radionuclide composition, activity value and amount of RW generated under NF normal operation and in case of accidents.

4.12. The NF design and operating documentation shall include specific technical solutions and organizational measures related to safe storage of each RW category, and set forth and justify maximum permissible amount (volume) of the stored RW, as well as specific and total activity values, radionuclide composition and storage terms.

Design and structural materials of RW storage facilities shall prevent release of radionuclides into the environment in excess of levels set forth in regulatory documents and provide for service life of the RW storage facilities that shall be not less than the service life of the NF on site of which the RW storage facilities are located.

4.13. Radiation monitoring shall be carried out during RW management in accordance with the requirements of the existing regulatory documents. The NF design and operating documentation shall regulate:

- subjects of radiation monitoring;
- types of radiation monitoring;
- monitored parameters;
- frequency of radiation monitoring;

engineered means and methodological support of radiation monitoring.

4.14. The engineered means of radiation monitoring during RW management shall provide for:  
 radiation health-physics monitoring;  
 radiation monitoring of NF premises and site;  
 radiation monitoring of non-proliferation of radioactive contaminations;  
 radiation monitoring of the environment;  
 radiation and process monitoring, including monitoring of RW radiation characteristics.

4.15. To define whether it is required to implement technical solutions and organizational measures aimed at improving safety level of RW storage facilities under operation, an analysis of their current safety level and predictive calculation to assess RW storage (disposal) system safety shall be done.

All reasonably practicable measures aimed at implementing the requirements of this document shall be carried out basing on the results of the analysis and predictive calculations done.

4.16. LRW discharge into water reservoirs, to the ground surface and into household, soil and storm sewage systems is prohibited.

4.17. Process blow-offs shall be subject to mandatory clean-up. It is allowed to connect process blowing pipelines to buildup ventilation ducts, through which air goes to the ventilation pipe, only when process blow-offs have been cleaned-up and (or) held up in equipment for GRW management.

Use of general (exhaust) ventilation system to remove the process blow-offs is not permitted.

4.18. The NF design and operating documentation shall establish safe operation limits for releases and discharges at MPR and MPD level and operational limits – at PR and PD level. Exceeding of MPR and (or) MPD during the NF normal operation is not allowed.

4.19. Reference levels for releases (discharges) per day and month shall be set forth basing on the design PR and PD values to carry out the monitoring of releases (discharges). Values of the reference levels for releases (discharges) shall be lower than the NF design PR and PD values and revised periodically taking into account the gained experience and improved technologies.

The values of the reference levels for releases (discharges) shall be monitored and recorded as regards each release (discharge) source, including:

in case of discharge – liquid flow, qualitative and quantitative radionuclide composition, total activity of radionuclides in the discharge (Bq/day, Bq/month, Bq/year);

in case of release – air (gas flow) rate, qualitative and quantitative radionuclide composition, total activity of radionuclides in the release (Bq/day, Bq/month, Bq/year).

4.20. RW transportation on NF site shall be carried out:

in special containers taking account of dimensions and mass of transported RW, RW physical and chemical properties, activity, radiation type and dose rate on the outside containers' surface;

following the routes established by the NF design in accordance with the process flow diagram for transportation.

On-site RW transportation shall not be carried out through premises permanently attended by the employees (personnel).

Conveyances and transport containers shall be subject to radiation monitoring and, if necessary, decontamination.

Off-site RW transportation shall be implemented in special transport containers (transport packages) by specially equipped conveyances in accordance with requirements of the regulatory documents.

4.21. RW management, the layout and reliability of appropriate NF systems (elements) shall be subject to quality assurance activities of an operating organization and (or) entities executing works for and rendering services to operating organizations in accordance with requirements of the existing regulatory documents.

4.22. A system of technical and administrative measures to ensue safety during RW management shall be incorporated in the Safety Analysis Report of a nuclear facility.

Any discrepancies between information related to RW management included in the Safety Analysis Report and the NF design, including implementation thereof are not allowed. The operating organization shall provide for the correspondence of the report with the actual state of RW management during the whole NF operating period.

## 5. General safety requirements to radioactive waste disposal

5.1. RWDF safety shall be ensured through the consistent implementation of the defense-in-depth concept which is based on physical barrier system which prevents propagation of ionizing radiation and radioactive substances into the environment as well as the system of technical and administrative measures to protect physical barriers and maintain their effectiveness and to protect personnel, population and the environment.

5.2. RWDF shall be provided with a system of barriers (engineered and natural) that prevent propagation of ionizing radiation and radioactive substances into the environment.

Number and purpose of the RWDF barriers shall be determined and justified in the design taking into account results of studies of barriers' material properties and predictive calculation to assess safety of RW disposal system.

5.3. Safety (long-term safety) of RW disposal system shall be ensured through implementation of the multi-barrier principle based on the use of a system of barriers on the path of propagation of ionizing radiation and radioactive substances into the environment where a loss of integrity of one of the barriers or probable external event of natural or man-induced origin does not result in reduction in the safety level of the RW disposal system.

5.4. Selection of the RW disposal method (near-surface disposal or disposal in deep geological formation), layout of the storage facility and barriers' properties shall be determined and justified in the RWDF design depending on RW characteristics (radionuclide composition, specific activity, potential hazard period, physical and chemical properties) and taking account of natural conditions for RWDF location.

5.5. RW that meets RW acceptance criteria for disposal in RWDF (LRW DDS) shall be subject to disposal. RW disposal acceptance criteria shall be set forth in the RWDF (LRW DDS) design and operating documentation in accordance with the requirements of the existing regulatory documents.

5.6 Technical solutions and organizational measures targeted to ensure safety during RW disposal shall be set forth and justified in the RWDF (LRW DDS) design basing on the predictive calculation to assess safety of RW disposal system safety taking account of:

- radionuclide composition of RW to be disposed;
- permissible total activity of disposed RW;
- total and specific activity of radionuclides in a RW package (average and maximum) in the RWDF;
- permissible amount of RW packages stored and disposed in the RWDF;
- specific activity (average and maximum) of LRW disposed in the RWDF;
- permissible content of long-lived radionuclides in LRW disposed in the RWDF;
- specific activity (average and maximum) of transuranium radionuclides in LRW disposed in RWDF.

5.7. In case of disposal of RW containing nuclear-hazardous fissile substances (materials) technical solutions and organizational measures aimed at preventing SCR initiation shall be provided for. Properties of the engineered and natural barriers shall exclude a possibility for SCR initiation, as caused by possible concentration of radionuclides during their migration within the RW disposal system.

5.8. Radiation monitoring and monitoring of the RW disposal system shall be implemented during RWDF (LRW DDS) operation, and within the RWDF (LRW DDS) post-closure period established and justified by the RWDF (LRW DDS) design.

Means, scope, frequency and duration of the radiation monitoring at the RWDF (LRW DDS) and the monitoring of the RW disposal system within the post-closure period shall be established and justified by the RWDF (LRW DDS) design.

5.9. To define whether it is required to implement technical solutions and organizational measures aimed at improving safety level of RWDF (LRW DDS) under operation, an analysis of their current safety level and predictive calculation to assess RW disposal system safety shall be done.

All reasonably practicable measures aimed at implementing the requirements of this document shall be carried out basing on the results of the analysis and predictive calculations done.

## **6. Safety ensurance in radioactive waste management generated during miming and processing of radioactive substance ores and other mineral sources**

6.1. During mining and processing of radioactive substance ores and other mineral resources engineered means shall be provided for and organizational and technical measures shall be implemented to ensure safe management of radioactive waste<sup>1</sup> which are aimed at:

- protecting the employees (personnel) and population against radiation impact from natural radionuclides;
- preventing radionuclide migration into the environment;
- minimizing RW generation;
- minimizing contamination of the environment with raw materials and tails, process products, mine (quarry) water and other drain water;
- using drain water in the process (water re-use);
- minimizing releases of radioactive gases, radioactive dust, toxic non-radioactive substances and other harmful impurities into the working premises.

6.2. During RW management generated in mining and processing of radioactive substance ores and other mineral resources the radiation monitoring shall be provided for according to paras 4.13 and 4.14 of this document, including radiation monitoring of mining tunnels, radionuclide and chemical composition of the environmental (atmosphere, soil) contamination.

6.3. During RW management generated in mines and tunnels and other underground structures, personnel protection against radiation impact from natural radionuclides shall be provided for, including:

- limitation of radon and thoron ingress into the atmosphere of underground premises by isolation of miming tunnels and premises, sources of underground water with high content of radon, separate high emanating sections of underground premises' surfaces, which are not in use;
- effective ventilation of underground premises by increasing the air exchange rate at working places where content of daughter products of radon and thoron in the air is increased, arranging for continuous ventilation of dead-end miming tunnel, using forced ventilation;
- reducing air dustiness level at working places;
- use of respiratory organs personal protective equipment by the employees (personnel).

6.4. During RW management generated in oil and gas mining, personnel protection against radiation impact from natural radionuclides shall be provided for, including:

- limitation of radionuclide ingress into the air of the operation area;
- minimization of equipment and site contamination with radioactive substances;
- processing of production waste (oil-slimes) to extract useful components from them.

## **7. Safety ensurance during radioactive waste management accumulated in surface reservoir-storage facilities for liquid radioactive waste and storage facilities for tails**

7.1. During RW management accumulated in the surface reservoir-storage facilities for LRW and storage facilities for tails, engineered means and organizational measures shall be provided and aimed at preventing:

- exposure of the employees (personnel) and population which exceeds levels set forth by the radiation safety standards;
- the environmental contamination, including contamination of surface reservoirs and ground water with radionuclides;
- radioactive aerosol transfer by wind, generation of dust and radionuclide transfer with dust.

7.2. During RW management accumulated in the surface reservoir-storage facilities for LRW and storage facilities for tails, radiation monitoring shall be provided for according to paras 4.13 and 4.14 of this document, including radionuclide and chemical composition of aqueous phase and bottom sediments, radionuclide and chemical composition of the environmental (atmosphere, soil) contamination.

7.3. Monitoring of conditions of surface reservoir-storage facilities for LWR and storage facilities for tails shall be provided for, including monitoring of:

- incoming RW (nomenclature, amount, radionuclide and chemical composition);
- conditions of the barriers (amount of water lost through filtration, radionuclide migration into the environment, radionuclide and chemical composition of ground water).

7.4. Storage facilities for tails shall be provided with physical barriers preventing contamination of surface and ground water with radioactive substances. Engineered means shall be provided for to collect filtration water, its return to the storage facilities for tails or transfer to the process water re-use system.

7.5. The operating organization shall develop and implement technical and organizational measures aimed at:

- limiting radionuclide ingress into the surface reservoir-storage facilities for LRW and storage facilities for tails;
- preventing impermissible discharges (leaks) from the surface reservoir-storage facilities for LRW and storage facilities for tails into the surface and ground water and to the ground surface;
- decommissioning of the surface reservoirs-storage facilities for LRW and storage facilities for tails;
- preventing discharges (leaks) of liquid phase contaminated with water radionuclides from the surface reservoir-storage facilities for LRW and storage facilities for tails into the surface and ground water and to the ground surface.

7.6. The following shall be set forth and justified for each surface reservoir-storage facility for LRW and storage facility for tails:

- terms of RW storage;
- amount (, mass, volume) of RW stored;
- radionuclide composition and activity value of RW stored;
- standards for radionuclide ingress;
- amount of water lost through filtration;
- maximum values of radionuclide migration into the environment.

## **8. Safety ensurance during radioactive waste management resulted from rehabilitation of the territories contaminated with radioactive substances**

8.1. During rehabilitation of territories contaminated with radioactive substances, engineered means and organizational measures to minimize volumes of generated RW and ensure safety of generated RW management shall be provided for.

8.2. Solutions made to ensure RW management safety shall be based on the results of the radiation survey of the territory subject to rehabilitation, including information on:

- gamma-radiation dose rate;
- levels of radioactive contamination by alpha- and beta-active nuclides;
- location, depth and volume (mass) of contaminated soils, ground, water;
- radionuclide composition and specific activity of contaminated soils, ground, water.

8.3. During RW management resulted from rehabilitation of territories contaminated with radioactive substances, radiation monitoring shall be provided for according to paras 4.13 and 4.14 of this document, including radionuclide and chemical composition of the environmental (atmosphere, soil) contamination.

8.4. During RW management resulted from rehabilitation of territories contaminated with radioactive substances, engineered means and organizational measures shall be provided for and aimed at preventing exposure of the employees (personnel) and population in excess of the levels set forth by the radiation safety standards, and radionuclide dispersion into the environment, including:

- timely detection of radiation contaminated soils, ground and water;
- RW collection;
- prevention of dust generation and radioactive aerosol transfer by wind;
- RW transportation to their storage (disposal) locations.