

**The Federal Nuclear and Radiation Safety Authority of Russia
(Gosatomnadzor of Russia)**

**FEDERAL NORMS AND RULES
IN THE FIELD OF USE OF NUCLEAR ENERGY**

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**MANAGEMENT
OF GASEOUS RADIOACTIVE WASTE.
SAFETY REQUIREMENTS**

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MANAGEMENT OF GASEOUS RADIOACTIVE WASTE. SAFETY REQUIREMENTS. NP-021-2000

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The regulatory document "Management of gaseous radioactive waste. Safety Requirements " constitutes the Federal Norms and Rules in the field of management of radioactive waste having an effect on nuclear and radiation safety. The present document establishes safety requirements for gaseous radioactive waste management at nuclear installations, radioactive sources, storage facilities for nuclear materials and radioactive substances, storage/disposal facilities for radioactive waste. The present document applies to nuclear installations, radioactive sources, storage/disposal facilities which are being designed, constructed, operated or decommissioned in the framework of gaseous radioactive waste management activities.

The regulatory document is published for the first time.

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BASIC DEFINITIONS

1. Discharge (gaseous) -release of substance (mixture of substances) in gaseous and/or aerosol forms to the environment (atmosphere) from discharge sources.

Note. Discharge source: any technical installation (for example, a stack) from which contaminants are released to the atmosphere.

2. Gaseous radioactive waste (GRW) - radioactive waste in gaseous or aerosol forms.

3. Long-lived nuclides (as used in this document) - any mixture of long-lived radioactive aerosols that can be detected with a one-day shift by carrying out measurements on the filter placed on the gas evacuation stream during the previous day.

4. Decontamination factor (K) – the value of the ratio of concentration of radioactive substances in the gaseous stream at the inlet of the GRW treatment installation to concentration of radioactive substances in the gaseous stream at the outlet of this installation.

5. Quality assurance of RW management (hereinafter - quality assurance) – planned and systematic activity necessary to ensure that all RW management activities having an effect upon nuclear and radiation safety are performed in compliance with the federal norms and rules in the field of nuclear energy use and with other regulatory documents, and that the results satisfy to the requirements.

6. Gaseous radioactive waste management- all activities related to GRW, including collection, treatment (filtration, gas trapping etc), and delay (e.g. during cryogenic condensation) etc.

7. Gaseous radioactive waste treatment equipment - apparatuses, systems, filters, adsorbers, bubbling devices and other equipment used to reduce the content of radioactive substances in the air of working rooms of nuclear installations, radioactive sources, storage facilities for nuclear materials and radioactive substances, storage/disposal facilities for radioactive waste (hereinafter - storage/disposal facilities) and to prevent release of radionuclides to the environment in amount exceeding levels set by sanitary regulations, norms and hygienic specifications, federal norms and rules in the field of use of nuclear energy.

8. Off-gas - gaseous mixtures, substances in gaseous and/or aerosol forms removed from process equipment.

9. Efficiency of decontamination (E) – the value characterizing the operational efficiency of GRW treatment equipment, expressed as one minus the inversed value of the decontamination factor (usually expressed in terms of percentages):

$E = (1-1/K)100\%$, where K is the decontamination factor.

1. OBJECTIVE AND APPLICATION

1.1. The present document establishes safety requirements for GRW management at nuclear installations, radioactive sources or storage/disposal facilities.

1.2. The requirements of the present document apply to nuclear installations, radioactive sources or storage/disposal facilities which are being designed, constructed, operated or decommissioned and have to deal with GRW management.

2. GENERAL SAFETY REQUIREMENTS FOR GASEOUS RADIOACTIVE WASTE MANAGEMENT

2.1. The safety objective of GRW management is to prevent release of radionuclides to the environment in amount exceeding discharge limits set by the federal norms and rules in the field of use of nuclear energy.

2.2. Technical means for safe GRW management and organizational measures to provide radiation safety during GRW management at nuclear installations, radioactive sources, storage/disposal facilities shall ensure that radiation impact on the workers (personal), the public and the environment will be kept within limits established by sanitary regulations, norms and hygienic specifications, federal norms and rules in the field of use of nuclear energy.

2.3. Specific technical measures for safe GRW management, developed in accordance with the requirements of the present document, the federal norms and rules in the field of use of nuclear energy and other regulatory document, must be provided by the design of nuclear installations, radioactive sources, storage/disposal facilities.

If such regulatory documents are not available, planned technical measures have to be specified and justified in the design of nuclear installations, radioactive sources, storage/disposal facilities in accordance with the state-of-the-art science and technology.

2.4. Requirements related to design, manufacturing and assembling of equipment used for collection, treatment and conditioning of GRW and design of relevant systems (components) of nuclear installations, radioactive sources, storage/disposal facilities, as well as classification of systems (components) and equipment used for collection, treatment, storage and conditioning, depending on their purpose, their safety importance, their safety function and their seismic, fire and explosive categories are set by the federal norms and rules in the field of use of nuclear energy related to regulation of the safety of nuclear installations, radioactive sources, storage/disposal facilities, and by the present document.

2.5. The classification of rooms for GRW management, depending on associated fire and explosion hazards, shall be specified in the design of nuclear installations, radioactive sources, storage/disposal facilities in accordance with the requirements of the federal norms and rules in the field of use of nuclear energy.

Specific technical and administrative measures necessary to provide fire and explosion safety during GRW management have to be specified and justified in the design of nuclear installations, radioactive sources, storage/disposal facilities.

2.6. Design and reliability of systems (components), equipment of nuclear installations, radioactive sources, storage/disposal facilities, documentation and operations associated to GRW management are subject to quality assurance according to the quality assurance program developed by operating organizations and/or organizations carrying out works and providing services for operating organizations and shall meet the federal norms and rules in the field of use of nuclear energy and other regulatory documents.

2.6.1. Quality assurance program is aimed at providing:

- effective training, re-training and qualification for the workers (personal);
- adequate and detailed information on quantitative and quality inventory of GRW;
- minimization of generated GRW with regard to its activity and quantity;
- quality control of purchased equipment, components and materials;
- quality control of the operations;
- utilization of metrological testing and certifying techniques for quality control of the GRW;
- organization of the system related to documentation, data recording and record keeping of the results of the process and radiation control.

2.6.2. The quality assurance program shall define the order and procedures of recording of nonconformities of GRW management processes as well as procedures related to data collection, data processing and analysis of information concerning the investigations of the nonconformities cases.

As a result of these investigations, corrective actions shall be identified and taken to preclude the repetition of the occurrence.

2.6.3. The operating organization must control how the quality assurance program is implemented at nuclear installations, radioactive sources and storage/disposal facilities, by means of inspections that deal with the following:

- verification of compliance of GRW management processes with operating parameters of the installation, in accordance with the requirements of the federal norms and rules in the field of use of nuclear energy and the conditions stated in the license issued by the State safety regulatory authority in the field of use of nuclear energy;
- checking of operational availability of process control systems.

If during the inspections, nonconformities with the quality assurance program in force at nuclear installations, radioactive sources, storage/disposal facilities are revealed, appropriate corrective measures shall be taken in all cases.

2.7. It shall be ensured during GRW management that:

- the required safety level in relation with management of ionizing sources is kept;
- the exposure of the workers (personal), the population and the environment is minimized to a reasonably practicable level with regard to sanitary regulations, norms and hygienic specifications, economical and social factors;
- the occurrence of potential accidents which may lead to radiological consequences are prevented and the consequences of accidents are mitigated, should they occur.

2.8. The technical means and administrative measures for safe GRW management as well as means and methods related to process and radiation controls shall be established, taking into account the following factors:

- a) volume of gaseous stream to be treated;
- b) content of radionuclides including:
 - alpha-emitters;
 - beta- and gamma-emitting long-lived nuclides;
- c) possible variation range of the total volume activity of the treated gas stream (range of average and maximum values);
- d) physical form and chemical composition of the radioactive materials including:
 - aerosols (mist, smoke, dust);
 - inert radioactive gases;
 - iodine in molecular, aerosol forms and/or in form of volatile (including organic) compounds;
 - radioactive steam and gaseous mixtures;
- e) physicochemical properties of the gaseous stream including:
 - presence of explosive and inflammable substances;
 - temperature and relative humidity;
 - dispersion of the particle sizes and mass concentration of aerosols;
 - solubility of gaseous radionuclides, aerosol particles in water or in other liquids that can be present in the equipment;
 - possibility for solid particles to form insoluble deposits on the surfaces of equipment;
 - possibility of accumulation of alpha-emitting radionuclides on the surfaces of equipment ;
 - presence of chemically aggressive substances;
- f) other factors having an affect upon GRW management safety.

2.9. During GRW management, the following arrangements shall be provided:

- set of technical means for safe GRW management and administrative measures to ensure fire- and explosion safety, including preventing fire and combustion products from spreading through air-ducts and gas-ducts;
- means for adjustment of capacities of ventilation pump systems (blowers, ventilation units, fans, compressors, etc.);
- redundancy of filtering and absorbing components of equipment in order to provide a capability of replacement or regeneration of filters (absorbing columns) without any discontinuity of the GRW cleaning;
- local cleaning of air removed from areas where GRW may be generated and accumulated (containment areas, boxes, cells, hoods, galleries, other similar installations and areas where maintenance operations are performed);
- means and methods to provide stability of those GW parameters which are important and can affect the operability and the efficiency of filters and absorbers (temperature, humidity, flow rate). In this field, means such as possible minimization of the length of air-ducts and their thermal protection or heating/cooling of the transferred GRW, may be used.

2.10. To prevent any efficiency reduction of units dedicated to treatment of GRW containing humidity (in a form of mist and/or steam), equipment used to remove humidity from a gas stream such as mechanical filters, heaters, dehumidifiers, condensers, apparatus for neutralization of aggressive vapors and other equipment intended for effective dehumidification shall be provided.

2.11. If alpha-emitters are present in GRW, the following technical means and organizational measures shall be provided (independently from each other) in order to:

- prevent uncontrolled accumulation of alpha-emitting radionuclides in equipment components, pipe lines (air-ducts);
- remove alpha-emitting radionuclides in the case of their potential uncontrolled accumulation;
- control of accumulation of alpha-emitting radionuclides on treatment equipment (filters);
- use geometrically-safe equipment.

2.12. If absorbent carbon is used as sorbant in GRW treatment equipment, the measures to prevent fire spreading must be provided, should the carbon ignite.

2.13. Off-gas stream must be compulsorily decontaminated. The off-gas stream pipelines can be connected to the collecting ventilation skips for transferring the air to the stack only after off-gas decontamination by GRW treatment equipment.

It is prohibited to use common ventilating system for removal of off-gas.

3. REQUIREMENTS RELATED TO EQUIPMENT AND MATERIALS USED FOR GASEOUS RADIOACTIVE WASTE MANAGEMENT

3.1. GRW treatment equipment, its components and filtering materials shall have the following properties:

- capability to sustain natural and man-made external events;
- stability under conditions of increased pressure and pressure depression;
- capability to sustain humidity, temperature, radiation, vapors of organic solvents, alkalis and acids actions;
- capability to sustain dynamic force loads of streams.

3.2. GRW treatment equipment must be certified.

3.3. Construction materials for GRW treatment equipment shall have the following properties:

- low absorbing capacity of radioactive materials and easy decontamination;
- resistance to action of alkalis, acids and other aggressive substances.

3.4. GRW treatment equipment shall satisfy the following requirements:

- meet criticality –related parameters;
- design and layout of equipment components shall ensure the capability to meet the requirements of the sanitary rules, norms and hygienic specifications during technical inspection, repair and replacement of these components (including filters);
- maximum suction pressure at equipment components during all the operational period shall be lower than the negative pressure produced by the ventilation units (at least, 10% lower);
- the decontamination factor shall not be lower than the design value (during operation of the equipment or its storage).

3.5. The increase of differential pressure in filters, arising as a result of the particles trapped, shall be taken into account for the calculation of the air flow rate limit through GRW treatment equipment. The increase of differential pressure shall not hinder the system operation, as defined by the design.

3.6. The evaluation of the decontamination factors of the GRW treatment equipment shall be carried out on the base of the following conservative assumptions:

- the size of all trapped particles shall be considered as equal to the size of the most penetrable particles (appropriate values of decontamination factors and the particle size shall be specified in the documentation of the treatment equipment components manufacturer);
- thermo-technical and aerodynamic process parameters shall be considered as the most unfavorable amongst any possible ones.

3.7. The adsorbers used for decontaminating GRW from iodine shall enable to trap this element in each type of configuration for which they have been designed (for justification of the decontamination factor for each form of iodine, iodine de-sorption shall be taken into account).

3.8. For the design calculation of adsorbers and other apparatus intended for removing radioactive iodine from GRW, sorption capacity of the sorbents, operated under designed operating conditions, and total amount of iodine passing through adsorbers (apparatus) during all their period of operation shall be taken into account.

The decontamination efficiency of the adsorbers intended for retaining the radioactive iodine shall provide decontamination from molecular iodine and methyl-iodide (separately) as required by the design.

3.9. The GRW treatment equipment shall undergo periodic tests and maintenance service according to the operating instructions. The results of the availability testing of the GRW treatment equipment shall be documented.

As soon as any GRW treatment equipment reaches its operation parameters limits, this equipment shall be replaced on a timely basis or its gas cleaning properties shall be regenerated.

Utilization of GRW treatment equipment whose performances (decontamination factors, resistance to gas stream etc.) become out of established limit values must not be accepted.

3.10. The GRW treatment equipment used during accidents at nuclear installations, radioactive sources, storage/disposal facilities shall be subject to detailed testing necessary to confirm its operability after accident remediation.

3.11. Each filter or batch of sorbent shall be supplied with the manufacturing certifications where basic design parameters and values of these parameters which have been reached during their testing are indicated, including:

- for filters –differential pressure under nominal flow rate, decontamination factor for the most penetrating particles;
- for sorbents - efficiency of trapping of substances for which the sorbent is intended; if it is iodine- the efficiency of trapping of molecular iodine and methyl-iodide (separately) .

3.12. The design of filters, adsorbers, absorbers and other GRW treatment equipment shall provide stability under a triple increase of the air flow rate without destruction of the structure of the component. If the flow rate is reduced to the nominal value, the decontamination factor shall not be lower than as designed.

3.13. The design of filters shall provide integrity of the structure of the filtering surface under a tenfold increase of the differential pressure for a filtrated flow identical to the initial one.

3.14. Increased (compared to process) temperature load on aerosol filters and sorbents shall not result in generation of toxic substances. Aerosol filters and their construction materials shall not be combustible.

3.15. The aerosol filters located at the last GRW treatment stage (prior to discharge) shall have decontamination factor enabling to provide effective trapping of the most penetrating particles amongst those entering these filters.

The established value of decontamination factor shall be justified in the design of nuclear installations, radioactive sources or storage/disposal facilities and specified in the safety analysis report.

3.16. Spent aerosol and iodine filters shall be dismantled and transported to their storage and processing areas.

The design of filters shall eliminate any possibility of release and dispersal of radionuclides collected on the filters into working rooms and the environment during the filter replacement and transportation to the storage and processing area.

The spent filters shall be stored in specially equipped places.

4. REQUIREMENTS RELATED TO PROCESS AND RADIATION CONTROL DURING GASEOUS RADIOACTIVE WASTE MANAGEMENT

4.1. For each component of GRW treatment equipment, the methods and means of technological control as well as the methods for recording the process parameters shall be provided, including:

- GRW flow rates (continuously);
- thermo-technical and aerodynamic parameters - pressure (negative pressure), differential pressure, temperature, humidity content (continuously);
- concentration of fire- and explosion hazard materials;
- decontamination factors of GRW treatment equipment.

4.2. During GRW management, the methods and means for radiation monitoring and recording of process parameters shall be provided, including:

- continuous monitoring of volume activity (Bq/m^3) at discharge points;
- periodic monitoring of the volume activity and the radionuclide content of GRW streams.

4.3. When designing new GRW treatment equipment and modernizing the operated equipment, implementation of process and radiation monitoring automated systems shall be provided.

4.4. Technical methods and means of radiation monitoring shall provide capability of measuring all controlled parameters for all possible ranges of their variation. Extent of radiation monitoring during GRW management is specified and justified in the design of nuclear installations, radioactive sources, storage/disposal facilities and is described in the safety analysis report.

4.5. For each discharge source, the discharge parameters shall be controlled and recorded including:

- flow of air (gas) being discharged, m³/s (m³/h) (continuously);
- total activity of alpha-emitting radionuclides in discharges, Bq/day, Bq/year (Ci/day, Ci/year);
- total activity of inert radioactive gases in discharges, Bq/day, Bq/year (Ci/day, Ci/year);
- total activity of iodine (gas + aerosol constituents), Bq/day, Bq/year (Ci/day, Ci/year);
- total activity of long-lived nuclide mixtures, Bq/day, Bq/year (Ci/day, Ci/year).