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(Rostekhnadzor)**

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

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**REQUIREMENTS TO CONTENTS OF SAFETY ANALYSIS REPORT FOR
RESEARCH AND DEVELOPMENT AT NUCLEAR FUEL CYCLE FACILITIES
INVOLVING PLUTONIUM-CONTAINING MATERIALS**

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List of abbreviations

EAS	- Emergency Alarm System
GRW	- Gaseous Radioactive Waste
LRW	- Liquid Radioactive Waste
NFC	- Nuclear Fuel Cycle
NFCF	- Nuclear Fuel Cycle Facility
NFM (S)	- Nuclear Fissile Material (Substance)
NFM	- Nuclear Fissile Material
NM	- Nuclear Materials
OO	- Operating Organization
PPS	- Physical Protection System
R&D	- Research and Development
RadS	- Radioactive Substances
RD	- Regulatory Document
RW	- Radioactive Waste
SAR R&D	- Safety Analysis Report for Research and
Development	
SAR	- Safety Analysis Report
SCR	- Self-Sustained Chain Reaction
SRW	- Solid Radioactive Waste
SW	- Software

1. PURPOSE AND SCOPE

This regulatory document establishes requirements to the package and contents of information justifying safety of nuclear fuel cycle facilities during R&D involving plutonium-containing materials and requirements to the package and contents of SAR R&D.

2. GENERAL REQUIREMENTS

2.1. Purpose of SAR R&D

The SAR R&D shall be a document justifying safety (nuclear, radiation, technical and fire safety) during R&D involving plutonium-containing materials at nuclear fuel cycle facilities.

2.2. General requirements to the information included in SAR R&D

The SAR R&D shall be developed before the practical implementation of R&D at the nuclear fuel cycle facility.

The information contained in SAR R&D shall be based on the design documents for NCF including buildings (structures), production area (workshop, department, division, laboratory, site, storage facility including transport communications etc.) where R&D involving plutonium-containing materials is planned, and systems (components).

The information shall reflect the actual state of technical, instrumental and methodological bases to be used during R&D and shall contain NCF safety justification as regards R&D impact on this NCF. Also the information shall provide for the assessment whether technical solutions used and organizational and technical measures taken to ensure safety are sufficient and meet RD requirements.

2.3. Requirements to SAR R&D contents and format

Chapter 3 of this regulatory document establishes the requirements to the SAR R&D structure.

References to SAR NCF are allowed while presenting the information.

Format of the SAR R&D shall meet the requirements applied to the design documentation.

SAR R&D Section containing confidential information shall be submitted separately in accordance with the established procedure.

3. CONTENTS OF R&D SAFETY ANALYSIS REPORT

3.1. Introduction

There shall be general information of the planned R&D including risks that may arise during R&D.

There shall be brief description of approaches to safety ensurance of the planned activities, their application experience in R&D practices at the nuclear fuel cycle facility or other facilities.

3.1.1. R&D justification

There shall be brief information regarding the decisions constituting the basis of the intended R&D.

3.1.2. General description of NFCF

There shall be general information about the NFCF and production area of the NFCF where R&D is implemented, building (structure) where the production area is located (architectural, construction, process and engineering solutions), equipment of the systems and basic process operations carried out within the given production area of the NFCF.

3.1.3. Information about Operating Organization and other entities carrying out work and rendering services in R&D

There shall be the information about the OO that provides for R&D and entities carrying out work and rendering services for the OO in the design, construction, production and assembling of the equipment required for the R&D. There shall be information about permits (licenses) to carry out activities in the field of use of atomic energy available to these entities.

3.1.4. Information about SAR R&D developers

There shall be general information about the organization which developed SAR R&D, including the information on availability of licenses to carry out activities in the field of use of atomic energy.

3.1.5. SAR R&D description

There shall be information about the work stages related to justification of NFCF safety during R&D and OO preparedness for R&D.

3.2. Chapter 1. General description of R&D

3.2.1. R&D objectives and tasks

The R&D objectives and tasks shall be described. There shall be brief information about the R&D procedure and safety ensurance during R&D.

3.2.2. R&D program

There shall be information about the R&D program including information about work arrangements, scope, sequence, stages and timing. Also information about the main safety-related activities at each R&D phase shall be presented.

3.2.3. Organizational aspects of R&D

There shall be description of the organizational structure of the management of the OO division, where R&D is implemented, to provide for safety in R&D, including tasks and responsibilities of the employees.

There shall be a list of documents to be guided by in R&D, including:

- a list of operating documentation;
- a list of instructions for safety arrangements and precautions;
- a procedure for handling of operative documentation;
- a list of guides determining a procedure for NM, RadS and RW accounting for and control of;

- a list of emergency procedures including instructions for personnel actions to be taken in case of violations of normal operation conditions and emergency situations.

There shall be information about employees involved in R&D including confirmation that they possess the required competence (education, working experience, training).

Training system for R&D personnel shall be described.

3.2.4. Physical protection

Herein, describe main organizational and technical measures to prevent unauthorized actions of personnel or other persons with regard to NM, RadS and RW or NFCF systems important for safety which can result directly or indirectly in accidents and jeopardize health of NFCF division personnel as a result of a radiation impact. The information shall confirm the compliance with requirements of Physical Protection Rules for Nuclear Materials, Nuclear Installations and Storage Facilities for Nuclear Materials and other existing RD.

3.2.5. Control and accounting of NM, RadS and RW

There shall be information about the NM, RadS and RW accounting and control system during R&D in OO including NFCF division which carries out R&D.

3.2.6. Emergency planning

There shall be information about organizational and technical measures to protect personnel in case of an accident in the NFCF during R&D.

3.3. Chapter 2. Main safety principles and criteria for R&D

3.3.1. The list of standards and rules

There shall be a list of standards and rules which establish requirements to be guided by in safety ensurance and justification during R&D involving plutonium containing materials.

3.3.2. Assessment of compliance with requirements

There shall be information about compliance with the safety principles during R&D. Herein present the information about the compliance with the requirements of the federal standards and rules, including requirements related to:

- radiation safety;
- nuclear safety;
- fire protection;
- technical safety;
- physical protection,

as well as:

- NM, RadS and RW accounting and control;
- emergency planning.

Herein, present the list of deviations from the RD requirements, assessment how these deviations affect safety, compensatory measures undertaken, and give a reference to that SAR R&D Section which addresses these deviations in detail.

3.4. Chapter 3. Chemical and physical bases of the processes during R&D

Herein, present physical properties of substances involved in the processes such as radionuclide composition (for plutonium), boiling and melting temperatures, steam pressure - temperature relationships, compressibility, temperature coefficient of volume expansion, temperature coefficient of linear expansion, density, solubility in other substances without changes to the chemical state. There shall be a brief description of the chemical properties of the parent substances and their transformation products.

Changes in the composition (in case of physical and chemical or chemical transformations) or physical properties of materials and substances should be presented giving references to the regulatory or scientific and engineering documents.

For the chemical transformations there shall be the anticipated basic and secondary substances' transformation diagrams taking account of the catalytic properties of specially used catalysts, as well as impurities that may be present in the initial substances and caused by the equipment corrosion and the process.

For the physical transformations (isotope separation, dispersion, agglomeration, melting, casting, machining of ingots, punching etc.) there shall be a description of the initial and final state of the substance, individual dimensions of lump materials, process or processing technology for such materials giving a reference to the place and conditions where the technology is used.

For the physical and chemical processes (rectification, heterogeneous ion exchange, sorption, aqueous extraction, electrolysis, membrane processes etc.) there shall be a brief description of the available process technology, physical patterns, this technology is based on, necessary conditions for its implementation and final properties of the substances mixtures.

3.5. Chapter 4. Description of systems and processes

There shall be a list and description of systems (components) which are planned to be involved in R&D. Process flow diagrams of the systems shall be presented.

Systems' purposes, classification in terms of safety (safety classes as per GSP NCF), seismic stability, fire and explosive risks etc. shall be specified.

Main technical characteristics of the system and its components should be presented.

There shall be a list and range of permissible values of the system's monitored parameters; locations of the reference points shall be indicated.

Herein, briefly present (if necessary) calculation methods used to analyze the system performance, calculation results and conclusions. Should experiments be carried out to justify the system's safety, conditions of the experiments shall be briefly described, their compliance with design conditions shall be analyzed, experimental base and metrological support of the experiments shall be described, results shall be interpreted in terms of the design conditions.

There shall be a description of the system's performance in case of the normal operation, operational events including pre-emergency situation and design basis accidents, as well as description of interaction with other systems taking account of their potential failures and measures to protect the system against these failures.

Herein present analysis results of system's components failures including personnel errors and analysis of the impact of the failures' consequences including common cause failures on the operability of the system in question and its related systems, and NCF safety, in whole.

There shall be an analysis of whether technical solutions used in design of the system and its components comply with RD requirements.

While presenting the information it is allowed to give references to other SAR R&D sections where this information is presented in more details.

It is allowed to exclude some sections or add other sections, if it is conditioned by the system's specifics.

There shall be a description of the processes during R&D.

Each of the processes shall be described in accordance with the following scheme:

- X¹. Name of the process.
- X.1. Process flow diagram.
- X.2. Material and energy balances of the process.
- X.3. Process parameters.
- X.4. Process monitoring methods, safety margins of the monitored parameters.

The process flow diagram shall reflect basic process operations or stages, their interlinks; name of material components and energy carriers and locations where they are involved into the process; directions of movements of components and/or products, basic for the process in question and generated at its different stages, throughout the process operations. .

Depending from the process arrangements (periodic, continuous, semi-continuous), the material and energy balances of the process shall include the amount or concentration of initial and final substances and products, physical characteristics of their state (state of aggregation, temperature, pressure, flow rate etc.).

Extensive (dependent from the amount of the substance) and intensive (independent from the amount of the substance) parameters shall be outlined among the parameters of process.

Extensive parameters:

- capacity (volume) of individual apparatuses;
- geometrical sizes of individual pieces of equipment;
- amounts of the substances prepared for the process operations;
- parameters of the equipment that moves the process media (pumps, vacuum devices, airlifts etc.).

Intensive parameters:

- flow rate of the process media;
- concentration of individual substances in the process media or equipment;
- pressure magnitudes in the equipment and pipelines;
- temperature of the process media, initial substances and reaction products in the equipment and pipelines;
- quantity of heat released or absorbed in the course of the process operation;
- time required for the process to reach a given parameter;
- parameters of the process media and products recorded and monitored automatically and in the laboratory conditions;
- process sensitivity with regard to the change in the process mode caused by the change in the process parameters or external disturbing effects etc.

The description of the monitoring methods for process parameters shall include the monitored parameters of the process and main characteristics of the equipment of the control and monitoring system.

3.6. Chapter 5. Safety justification of buildings, structures and systems during R&D

3.6.1. List of buildings and structures

There shall be a list and description of buildings and structures where R&D involving plutonium-containing materials and other hazardous substances and materials will be conducted taking account of their storage locations and movement routes.

3.6.2. Description of natural and man-induced loads

¹ X – subsection of the process in question.

There shall be a list of the recorded natural and man-induced impacts (external and internal), loads on the buildings and structures, as well as the systems and their components.

Justification of this list shall include the references to the process (operations) flow diagrams presented in Chapter 4 of SAR R&D.

3.6.3. Applied classifications of structures, systems and components

There shall be information about the classification of structures, systems and components including that in terms of seismic stability, resistance against external natural and man-induced impacts as regards buildings and structures used in R&D as well as systems and components located inside them.

It is allowed to apply the classification of buildings and structures, systems and components used for the NFCF design, if the planned R&D does not affect the earlier accepted classifications. Appropriate justification shall be presented.

3.6.4. Methods and results of justification of strength, stability and resistance of buildings and structures

They shall be described in the scope sufficient to assess their applicability, justification methods of the strength and stability of the buildings and structures used for R&D or references to the information sources shall be given.

There shall be the strength and resistance justification of the buildings and structures used for R&D or references to the information sources about the strength and resistance justification of these buildings and structures.

3.7. Chapter 6. Nuclear safety

This Chapter shall be presented for NFCF that includes nuclear-hazardous areas.

There shall be basic provisions for nuclear safety in OO. It shall be demonstrated whether the accepted solutions comply with the RD requirements for R&D.

3.7.1. General information about safety ensurance in OO

There shall be information about NFM used in R&D, limitations of NFM amount being involved at the same point of time in the working place, the process operation in the equipment, premises, storage facility.

There shall be equipment and process diagram of the NFM movement during the operations; characteristics of the equipment where NFM are in place (or may enter); planning solutions (equipment layout); state of aggregation and chemical composition of NFM, process media; the established limitations of the nuclear safety parameters; used methods and means to measure nuclear safety parameters; justification whether nuclear safety requirements for NFM storage are met.

It shall be demonstrated what engineered means and organizational measures are used to provide nuclear safety conditions for each item of equipment and process operation during R&D taking into account the reviewed deviations from the normal operation conditions and during initial events. References to the nuclear safety statements approved in accordance with the established procedure shall be given.

There shall be an analysis of the design basis accident consequences, planned measures to mitigate SCR in case of its initiation.

3.7.2. SCR emergency alarm system

There shall be information about the EAS availability within the nuclear-hazardous areas related to R&D, EAS used (EAS name, the principle of operation, manufacturer), layout diagram of detection units, reference whether the system meets the RD requirements.

3.7.3. Organization of work related to nuclear safety

There shall be information about organizational measures related to nuclear safety, list of RD establishing nuclear safety of OO division, the procedure to grant permits to employees to carry out work within nuclear-hazardous area, the procedure to monitor nuclear safety. The structure of nuclear safety service unit and main duties of its employees shall be described.

3.8. Chapter 7. Radiation safety

The Chapter shall present radiation safety criteria and principles for the employees and population during the normal operation and accidents, which are applied in OO and OO division performing R&D.

It shall be demonstrated that radiation impact on the employees and environment caused by R&D does not result in exceeding of exposure dose limits for the employees and standards established for the release and discharges of radioactive substances, content of the radioactive substances in the environment during the normal operation and operational events including design basis accidents.

3.8.1. Radiation safety principles and criteria

There shall be principles, calculation methods, engineered means and organizational measures, protection of the employees, population and environment against the impermissible radiation impact during R&D is based on.

There shall be description of the provided engineered means and organizational solutions targeted to reduce the individual exposure doses of the employees up to such a low level that is reasonably achieved taking into account the economical and social factors.

3.8.2. Ionizing radiation sources

There shall be characteristics of ionizing radiation sources used during R&D at the working places, places that may be attended by the personnel. At that:

- in case of the operations involving the open sources - the radionuclide, compound, state of aggregation, activity at the working place, need to be involved in R&D, type and nature of planned works, class of works shall be specified;
- in case of the operations involving the sealed sources - the radionuclide, its type, activity, permissible number of radiation sources at the working places and their total activity, nature of planned works shall be specified.

Limiting conditions for the works shall be indicated.

There shall be a list of systems (components) during which maintenance the employees should be protected against the external exposure. Herein, briefly describe the calculation techniques for the employees' protection against the external exposure. There shall be a list of SW used in design of the employees' protection against the external exposure. The purpose of SW, calculation methods applied in SW, main constraints and assumptions, data on SW certification shall be presented in brief. The calculation results of the employees' protection against the external exposure shall be included.

There shall be description of the sources of the RadS ingress in the form of gases and aerosols into the atmosphere of the premises related to the R&D. The sources available in case of the normal operation, as well as the sources of RadS ingress in the form of gases and aerosols during the technical maintenance, repair, operational events and accidents shall be described. There shall be the calculation results of the concentrations (volumetric activities) of RadS in the form of gases and aerosols inside the premises.

3.8.3. Assessment of the occupational exposure doses

Herein present the assessment of the annual effective occupational dose and effective collective occupational dose during the operation, maintenance and repair of the NFCF systems (components) during R&D.

Calculations of the occupational exposure dose during the normal operation and accidents shall be presented. There shall be brief description of the calculation techniques for the occupational exposure dose, input data for the calculations and accepted assumptions. The list of SW applied to assess the occupational exposure dose shall be presented. The purpose of the computer codes, calculation methods used in the computer codes, main constraints and assumptions shall be briefly described.

3.8.4. Radiation monitoring

Herein, present radiation monitoring methods and means (including additional ones) provided for in the NFCF design and used during R&D.

There shall be objects of the radiation monitoring, types of the radiation monitoring, monitored parameters, permissible levels of the monitored parameters, points of the radiation monitoring, frequency of the radiation monitoring, engineered means and methodological support of the radiation monitoring, staff responsible for the radiation monitoring, the procedure for recording and keeping of results of individual monitoring of the employees' doses.

Herein, present the individual monitoring methods and means for the occupational exposure depending from the nature of the activities performed.

There shall be information about the availability of the radiation monitoring means involving audio and light alarm devices in the premises where operations with NFM (S) are performed, and in the premises where class I activities are carried out and radiation situation may considerable change during the activities.

Herein, present the organizational chart of the division that provides for the radiation monitoring within the OO division responsible for R&D.

There shall be description of the organizational and administrative measures to control the personnel attendance in the permanently and temporary attended premises. The personal protection equipment of the employees, characteristics of the personal protection equipment, the procedure for its use and technical maintenance shall be described.

3.9. Chapter 8. Technical safety

There shall be information about the means and organizational measures which during R&D provide for the acceptable protection of the people and environment against the radiation hazard, including that in the case of the initial events (fires, damages, emergency values of the pressures and temperatures etc.) by the quality and reliability of the equipment and pipelines used.

If necessary, herein present the information on how the technical safety of the special equipment and climbing cranes (which failures may affect nuclear and radiation safety), as well

as general industrial equipment and climbing cranes (which failures may affect technical safety of the equipment and cranes), is ensured.

There shall be methods applied to the strength analysis.

Herein, present the strength analysis of the equipment and pipelines used during R&D or give a reference to the document which covers this analysis.

Permissible loads on the equipment and pipelines shall be presented.

There shall be the methods of sealing the equipment connections and justification of their operability during R&D, types of the sealing arrangements or sealing units in use, properties of the materials of the sealed connection and sealing, permissible limits of the leak, service lifetime, total operating period taking into account the chemical corrosiveness of the media in relation to the sealing material.

3.10. Chapter 9. Explosion and fire safety

It shall be demonstrated that R&D conditions meet the explosive and fire safety requirements and radiation impact on the personnel, population and environment in case of the fire and explosion does not result in exceeding of the established exposure doses for the personnel and population, standards for releases and discharges, content of the radioactive substances in the environment.

There shall be information about the technical and organizational measures targeted to prevent (limit) the generation of the explosive mixtures and substances and to protect employees (personnel) against adverse impacts of fire and explosion.

Herein, present information on the procedure to notify the personnel about the fire initiation, personnel actions in case of fire, measures to provide for the evacuation of the employees (personnel) during the fire, communications and alarm system in the event of the fire.

Measures to protect the fire brigade staff against the radiation impact shall be presented.

There shall be analysis results of the explosive and fire safety and assessment results of the explosion and (or) fire consequences taking into account failures of the fire fighting system.

3.11. Chapter 10. RW management

3.11.1. Sources of RW generation

There shall be data based on the inventory (material) balance (see para 3.5 of this regulatory document) about the amount of GRW, LRW and SRW generated during the normal operation of the systems, and assessment of the amount of GRW, LRW and SRW generated during design basis accidents, their radionuclide composition.

3.11.2. GRW, LRW and SRW management systems

The Section shall include main characteristics of the GRW, LRW, SRW management system (equipment).

There shall be parameters, assumptions and input data used to calculate the amount of generated GRW, LRW, SRW, their quantitative and radionuclide composition. Processes and operations resulting in RW generation shall be addressed.

There shall be a list of the equipment of the systems where explosive concentrations of gases may be generated, values of the design pressures, safety justification for the equipment applied in the design. Herein describe instrumentation and control system (including gas analyzers), system's monitoring means, measures to prevent explosions and measures to prevent loss of the equipment integrity caused by the explosion provided for in the design.

There shall be the anticipated contributions to the NFCF radioactive releases and discharges during R&D, including those caused by the emergencies.

Ultimate forms of conditioned RW, types of the containers used shall be presented, their storage locations shall be specified. It shall be demonstrated that the RW amount does not exceed the established standards for their generation and storage at the NFCF, and properties of the conditioned RW meet the RD requirements.

3.12. Chapter 11. Safety analysis

There shall be values of the process parameters corresponding to the boundary values of the normal operation area for each system including justifications of the selected parameters values under the permitted modes, error of their measurements, measurement areas.

Values of the process parameters, when main process protection and interlock systems and automated controllers are actuated, shall be presented.

There shall be values of the process parameters deviations from which may cause accidents, monitored parameters, method and area of their measurement, justification of the accepted maximum permissible value in terms of safe operation conditions and its measurement error, change and measurement ranges for the parameter, adequacy of the calculated and (or) experimental justification of the parameter.

A list of conditions, under which an operator shall stop the process, shall be presented.

There shall be a list of initiating events of accidents during R&D. For each initiating event the analysis results of potential systems' (components') failures shall be presented.

There shall be brief information about analysis methods and used models.

Certification results of computer codes, if used for the process analysis, shall be included.

The safety analysis shall result in confirmation that the accepted safety criteria are met.

3.13. Chapter12. Quality assurance

To assess whether quality assurance activities related to R&D are acceptable, information about the sufficiency of measures provided for by the Requirements to Quality Assurance Program for the Nuclear Fuel Cycle Facilities shall be presented. It is permitted to give a reference to an appropriate quality assurance program during R&D.

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