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Federal Standards and Rules

REQUIREMENTS FOR SAFETY ANALYSIS REPORT FOR NUCLEAR INSTALLATIONS OF NUCLEAR FUEL CYCLE

(draft second version)

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

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REQUIREMENTS FOR SAFETY ANALYSIS REPORT FOR NUCLEAR INSTALLATIONS OF NUCLEAR FUEL CYCLE (FSR)

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REQUIREMENTS FOR SAFETY ANALYSIS REPORT FOR NUCLEAR INSTALLATIONS OF NUCLEAR FUEL CYCLE

Gosatomnadzor of Russia
Moscow, 2002

The federal standards and rules “Requirements For Safety Analysis Report For Nuclear Installations Of Nuclear Fuel Cycle” establish requirements for Safety Analysis Report for nuclear installations of the nuclear fuel cycle, its format, uniform structure to describe nuclear installation systems as well as the requirements for content of the report chapters.

This regulatory document applies to constructions, complexes and installations (excluding production reactors) with nuclear materials, which are under siting, design, construction and operation and intended for production, processing of nuclear fuel and nuclear materials including uranium ore mining, hydrometallurgic processing, uranium hexafluoride production and enrichment, metallurgic productions, nuclear fuel fabrication, uranium isotope fabrication, and reprocessing of spent nuclear fuel.

This regulatory document has been developed on the basis of the Federal Law “On the Use of Atomic Energy” considering federal standards and rules approved by Gosatomnadzor of Russia and on the basis of “Basic Sanitary Rules of Radiation Safety (OSPORB-99)”.

This is the first release of the regulatory document.

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LIST OF ABBREVIATIONS:

ARMS	Automatic Radiation Monitoring System
CA	Controlled Area
CfSS	Confining Safety System
CSS	Controlling Safety Systems
EAS	Emergency Alarm System
Expl.	Explosives
GRW	Gaseous Radioactive Waste
GSP NFCF	General Safety Provisions for Nuclear Fuel Cycle Facilities
HGP	Hazardous Geologic Process
I&C	Instrumentation and Controls
IE	Initiating Event
LRW	Liquid Radioactive Waste
MWS	Maximum Wave Setup
NFM (S)	Nuclear Fissile Material (Substance)
NI NFC	Nuclear Installation of Nuclear Fuel Cycle
NM	Nuclear Materials
NOCS	Normal Operation Control Systems
OO	Operating Organization (Utility)
PPS	Physical Protection System
QAP	Quality Assurance Program
R&D	Research and Development
RadS	Radioactive Substance
RD	Regulatory Document
RW	Radioactive Waste
SAO	Start-up and Alignment Operations
SAR NI NFC	Safety Analysis Report For Nuclear Installation of Nuclear Fuel Cycle
SCR	Self-Sustained Chain Reaction
SIS	Safety Important Systems
SRW	Solid Radioactive Waste
SS	Safety Systems
SSE	Safe Shutdown Earthquake
SSS	Supporting Safety Systems

GENERAL PROVISIONS

1. Purpose and scope

1.1. This document establishes requirements for Safety Analysis Report for nuclear installations of the nuclear fuel cycle, its format, uniform structure to describe nuclear installation systems as well as the requirements for content of the report chapters.

1.2. This regulatory document applies to constructions, complexes and installations (excluding production reactors) with nuclear materials, which are under siting, design, construction and operation and intended for production, processing of nuclear fuel and nuclear materials including uranium ore mining, hydrometallurgic processing, uranium hexafluoride production and enrichment, metallurgic productions, nuclear fuel fabrication, uranium isotope fabrication, and reprocessing of spent nuclear fuel.

2. Purpose and scope SAR NI NFC

2.1. SAR NI NFC is the document to justify safety of NI NFC. SAR NI NFC is developed by OO and submitted to Gosatomnadzor of Russia as a constituent of the document package to obtain a license from Gosatomnadzor of Russia for siting, construction, and operation of NI NRF.

2.2. The SAR NI NFC shall contain information, which is sufficiently complete for adequate understanding of the safety concept the design is based upon, Quality Assurance Program NI NRF and basic principles of operation as proposed by OO.

2.3. Each NI NRF shall be covered by a separate SAR NI NRF.

3. SAR NI NRF development procedure

3.1. The activities related to preparing and maintaining of SAR NI NRF shall be carried out at siting, construction, commissioning and operation of NI NFC.

3.2. At the stage of NI NFC siting information contained in SAR NI NFC shall be based on the available results of surveys, R&D; and at the NI NFC construction and operation stages – and the NI NFC design materials.

3.3. After NI NFC commissioning the SAR NI NFC shall be updated to make its information consistent with the NI as constructed and ready for operations as well as it shall reflect the actual state of NI as built and after SAO.

3.4. All changes to NI NFC design shall be reflected in SAR NI NFC.

4. Requirements to report format

The requirements to SAR NI NFC are given in Appendix 1.

5. Uniform structure of systems' description in SAR NI NRF

It is recommended to follow the description structure of this Section while presenting the information about the systems.

5.1. Purpose, design bases

The purpose of facility systems shall be described to include their categorization in terms of safety, as per GSP NFCF, seismic stability, fire and explosion hazard, etc.

There shall be a list of safety regulations to be met by the system being described, as well as principles and criteria laid as the basis of the system design.

The system design bases shall be described.

The above shall be presented in the following sequence:

* purpose and functions of the system;
* design bases.

5.2. System design

The subsection shall describe the design and (or) process flow diagram of the system as the whole and its subsystems and components if they perform independent functions. There shall be sufficiently detailed drawings, figures and diagrams to illustrate the system design and performance, its spatial arrangements and links with other systems of NI NRF along with references to specific drawings.

The basic technical characteristics of the system and its components should be given.

A justification of selection of materials should be given with taking account of normal operation conditions, violations of normal operation including pre-accident situations and accidents.

The above shall be described in the following sequence:

* description of the design and (or) process flow diagram;
* description equipment (components);
* description of the materials in use;
* location of the equipment (components).

5.3. Control arrangements

This subsection shall list and indicate the ranges of permissible monitored parameter values for all system operational modes with relevant justifications. The location of control points should be indicated, monitoring techniques described, metrological certification of the applicable methodologies provided, requirements to instrumentation and controls given. The links of the system with the controlling systems, redundancy of sensors and communications channels shall be described. There shall be complete lists of control points and sensors, protections, principal descriptions of controlling devices, actuators, and automated control codes.

The above shall be described in the following sequence:

- control points, list of controlled items with indication of the used controls (by operator, automation, equipment protection method), actuator;
- description of controllers' protections, automated control codes.

5.4. Tests and inspections

The subsection shall list the parameters to be monitored in the course of manufacturing and construction of NI NFC systems and components.

The scope and methodologies of acceptance inspection, start-up and alignment tests, tests and inspections during operation and their metrological support shall be justified. A list and permissible values of the parameters to be monitored and the requirements to controls shall be presented and justified.

5.5. Analysis of the system

The subsection shall contain a brief description of computer codes used for the system performance analysis, calculation results and conclusions. If experiments were conducted to justify the system safety, there shall be brief descriptions of experiment conditions, an analysis of their conformance with calculation conditions, a brief description of the experimental equipment, metrological support of experiments, and an interpretation of the results with regard to design conditions.

The information on certification of equipment, systems and components (equipment) shall be given.

There shall be a description of how the system functions in normal operation conditions, operational events including pre-accident situations and design basis accidents; its interaction with other systems taking into account their possible failures, and measures to protect the system from consequences of these failures. For the intended operational modes there shall be operating limits and conditions, safe operation limits and conditions, SS actuation settings and indicators of reliability of the system and its components.

There shall be analysis results of the system components' failures including personnel errors, and an analysis of failure consequences, including that of the common cause failures, to

performance of the system in question and related systems, to NI NFC safety as a whole. An analysis of the system design compliance with the RD requirements shall be provided.

The information shall be presented in the following sequence:

* normal operation including the data on computer codes;
* safe operation limits and conditions;
* system performance in case of failures;
* system performance in pre-accident situations and design basis accidents;
* system performance in case of external impacts;
* system reliability indicators;
* certification of systems and components (equipment).

While presenting the information it is possible to make references to other sections where this information is given in more detail.

Specific contents of each section may be changed depending on features of the system.

It is permitted to omit individual subsections or supplement them with other provided it is determined by the system's features.

5.6. Conclusions

There shall be conclusions made on whether the system meets the Federal Standards and Rules in the field of use of atomic energy and whether it complies with requirements of other safety related RDs.

REQUIREMENTS TO CONTENTS OF SAR SECTIONS

INTRODUCTION

There shall be general information about NI NFC design and a general description of SAR NI NFC.

1. Basis of the design development

Brief information shall be given about formal decisions made by the federal executive bodies and that by the Russian Federal subjects laid as the basis for NI NFC design development and construction shall be presented.

2. General description of NI NFC

There shall be a general description of NI NFC including its purpose, brief description of the site and its features, planned production capacity of NI NRF, anticipated commissioning schedule of the designed NI NFC, and a brief description of the NI NFC principle process flow diagram.

3. SAR NI NFC development stage

It is required to indicate the purpose and a brief contents of SAR NI NFCF and the activity(ies) to be covered by the developed SAR NI NFC.

4. Information about operating organization and organizations executing work and rendering services

There shall be the information on the Operating Organization, which is to submit SAR NI NFC to Gosatomnadzor of Russia, and on the developers of separate SAR NI NFC sections.

The major organizations performing work and rendering services to OO related to design, construction, manufacturing and assembling of NI NFC safety important main systems and components shall be indicated.

There shall be references to the corresponding documents; the distribution of functions and responsibilities among these organizations shall be described.

5. Information on R&D

The brief information about R&D carried out or planned to justify technologies, system and element designs, and NI NFC basic safety design solutions shall be provided.

7. Description of report

The completeness of the information presented shall be outlined and demonstrated whether it complies with the requirements of this document.

In case the NI NFC design development is at the initial stage (siting, construction) and due this mere fact the information presented does not fully meet the requirements therein, this shall be indicated in this SAR NI NFC section.

CHAPTER 1. NI NFC GENERAL DESCRIPTION

The information on contents of all SAR NI NFC sections shall be presented herein.

The information shall be presented in a way that allows for its use independently from other SAR NI NFC sections, including for the purposes of getting familiarized the local administrations, public organizations and general public with the concept and main technical solutions to ensure safety of NI NFC. The information shall be simple and easy to perceive. This chapter shall provide for sufficient information to understand NI NFC design bases without reading subsequent chapters. This shall not be, however, the information pertaining to other section which was made concise mechanically but an independent description supported by tables, diagrams and drawings.

1.1. Construction conditions

There shall be brief data on the NI NFC site and region of its location for NI NFC under construction with the exclusion of the ore mining sites:

- general information (location, topographic conditions, etc.);
- geographic location, site boundaries, CA and surveillance zone boundaries, land lease;
- population density data residing within 25 km radius around NI NFC including contracted and operating personnel of NI NFC;
- climatic conditions, atmospheric conditions;
- hydrogeological and seismic and tectonic characteristics;
- seismic conditions of the NI NFC site location region, boundaries of the solid block where seismic deformations will not be manifested including that of during SSE;
- characteristics of extreme natural impacts (whirlwinds, hurricanes, tornadoes, sand storms, icing, flood, etc.);
- soil characteristics for depths not less than 100 m along with distributions of compressible (clay, sand) and non-compressible (rock, semirock) soils;
- occurrence depth of the first from the surface water-bearing stratum and its linkage with surface water;
- justification of choice of the site.

The following information shall be presented for the uranium ore mining sites:

- general information (location, topographic conditions, etc.);
- geographic location, land lease boundaries, site boundaries, CA and surveillance zone boundaries;
- population density data residing within 25 km radius around NI NFC including contracted and operating personnel of NI NFC;
- climatic conditions, atmospheric conditions;
- hydrogeological and seismic and tectonic characteristics;
- seismic conditions of the NI NFC site location region, boundaries of the solid block where seismic deformations will not be manifested including that of during SSE;
- characteristics of extreme natural impacts (whirlwinds, hurricanes, tornadoes, sand storms, icing, flood, etc.)

1.2. Siting plan

There shall be a brief description of the NI NFC site region to include a brief characterization and locations of facilities, water reservoirs, irrigation channels, hydro power plant dams, airfields, highways, railways with their relation to CA and surveillance zone.

There shall be descriptions of relief of the site and down gradients towards water reservoirs. Land use information shall be given in brief.

The access railway and highway routes and anticipated residential area for NI NFC employees (personnel) shall be indicated.

Facilities that are especially hazardous in terms of explosion and fire safety and toxic releases into the environment shall be indicated.

1.3. Main technical characteristics of NI NFC

There shall be a NI NFC process flow diagram, its description and the following information:

- purpose of NFC;
- service life of NFC;
- type of products;
- each production output.

The following shall be presented for the uranium ore mining sites:

- principle process flow diagram and its description;
- ore production output.

1.4. NI NFC operational mode

There shall be information on the process operational mode of NI NFC.

1.5. NI NFC safety ensurance concept

1.5.1. Main safety principles and criteria of NI NFC

There shall be:

a list of applicable RD related to safety used during design, construction and operation of NI NFC;

quantitative values of safety criteria laid as the basis for the NI NFC design;

a description of safety ensurance arrangements supported by graded implementation of the defense-in-depth concept, which is based on application of a physical barrier system on routes of propagation of ionizing radiation, NM and RW into the environment, and a multi-layer system of technical and organizational measures to protect the physical barriers, maintain their efficiency and protect employees (personnel) and population;

a description of measures to prevent the self-sustained chain reaction during handling of nuclear materials shall be given for NI NCF and their structural units where operations (use, processing, storage, transportation, etc.) are performed with plutonium, uranium-233, uranium with the enrichment is higher 1% (mass) with regard to uranium-235 if the total mass of plutonium isotopes and uranium-233 and uranium-235 nuclides does not exceed 300 grams at any point of time at NI NCF (its structural unit). The corresponding masses of other nuclear hazardous fissile nuclides shall be set and justified;

information on the solutions incorporated in the NI NCF design, which provide for the required level of safety;

a list of SS, main SS functions;

information about beyond design basis accidents (a list of beyond design basis accidents considered; measures to mitigate consequences of beyond design basis accidents; measures to manage severe accidents);

information on the previous experience in designing, constructing, assembling, operating, testing to verify sufficiency of the technical and organizational solutions used to ensure NI NCF safety.

1.5.2. Nuclear safety

The information in this section shall be given for NI NCF and their structural units where operations (use, processing, storage, transportation, etc.) are performed with plutonium, uranium-233, uranium with the enrichment is higher 1% (mass) with regard to uranium-235 if the total mass of plutonium isotopes and uranium-233 and uranium-235 nuclides does not exceed

300 grams at any point of time at NI NCF (its structural unit). The corresponding masses of other nuclear hazardous fissile nuclides shall be set and justified.

The nuclear safety goals shall be formulated and it shall be demonstrated what systems and organizational measures are in place to meet them during the use, reprocessing, storage and transportation of NFM (S) including brief descriptions of:

engineered means and organizational measures to prevent initiation of SCR;

engineered means and organizational measures to prevent uncontrolled and unauthorized operations with NFM (S) including their use, reprocessing, accumulation, movement, transfer, and transportation.

1.5.3. Radiation safety

There shall be the information on engineered means and organizational measures to ensure protection of employees, population and environment from radiation impacts. It should be demonstrated that the application of the proposed protective means and measures is practicable and does not lead to an excess of the established dose limit, excludes unreasonable exposure The design engineered means and organizational arrangements shall be described which reduce the employees (personnel) exposure level as low as reasonably achievable, economic and social factors being taken into account (ALARA principle).

1.5.4. Technical safety

The information shall be given on means and organizational measures to ensure during NI NFC operation the acceptable protection of people and environment from such unfavorable factors as explosions, destruction, emergency pressure and temperature, environ toxicity, voltage, etc. This protection shall be achieved through quality and reliability of the equipment and machinery in use. The technical safety information shall be presented separately for special equipment and climbing cranes (which failures may affect nuclear and radiation safety) and the commonly used industrial equipment and climbing cranes (which failures may affect technical safety of the equipment and cranes). The information shall contain data separately on boilers (steam and hot-water boilers), pressure vessels, steam and hot water piping, and climbing cranes.

The following information shall be presented:

a list of pressure equipment and climbing cranes;

purpose of equipment and cranes;

design service life, residual life;

operational parameters;

possible failures and their impacts to nuclear and radiation safety;

locations, references to installation drawings and general view drawings;

a list of regulations used for design, engineering, manufacturing and operation of the equipment and cranes;

information on deviations from requirements of applicable regulatory documents, design and engineering documentation and relevant compensatory measures to ensure nuclear and radiation safety and (or) technical safety of the equipment and cranes;

references to the documents containing strength calculations, justifications of stability to external impacts, reliability of the equipment and cranes during normal operation, operational events including accidents.

1.5.5. Fire safety

There shall be given a fire protection concept of NI NFC presented and the justification of fire suppression systems' sufficiency.

The results of NI NFC fire safety analysis shall be presented along with the results of fire consequences analysis considering possible failures of fire suppression systems.

The employees (personnel) evacuation measures in case of fire, provided for in the design, shall be briefly described.

The fire water supply of the NI NFC site, main buildings and structures shall be described.

The following shall be described:

fire warning and communications system;

fire protection units' conduct.

It shall be demonstrated that external fires do not affect NI NFC safety. It shall be demonstrated that the RD fire safety requirements are met.

1.5.6. Protection from natural and man-induced impacts

The following information shall be provided:

for SIS structures, components – a list of extreme impacts with frequency more than 10^{-2} 1/year (winds, hurricanes, tornado, whirlwinds, extreme temperatures, floods, icing, etc.) along with impact magnitude as well as the impact magnitude from aircraft crash, projectiles and shock wave;

on protective measures from external impacts;

on characteristics of earthquakes and their parameters considered in calculations of buildings and structures pertaining to the first and second categories; information about the Seismic Protection System;

on hazards posed by industrial, transportation and military facilities located near NI NFC.

1.5.7. Action plans to protect employees (personnel) and population in case of accidents

The main provisions of action plans to protect the employees (personnel) and population in case of a radiation accident at NI NFC shall be presented.

The procedure for notification of the population shall be outlined and the organizational measures to be taken in case of an emergency shall be given to include coordination of actions of the NI NFC personnel with the facility, federal and local force of the Ministry of the Russian Federation for Civil Defense and Emergencies and Elimination of Consequences of Natural Disasters.

1.5.8. Physical protection

The basic NI NFC physical protection measures shall be described.

The main results of NI NFC vulnerability analysis shall be given to include internal and external threats and possible ways of their realization.

1.6. Safety analysis results

1.6.1. Reliability of equipment and components

The information shall be provided on reliably indicators of the normal operation systems, safety important systems and their components.

1.6.2. Safety analysis

There shall be brief information on methods and results of safety analyses.

The information shall be given regarding all groups of accidents considered.

There shall be a general assessment of the NI NFC safety analysis results.

1.7. Main technical solutions

1.7.1. Description of main technical solutions

A description of main technical solutions shall be supported by process flow diagrams and figures. The process flow diagrams and assembly drawings (in plan and cross-sections) of major systems shall be provided.

The following brief information shall be given:

- general description of NI NFC systems;
- main process characteristics of systems and components;
- design principles and criteria of the systems.

Brief descriptions shall be provided of the NI NFC main systems and components including the following:

- normal operation systems non-important for safety;
- safety important normal operation systems;
- safety systems.

There shall be an analysis of design solutions for major systems, a list of initiating events the NI NFC is designed to withstand along with a brief analysis of emergencies and accidents.

There shall be brief information describing materials and substances planned to be handled at NI NFC:

- names, specifications and amount (maximum and minimum) of all NM;
- names, specifications and amount (maximum and minimum) of all RadS;
- specifications and amount (maximum and minimum) of all RW;
- names and amount (maximum and minimum) of non-radioactive substances (extracting agents, recovery solutions, solvents, decontaminating agents, etc.) used in the processes.

There shall be information justifying that an unauthorized use of NM, RadS and RW is excluded and their physical protection is ensured.

It is required to provide information on the storage vessels of all NM, RadS, RW, and non-radioactive substances including:

- a list of storage facilities;
- maximum design capacity of each storage facility and capacities envisaged in case of an accident;
- method of storage.

It is required to give the main information on engineered features for:

- on-site transfers of nuclear materials, radioactive substances, radioactive waste and non-radioactive substances (information about shipment frequency, types of vehicles and packaging), physical protection features of the vehicles to ensure physical protection of shipments;
- NI NFC on-site and off-site shipments of NM, RadS, RW and non-radioactive substances (information about anticipated shipment frequency, types of vehicles and packaging), physical protection features of vehicles to ensure physical protection of shipments.

1.7.2. General layout

The scale of general layout shall be 1:2000 with the horizontal relief cross-sections by each 0.5 m, and, if necessary, with scale 1:500 with the horizontal relief cross-sections by each 0.25-0.5 m.

A list of main buildings and structures of the NI NFC shall be presented along with the general layout.

The following information shall be provided:

- conditions determining locations of main buildings and structures on the general layout (process interlinks, natural local relief features, directions of prevailing winds, geologic and hydrogeologic conditions of the site, construction sequence of buildings and structures, etc.);
- site plan showing locations of all buildings, structures and perimeter boundaries outlying the buildings subject to physical protection;
- orientation of the NI NFC main buildings;

- distances between main buildings and structures and their justification;
- justification of locations of hydraulic structures, auxiliary buildings and structures on the general layout;
- highways and railways, conditions of entrance to main buildings and structures;
- slope of the site;
- site plan elevations;
- site protection from surface water drains;
- utilities, transport, process and electric connections between buildings and structures.

1.7.3. Handling of NM

A brief characteristic of systems, their main goals, criteria and principles of design shall be given.

1.7.4. Management of RadS

A brief characteristic of systems, their main goals, criteria and principles of design shall be given.

1.7.5. Management of RW

A brief characteristic of systems, their main goals, criteria and principles of design shall be given.

1.7.6. Radiation safety and radiation monitoring

The information shall be presented on radiation safety ensurance. It is required to briefly describe the engineered means of radiation monitoring and ARMS provided for by the design.

1.7.7. Physical protection system

Brief information shall be given on PPS, recent NI NFC vulnerability analysis results, and PPS efficiency.

It shall be demonstrated that the physical protection meets the following requirements:

independence;

multi-channel arrangement;

fire safety;

operability and reliability under external and internal natural and man-induced impacts considered in the design.

Brief information on PPS composition shall be given. The information on stage-by-stage commissioning of PPS during NI NFC construction and stage-by-stage phasing out of PPS during the facility decommissioning shall be given.

The requirements of this section does not cover the uranium mining facilities.

1.7.8. Control and accounting of NM, RadS and RW

The information shall be given on NI NFC procedures for control and accounting of NM, RadS and RW.

1.7.9. Technical safety measures

The following information shall be given for each type of equipment and cranes:

- on organization of the institutional control;
- on requirements for qualifications of employees (personnel) servicing the equipment and (or) cranes;
- on organization of maintenance and repairs;
- on quality assurance programs for operations and on quality control of equipment and cranes.

The information shall be given on work conduct and methods of diagnostics and evaluation of service life of the equipment and cranes.

1.8. Brief description of NI NFC operation

There shall be a description of main processes conducted at NI NFC during its commissioning, normal operation and termination of operation. The main parameters of the given systems and process flow diagrams shall be given.

It is required to indicate on-site transportation routes for NM, RadS, RW and other substances and materials in use.

1.9. NI NFC environmental impact

Brief information justifying design solutions with regard to environmental impacts i.e. chemical, radiation and thermal impacts, shall be provided.

It is required to note the following:

- the assessment of impacts caused by NI NFC to the environment shall take into account its actual state, ecological conditions in the NI NFC site region, present sanitation and hygienic, biological, antropogenic and man-induced features of pollution of the biosphere;
- description of all unique features of the site related to NI NFC including natural resources, archaeology sites, rear or disappearing animal spices;
- the comprehensive assessment results of consequences of environmental impacts caused by NI NFC shall be given.

1.10. Comparison of NI NFC design with national and foreign NI NFC designs

It is required to identify the NI NFC design analogues.

An NI NFC analogue may be a NI NFC conducting the same or close activities.

1.11. Basic provisions for operations conduct of NI NFC

1.11.1. commissioning of NI NFC

The SAO Program shall be briefly described to include testing of structures, systems and components during the NI NFC commissioning.

Such information shall list main stages of SAO along with their description. For each stage there shall be a goal to be achieved in the course of inspections and tests.

The documenting and document management and keeping procedures shall be outlined.

1.11.2. Management of NI NFC operations

The information regarding preparation of and arrangements for operations of the NI NFC shall be given.

This information shall briefly describe the OO organizational structure to include responsibilities of structural units for NI NFC operations, employees (personnel) training to achieve required competence (availability of training centers, training programs, and timeliness of training, qualification procedures and permits for independent work).

1.11.3. Safe operation limits and conditions

General information on safe operation limits and conditions shall be provided.

1.12. Quality assurance

The brief information shall be presented on sufficiency of measures regarding the activities outlined in the “Requirements for Quality Assurance Program for Nuclear Fuel Cycle Facilities”.

1.13. General assessment of the design

It is required to provide information stating that the NFC has been designed (is being designed), constructed (under construction) and operated (will be operated) in accordance with the requirements of federal laws and safety RD.

CHAPTER 2. NI NFC SITE AND REGION CHARACTERISTICS

There shall be a description of the NI NFC site and region in accordance with the requirements of regulatory documents.

2.1. While describing the NI NFC site and location region the following information shall be given:

- on completeness and sufficiency of surveys and studies to obtain confident data about NI NFC site and region necessary, as per applicable regulations for assessment of external natural and man-induced impacts to NI NFC and NI NFC impact assessment to the population and environment;
- presence or absence in the NI NFC site and region the processes, phenomena and factors that could influence nuclear and radiation safety of the population and environment as listed in RD.
- The information on each process, phenomenon and factor, which is based on special survey results, statistical data analysis results and special calculation results, shall be given separately for each event along with its intensity and frequency considering error of the methodology used, as well as characteristics of instrumentation and equipment.

The following shall be presented:

- design parameters of the considered natural processes, phenomena and factors with confidence 1%, 0.1% and 0.01% or average occurrence frequency of once in 100, 1,000 and 10,000 years. While considering sources of man-induced hazard the impacts of probability of more than 10^{-6} a year shall be considered;
- the used methods and results of prognosis of unfavorable changes in the NI NFC siting conditions which can trigger that or another hazardous natural or man-induced process, phenomenon or factor during NI NFC construction, operation and decommissioning capable of affecting safety of the population and environment;
- possibility of changes in the site conditions at all stages of NI NFC life cycle;
- avoidance of taking account of an extremely low probability event impacts to NI NFC, insignificant intensity of such event or large distance from the event epicenter to the facility. Safe distances and intensities are determined by special standards;
- safety of NI NFC, environment and population considering possible combinations interrelated of NI NFC processes, phenomena and factors to the population and environment.

2.2. The NI NFC siting conditions as regards human activities shall be described:

- NI NFC site in terms of physical geography conditions, administrative and territorial location;
- demographic data as per the latest census considering possible migration and demographic changes in the NI NFC location region over the facility operation period;
- utilities, pipelines, industrial, transport and other facilities that can affect NI NFC safety or which can be affected by NI NFC operations.

2.3. There shall be results of analysis of man-induced processes, phenomena and factors for the NI NFC site and region and a forecast of their influence to NI NFC including:

- aircraft crash;
- fire due to an external cause;
- explosions at facilities;
- water reservoir dam breaks;
- releases of explosive, flammable, toxic vapor, gases and aerosols into the atmosphere;
- on-site fire and explosion sources.

2.4. It is required to provide a description of how natural processes, phenomena and factors featured by NI NFC location region affect NI NFC and its site.

2.4.1 Topographic data of the region and site shall be presented in the unified system of coordinates and elevations including maximum and minimum absolute relief marks; surface slope and slope direction; topographical and bathymetric maps of the shelf zone and topographical maps indicating relief instability features, water-logged grounds, forests, croplands, other holdings.

2.4.2. Climatic and hydrometeorological conditions including: air temperature; glaze; extreme atmospheric precipitation and snowfalls; snowbanks and snow avalanches; ice jams and gorges on waterways; floods; negative and positive setup, storm sea in the coastal area; tsunami; seiche; high and low tides; Extremely low flow, abnormal decrease in water level; wind and whirlwind.

2.4.3. Geologic and tectonic conditions including: characteristics and parameters of geologic and tectonic structure and recent tectonics; geodynamic conditions resulted from decoding of satellite images and morphostructural analysis; description of lithology and stratigraphy of the region, composition and thickness of the Quaternary deposits, structure and depth of the crystalline basement; zoning sketch maps of the NI NFC region regarding the degree of hazard of exogenic geological processes (eruption, mud volcanism, landslides, downfalls, mudflows, snow-stone and rock-debris-block avalanches, territory sinks and subsidences, underground washouts including karst manifestations, deformations of specific soils); observation data on recent crust movements.

2.4.4. Hydrogeological conditions including season depth and oscillations of the ground water level; interlinks of water-bearing horizons and their links to surface water; water-bearing horizons' feed and drain areas; flow directions and rates, soil filtering factors; assessment of hydrogeological dispersion in the ground water.

2.4.5. Engineering and geological and geotechnical conditions including engineering and geologic zoning maps to show geologic cross-sections, reference bores and main buildings; additional cross-sections along the axes of the important buildings and geologic bore columns made in their locations; physical and mechanical and dynamic properties of soils in native and water saturated states (for pergelisol – in native and thawed states) including the revealed lens and interbeds of unstable soils with unstable properties; micro-deformations of soils in the basement of important NI NFC buildings; observed subsidence and inclination of buildings and structures.

2.4.6. Seismological and seismotectonic conditions including descriptions and parameters of active faults, fracture displacements, seismic dislocations, seismotectonic uplifts and subsidences of crust blocks; micro-seismic and instrumental data on earthquakes; seismic zoning map of the region indicating possible seismic focuses and NI NFC site; seismic micro-zoning maps of NI NFC site indicating main buildings and structures and design parameters for design basis and safe shutdown earthquake set forth for natural and man-induced conditions.

2.5. It is required to present the results of NI NFC environmental and population impact assessments including results of assessments of consequences of releases and discharges of radionuclides into the environment during normal operation and operational events.

2.6. The issues related to life support of employees (personnel) and population, their evacuation in case of emergency shall be reflected to include:

- analysis of accidents at NI NFC and its location region;
- organizational and technical measures to support evacuation activities;
- recommendations on the use of the corresponding access routes in case of emergency, their upgrading and construction of new transportation routes to access NI NFC from three-four directions.

2.7. It is required to describe processes and phenomena monitoring programs during NI NFC construction and operation.

The programs shall be described for each type of observation.

Each program shall outline:

- goal and objectives of the observations;
- justification of locations and number of survey posts;
- specifications of hardware, test facilities and methods, and observation result analyses;
- content of the observation results' report.

2.8. It is required to provide a Summary Table of external impacts at NI NFC.

The Summary Table of external impacts shall include:

- characteristics and parameters of hydrologic and weather phenomena;
- characteristics and parameters of geodynamic, seismotectonic, geologic, hydrogeologic, seismic and engineering and geologic parameters, processes, phenomena and events;
- characteristics and parameters of MIIs.

The exemplary Table is given below.

№	Process, phenomenon, event	Source of process, phenomenon, event	Degree of hazard	Frequency of occurrence	Impact parameters	Additional information

The Table shall list natural processes, phenomena and external man-induced events considered in the NI NFC design.

There shall be a list of initiating events considered in the plans of measures to protect employees (personnel) in case emergencies.

2.9. Documenting of information concerning NI NFC location conditions

This subsection shall be generated as an Appendix to section 2 and include the information which describes NI NFC location conditions in terms of natural processes, phenomena and external man-induced events affecting NI NFC.

The subsection shall be structured in a way allowing for its modification regarding changes that may occur at all stages of the NI NFC service life (see recommended Appendix 2).

CHAPTER 3. GENERAL PROVISIONS FOR DESIGN OF BUILDINGS, STRUCTURES, SYSTEMS AND COMPONENTS

3.1. Basic design principles and criteria for buildings, structures, systems and components

3.1.1. List of used regulatory documents

A list of regulatory documents used for design shall be given.

3.1.2. Assessment of compliance

There shall be an information on compliance with the main principles of NI NFC safety ensurance including:

- demonstration of how the defense-in-depth concept is implemented;
- measures to ensure nuclear safety;
- measures to ensure that the established guidelines for releases and discharges of RadS into the environment are not exceeded;
- demonstration of to what extend the safety important design solutions have been tested and supported by experience and research;
- demonstration of how quality is assured at all stages of NI NFC life cycle;
- measures to ensure fire protection;
- measures to ensure physical protection;
- demonstration of the approach to account for human factor targeted to eliminate errors or mitigate consequences related to NI NFC employees (personnel) actions including those during maintenance;
- measures to provide qualification and psychological training of the OO employees (personnel) ensuring design safety culture principle.

3.1.3. Allowed deviations, their safety impact assessment and compensatory measures taken

It is required to list deviations from the requirements of federal standards and rules in the field of use of atomic energy, justifications of such deviations and compensatory measures taken, as well as a reference shall be made to the document section where these deviations are presented in detail.

3.2. Classifications of buildings, structures, systems and components in use

3.2.1. Classification of buildings, structures, systems and components with regard their impact to safety

It is required to provide information on classification of safety important buildings, structures, systems and components with regard to safety classes in accordance with GSP NFCF.

3.2.2. Classification quality groups

It is required to provide information on classification of safety important components with regard to quality groups. The results shall be presented in the tabulated format (Appendix 3.1).

3.2.3. Seismic stability classification

It is required to provide information on classification of buildings, structures, systems and components with regard to seismic stability.

The results shall be presented in the tabulated format (Appendix 3.1).

3.2.4. A list of buildings, structures, systems and components subject to analysis of their resistance to natural and man-induced impacts

It shall be indicated whether the analysis of stability to natural and man-induced impacts of buildings, structures, systems and components is needed in accordance with the RD requirements (Appendix 3.1).

3.3. Description of buildings and structures, justification of their locations

3.3.1. There shall be the NI NFC general layout, its description including locations of water supply lines, communication lines, access routes, water intake units, out-door switchgears, surface and underground storage facilities for diesel fuel and oil, warehouses for fire and explosion hazardous substances.

3.3.2. There shall be a brief description and justification of locations, dimensions and engineered judgments for main buildings and structures considering SIS housed by these buildings and structures.

3.3.3. Fire protection measures (as related to locations of buildings and structures in the NI NFC general layout) shall be described.

3.3.4. There shall be results of review and qualitative analysis of probable development scenarios of natural and man-induced impacts and those initiated by accidents at the NI NFC site triggered by:

- natural and man-induced events;
- impacts initiated by accidents at the NI NFC site.

For the analysis convenience it is recommended to put the scenario consideration results in the tabulated format. An exemplary table is given in Appendix 3.2

3.4. Parameters of impacts caused by possible NI NFC on-site accidents

3.4.1. Mechanical and thermal dynamic impacts including air shock waves, projectiles, dynamic impacts caused by pipeline breaks.

3.4.2. Chemical and corrosive impact including reactions of used corrosive agents with material of equipment, concrete, isolating coatings, paints; assessments of toxicity, flammability, explosiveness, chemical and corrosive activity of the reactions' products.

3.4.3. Impact of toxic gases and aerosols including assessment of possibility of toxic gas and aerosol releases to the premises as a result of accidents.

3.4.4. Radiation impacts including the determining of radiation intensity in case of possible damages to buildings and (or) structures containing radioactive materials, as resulted from on-site accidents and an assessment of parameters of radionuclide dispersion processes to the atmosphere, surface and ground water.

3.4.5. Fire load including conditions of fire load build-up during fires; combinations of loads where it may be present; and justifications of strength margin coefficients for consideration of fire loads.

3.5. Design combinations of loads to NI NFC buildings and structures

Herein, describe general approaches to identifying combined loads to buildings and structures including loads from natural and man-induced external impacts, internal impacts caused by on-site accidents and impacts induced inside main structures under normal operation, as well as the input data for further analysis of stability of systems and components to external impacts.

It shall be demonstrated that the combinations of loads to buildings and structures selected are assumed in accordance with the RD requirements. Combinations of loads to NI NFC buildings and structures shall be described.

All types of loads to buildings and structures shall be presented in the tabulated format.

3.6. NI NFC territory protection against hazardous geologic processes

A description and justification of measures to protect NI NFC territory against HGP shall be performed in accordance with RD requirements.

There shall be lists of design documents containing information on engineering measures to eliminate, mitigate the consequences and monitor HGP sequences, as described in Section 2. There shall be a general road-map for implementation of the design-envisaged measures to protect NI NFC territory including actions to prevent underflooding (control the run-off, surface and ground water drainage), to build mudflow protection barricades and banks, to strengthen hillslopes subject to slides and wash-away, etc. Evidences that protective measures are sufficient shall be presented along with external impact characteristics as changed by implemented protection features.

3.7. Protection against flood

The following information shall be given:

a description and justification of protective measures for safety important buildings, structures, systems and components;

a list of design documents containing the information on engineering measures to eliminate, mitigate consequences and monitor development of unfavorable HGP processes;

a general road-map for design measures to protect the site;

a justification that the protective measures are sufficient along with external impact characteristics as changed by implemented protection features.

3.8. Justification methods and criteria for NI NFC building and structure resistance

3.8.1. There shall be a description of main buildings, structures and foundations including main characteristics of each structure; layout approach to structures and foundation plates; mutual location of individual foundations; distribution of temperature, settlement, seismic joints; assembling convenience; structural used and their design characteristics for all structures; arrangements to ensure stability of foundations and basements; examinations and monitoring of foundations, buildings and structures; strength, leaktightness, fire resistance and stability of main buildings and structures to external and internal impacts.

3.8.2. There shall be a list of safety important buildings and structures along with their limiting states. The limiting states shall be considered a performance criterion. This information shall be given in the table. An exemplary table is give in Appendix 3.3.

3.8.3. The quality control programs shall be presented for the materials, execution of works, in-service inspection, behavior of safety important structures including tests to determine physical and mechanical properties of concrete, reinforcement steel, fixing parts, lining sheets, anchoring joints, as well as the information on whether in-service inspection programs are incorporated into specifications.

3.8.4. There shall be descriptions and justifications of strength, leaktightness, fire resistance and stability to external impacts for all safety important buildings and structures, their foundations and internal constructions, as well as the descriptions of measures to reinforce them.

3.8.5. There shall be information on how the loads from dynamic impacts of natural and man-induced origin transferred through buildings and structures affect systems and components; input data; analysis methods for dynamic behavior of a structure (method of the analysis, methods of simulation) considering interaction of soil and building; interaction of buildings; three mutually perpendicular components of seismic impact, twisting impact from the earthquake; and dynamic loads from non-seismic impacts (aircraft crash, shock wave, etc.).

3.8.7. There shall be a description of the diagnostic system for structural arrangements and structures including survey programs, benchmarks, monitoring systems for inclination, settlements, building and structure oscillations, foundations and soils conditions as well as for their stress and strain state.

3.8.8. There shall be a description of survey programs and inspection plans for conditions of essential buildings and structures and their foundations.

3.8.9. There shall be a list of software used to justify stability of buildings and structures including that with considering external impacts. Purposes of the computer codes shall be briefly described along with their calculation methodologies, main constraints and assumptions, information on the code qualification by Gosatomnadzor of Russia, verification results by analytical and experimental techniques (if a code were not certified).

3.8.10. All justification methods and stability criteria used for NI NFC buildings and structures shall be described to confirm their acceptability for design calculations of buildings and structures as per their classification (para 3.2 of Section 3 of this document) and types of impacts.

3.9. Methods to determine loads from natural and man-induced dynamic impacts transferred via building structures to systems and components

There shall be a description of methods used to determine loads to NI NFC systems and components for a more detailed analysis of their stability to external and internal dynamic impacts.

The following information shall be given:

a description of test methods for systems and components including tests and studies of performance, vibration tests, performance tests of equipment under external impacts, used computer codes;

information sources containing a complete analysis of strength and stability to natural and man-induced external and internal impacts;

conclusion statements on strength and stability including design loads, analysis and calculation methods, simulation, test methods, test benches and equipment, strength and stability criteria, anchoring techniques, strength of supports, explanatory diagrams, drawings;

results of NI NFC vulnerability analysis on the basis of the list of threats and intrusion patterns set in the design.

3.10. Methods to justify strength and performance of NI NFC systems and components considering loads caused by natural and man-induced impacts and transferred via structural arrangements of buildings and structures

There shall be information containing calculation bases to justify strength and performance of the NI NFC systems and components, to determine capabilities of mechanical, instrumentation and controls and electric systems to perform designated functions under combined external impacts, emergency internal impacts, normal operation impacts.

3.10.1. External impacts to be taken into account for calculation of mechanical, electrical equipment and instrumentation and controls

Herein, present information regarding external conditions the mechanical, electrical equipment and instrumentation and controls are calculated to withstand.

Describe methodologies, test benches, test equipment used to justify stability of NI NFC systems and components. The information shall be presented as follows:

1. Performance testing and checks

Herein, describe tests and checks which are or will be implemented for each component to verify its performance under a combination of such impacts as temperature, pressure, humidity, chemical composition and radiation. Indicate specific impact values (temperature, pressure etc.).

2. Vibration testing techniques

There shall be a description of criteria and techniques for vibration tests and dynamic analysis used to justify structural and functional integrity of systems and components affected by vibration loads (if any).

3. Tests to verify system and component performance under external impacts

There shall be information on the impacts of non-seismic nature only.

3.10.1.2. Applicable software

There shall be a list of computer codes applied to justify resistance of NI NFC systems and components to external impacts. The following information shall be presented for each computer code:

- a brief description of the software purposes;
- a calculation method used by the software;
- main software constraints and assumptions;
- software certification data.

3.10.2. Mechanical systems and components

3.10.2.1. Strength analysis

Herein, describe methods of strength analysis of mechanical systems and components. There shall be complete input information to analyze strength during NI NFC operation and anticipated operational events (or there shall be a reference to the section which contains such information).

There shall be a list of computer codes used for static and dynamic analyses of structural and functional integrity and strength of all safety important systems and components.

Describe methods used to assess accident stresses. There shall be a description of experimental techniques to analyze stresses, should these methods replace calculations.

Should creep deformation possibly occur at this equipment under emergency conditions, a description of methods used to determine deformation and stress in this particular case and accepted criteria shall be described.

3.10.2.2. Dynamic tests and analysis of mechanical systems and components

There shall be criteria, test and dynamic analysis methodologies used to verify structural and functional integrity of the systems and components affected by vibration loads from seismic impacts.

3.10.2.2.1. Pre-operational, vibration and dynamic pipeline testing

Information on testing program availability shall be provided for.

3.10.2.2.2. Seismic stability testing and verification of safety important mechanical systems and components

Herein, provide for the information regarding seismic stability tests which contains, as per types of mechanical systems and components:

- a description of seismic stability criteria, test techniques, main parameters of test modes, methods to account for the impact of equipment location elevation to the parameters of selected test modes;
- a justification of test program sufficiency to determine the equipment seismic characteristics.

Describe analysis methods and methodologies, mechanical equipment supports' tests.

Conclusions statements related to the results of seismic stability of mechanical systems and components shall be presented.

3.10.3. Electrical equipment

Describe methods to justify performance of electrical equipment, provide for information demonstrating compliance with RD requirements and testing techniques.

3.10.3.1. Criteria to verify electrical equipment performance under dynamic loads

Herein, describe criteria for seismic stability verification, which include criteria for test technique selection, methods to assign oscillation input parameters.

Describe load types to assess equipment performance as well as their values considering electrical equipment locations at NI NFC.

3.10.3.2. Methods and methodologies to verify equipment stability and performance under loads

A description of methods and methodologies used to verify seismic stability of electric engineering equipment of Seismic Stability Category I including test calculations shall be presented.

3.10.3.3. Methods and methodologies to analyze support structures' stability

Herein, describe methods and methodologies for calculated analysis or tests to verify resistance of support structures of Seismic Stability Category I electrical equipment to dynamic loads.

3.10.4. Thermal mechanical equipment

Herein, describe criteria used for tests or analytical studies to justify performance of thermal mechanical equipment. A brief description of test programs, calculation methodologies and load combinations shall be presented.

Main conclusions regarding the results of strength analyses and assessments of thermal mechanical equipment performance shall be presented.

Describe methods and methodologies to verify thermal mechanical equipment supporting structure stability under selected load combinations including external impacts.

3.10.5. Instrumentation and controls

Herein, present a list of instrumentation and controls related to Seismic Stability Category I, conditions for their location and fixing to structures. Specify criteria to verify seismic stability and resistance to external impacts. Loads used to verify seismic stability and resistance to external impacts considering their locations, methods and methodologies used to test resistance of instrumentation and controls to external impacts shall be described.

Methods and methodologies to verify resistance of support structures housing instrumentation and controls to external impacts shall be outlined.

Conclusions shall demonstrate that these components perform their safety functions after external impacts assumed in the design.

3.10.6. Ventilation systems

Herein, justify strength and stability of ventilation equipment and air ducts as well as filtration system equipment to loads specified in para 3.5 of this document.

Describe safety important equipment, air ducts and filtration systems.

Identify references containing the complete analysis of strength and resistance to internal and external natural and man-induced impacts. Conclusions on strength and stability shall be presented herein with indication of:

- design loads and their combinations;
- calculation and analysis methods, modeling;
- test techniques, test benches and equipment;
- strength and stability criteria of ventilation equipment, air ducts and filtration systems;
- fixing techniques, support unit strength, clarifying diagrams and drawings.

CHAPTER 4. NI NFC NORMAL OPERATION SYSTEMS

Sufficiently detailed information on NI NFC systems and their functioning shall be presented.

4.1. Purpose and design bases

The purpose of NI NFC main systems, their brief description and characteristics of the main system components shall be provided.

The section shall contain a list of safety relevant RDs which requirements shall be met by NI NFC main systems.

The section shall contain main design principles.

4.2. Description of process flow diagram

There shall be a description of NI NFC process flow diagram.

While describing the process flow diagram, the process flow diagrams of NI NFC main systems should be presented along with their boundaries and all main components.

The diagrams shall indicate elevations of the equipment and pipelines incorporated in a system.

The diagram shall explain on – section-by-section – temperature, volumes, flow area cross-sections of piping, pressure and flow rates and other process parameters necessary for its understanding.

Pipeline laying of NI NFC main systems should be presented in isometric projection or references to the documents containing the above laying shall be given.

In the process flow diagram's description the scheme for NI NFC system parameter monitoring shall be given.

It is required to demonstrate that NI NFC systems are designed so that they are accessible for maintenance and repair and that the employees (personnel) exposure doses do not exceed the limits established by RD.

It is required to demonstrate that all NI NFC systems and components were designed taking into account the possibility to withstand conditions of the operational environs during entire service life (pressure, corrosion impacts from working media, temperature, humidity, radiation, etc.) arising from normal operation, violations of normal operation, pre-accident situations and design basis accidents.

The design solutions shall be supported by the previous operating experience available.

It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

4.3. Description of processes

All processes (operations) conducted at NI NFC shall be listed.

Each NI NFC process (operation) (except for uranium mining facilities) shall be described in detail following the sequence below.

In case of uranium mining facilities the description of processes (operations) shall be done in accordance with the mining technique laid in the design (shaft, open, well).

4.3.X[1*] . Name of the process.

4.3.X.1. Description of the process.

4.3.X.1.1. Complete descriptions and process flow diagrams.

There shall be a detailed description of the process and related operations.

4.3.X.1.2. Chemical and physical bases of the process (operation).

Herein, provide a detailed description of physical, chemical and radiation characteristics of NM, RadS and RW involved in the process (operation).

Describe physical and chemical bases of the process (operation).

[1*] X – subsection of a specific process (operation).

4.3.X.1.3. Process (operation) material and energy balances.

It is required to indicate material and energy balances of the process including a possible range of their values variation. Results of analysis shall be tabulated. In the process flow diagrams of Section 4.2 there shall be summarized information of the balances.

Indicate NM, RadS or other substance (material) quantities required for each process stage along with regular and maximum permissible quantities of NM, RadS or other substances (materials).

4.3.X.1.4. Operating parameters

A summarized description of main operating parameters, their alteration ranges as well as design limits related to the process shall be indicated.

4.3.X.1.5. NM and RadS management

The systems (components) used for NM and RadS management shall be described in detail.

4.3.X.1.6. RW management

The systems (components) used for RW management for the given process (operation) shall be described in detail.

4.3.X.1.7. Start-up, operation and shutdown of process (operation) systems (equipment)

There shall be a detailed description of actions related to start-up, operation and shutdown of systems (equipment) pertaining to a given process. The information shall include descriptions of normal operation limits and conditions, different shutdown modes (prolonged, short-term, emergency), and time required for start-up or shutdown in each mode.

4.3.X.2. Process (operation) safety

The information on the aspects below shall be provided:

4.3.X.2.1. Nuclear safety.

A description shall be given of main design features, procedures and methods used to prevent SCR during a process (operation). The information in this subsection shall be given for NI NCF and their structural units where operations (processing, storage and transportation, etc.) are performed with plutonium, uranium-233, uranium with the enrichment higher 1% (mass) with regard to uranium-235 if the total mass of plutonium isotopes and uranium-233 and uranium-235 nuclides does not exceed 300 grams at any point of time at the NI NCF (its structural unit). The corresponding masses of other nuclear hazardous fissile nuclides shall be regulated and justified.

4.3.X.2.2. Radiation safety

A summarized description of main design features, procedures and methods used to protect employees (personnel) and population during the process (operation) shall be given.

4.3.X.2.3. Fire and explosion safety

A summarized description of technical and organizational measures to prevent explosions and fires; to warn and suppress fires during the process (operation) shall be presented.

4.4. Description of NI NFC normal operation systems

There shall be a description of normal operation systems following the sequence presented in section “General requirements”.

4.5. NM, RadS and RW on-site transport and transport and handling equipment

There shall be a description of NM, RadS and RW transport arrangements on NI NFC site. It shall be demonstrated that the shortest and simplest transportation routes have been selected. There shall be a list of transport and handling equipment, its locations and explanatory diagrams and drawings. The following shall be described:

- lifting and transportation equipment in use; its maintenance, inspection, repair and decontamination procedures;
- means of protection against external radiation in use;
- radiation monitoring techniques and means;

- use of special vehicles to transport NM, RadS and RW.

Herein, provide for a justification of strength, stability and resistance of lifting and transportation equipment considering the complete list of external and internal impacts. In doing so, the proofs of acceptability of methods chosen for justification and that of confidence of results shall be presented. There shall be information on strength, stability and resistance criteria along with test programs.

It shall be demonstrated that during NM transportation the engineered features and organizational measures designed to prevent SCR are provided for.

There shall be information to justify that during transportation of NM, RadS and RW their ingress into the environment is prevented.

CHAPTER 5. RADIOACTIVE WASTE MANAGEMENT

The complete information about management of RW generated in the course of NI NFC operation shall be provided. The following shall be considered:

- RW generation sources;
- all possible propagation paths of SRW and LRW; its storage methods;
- all possible propagation paths of GRW.

The basic safety provisions for RW management at NI NFC shall be described. A degree of compliance of solutions applied with the RD requirements shall be demonstrated.

5.1. RW generation sources

Sources of RadS and NM (radionuclide) migration beyond the process boundaries shall be described. It is required to describe a calculation methodology for specific volumetric activity of radionuclides generated by the given processes and provide calculation results.

While designing technical measures for RW management it is required to analyze processes and operations (decontamination, maintenance, repair, etc.) generating solid, liquid or gaseous RW

Main data regarding quantity, qualitative and quantitative radionuclide composition of LRW, SRW and GRW generated during normal operation and design basis accidents shall be given.

It is required to provide estimates regarding generation of LRW, SRW and GRW during NI NFC decommissioning.

5.2. Gaseous radioactive waste management systems

The subsection shall describe main characteristics of GRW management systems in all operational modes.

5.2.1. Generation sources, design bases

Parameters, assumptions and input data used for calculations of GRW amounts being generated and its qualitative and quantitative radionuclide composition shall be presented. While determining GRW amounts, one should be guided by the data on radionuclide presence in waste presented in para 6.1 of this document. Processes and regular operations generating GRW shall be described.

All NI NFC systems which may be possible sources of RadS releases into premises and the environment in the form of GRW including ventilation systems of the premises, where employees (personnel) work permanently or on part-time basis, and process blow-off systems shall be represented in the form of block diagrams.

It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

5.2.2. Description of systems

The systems shall be described in accordance with the structure given in Section “General requirements”.

Basic safety principles and criteria of GRW treatment implemented in the design shall be outlined.

It shall be demonstrated that the systems have sufficient capacity, efficiency and redundancy to provide the required degree of cleanup of GRW and ensure that the permissible limits of RadS releases in all operational modes including design basis accidents are not exceeded.

There shall be descriptions of each GRW treatment system and diagrams of gas flows, gas routes within the system, capacity, efficiency of the system and related equipment, back-up equipment and its start-up procedures. Describe how GRW flows are separated, their

separation principles as regards their physical and chemical properties, value of specific volumetric activity, etc.

For each system, in the tabulated format or diagrams, there shall be maximum and regular input values for gas flow rates and specific volumetric activities of radionuclides in GRW for all operational modes and design basis accidents.

The process flow diagrams shall indicate system interfaces and system boundaries regarding the components pertaining to different classes. List the instrumentation and controls and system means of control.

There shall be a list of all systems' equipment where it is possible for explosive concentrations of gases to form; list design pressure values; justify the equipment provided for by the design. There shall be a description of process instrumentation and controls (including gas analyzers) provided for by the design to prevent explosions as well as describe the measures to maintain integrity in case of an explosion.

List the anticipated values of RadS releases at NI NFC for all operational modes including design basis accidents. In the tabulated format, present for each source the release values along with its radionuclide composition, specific volumetric activity value of each radionuclide and total activity.

5.3. Liquid radioactive waste management systems

The subsection shall describe main characteristics of LRW management systems in all operational modes.

5.3.1. Generation sources, design bases

Parameters, assumptions and input data used for calculations of the amounts of LRW being generated and its qualitative and quantitative radionuclide composition shall be presented. While determining LRW amounts, one should be guided by the data on radionuclide presence in waste presented in para 6.1 of this document. Processes and regular operations generating LRW shall be described.

It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

5.3.2. Description of systems

The systems shall be described in accordance with the structure given in Section "General requirements".

The purpose, basic safety principles and criteria of LRW management implemented in the process layout shall be outlined.

There shall be descriptions of each LRW treatment system including flow diagrams, capacity, efficiency of the system and related components. For each system, in the tabulated format or diagrams, there shall be maximum and regular input values for LRW flow rates and specific volumetric activities of radionuclides in LRW for all operational modes and design basis accidents. The input data for determining the said values shall be presented.

Describe design features of LRW treatment systems including LRW volume reduction features. It shall be demonstrated that the systems have sufficient capacity, efficiency and redundancy to provide for LRW reprocessing and required clean-up degree of RadS discharges in all operational modes and design basis accidents.

There shall be a description of the LRW flows separation, their separation principles regarding physical and chemical properties, specific volumetric activity, radionuclide composition, etc. It shall be demonstrated that the solutions adopted comply with the RD requirements.

LRW storage engineered solutions shall be described. There shall be a description of methods and equipment of LRW conditioning, types of containers in use, ultimate forms of conditioned LRW and its storage locations. It shall be demonstrated that the conditioned LRW properties comply with the RD requirements.

The process flow diagrams shall indicate the interfaces between the systems and the system boundaries regarding the components pertaining to different classes. The instrumentation and control and the system controls shall be described.

Indicate anticipated amounts of RadS discharges from NI NFC in all operational modes including design basis accidents. Indicate all RadS discharge sources. In the tabulated format, present the release values for each source along with its radionuclide composition, specific volumetric activity of each radionuclide and total activity.

5.4. Solid radioactive waste management system

The subsection shall describe main characteristics of SRW management systems in all operational modes.

5.4.1. Generation sources, design bases

Parameters, assumptions and input data used for calculations of the amounts of SRW being generated and its qualitative and quantitative radionuclide composition shall be presented. While determining SRW amounts, one should be guided by the data on radionuclide presence in waste presented in para 6.1 of this document. Processes and regular operations generating SRW shall be described.

It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

5.4.2. Description of systems

The systems shall be described in accordance with the structure given in Section “General requirements”.

The purpose, basic safety principles and criteria of SRW management implemented in the process layout shall be outlined.

There shall be descriptions of each SRW treatment system including flow diagrams, capacity, efficiency of the system and related components. For each system, in the tabulated format or diagrams, there shall be maximum and regular input values for SRW flow rates and specific volumetric activities of radionuclides in SRW for all operational modes and design basis accidents. The input data for determining the said values shall be presented.

Describe design features of SRW treatment systems including SRW volume reduction features. It shall be demonstrated that the systems have sufficient capacity, efficiency and redundancy to provide for SRW reprocessing.

Describe the chosen technical solutions for SRW collection, sorting out and storage. Demonstrate that the chosen solutions comply with the RD requirements.

There shall be a description of methods and equipment of SRW conditioning, types of containers in use, ultimate forms of conditioned RW and its storage locations. It shall be demonstrated that the conditioned RW properties comply with the RD requirements.

The process flow diagrams shall indicate the interfaces between the systems and the system boundaries regarding the components pertaining to different classes. The instrumentation and control and the system controls shall be described.

CHAPTER 6. RADIATION SAFETY

This chapter shall present radiation safety criteria and principles for employees (personnel) and population in normal operation and in case of accidents, as implemented in the NI NFC design.

It shall be demonstrated that in all normal operation modes and operational events including design basis accidents the NI NFC radiation impacts do not lead to an excess of the established dose limits of exposure of employees (personnel) and population as well as guidelines for releases and discharges of radioactive substances in the environment.

If necessary, references to information contained in other sections may be given.

There shall be descriptions of basic provisions of radiation safety ensurance at NI NFC and it shall be demonstrated that the solutions adopted comply with the requirements of federal standards and rules in the field of use of atomic energy.

6.1. Radiation safety principles and criteria

Principles, criteria, calculation techniques, engineered means and administrative measures used as a basis for protection of employees (personnel), population and the environment against unacceptable impact of radiation shall be presented.

It shall be demonstrated that compliance with safety requirements is justified by operational experience of similar NI NFC and will not result in exceeding of radiation impact levels regulated by RD.

Technical solutions and administrative decisions used in the design and targeted to reduce exposure of employees (personnel) down to the low level that is reasonably achievable, economic and social factors being taken into account (ALARA principle) shall be described.

It shall be demonstrated how experience gained in designing and operating of other NI NFC is used in the design to reduce exposure levels of employees (personnel) down to possibly low values.

Indicate NI NFC category as per the classification of radiation facilities with regard to their potential hazard established by “Basic Sanitary Rules of Radiation Safety” and justify such NI NFC categorization.

It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

6.2. Radiation sources

There shall be presented characteristics of ionizing radiation sources at the working places of rooms (bays) of NI NFC:

- for operations with unsealed radiation sources: radionuclide, state of aggregation, activity at the working place, annual consumption, type and nature of planned work, class of work;
- for operations with sealed radiation sources: radionuclide, its type, activity, permissible number of sources at a working place and their total activity, nature of the planned work;
- for operations with radiation sources having complex radiation characteristics: type of radiation source and its radiation characteristics (radionuclide composition, activity, radiation energy and intensity, etc.).

The limiting conditions for execution of work shall be given.

Herein, list the systems (components) where external exposure protection is needed for employees (personnel) during servicing. Describe briefly methodologies to calculate employees (personnel) shielding and population protection against external exposure. List computer codes used for design of employees (personnel) shielding and population protection against external exposure. Describe briefly purposes of the computer codes, calculation method used by the code, main constraints and assumptions, information on certification of codes by Gosatomnadzor of Russia. The calculation results of employees (personnel) shielding and

population protection against external exposure shall be presented in the tabulated format. It shall be demonstrated that the values of design dose rate equivalents for the standard duration of the employees (personnel) stay in NI NFC premises do not exceed values established by RD.

The sources of gaseous and aerosol RadS ingress into the atmosphere shall be described. The sources of gaseous and aerosol RadS ingress during maintenance, repair, operational events and accidents shall be described in addition to the sources of RadS ingress regularly used during normal operation. The calculation results of gaseous and aerosol RadS concentrations (volumetric activities) shall be presented in the tabulated format. A list of computer codes used shall be given. The calculation methodologies for gaseous and aerosol RadS ingress into the atmosphere shall be briefly described; main constraints and assumptions, information on certification of codes by Gosatomnadzor of Russia shall be given.

6.3. Design features relevant to radiation protection

6.3.1. Layout of buildings, structures, systems (components)

The layout of a complex of the NI NFC process buildings, structures and premises with indication of the process equipment containing NM, RadS and RW and being a source of ionizing radiation shall be presented in scale 1:1000. The concept of layout and assembling of buildings, structures and equipment they house shall be presented from the point of radiation protection. The premises zoning principle used in the design shall be described.

The following shall be indicated in the layout:

- NI NFC division into premises of periodic presence of employees (personnel), premises of permanent stay of employees (personnel) and administrative and housekeeping premises;
- locations of personnel air locks, stationary sanitary locks, special-purpose laundries and medical aid posts;
- routes of employees (personnel) and vehicles;
- locations of rooms (places) for storage of contaminated equipment, decontamination bays, RW collection and storage rooms (places), and ionizing radiation source storages;
- locations of sensors and control boards of the radiation monitoring system;
- locations of laboratories for analysis of radioactive media samples, laboratory of individual dosimetry monitoring;
- locations of external dose measuring laboratories, surveillance and monitoring stations;
- rooms (places) for collection of non-radioactive waste.

6.3.2. Design features of systems and components

Design features of NI NFC systems and components which allow reducing occupational doses according to ALARA principle shall be presented.

The description shall include design features that reduce time of maintenance or other operations at systems and components, as well as provide for easy access to working places, remote operations or reduce time of the employees' (personnel's) stay and other measures reducing occupational exposure of the employees (personnel).

A description of methods used in the design to minimize stagnant zones (cavities, pockets) where NM, RadS and RW can accumulate shall be presented.

It shall be demonstrated that the necessity of employees (personnel) presence in nuclear hazardous zones is avoided or limited at maximum by automation and mechanisms used in the processes; by relevant locations of equipment, working places, storage places; by protective measures and by other measures.

Illustrative examples shall be presented including equipment drawings and pipeline layouts for such components that require access of workers during NI NFC operations.

Location of process media sampling points, instrumentation and control devices, control panels and control rooms shall be shown.

6.3.3. Protection of employees (personnel) against external exposure

There shall be information on methods and means of protection of the employees (personnel) against external exposure. There shall be descriptions of special protective features and equipment including containers, shrouds, shields, loading equipment, etc. which are used in handling NM, RadS and RW.

6.3.4. Ventilation systems

There shall be descriptions of equipment for air clean up from gaseous and aerosol RadS used by the design, including the layout of premises where air is cleaned up and ventilation systems' equipment is located. Ventilation systems of each building shall be described. The descriptions shall contain: building volumes, anticipated flow rates in the building ventilation systems, specifications of filters. For each ventilation system the normal operational mode shall be described along with operational features of different operational modes including design basis accidents.

It shall be demonstrated that in case of work with unsealed radiation sources the ventilation systems provide for protection against radioactive contamination of air in the working premises and the atmospheric air. It shall be demonstrated that in case of operations with unsealed sources of radiation the working premises, exhaust hoods, boxes, canyons and other process equipment are designed so that the air flow is directed from less contaminated spaces to more contaminated ones.

The methods and means of determining air clean-up efficiency shall be described. The specifications of air filters in use and their filtering components' replacement criteria shall be given.

6.4. Evaluation of exposure doses of employees (personnel) and population

There shall be an estimation of the annual individual effective dose to the employees (personnel) and personnel collective dose during operation, maintenance and repair of NI NFC systems (components).

Provide for results of calculations of exposure doses to the employees (personnel) and population during normal operation and accidents. There shall be a brief description of calculation methodologies of exposure doses to the employees (personnel) and population, input data for the calculations, and assumptions made. List computer codes used to evaluate exposure doses to the employees (personnel) and population. Briefly describe purposes of codes, calculation methods used by the codes, main constraints and assumptions. The calculation results of exposure doses to the employees (personnel) and population shall be presented in the tabulated format. It shall be demonstrated that the exposure doses to the employees (personnel) and population do not exceed vales established by RDs.

6.5. Radiation monitoring

It shall be demonstrated that the methods and means of radiation monitoring used by the design cover all main types of ionizing radiation impacts to the employees (personnel) and population as established in the "Radiation Safety Standards".

It shall be demonstrated that the radiation monitoring system for NI NFC premises, its site and within the controlled area ensures receipt and processing of the information on monitored parameters describing radiation situation at NI NFC and environment. Describe the objects of radiation monitoring outlined in the NI NFC design; types of radiation monitoring; monitored parameters; permissible levels of monitored parameters; radiation monitoring points; frequency of radiation monitoring; engineered means and methodologies in support of the radiation monitoring; availability and purposes of rooms and staffing of the employees (personnel) engaged in radiation monitoring.

Describe types and scope of radiometric and dosimetry monitoring; list of radiometric and dosimetry instruments, auxiliary equipment provided for by the design; locations of stationary instrumentation and points of continuous and periodic monitoring.

Describe methods and means of individual monitoring of the employees (personnel) exposure depending on a nature of operations performed. Describe methods and means of radiation situation monitoring.

In case of NI NFC belonging with Categories I and II radiation facilities it shall be demonstrated that the following engineered means of radiation situation monitoring are used:

- continuous monitoring on the basis of stationary automated devices;
- operative monitoring on the basis of portable, mobile devices;
- laboratory analysis on the basis of laboratory installations, means of sampling and preparing samples for analysis.

It shall be demonstrated that the automated radiation situation monitoring systems used by the design provide for monitoring, recording, displaying, collecting, processing, storing, and retrieval of information.

Present information on availability of radiation monitoring devices featuring audible and visible warning devices in the premises where operations are performed with NFM (S) in the amounts which make SCR possible as well as in the premises where Class I operations are carried out and radiation situation may substantially change during operations.

There shall be an organizational chart of the OO structural units, including nuclear safety office at NI NFC, responsible for radiation monitoring.

There shall be a description of organizational and administrative measures to control the employees (personnel) presence in permanently and periodic attended premises. Describe personal protective equipment, its specifications, use and maintenance.

Describe an organizational structure of the system and conditions for keeping radiation monitoring instrumentation, its calibration and metrological qualification.

Describe procedures used by the design for recording and keeping the results of individual dose rate monitoring of the employees (personnel).

Indicate locations of medical aid rooms (first aid stations, sanitary posts, special laundry) and personnel airlocks (shower rooms, casual wear locker rooms, working clothes locker rooms, personal protective equipment storage rooms, skin and working clothes' radiometry control posts, etc.).

CHAPTER 7. NUCLEAR SAFETY

The information in this subsection shall be given for NI NCF and their structural units where operations (use, processing, storage and transportation, etc.) are performed with plutonium, uranium-233, uranium with the enrichment higher 1% (mass) with regard to uranium-235 if the total mass of plutonium isotopes and nuclides - uranium-233 and uranium-235 - does not exceed 300 grams at any point of time at the NI NCF (its structural unit). The corresponding masses of other nuclear hazardous fissile nuclides shall be regulated and justified. Presence of nuclear material and the meeting of the requirement for limiting its mass shall be verified by continuous accounting process and documented.

Requirements of this Section do not cover the uranium ore mining facilities and the facilities (units) which reprocess, store and transport plutonium, enriched uranium, uranium-233 if the total mass of uranium-233 and uranium-235 and plutonium isotopes does not exceed 300 grams at any point of time.

In this Section it shall be demonstrated that the NI NFC design provides for engineered features and organizational measures to create and maintain the conditions to prevent SCR and limit its consequences.

There shall be described main nuclear safety provisions for the NI NFC and it shall be demonstrated that the solutions made comply with the RD requirements. It is required to list deviations from RD requirements, their safety impact and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

7.1. Design bases

Describe the nuclear safety ensurance principles used by the NI NFC design. It shall be demonstrated what methods and means used by the design are intended to prevent SCR, uncontrolled and unauthorized reprocessing, accumulating, movements, transfers, and transports of NFM.

Describe nuclear safety ensurance engineered features used in the design.

It is required to list deviations from RD requirements, their safety impacts and compensatory measures taken, as well as a reference shall be made to the SAR NI NFC section where these deviations are described in detail.

7.2. Rooms, systems and components containing NFM (S, N)

There shall be a list of rooms, systems (components) and storage facilities where NFM may be present. Provide for a brief description of process operations related to processing and movement of NFM (S) along with indication of their state of aggregation, density, isotopic, nuclide and chemical compositions of fissile materials, availability and composition of moderators, reflectors, absorbers, etc. in the scope necessary for physical calculation of the systems.

List systems (components), including packagings, which can be loaded with NFM (S, N) or where it can get in, with indication of the equipment serial number, drawing serial number, type of equipment (“S”, “HMC” “U”); safe (permissible) parameters and standards of nuclear safety; errors the standardized values are measured with; ways of meeting nuclear safety standards and requirements; references to RD paragraphs and nuclear safety conclusion statements which are the bases for imposing limitations on nuclear safety parameters and standards.

7.3. Design features related to SCR prevention

There shall be information on the organizational and technical measures implemented at NI NFC to prevent SCR.

7.3.1. It shall be demonstrated that the design provides for the use of safe equipment (“S” type) and, where it is impossible or unreasonable, the unsafe equipment with a higher margin coefficient (“HMC” type) is used. It shall be demonstrated that the unsafe equipment (“U” type) is used only in cases where “S” and “HMC” equipment is impossible to use due to features of the technology in use or due to unavailability of appropriate equipment designs. Provide for justifications required by RD.

7.3.2. It shall be demonstrated that the design provides for the use of “U” and “HMC” unsafe equipment only in combination with the limitations of nuclear safety parameters, monitoring of these limitations as well as with interlocks, if necessary. Provide for the information on monitoring of NFM (S, N) parameters when it is transferred from the safe equipment into the unsafe equipment.

7.3.3. There shall be information on the automated and (or) analytical means of monitoring of nuclear safety parameters.

7.3.4. It shall be demonstrated that the design excludes a possibility of an ingress of hydrogen-containing substances into the equipment, storage facility where such substances are not allowed according to the nuclear safety requirements.

7.3.5. There shall be information on methods and means of excluding an ingress of unsafe amounts of NFM (S, N) into the auxiliary equipment and unsafe connecting components.

7.3.6. Indicate what of the below nuclear safety requirements and how are used in the NI NFC design:

Restrictions imposed on geometry and dimensions of the equipment.

Limitations of NFM (S, N) mass.

Limitations of NFM concentration.

Use of homogeneous and heterogeneous neutron absorbers.

Limitations on NFM isotopics or nuclide composition.

Limitation of mass portion of neutron moderators in NFM.

Restrictions imposed on neutron reflectors and on equipment location.

Combination of the above mentioned methods and limitations.

7.3.7. The methods and means of nuclear safety ensurance during storage of NFM (S) used by the design shall be described. There shall be information on designs of NFM (S) storage facilities and packagings. Indicate constraints used by the design on the number of packagings emplaced in the storage facility, their emplacement procedure and fire extinguishing equipment in use.

7.4. Methods and means of monitoring of nuclear safety parameters

It is required to provide for the information on methods and means to monitor limitations imposed on the NFM parameters, equipment, equipment locations and packages emplacement.

Describe the procedure used by the design to monitor parameters of the equipment and systems, which determine geometry, dimensions, mutual arrangement of the equipment, packagings, and structural components’ properties associated with neutron moderation and absorption.

Describe the methods and means of monitoring of nuclear safety parameters listed below:

masses of NFM (S, M) loaded into the equipment;

NFN concentrations and content in NFM;

masses of NFM (S, M) present in the equipment before loading;

masses of NFM (S, N) accumulated in the auxiliary equipment (filters, connecting components, traps, etc.);

content of neutron moderators, NFM moisture content;

burnup of spent nuclear fuel;

concentrations of homogeneous neutron absorbers, level, volume of NFM, homogeneity of NFM distribution over the internal volume of the process equipment.

It shall be demonstrated that the measurement methods and means of the values imposed with nuclear safety limitations meet the RD requirements.

7.5. SCR emergency alarm systems

It shall be shown that the nuclear hazardous sections are equipped with SCR emergency alarm systems (EAS). The equipment, its locations, type of instruments, alarm installation points and requirements for the ranges of EAS actuation parameters and for its testing shall be described. EAS reliability indicators shall be justified. Information on frequency of periodic calibrations of EAS instrumentation shall be presented.

It shall be demonstrated that EAS complies with regulatory requirements for EAS design and operation.

7.6. Organization of work to ensure nuclear safety

There shall be information on organizational measures to ensure nuclear safety. List the regulatory and technical documents that describe nuclear safety ensurance arrangements at NI NFC, determine procedures for permitting the employees (personnel) to execute work in nuclear hazardous sections, procedures for control over nuclear safety. Describe an organizational structure of nuclear safety department and its main responsibilities.

CHAPTER 8. SAFETY SYSTEMS

A justification of SSs selection used by the NI NFC design, their functions, classification of SSs systems and components, SSs flow diagrams and basic design features of SS components shall be presented in this Chapter. It shall be justified that safety functions assigned to SSs are performed. In cases where individual SSs are described in other sections, the name of the system and reference to the section giving its full description shall be provided for.

8.1. A list of Safety Systems

A list of all safety systems used by the NI NFC design shall be presented.

8.2. Description of safety systems

Each of the SSsafety systems used by the design shall be described.

8.2.1. Purpose

The information on the purpose of each safety system and its components with indication of the functions being performed and safety class according to the requirements of GSP NFCF shall be presented.

8.2.2. Design bases

Information on design bases, design requirements and criteria shall be presented.

8.2.3. Description of the design and (or) process flow diagram

The following information on systems and their components shall be presented:

- a description of the design and (or) process flow diagram;
- detailed drawings (diagrams) illustrating the design of a system or its process flow diagram. All components listed in description of the design and (or) process flow diagram shall be indicated in drawings (diagrams) as individual items;
- external conditions and environmental parameters affecting SS components under all modes of operation;
- main performance specifications of the system.

Protection of systems against external impacts (fires, projectiles, floods, etc.) shall be described.

Protection of systems against unauthorized intervention of the employees (personnel) shall be demonstrated.

If pipelines, fittings, heat exchangers, pumping units, tanks, safety valves and other equipment are parts of the system, the basic information on features of these components shall be given in their description.

8.2.4. Materials

Data confirming compliance of materials, fabrication methods and control techniques with regulatory requirements shall be presented.

8.2.5. Justification of the design

It shall be shown that all components of SS were designed taking account of the capability to withstand environmental conditions (pressure, temperature, vibration, shock loads, humidity and radiation fields resulted from operation, etc.) both under normal operation and in case of deviations from normal operation including design basis accidents.

Information on calculations done to justify SS design and information on compliance of the SS with safety requirements (with reference to a section) shall be presented.

Provide for the information on SS and how the operating experience of similar SSs was taken account of in the design of the system.

Information on R&D and experiments conducted to justify the design shall be presented in the following sequence:

- a list of experimental activities performed;
- a description of experiment techniques;
- results of experiments with conclusions.

8.2.6. Quality assurance

It shall be demonstrated how quality is assured for all components of SS during its manufacturing, assembling and construction.

8.2.7. Control

Signals used for SS initiation, required power sources and process medium supply shall be listed.

The following information shall be presented:

- a list of control points;
- a list of protections and interlocks (intra-system);
- operational algorithms, alarms;
- a description of control systems, parameter measurement error;
- a list of manual operations to control the systems;
- availability of the operator's aids regarding control over systems and components.

8.2.8. In-service inspections and tests

The following SS information shall be presented:

- frequency of tests and inspections to verify conditions of systems and components;
- periodic checks of systems and their components.

Data on inspection of metal of pipelines and equipment of systems shall be presented.

8.2.9. Commissioning

Information on SAO of the system including its tests shall be presented. Adequacy of pre-operational tests to ensure safe NI NFC operation shall be justified.

8.2.10. SS functioning

The following shall be described: the system's operation when performing the designated functions.

A list of signals to actuate the system shall be presented. The system performance criteria regarding the functions assigned to the system shall be given.

8.2.11. System operation of in case of failures

An analysis of failures of the system components including human errors shall be presented. Effects of failure consequences regarding the system operability and the possibility to perform designated functions shall be assessed. At the same time, failures of passive and active components, instrumentation and controls of the system itself and CSS and SSS connected with this system shall be considered. Special emphasis shall be placed on analysis of common cause failures.

8.2.12. Reliability

Information on the system's reliability analysis and reliability calculations shall be presented.

8.2.13. Assessment of the design

Compliance with design bases presented in para. 8.2.1 of this document shall be demonstrated.

It shall be stated that the design of SSs and their manufacture and assembling comply with requirements of safety RD.

CHAPTER 9. COMMISSIONING

Information on organization, scope, sequence and timeframes of start-up and alignment operations and tests carried out during NI NFC commissioning shall be presented for all safety important structures, systems and components of the NI NFC.

The information shall cover all stages of commissioning starting from acceptance of systems and components after assembling and ending up with NI NFC acceptance for operation.

9.1. General provisions

Main provisions of NI NFC commissioning programs and quality assurance of operations during NI NFC commissioning shall be defined and justified including work breakdown into stages and sub-stages, their interactions and coordination, routine and timeframes for implementation of each stage or sub-stage, success criteria of their implementation, required administrative and technical measures.

It is required to present the information that at the NI NFC commissioning stages the transition from the completed stage to the subsequent one is done considering the growth of potential hazard of possible accidents.

It is required to demonstrate that:

- the RD requirements are fully met during commissioning (first load of NFM (S));
- safety is ensured during SAO and tests at all stages of NI NFC commissioning;
- the required completeness of studies and verification of all modes and parameters of NI NFC systems related to NRF operational safety is provided for;
- design bases and characteristics of systems for normal operation are proved.

9. 2. Work conduct

Anticipated work organization and system of interaction between the OO employees (personnel) and representatives of scientific, design, engineering, assembling, constructing and setting-up organizations and suppliers both in preparation for commissioning and during NI NFC commissioning shall be described. Allocation of managerial and executive functions and responsibilities both among organizations involved and among executors of different levels aimed at achievement of objectives and solving tasks of commissioning shall be presented. Work routine and recruitment of the employees (personnel) of organizations involved shall comply with RD requirements.

The following matters shall be covered:

- an organizational structure of OO including the NI NFC employees (personnel), their rights and responsibilities, qualification requirements (information shall be presented if some changes in organizational structure of OO are anticipated for the period of NI NFC commissioning);
- administrative measures implemented by OO, designers, suppliers of equipment and other organizations involved in the work;
- description of functions of different organizations, their interaction and allocation of responsibilities;
- plans to involve additional employees (personnel) at each stage of commissioning, requirements for their professional skills;
- description of administrative measures aimed at safety ensurance including measures on radiation protection, nuclear safety, fire safety, appropriate medical care, compliance with health (sanitary-hygienic) requirements, etc.;
- description of PPS functioning.

9.3. Stages of work

Division of the whole period of NI NFC commissioning into stages and sub-stages according to specific nature of any stage and tasks to be solved at each stage (sub-stage) shall be justified. The information on main commissioning stages shall be presented. Selection of the optimal sequence of activities, implementation and (or) combination of tests, measures to ensure high-quality monitoring over their implementation shall be explained. Acceptance criteria shall be clearly specified.

Describe SAO and acceptance tests of the safety important systems and SS.

A brief description and scope of activities for each stage or sub-stage of SAO and tests shall be presented. Features and purpose of stages (sub-stages) shall be reflected.

9.4. Test programs

A brief description of tests programs for each stage (sub-stage) of commissioning shall be presented. The information on test programs for all systems important to safety shall be given.

The following information shall be presented for each stage (sub-stage):

- objectives of work and tests, success criteria of their implementation;
- work sequence;
- requirements for preparedness of premises, systems and equipment for tests;
- process constraints, conditions and measures for safe performance of work and tests;
- scope, order, interactions and duration of tests;
- key provisions of manuals for work conduct; at this, preparation for tests and methods of testing the equipment that does not have analogues shall be described in more detail with indication of acceptance criteria for this equipment;
- requirements for reporting documentation including those for its formatting, submission and storage, procedure for getting access to it;
- requirements for a number and professional skills of the employees (personnel) involved in the work and tests, allocation of responsibilities including administrative units.

Assessment techniques for the most important characteristics of componentsof safety important systems, SS and main characteristics of NI NFC shall be described.

The information on potentially hazardous operations and measures preventing accidents shall be presented.

A procedure for development and approval of NI NFC commissioning program, quality assurance program for NI NFC commissioning and working programs on the basis of the design documentation shall be indicated.

9.5. Work and tests schedule

A schedule for NI NFC commissioning activities shall be presented with indication of a starting date for operation, date of NI NFC acceptance for operation and dates of main stages.

Main work stages, their tentative duration shall be indicated on the schedule. A list of all activities and tests shall be presented for each stage individually. Planned schedules of adjustment and tests of individual structures, systems and components of NI NFC shall be presented.

9.6. Additional requirements to NI NFC commissioning

Additional requirements to be considered in preparation for activities and during their implementation on the NI NFC site shall be presented, including requirements for:

- conditions for development, concurrence and approval of working documentation (operating regulations, a set of procedures, etc.);
- participation of the operating and extra employees (personnel) in activities and tests and in development of documentation including reporting documents (including requirements for the format of reporting documents);
- administrative and technical measures and actions in case of deviations from the design or getting characteristics that were not anticipated in the design, including revision of the design and operating documentation;

- organization of production and engineering support and documents' archiving;
- organization of fire fighting and fire monitoring services;
- arrangements for sanitary areas, radiation monitoring units in the NI NFC premises and site, and within CA;
- development and introduction of emergency response plans for protection of the employees (personnel) and population in case of accident at NI NFC.

9.7. Report on SAO completion

Brief information on results of test's stages shall be provided.

Completion of the planned activities and observation of requirements as well as compliance of characteristics of structures, systems and components with the design and RDs currently in force shall be justified based on the reports concerning the results of the work and tests done.

In case of non-compliances with the design and current RDs the design documentation shall be revised. In the corresponding sections of SAR NI NFC it shall be justified whether the non-compliances with regard to conditions ensuring required level of safety and reliability are permitted.

Deviations from the ordinance and organization occurred during alignment work and tests shall be described. An analysis of their causes and lessons learnt shall be presented.

Completion of the integrated work schedule of the NI NFC commissioning program shall be analyzed. Actual results shall be compared with plans with regard to completeness (scope of the implemented work) and dates. The validity of the accepted deviations shall be evaluated.

The information on additional requirements for commissioning and degree of ,including information on updating of the operating documentation based on the work results.

CHAPTER 10. MANAGEMENT OF NI NFC AND ASPECTS IMPORTANT FOR SAFETY DURING OPERATION

10. 1. Organization of management

10.1.1. Operating organization

An organizational chart of OO and OO divisions, which activity is targeted to support operation, and information on principles and a diagram of interaction between NI NFC administration and OO shall be presented.

It shall be demonstrated that the structure of divisions, distribution of responsibilities and authorities within the divisions, official duties of the employees (personnel), their competence and responsibility ensure that OO performs the functions stipulated by RD.

The OO organizational chart shall list all OO structural units.

As regards each division according to the said list, its structure with positions starting from a division head through the minor employee (personnel) positions; number of employees working in each position taking into account substitutes; and also a list of job descriptions shall be presented.

Data which provide more comprehensive information on educational level of the employees (personnel) including academic background, training, specialization and work experience acquired while working in other positions and (or) for other organizations shall be presented for each job position.

10.1.2. NI NFC administration and operations management

An organizational chart of NI NFC operations management shall be presented.

The presented information shall contain: a list of divisions including their names and managerial administrative positions; structures of divisions; duties of the employees (personnel), their competence and responsibilities.

As regards each division, its structure with positions starting from a division head through the employees (personnel) positions (shift supervisors, shift operators, repair personnel, etc.), number of shifts and also number of employees working in each position taking into account substitutes (back-up personnel) shall be presented.

A list of job descriptions setting up rights and responsibilities of the NI NFC employees (personnel) shall be presented. In particular, a procedure for continuity of authority (including transfer of the right to issue permanent or temporary directives and orders) and responsibility for NI NFC operation shall be presented for at least three officials (in case of circumstances of temporary nature).

10.2. Employees (personnel)

10.2.1 Employees (personnel) qualifications

It is required to present an analysis of how the RD provisions on the employees (personnel) recruitment to positions indicated in the structural diagrams in accordance with required competence (education, experience, training) and psychological and physiological requirements are met.

10.2.2. Organization of employees (personnel) training

Herein, present information which demonstrates the way RD requirements are met during NI NFC operation and personnel recruitment for the positions.

10.2.3. Coordination (correlation of stages) of personnel training with SAO stages. Staffing plan

A stage-by-stage training schedule of the employees (personnel) during NI NFC commissioning shall be presented.

10.2.4. Maintaining employees (personnel) qualification level

A system to control the employees (personnel) qualification level and activities to maintain required qualification including periodic training and exercises to master actions to be undertaken in case of normal operation and accidents shall be described.

10.3. Manuals

10.3.1. Job descriptions

Information on job descriptions for administrative and managerial personnel and operating employees (personnel) shall be presented along with their list.

10.3.2. Operating procedures

10.3.2.1. Process regulations

A list of process regulations and main provisions of process regulations shall be presented.

10.3.2.2. Operating procedures for systems

Herein, present a list of operating procedures for NI NFC systems; indicate manuals the operating employees (personnel) shall know in full scope.

10.3.2.3. Repair and maintenance manuals

Lists of plant, shop and standard manuals the personnel shall be guided by during maintenance and repair of the systems, inspection of protection features, automatic devices and other systems specified in the appropriate SAR NI NFC sections shall be presented.

10.3.2.4. Occupational safety manuals

A list of occupational safety manuals which shall be available at each working place along with operating procedures shall be listed.

10.3.2.5. Manuals on management of operations documentation

The information related to a manual on maintaining and managing the operations documentation shall contain a procedure for maintaining the operations documentation by the employees (personnel). Actions to be undertaken by the NI NFC administrative and technical employees (personnel) to control maintenance of the operations documentation shall be described.

10.3.2.6. Nuclear material control and accounting manuals

Herein, list manuals for control and accounting of nuclear materials.

10.3.3. Emergency procedures

10.3.3.1. Herein, present a list of emergency procedures:

- procedures for elimination of violations of normal operation conditions and emergencies;
- procedures for mitigation of design basis accidents;
- manuals (guides) for management of beyond design basis accidents.

10.3.3.2. Requirements specified in the procedures shall contain:

- employees (personnel) actions to identify emergencies and accidents;
- required number of the operating employees (personnel) to implement corrective measures;
- success (failure) criteria regarding equipment manipulations;
- action level criteria as per the Accident Management Guide.

10.3.4. Accident Management Guide

Brief information on accident management shall be presented.

10.4. Maintenance and repair

10.4.1. Annual plans of equipment maintenance and repair

Plans of equipment maintenance and scheduled preventive repair specifying main types and scopes of activity (general maintenance, heavy overhaul, repair and replacement of components, tests, modifications of systems and others) shall be presented.

A schedule of preventive maintenance shall be presented.

10.4.2. Maintenance conditions

A list of means to ensure maintenance shall be presented.

10.5. Organization of control and reporting of information on NI NFC safety

Information on accepted operational (current) NI NFC state control system, on data collection and analysis procedure and also safety data reporting shall be presented.

10.5.1. Control by OO representatives

Information on activities planned (implemented) by OO to check whether NI NFC complies with RD requirements shall be presented. Describe programs of planned (implemented) checks. There shall be information on the OO divisions and officials who carry out checks.

10.5.2. Preparation and submission of periodic information on current safety level

Information shall comply with the requirements set forth in applicable provisions regarding annual reports on assessment of current NFCF safety level and the procedure for investigating and accounting of NFCF operational events.

10.6. Physical protection

Herein, describe main organizational and technical measures to prevent unauthorized actions of the employees (personnel) or other persons in relation to NM, RadS and RW or NI NFC systems important for safety which can result directly or indirectly in accidents and jeopardize health of the NI NFC employees (personnel) and population as a result of a radiation impact. The information presented in this Section 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.

The following shall be presented:

- a list and description of facilities (indicating categories of nuclear materials in use) provided with the physical protection; a geographic map showing configuration of perimeters of the protected, inner and essential areas;
- a description of engineered and technical means of physical protection; information on meeting the requirements of paras 28, 29, 31 of Physical Protection Rules for Nuclear Materials, Nuclear Installations and Storage Facilities for Nuclear Materials (hereinafter “the Rules”);
- in case of nuclear materials and nuclear installations transportation, present the information on meeting the requirements of Section 4 of the Rules;
- a description of the organizational chart and composition of the facility security service and guard arrangements;
- a list of institutional and on-site documents used by OO in accordance with para 27e of the Rules;
- the information on the facility vulnerability analysis to identify internal and external threats and likely means of their realization; to reveal vulnerable areas of the nuclear installation, nuclear material storage facility, processes which use and store nuclear materials;
- the information on estimates of possible damage due to internal and external threats;
- the information on assessment of PPS efficiency;
- the information on certification of the equipment used by PPS.

10.6.1. Composition of physical protection and requirements for physical protection

The Section shall describe:

10.6.1.1. Engineered and technical means with description of:

- security alarm systems;
- access control systems;
- visual electronic surveillance systems;
- special communications systems;
- physical barriers;
- auxiliary systems and means to ensure physical protection functioning.

10.6.1.2. Organizational measures:

- organization of the NI NFC security, including training of the security employees (personnel);
- training of the NI NFC employees (personnel) to be able to respond to extreme situations;
- provisions for granting access to permanent and shift NI NFC employees (personnel) to the protected area and essential areas;
- organization of the system for NM accounting, storage, use, protection, transportation and control;
- organization of personal and special checks of the employees (personnel), persons on-business vehicles, etc.

10.6.2. PPS schematic and hierarchy

Basic schematics of engineered control and alarm means with regard to PPS shall be presented.

Principal PPS hierarchy from the point of security arrangements without disclosure of locations of control boards, surveillance and alarm stations shall be presented.

Due to the fact that PPS documentation is classified, access to it shall be restricted.

10.7. NM, RadS and RW control and accounting

The section shall contain the following information:

- organization of activities to control and account of NM, RadS and RW;
- an organizational chart and employees (personnel) positions involved in control and accounting of NM, RadS and RW;
- a number of material balance areas (MBA), their boundaries and structure;
- methodologies and measurement means used for control and accounting of NM, RadS and RW;
- NM access controls (SNC);
- a list and formats of accounting documents and records;
- a procedure for inspection of NM control and accounting in the material balance areas;
- a procedure for investigation of anomalies in control and accounting of NM, RadS and RW;
- procedure for training of and granting access to the employees (personnel) to carry out NM, RadS and RW control and accounting operations;
- time frames for development of PIL for MBA and the operating organization as a whole;
- physical inventory taking procedures.

10.8. Emergency planning

Herein, present the information about planned measures to protect the employees (personnel) and population in case of an accident, as per RD requirements.

The information shall provide for a clear picture of the planned and implemented measures to protect the employees (personnel) in case of an accident at NI NFC and include

lists of accidents which may occur to NI NFC; engineered means and organizational measures in case of an accident including the division of responsibilities and coordination of activities with off-site organizations; actions of officials notifying about accidents and starting of implementation of plans of protection of the employees (personnel) and population in the event of an accident at NI NFC and the like.

There shall be descriptions of possible consequences of accidents and corresponding measures to eliminate them as well as of methods and means of decontamination of equipment, buildings and structures, and territory; methods and means of aid to the employees (personnel) and population affected by radiation including the information on sanitary actions and medical aid; a list of medical preparations, bandaging materials and other auxiliary means with indication of their locations.

There shall be information on emergency drill and emergency exercise programs indicating the employees (personnel) categories who participate in mastering the corresponding actions in case of accident consequences elimination along with the training equipment in use.

CHAPTER 11. NI NFC SAFETY ANALYSIS

11.1. Analysis of operational events

The NI NFC safety analysis shall include an analysis of the NI NFC systems and buildings responses to possible initiating events.

The safety analysis shall be the basis for organization of control over NI NFC systems in various situations.

11.1.1. A list of initiating events of operational events

It is required to list initiating events for NI NFC.

The list of initiating events depends on the NI NFC process flow diagram, its operational modes and servicing schedule.

11.1.2. Analysis of accidents

For each IE the analysis results shall be presented in the following sequence:

11.1.2.1. The initial state of NI NFC and its systems before the initiating event

For each IE there shall be a detailed description of the state of NI NFC systems and components at the point of time when the normal operation conditions are violated. In doing so, the degree of detail shall depend on the nature of the event. The description shall be sufficient for the subsequent safety analysis.

11.1.2.2. Functioning of systems

There shall be a description of functioning of systems which must ensure NI NFC operation without violation of safe operation limits. There shall be descriptions of events along with the necessary parameter change magnitudes.

11.1.2.3. Considering system failures

For each IE there shall be results of analysis of possible safety important system failures. While describing SS functioning to the design algorithm, it is required to consider possible failures.

11.1.2.4. Analysis methodology

There shall be brief information on methods of analysis and used models.

Mathematical models and computer codes applied for calculation study of processes in case of operational events shall be described. If some experimental data is used for analysis, it is required to briefly describe the conditions for obtaining these data; a possibility to use these data for the case under consideration shall be justified; references to publications containing these data shall be presented. A level of detail of the description of mathematical models and computer codes shall depend on their certification status. As regards certified codes, it is sufficient to give a brief description explaining on the substance of the codes used and assumptions made along with a reference to existing certification documents. As regards uncertified codes, the description shall be detailed, information on mathematical models, assumptions, calculation techniques, codes verification, comparison of calculations with experimental results, if any, shall be presented.

There shall be code certification results if such were used for processes' analyses.

11.1.2.5. Input data for analysis

Herein, describe input data needed for analysis of non-stationary processes at NI NFC (design characteristics of systems, parameters describing their operational mode, physical, chemical, thermal and mechanical properties of substances and materials, etc.). A full set of input data shall be determined taking into account functioning of the NI NFC components susceptible to major changes which characterize consequences of operational events. If input data for analysis is contained in other Sections of SAR NI NFC, then reference to a number of Section, Table, Figure containing the mentioned input data shall be made in a relevant Section. In the other cases, where the calculations use the data beyond the scope of the description

presented in Sections of SAR NI NFC, this data shall be specified in this Section with a reference to the data source.

11.1.2.6. Analysis results

The analysis of NI NFC operational events shall confirm that the design safety criteria and requirements are met. The analysis of pre-emergency situations shall demonstrate efficiency of the safety important systems foreseen by the design, impossibility of evolution of a pre-emergency situation into an accident.

11.1.2.7. Assessment criteria

The main criterion is that the safe operation limits are not exceeded.

11.1.3. Conclusions

Herein, present analysis results; make a conclusion whether the design complies with RD requirements for NI NFC safety; whether all criteria presented in these documents are complied with.

11.2. Analysis of design basis accidents

11.2.1. List of initiating events for design basis accidents

It is required to present an approximate list of initiating events for NI NFC.

The list of initiating events depends on the NI NFC process flow diagram, its operational modes and servicing schedule.

11.2.2. Safety analysis

A description of systems and components functioning in case of accident is required to be presented. Analysis results for each design basis accident shall be presented in the following sequence.

11.2.2.1. Initial state

A description of initial state of the NI NFC systems and components before the design basis accident, a scope of this description and accident sequences shall be supplemented by an assessment of radiation consequences of design basis accidents.

11.2.2.2. Functioning of safety systems under design algorithm after accident initiation

Herein, describe a design sequence of SS, which ensure that NI NFC safe operational limits are not exceeded.

11.2.2.3. Accounting of possible failures of safety systems and human errors in analysis of design basis accident

Herein, present a list of postulated SS failures which shall be taken into account in the analysis of design basis accidents. Basic principles to postulate these failures are accepted to be the same as for the analysis of violations of normal operation conditions.

11.2.2.4. Analysis technique of emergency processes

Mathematical models and computer codes used for calculations and analysis of design basis accidents shall be described. As regards certified computer codes, a brief description with reference to appropriate documents shall be presented. Uncertified codes shall be described in more detail. Special attention is required to be paid to verification of these codes. Herein, present a brief description of calculated and experimental data, which confirms adequate level of accuracy of codes used, and make references to publications containing these data.

11.2.2.5. Input data for analysis

A full set of input data needed for calculation of a design basis accident and analysis of its consequences shall be described. It is allowed to refer to other Sections of SAR NI NFC, which contain design features of a subject of the study, descriptions of operational modes, nominal or other parameters. Special attention is required to be paid to nonstandard parameters: chemical, physical, thermal and other properties of substances and materials. In all cases, it is required to make references to sources of these data.

11.2.2.6. Results of design basis accident analysis

Herein, present calculation results and subsequent analysis of emergency processes in case of the SS design functioning, systems failures and human errors postulated in accordance with safety RD requirements. Analysis results of emergency processes serve as a justification of SS characteristics foreseen by the design.

It shall be demonstrated that violations of safe operation limits with regard to occupational and population overexposure will not occur. Calculation results of emergency processes in the NI NFC systems shall be presented, as well as calculation results of RadS releases.

11.2.2.7. Radiation consequences of design basis accidents, calculations of occupational and population effective exposure doses

Herein, present calculation results of RadS propagation within and beyond the NI NFC premises. Occupational and population effective exposure doses after accidents shall be determined. Recommendations on actions to be implemented by the employees (personnel) in emergency conditions shall be presented and these actions shall be specified in appropriate manuals.

11.2.2.8. Criteria of NI NFC safety assessment in case of design basis accident

Herein, specify assessment criteria for consequences of a specific accident being considered from the point of Rs. As regards design basis accidents, it is required to comply with limits of NI NFC the employees (personnel) and population exposure after an accident which are established by the Radiation Safety Standards (RSS).

11.2.3. Conclusions

Analysis results of design basis accidents shall be specified. Accident consequences shall be described in a concise format, a conclusion in respect of NI NFC safety ensurance in case of these accidents shall be made on the basis of criteria specified in para 11.2.2.8.

11.3. Analysis of beyond design basis accidents

11.3.1. A list of beyond design basis accidents and its justification

11.3.1.1. Beyond design basis accidents

A list of beyond design basis accidents shall include accidents which may result in SCR and maximum RadS release into the environment.

The list of beyond design basis accidents shall be justified.

Compliance with design criteria shall be confirmed in the course of accident analysis.

11.3.1.2. Scenarios of beyond design basis accidents

Basing on analysis results all scenarios of beyond design basis accidents, which result in SCR, an excess of occupational and population exposure doses and non-compliance with standards on RadS releases and content in the environment established for design basis accidents, shall be identified. The most vulnerable NI NFC locations shall be determined (combinations of arrangements and features of NI NFC systems and components, process flow diagrams, equipment layout, operational procedures and organization of the employees (personnel) activities which are the most likely causes of SCR, NM (RadS) releases to exceed the damage thresholds permitted for design basis accidents.

11.3.1.3. Typical groups of scenarios of beyond design basis accidents

Groups shall be formed from scenarios identified in the previous Section in such a way that response of the plant systems needed to prevent accident progression is the same.

11.3.1.4. Representative scenario of beyond design basis accidents

One or several representative scenarios which comply, as a whole, with the following four criteria shall be identified within each group:

I. Maximum occupational exposure dose rate;
II. Maximum rate (intensity) of radionuclide release (discharge);
III. Maximum integral radionuclide release (discharge);
IV. Maximum damage to the NI NFC systems and equipment.

11.3.1.5. A list of beyond design basis accidents

Scenarios identified in section 11.3.1.4 shall be presented as a list of beyond design basis accidents for subsequent analysis.

11.3.2. Sequence of beyond design basis accident analysis

Analysis of each beyond design basis accident shall be carried out in the following sequence.

11.3.2.1. Initial NI NFC state before an accident

Requirements for description of initial NI NFC state before an accident shall be similar to those set forth for description of design basis accidents.

11.3.2.2. Analysis technique

Herein, describe mathematical models and computer codes used for analysis of a relevant beyond design basis accident, assumptions and errors used in calculations, experimental data, if any. Also, it is required to describe software certification status; to justify a possibility to use software for analysis of a relevant accident.

11.3.2.3. Input data for analysis

It is required to specify properties of the NI NFC systems and components, which allow to simulate processes in the object in question. Additionally, it is required to present description of the NI NFC site and local environment, hydro and meteorological data, data on location of settlements in the NI NFC vicinity which is needed for following calculations of propagation of radioactive substances over the nearby territory and for calculations of equivalent effective occupational and population exposure doses.

11.3.2.4. Calculation results of emergency processes, assessment of RadS releases (discharges) during an accident

Herein, present calculation results of emergency processes at NI NFC in accordance with the scenario of a beyond design basis accident. Calculation of the beyond design basis accident shall be finished by determination of dose rate to the employees (personnel) or assessment of RadS release (discharge). Basing on calculations of occupational and population effective and equivalent exposure doses, it is required to make a conclusion on whether the Radiation Safety Standards (NRB-99) requirements are complied with and whether the intervention is necessary.

11.3.2.5. Beyond design basis accidents management measures

Operative safety goals shall be formulated for each level of beyond design basis accident severity, i.e. the goals the NI NFC operational employees (personnel) shall be aimed at achieving under the given conditions in order to prevent or to eliminate further development of equipment and (or) SIS damages or to limit RadS releases into the environment.

On the basis of the performed calculation analysis of beyond design basis accidents, attributes of systems and components' state shall be formulated and criteria, which allow to identify a fact of beyond design basis accident initiation, shall be set forth.

Herein, determine the NI NFC systems and components (including systems which are not related to safety) which can be used – possibly not in the designed capacity and not under design operational modes – to achieve operative safety goals and to limit accident consequences. Issues connected with redundancy of systems which perform the same function shall be considered. Possibility to use materials and equipment located beyond the NI NFC site shall be described, their means of delivery shall be planned for.

Success criteria with regard to actions undertaken by the employees (personnel) to achieve operative safety goals for each level of accident severity shall be formulated. These criteria shall be expressed through attributes of the state.

Herein, determine a scope of information required to trace attributes of the NI NFC systems and components' state, to control required technical systems, to assess success in management of beyond design basis accidents and also to determine technical means and methods which enable to receive this information under forecasted conditions. If it is necessary to carry out indirect assessment of required parameters, methods of such assessment shall be presented.

Herein, describe strategy of corrective actions undertaken by the employees (personnel) under conditions of the beyond design basis accident and targeted to achieve safety goals at all possible levels of accident severity.

11.3.3. Information on assessment of probability of hazardous RadS releases (discharges) basing on the results of beyond design basis accident analysis

Herein, assess probability of hazardous RadS releases (discharges). Consider and describe the full scope of information and data obtained; make preliminary conclusions on possible propagation paths of radionuclides.

11.3.4. Conclusions

Analysis results of beyond design basis accidents and conclusions on compliance with RD requirements shall be presented.

CHAPTER 12. SAFE OPERATION LIMITS AND CONDITIONS. OPERATIONAL LIMITS AND CONDITIONS

12.1. Safe operation limits

The following shall be presented: safe operation limits, controlled parameters, a method and exact point of their measurement, justification of accepted maximum permissible value and measurement error from the point of safe operation conditions, range of changes and measurement range, accuracy of calculated and (or) experimental justification of a parameter, permissible interruption in information supply, redundancy of measurement channels.

All SS actuation settings shall be presented. Accepted values of settings shall be justified, modes (processes) defining whether these values are reached, and also error of their measurement shall be specified. Warning and emergency alarm actuation settings shall be presented and justified.

It shall be demonstrated that SS actuation ensures that the safe operation limits are not exceeded taking into account time lag of signal passage. Available margins shall be indicated.

A list of conditions under which an operator is obliged to stop an experiment shall be presented.

For the cases when SS actuation is allowed to be done by an operator, the following information shall be presented:

- the operator is provided with appropriate information prepared in accordance with a requirements set forth for CSS;
- the operator has sufficient time to initiate SS; an analysis of consequences of operator's errors is described.

12.2. Safe operation conditions

12.2.1. Permitted modes of normal operation

Permitted modes of normal operation shall be specified. Operational limits of main parameters shall be indicated for permitted modes of normal operation. The mentioned limits shall be expressed through values of parameters which are controlled by an operator, otherwise it is required to demonstrate linkage of a limiting parameter with directly controlled parameters using appropriate tables, diagrams or methods of their calculation.

Justification of limits imposed on permitted modes of normal operation with references to appropriate Sections of SAR NI NFC shall be presented.

12.2.2. Normal operation conditions and a composition of operable systems and equipment needed for NRF operation under permitted modes

Information on composition and state of systems, which operability or availability is required for NI NFC operation under permitted modes, shall be presented.

Herein, present conditions of permissible duration of NI NFC operation in case of SS (channels) failure (repair) specifying operator's actions if a failure (or repair) is not eliminated within the established period of time.

The above mentioned conditions shall be set up for such particular process systems of normal operation which complete failure makes it impossible to bring NI NFC to a safer state in compliance with design procedures of normal operation (i.e. without SS use).

The NI NFC safe operation conditions in case of complete failure of a control system (a part of NOCS) shall be determined.

Conditions of periodic tests shall be set up.

Normal operation conditions which are conditioned by SS state and frequency of tests shall be justified.

12.2.3. Conditions for SIS maintenance, tests and repair

Conditions for tests, inspections (examinations), maintenance and repair of safety important systems shall be specified.

12.3. Operational limits and conditions

The following shall be indicated:

▪ limiting values of process parameters corresponding to marginal values of normal operation range for each system;

▪ limiting values of parameters for all components within a system;

▪ justification of selected values of parameters under permitted modes, error of parameter measurements, measurement points, redundancy of measurement channels, permissible time of interruption in information supply.

Provide for the process parameter values at which the main process protection features, interlocks and automatic controllers actuate.

12.4. Documenting the data on control of safe operation limits and conditions

Herein, present procedures of documenting and storing of information related to safe operation limits and conditions in accordance with RD requirements.

CHAPTER 13. QUALITY ASSURANCE

13.1. This Section contains requirements for information on quality assurance of all activities and services affecting NI NFC safety.

13.2. The information shall ensure the confidence that the NI NFC siting, design, construction, commissioning, operation and decommissioning are carried out (will be carried out) in due way and comply with the established requirements for quality assurance.

For assessment of acceptability of activities to assure quality at a corresponding licensing stage, there shall be information on whether the measures as regards the activities listed in the “Requirements to the Quality Assurance Programs for Nuclear Fuel Cycle Facilities” are sufficient.

13.3. The Section shall be divided into subsections under titles corresponding to the areas of quality assurance as described in the quality assurance programs.

The information presented in the Section is required to be prepared taking into account the analysis results of quality assurance programs developed and progress of their implementation as of the point of time when SAR NI NFC is developed.

13.4. As regards each quality assurance activity area, the RD used in development and implementation of quality assurance measures for this specific area shall be indicated.

13.5. The following information on the quality assurance areas of activity shall be presented:

- quality assurance organizational activity;
- staffing and employee (personnel) training;
- design management;
- documentation management of;
- control over purchases of equipment, component parts and materials and also services rendered;
- control over process related activities;
- inspections and tests;
- metrological support;
- ensurance of reliability;
- control over non-compliance with the established requirements and corrective measures;
- quality assurance documentation;
- audits.

While presenting the quality assurance activities information, the following measures shall be described:

- identification of materials, products, operations and services which do not comply with the established requirements;
- impact analysis of the revealed non-compliances to NFCF safety;
- recording of the non-compliances revealed;
- notification of the management at the appropriate level on non-compliances revealed;
- determining causes of the revealed non-compliances and implementation of corrective measures to prevent their recurrence;
- prevention of the use (including inadvertent) of materials and products as well as execution of work and services which do not comply with the established requirements.

The measures shall be described which reflecting the assessment of the organization’s management conduct and how its employees (personnel) carry out their duties. The assessment is to be done by a special commission (unit) or an off-site organization.

CHAPTER 14. DECOMMISSIONING

The Section shall contain the information necessary for the adequate understanding of the main safety provisions for NI NFC decommissioning.

The NI NFC decommissioning concept shall be considered through studying of various decommissioning options and supplemented with a description of possible NI NFC ultimate states for each option.

The concept shall demonstrate how the listed below will be ensured during the NI NFC decommissioning:

- reduction of exposure doses to the employees (personnel) and population in accordance with the ALARA principle;
- producing minimal quantity (amounts) of RW;
- reduction of RadS releases into the environment down to the minimum level possible.

The detailed information on technical and organizational measures related to safety ensurance during NI NFC decommissioning shall be presented in the Safety Analysis Report on NI NFC Decommissioning on the basis of the NI NFC design documentation on decommissioning, results of the integrated examination of the NI NFC being decommissioned, and considering the actual state of NI NFC at the moment of the report development.

Appendix 1

Requirements to SAR NI NFC format

1. The SAR NI NFC content shall be such, as practicably possible, for Gosatomnadzor of Russia will not need to review additional design, engineering and operating documentation to assess safety.

The information shall be presented clearly, unambiguously, in a concise way and without emotional coloring. The information presented shall not be contradictory over different subsections. The compliance information shall not be declarative in nature. The documented evidence of compliance shall be presented.

When the information is based on the work performed or documents, they should be referenced to by a type of document, authors or organization, year of conduct or issue, archive code or identification number.

Repetitions of information should be avoided. To avoid unnecessary repetitions it is recommended to give references to corresponding sections.

2. The information on performed calculations and analytical calculations shall prove sufficiency and completeness of the calculations done, that all factors affecting the results were taken into account, and contain data sufficient for an expert calculation (diagrams, assumptions made, input data, its interpretations, conclusions), as necessary.

All software shall be briefly described in a scope sufficient for its understanding and acceptability assessment along with their names and certification or verification information.

3. The format of the report shall be uniform over all stages and all sections. The Applicant shall arrange the SAR NI NFC in separate files – each file for one chapter or, if necessary, section or subsection.

Each file shall bear the name of NI NFC, full title of the SAR NI NFC and the corresponding chapter section (subsection).

4. The first file shall contain:

- list of contents of the whole SAR NI NFC;
- Introduction, Section 1;
- general information (Summary, List of Abbreviations).

In the beginning of each file there shall be the complete SAR NI NFC table of contents and the list of abbreviations.

The SAR NI NFC should be formatted in accordance with the textual document formatting requirements.

5. In the end of each chapter, section (subsection) there shall be the list of references and the change record page.

6. The SAR NI NFC sections containing confidential information shall be presented separately as established by the procedure.

Appendix 2.

NI NFC Location Conditions

1. General information

1.1. NI NFC name _____

1.2. NI NFC commissioning/decommissioning year _____

1.3. Location:

Russian Federation Subject _____

Nearest city(ies) _____

Distance from site to _____ km.

Azimuth (grade) _____

1.4. Site geographic coordinates (NI NFC center):

Latitude _____ Longitude _____

1.5. Site absolute marks per the Baltic System of Elevations (BS):

Natural: highest/medium/lowest _____/_____/_____ m BS.

Plans _____ m BS.

1.6. Landscape within 20-30 km radius.

Brief description:

Plain _____

Hilliness _____

Location in the hollow _____

Location of rivers _____

Coastal line of lake/sea_____

Other (to be described)_____

1.7. Population distribution:

Closest administrative center, village, town

Name_____

Distance / azimuth_____ km /_____

Population (number) _____

Closest city (>100 000)

Name: _____

Distance / azimuth_____ km /_____

Population (number) _____

2. Weather conditions:

2.1. Whirlwind hazard zone as per zoning map _____

2.2. Whirlwind intensity as per Fujita Scale: _____

2.3. Maximum rotating speed of whirlwind side _____m/s.

2.4. Whirlwind route length / width _____km / _____m.

2.5. Whirlwind cone periphery-to-center pressure differential _____gPa.

2.6. Probability of whirlwind passing through the NRF site _____

2.7. Probability of hurricane (tornado) passing through the NRF site _____

2.8. Design characteristics of maximum hurricane (tornado) _____

2.9. Design maximum wind velocities of different probability

including 1; 0.1; and 0.01 % _____, _____,_____ m/s.

3. Hydrologic conditions

3.1. Type of water reservoir affecting the NI NFC safety (river, lake, reservoir, sea)

_____

3.2. MWS formation factors considered in design

For rivers: spring flood, rain flood; dam break, clogging, ice jams and gorges, volcanic activity, earthquake, landslide, downfall, mudflow, etc. (underline relevant; indicate other factors)

_____

For water reservoirs: wind setup, storming, maximum on-shore wave setup, seiche, tides, etc. (underline relevant; indicate other factors) _____

3.3. Absolute highest mark of observed (historic) water level in the reservoir _____ m BS.
3.4. MWS parameters:
Maximum probability levels including
1; 0.1; and 0.01 % _____,_____,_____m BS.
Maximum wave height probability
including 1; 0.1; and 0.01 % _____,_____,_____m.
For rivers
Maximum water flow rate probability
including 1; 0.1; and 0.01 %_____,_____,_____m^3
For water reservoirs:
Absolute MWS level mark _____ m BS.
Peak seiche water level _____ m.
The peak amplitude of the sea tide oscillations _____ m.
Design storm setup height at maximum wind speeds of various probability
including 1; 0.1; and 0.01 % _____ , _____ , _____ m.
Highest wave at deep waters at maximum wind speeds of various probabilities
including 1; 0.1; and 0.01 % _____ , _____ , _____ m.
Highest tsunami wave flood mark of various probability including 1; 0.1; and 0.01 %
_____ , _____ , _____ m BS.
Lowest tsunami wave flood mark of coastal line including 1; 0.1; and 0.01 % _____ ,
_____ , _____ m BS.

4. Hydrogeologic and engineering and geologic conditions

4.1. The first from surface water-bearing horizon.
Unpressurized / pressurized (underline the relevant).
Expansion area _____
Absolute mark of lower / upper confining layer _____m / _____m BS.
Maximum / medium / minimum absolute marks of
ground water level _____m/ _____m/ _____m BS.
Lithologic characteristic of surrounding rock_____
Rock permeability coefficient _____m/days.
Rock active porosity _____%
Existing water intake _____
Maximum / medium / minimum absolute marks of ground water level.
_____m/ _____m/ _____m BS.
4.2. The second from surface water-bearing horizon.
Expansion area _____
Absolute mark of lower / upper confining layer _____m / _____m BS.
Maximum / medium / minimum absolute marks of
ground water level _____m/ _____m/ _____m BS.
Lithologic characteristic of surrounding rock_____
Rock permeability coefficient _____m/days.
Rock active porosity _____%
Existing water intake _____
Maximum / medium / minimum absolute marks of ground water level at the section
_____m/ _____m/ _____m BS.
4.3. Confining layer
Expansion area _____
Absolute mark of to / bottom of water confining level _____m / _____m BS
Water confining layer rock lithographic characteristic _____
Rock permeability coefficient _____m/days.
Presence of hydrogeological windows in water confining layer _____
4.4. Engineering and geologic conditions:

Specific soils: soft with module of deformation <20 MPa, uncompressible, sinking, swelling, salinated, pergelisol (underline the relevant; indicate other) _____
Recent hazardous geologic processes and phenomena: sliding, karst, suffosion, karst-suffosion, etc. (underline the relevant; indicate other) _____

5. Seismicity

5.1. Geodynamic model of the NRF location region and site.
5.2. Seismotectonic model of the NRF location region and site.
5.3. Seismologic model of the NRF site.
5.4. Detailed sketch of the region seismic zoning.
5.5. Sketch of structural and tectonic conditions of the site.
5.6. Sketch of seismic microzoning of the site regarding natural and man-induced conditions as changed.
5.7. Characteristics of spectra and duration of oscillations for distant, medium distant and local earthquakes
5.8. SSE and DE parameters of the closest seismogenic zones: magnitude, focus depth, distance to the seismogenic area r, seismicity J as per MKS-64 Scale at the reference soil of the site.

Seismogenic zone number	Magnitude		Focus depth, km		r, km		J	
	SSE	DE	SSE	DE	SSE	DE	SSE	DE

5.9. Site seismicity in case of SSE / DE _____/_____
5.10. Maximum amplitudes of horizontal oscillations
on free area of the site plan in case of SSE / DE:
accelerations _____/_____m/s^2 ; velocity _____/_____cm/s.
5.11. Maximum amplitudes of horizontal oscillations of
rock top in case of SSE / DE.
accelerations _____/_____m/s^2 ; velocity _____/_____cm/s.
5.12. Maximum amplitude of acceleration / velocity periods
at the plan level in case of SSE / DE _____/_____ s.
5.13. Horizontal to vertical ratio _____.

6. Aircraft crash (AC)

6.1. Minimum distance of site from air traffic routes, arrival route, any airport _____, _____, _____km.
6.2. Distance to a large airport _____ km.
6.3. Probability of an aircraft crash on site.

	Over 10 years forecast	over 50 years forecast

7. Emergency explosions off-site within 10-20 km radius zone

7.1. PEES
Components of chemical and oil refinery complexes; energy carriers storage facilities, explosives; pipelined for pumping over liquid and gaseous energy carriers – aboveground; defense facilities (underline the relevant).
7.2. Surface transport PEES
Traffic routes, ports, harbors, channels, railway stations, cargo flow characteristics. Appendix: Contingency plan (scale 1:25 000).

8. Off-site fires (within 2 km radius)

Potential fire sources: forest, peatbogs, gas/oil/product pipeline, base/storage of combustible materials, navigation canal (underline the relevant).

Appendix: Topographic and landscape map of the region indicating stationary potential fire sources.

9. Toxic emissions into atmosphere

Off-site emission sources of vapors/gases/aerosols, fallouts (underline the relevant).

Appendix: Sketch of the emission sources' locations.

10. Data on natural radioactivity in the NI NFC location region

Present data on the background exposure dose of gamma-radiation and content of radionuclides in the soil and near-surface water.

Appendix 3.1

List of NI NFC buildings, structures, systems, components, and their classification

Code building, structure, system and element	Name of building, structure, system and element	Function (functional classification)	Safety class	Quality group	Seismic stability category (sub-category)	Account for man-induced and natural impacts (results of scenario probability analysis)
1	2	3	4	5	6	7

Appendix 3.2

Analysis results of natural and man-induced initiating event scenarios

N	Initiating event	Primary impact	Secondary impact	List of buildings and structures, systems and components subject to possible impact	Mark if resistance analysis is needed
1	2	3	4	5	6
1. ***External impacts***					
	1.1. Earthquakes of any nature	Base oscillations, foundation deformation	1. Oscillation of buildings and structures 2. Projectiles 3. Oscillations of systems and components	All NRF systems and components	
2. ***Internal impacts caused by accidents on NI NFC site***					
	2.1. Explosion of explosive gases	1.Air shock wave 2. Projectiles 3. Fire	1.Building and structure damage 2. Projectiles	1. Individual systems and components	
3. ***Internal impacts caused by accidents inside NI NFC buildings and structures***					
	3.1. Pipeline rupture. 3.2. Explosion of explosive gases.	1. Projectiles. 2. Jet flows.	1.Structure damage. 2. Projectiles.	1.Equipment	
	3.3.Other internal impacts				

Note: Mark «Yes» in column 6 if safety important systems are referred to column 5. According to the mark put in column 6 the Report shall contain the results of quantitative assessment of event probability, system and element impact parameters and conclusions regarding impact resistance of these systems and components to be presented in corresponding sections and chapters.

Appendix 3.3

Limiting states of safety important buildings and structures

	Names of buildings and structures	Limiting states		
		Indicators	Numeric value	Other indicators
1	2	3	4	5