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Federal Standards and Rules

REQUIREMENTS TO SAFETY ANALYSIS REPORT FOR NUCLEAR MATERIAL STORAGE FACILITIES

(final draft revision)

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FEDERAL ENVIRONMENTAL, INDUSTRIAL AND NUCLEAR SUPERVISION SERVICE OF THE RUSSIAN FEDERATION

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

Approved by
the Order of Federal
Environmental, Industrial
and Nuclear Supervision Service
of the Russian Federation
of_____ № ___

REQUIREMENTS TO SAFETY ANALYSIS REPORT FOR NUCLEAR MATERIAL STORAGE FACILITIES

(draft final version)

SR – XX - XX

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REQUIREMENTS TO SAFETY ANALYSIS REPORT FOR NUCLEAR MATERIAL STORAGE FACILITIES SR –XX- XX

Federal Environmental, Industrial and Nuclear Supervision Service of the Russian Federation
Moscow, 2004

These Federal Standards and Rules regulate the requirements to Safety Analysis Report for nuclear material storage facilities of nuclear fuel cycle enterprises, its structure, contents and paper work procedure. The regulatory document is developed on the basis of the Federal Law "On the Use of Atomic Energy", other legal regulatory acts of the Russian Federation, Joint Convention on safe management of spent fuel and on safe management of radioactive waste, federal standards and rules in the field of the use of atomic energy as well as the IAEA recommendations.

This is the first issue of this regulatory document[1*].

[1*] The regulatory document is developed by the Working Group consisting of A.S.Alpeev, N.F.Andryushin, E.G.Bugaev, I.V.Kaliberda, M.A.Nepeypivo, V.Sh.Plekhanov, V.P.Slutsker, R.B.Sharafutdinov (SEC NRS of Gosatomnadzor of Russia), V.A.Grivizirskiy, V.M.Iruyshkin, A.I.Kislov, V.E.Melamed, V.L.Pervin (Rostechnadzor).

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LIST OF ABBREVIATIONS

ARMS	Automatic Radiation Monitoring System;
CA	Controlled Area;
CR	Control Room;
DBE	Design Basis Earthquake;
FA	Fuel Assembly;
GRW	Gaseous Radioactive Waste;
GSP NFCF	General Safety Provisions for Nuclear Fuel Cycle Facilities;
I&C	Instrumentation and Controls;
IE	Initiating Event;
LRW	Liquid Radioactive Waste;
NF	Nuclear Fuel;
NFCI	Nuclear Fuel Cycle Installation.
NFM (S)	Nuclear Fissile Material (Substance, nuclide);
NFN	Nuclear Fissile Nuclide;
NM	Nuclear Materials;
NMSF	Nuclear Material Storage Facility
OO	Operating Organization (Utility);
OSTP	On-Site Transportation Package;
PPS	Physical Protection System;
PSA	Probabilistic Safety Analysis;
QAP	Quality Assurance Program;
R&D	Research and Development;
RadS	Radioactive Substances;
RD	Regulatory Document;
RW	Radioactive Waste;
SAO	Start-up and Alignment Operations;
SAR	Safety Analysis Report;
SCR EAS	SCR Emergency Alarm System;
SFA	Spent Fuel Assembly;
SIS	Safety Important System;
SNF	Spent Nuclear Fuel;
Spec.	Specification;
SRW	Solid Radioactive Waste;
SS	Safety System;
SSE	Safe Shutdown Earthquake;
SW	Software;
TP	Transportation Package;

TERMS AND DEFINITIONS

All terms used in this document shall have the meanings as determined in Federal laws and Federal standards and rules in the field of the use of atomic energy.

GENERAL PROVISIONS

1. Purpose and scope of the document

1.1. This document establishes requirements to the structure and contents of Safety Analysis Report for nuclear material storage facilities of nuclear fuel cycle enterprises, to completeness of the information submitted to justify safety of the activities, to the structure of NMSF system description as well as to report-related paper work procedure.

1.2. The requirements of this document apply to NMSF to be deployed, under design and construction and to those in operation.

2. Purpose and scope of SAR NMSF

2.1. SAR NMSF is a document that justifies NMSF safety for siting, construction and operation.

2.2. SAR NMSF shall contain information, which is sufficient for adequate understanding of the NMSF design, safety concept, QAP NMSF and basic principles of operation.

2.3. Information contained in SAR NMSF shall provide for an opportunity to assess whether adopted design, engineering, technical and administrative solutions are in compliance with the requirements of the Federal laws, other legal regulatory acts of the Russian Federation, Federal standards and rules as well as other RD setting forth safety requirements in the field of the use of atomic energy.

2.4. Separate SAR shall be developed for each NMSF.

2.5. SAR NMSF preparation is carried out during NMSF siting, construction, commissioning and operation as well as decommissioning.

2.6. During NMSF siting phase SAR shall contain information justifying NMSF safety which is specified in Introduction, section 1 (items 1.1 – 1.7, 1.10), section 2 (item 2.1, items 2.3 – 2.8), sections 5-7 of this document based on Justification of Investments, surveys, R&D.

2.7. During NMSF construction phase SAR shall contain information justifying NMSF safety, which is specified in sections 1 - 13 of this document based on Feasibility Study for MNSF, R&D results.

2.8. After completion of NMSF construction, commissioning and during NMSF operation SAR shall reflect actual condition of NMSF, results of start-up and alignment operations and take into account all modifications incorporated into NMSF design.

2.9. SAR NMSF shall be added with relevant changes and modifications if changes have been introduced to design, engineering, process and operational documentation governing nuclear and radiation safety.

Operating organization establishes the procedure for changes and modifications to be incorporated in SAR NMSF.

3. Requirements to SAR contents and format

Requirements to SAR NMSF contents and format are listed in Attachment 1.

REQUIREMENTS TO REPORT CONTENTS

INTRODUCTION

The section shall contain general information about NMSF design, operating organization and design development stage as well as SAR MNSF general characteristics.

1. Basis of the design development

Brief information should be given about formal decisions made by the federal executive bodies and that of the Russian Federal subjects laid as the basis for design development and construction of NMSF.

2. General description of NMSF

There should be a general information about NMSF including NMSF name and purpose, title of NFCI which hosts or will host NMSF (in the relevant case), NMSF (NFCI) siting, NMSF category by potential radiation hazard.

3. SAR development stage

It is required to indicate the activity to be covered by the safety justification in SAR NMSF being submitted.

4. Information about operating organization and contractors

There shall be the information on the Operating Organization and SAR NMSF chapter (section) developers.

Entities, which perform work and render services for siting, design, construction, manufacturing and assembling the NMSF main safety important systems and components shall be listed. Scope of work (services) shall be indicated and there shall be the information whether they have licenses covering activities and services in the field of the use of atomic energy.

5. Information about R&D

Brief information about R&D carried out or planned to justify technologies, equipment designs, basic design solutions, and safety of NMSF shall be provided for.

6. SAR NMSF characteristics

Completeness of the information submitted and compliance thereof with the requirements of this document shall be specified.

CHAPTER 1. GENERAL DESCRIPTION OF NMSF

NMSF information reflecting briefly the contents of all other sections of SAR NMSF shall be presented in this Chapter. This information is intended for familiarization with the concept and basic engineering solutions regarding NMSF safety.

1.1. Characteristics of NMSF location region and site

This section shall contain brief information on NMSF site (or NMSF-related NFCI) and location region.

1.2. NMSF general layout and arrangement

There shall be presented the general layout with a list of NMSF main buildings and structures, conditions determining locations of main buildings and structures on the general layout including the NMSF location on NFCI site; location of highways and railways, conditions of entrance to main buildings and structures; utilities, transport, process and electric connections between buildings and structures.

1.3. NMSF general characteristics

This section shall briefly describe NMSF purpose and structure; indicate NMSF main technical characteristics and basic processes and procedures.

There shall be main technical characteristics of NMSF:

- conditions of NMSF siting;
- NMSF structure with a list of all NM storage facilities;
- NM nomenclature;
- MN storage method;
- storage facility class (for SNF storage facility);
- NM storage period;
- method of NM delivery to and removal from NMSF; specifics of NM on-site transportation;
- NMSF maximum design capacity (volume);
- actual fillup;
- NMSF operation modes;
- expected time schedule for commissioning NMSF under design;
- NMSF design lifetime.

Herein, provide for a description of main processes, operations and procedures carried out at NMSF (acceptance and incoming inspection of NM, reloading, loading and retrieval of NM from storage locations, inspection of NM during storage and off-site shipment, on-site transport at NMSF, handling of damaged NM packages).

This section shall contain main technical solutions providing for nuclear material safe storage, acceptance and reloading as well as on-site transportation. The description of main technical solutions shall be supported by process flow diagrams and drawings.

1.4. NMSF safety ensurance concept

There shall be basic principles and criteria relevant to NMSF safety ensurance including:

- a list of applicable Federal laws, Federal standards and rules as well as other RD governing safety ensurance and justification;
- quantitative values of safety criteria laid as the basis of the NMSF design;
- implementation of the defense-in-depth principle and description of multi-barrier protection as well as properties of inherent self-protection;
- description and justification of the system of technical and organizational measures to protect employees, population and environment;
- information on design solutions to provide for the adequate safety level;
- region and site selection criteria (for newly constructed facilities);

- description and justification of selection of materials;
- information on the personnel qualifications and training;
- information on beyond design basis accidents (a list of accidents considered; measures to prevent and mitigate their consequences);
- information on the experience in design, construction, assembling, operation, testing which confirms sufficiency of engineering and organizational solutions applied to ensure safety of NMSF.

It shall be demonstrated what engineered means and organizational measures are in place to ensure nuclear safety during storage, handling and transportation of NFM (S, N). There shall be the information on availability of emergency alarm system in case of SCR.

There shall be brief information on engineered means and organizational measures to ensure protection of employees, population and environment against impermissible radiation impact and to exclude unreasonable exposure (ALARA principle).

There shall be the information on engineered means and organizational measures to ensure protection of employees, population and environment against such adverse factors as explosions, disintegrations, emergency values of pressure and temperature, medium toxicity, electric voltage and etc. which are possible during NMSF operation as well as safety ensurance during operation of heavy load cranes, boilers (steam and water-heating boiler), high-pressure vessels, steam and hot-water pipelines (if any).

Brief information on NMSF fire and explosion safety during nuclear material storage, handling and transportation shall be presented; compliance of the decisions made with fire safety-related RD requirements shall be demonstrated.

There shall be information on NMSF physical protection.

Basic provisions of action plans to protect personnel and population in case of radiation accident at NMSF.

1.5. Safety analysis results

There should be brief information on the safety analyses done. The information should be grouped with regard to accidents considered. There shall be a list of initiating events the NMSF is designed to withstand, list of design basis and beyond design basis accidents and evaluation of design solutions, which ensure NMSF safety.

PSA results should be presented (if any).

1.6. NMSF environmental impact assessment

Brief information reflecting assessment of NMSF radiological impact to the environment under normal operation and in case of accidents.

It shall be demonstrated that:

NMSF construction and operation will not produce a negative impermissible effect to the environment beyond the CA boundaries;

NMSF construction and operation of, neither at present nor in future, will not lead to impermissible limitation of industrial activities and use of natural resources including wildlife refuge, recreation and other purposes beyond the designated area;

during NMSF operation period and after it is decommissioned the environment will be protected in accordance with the requirements of the Russian Federation legislation and regulatory documents.

It shall be indicated whether NMSF environmental impact assessment has been carried out taking account of its actual state, ecological conditions of NMSF site region, sanitary and hygienic, biological, anthropogenic and man-induced features of the biosphere pollution.

1.7. Comparison of NMSF design with national and foreign NMSF designs

The information shall be presented to allow for comparing the given design with similar national and foreign designs of NMSF of this type (if relevant data are available).

1.8. NMSF construction schedule

It is required to provide for a NMSF construction roadmap (if SAR NMSF is submitted to justify safety of NMSF construction activities).

1.9. Basic provisions for NMSF operation management

There shall be brief information on NMSF commissioning along with data on SAO Program, testing of structures, systems and components during NMSF commissioning.

The documenting and record keeping procedures should be briefly outlined.

The information regarding preparation and arrangements for operations of the NMSF shall be included.

This information shall briefly describe the OO organizational structure and NMSF administration.

NMSF maintenance and monitoring of operating conditions shall be demonstrated.

The information on setting and monitoring procedure for the safe operation limits and conditions shall be provided.

There shall be the information on basic solutions provided for in NMSF design to ensure NMSF safe decommissioning.

1.10. Quality assurance

Brief information shall be provided on the quality assurance measures at NMSF siting, construction and operation.

CHAPTER 2. SAFETY ANAYSIS FOR DESIGN OF BUILDINGS, STRUCTURES, SYSTEMS AND COMPONENTS

2.1. Basic safety principles, criteria and requirements applied in the design for buildings, structures, systems and components

Safety principles, criteria and requirements which laid the basis in NMSF design shall be presented in this Chapter.

2.1.1. List of applicable regulatory documents

Herein, present a list of applicable safety regulatory documents used for NMSF design.

2.1.2. NMSF design principles and criteria

Safety principles and criteria laid as the basis for NMSF design shall be described. The selection of these criteria shall be justified. It shall be demonstrated whether the design criteria comply with the applicable regulatory documents.

2.1.3. Assessment of compliance

There shall be information on compliance with the main principles and criteria of NMSF safety ensurance including:

- demonstration of how the defense-in-depth concept is implemented;
- 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 NMSF life cycle;
- demonstration of how radiation safety, limitation of radiation impact to personnel, population and environment and non-violation of established standards for RadS release and discharge to the environment are ensured;
- measures to ensure nuclear safety;
- measures to ensure fire protection;
- measures to ensure physical protection.

Implementation of the safety culture principles shall be demonstrated.

It is required to provide for the information related to non-conformance of NMSF with the requirements of Federal standards and rules and other RDs in the field of use of atomic energy (list, justifications of such deviations and compensatory measures taken).

2.2. Classification of buildings, structures, systems and components

It is required to list safety important buildings, structures, systems and components with regard to safety classes in accordance with GSP NFCF. The results shall be presented in the tabulated format (Table 2.1).

Information on classification of buildings and structures with regard to fire-resistance shall be presented. Classification of buildings, structures and rooms with regard to fire and explosion risk shall be indicated. The results shall be presented in the tabulated format (Table 2.1).

Information on classification of buildings, structures, systems and components with regard to seismic stability shall be provided for. The results shall be presented in the tabulated format (Table 2.1).

List of buildings, structures, systems and components subject to the analysis of resistance to natural and man-induced impacts (Table 2.1, column 7) which are laid as design basis as set forth in the Federal standards and rules in the field of the use of atomic energy shall be indicated.

Table 2.1

List of NMSF buildings, structures, systems, components, and their classification

Code of building, structure, system and element	Name of building, structure, system and element	Function (functional classification)	Safety class	Fire and explosion risk category of buildings, structures and rooms	Seismic stability category (sub-category)	Account for man-induced and natural impacts
1	2	3	4	5	6	7

2.3. NMSF general layout and arrangement

There shall be NMSF general layout and its description.

There shall be justification of NMSF main building and structure location at NMSF general layout for safety purposes including in case of external impact.

Arrangement of NM storage facilities and other related buildings and structures against other NFCI and adjacent systems shall be specified and justified.

Design and layout solutions for the main buildings, structures, its constructions and foundations shall be described.

It shall be demonstrated, in particular, that:

- the layout of rooms and design solution exclude a possibility of flooding and ingress of other neutron moderating materials into the NM storage areas;
- the expedite evacuation of personnel from the premises in case of an accident is arranged for;
- there are no routes to other operational premises running through the NM storage facility.

Fire protection measures (as related to the assessment of NMSF building and structure location, fire-engine access roads, availability of water reservoir and relevant tanks) shall be described.

There shall be the information about all roads, which are used (will be used) for NM transportation to/from NMSF and will be constructed.

2.4. Description and justification of NMSF location

It is required to provide for characteristics of NMSF region and site and evaluate to which extent location is sufficient to site NMSF.

There shall be parameters and characteristics of external impacts of natural and man-induced origin which are possible in NMSF region and site and are taken into account in

the design of buildings, structures and technological systems during NMSF safety analysis and emergency planning including population evacuation planning in case of emergency.

Information on NMSF site and region shall include:

- geographical location with indication of administrative location, site borders, CA and survey area borders, land allotment borders;
- topographic conditions;
- hydro-meteorological conditions including climate conditions, characteristics of extreme impacts of natural origin (flood, tornado, icing, thunderstorms and etc.), air temperature, meteorological conditions determining RadS transfer in case of normal and emergency release of RadS, wind rose;
- demographic conditions including information on population distribution and density in NMSF region by radii and directions (considering the prospects of population growth during NMSF design life);
- seismic and tectonic characteristics of NMSF region including information on availability of breaks, levels of DBE and SSE;
- geological description of NMSF region and site;
- physical and mechanical characteristics of soils, justification of soil and site stability, assessment of possible impacts of physical and geological phenomena (landslides, avalanche and etc.);
- hydro-geological and hydrological characteristics including characteristics of water-bearing horizon, interaction with surface water, chemical composition of underground water, level of underground water, information on possible impact of hydrosphere and hydrostructures of NMSF region to the safety thereof;
- information on man-induced conditions of NMSF site including industrial enterprise structure and specifics which may unfavorably affect NMSF (chemical and oil-refining plants, warehouses, mines and open-pits, drilling rig and boreholes, gas underground storage facilities, military facilities, roads (air, ground and water), transportation structures (docks, ports, airports) that are facilities which are considered as a source of explosion and fire hazard and release of toxic substances to the environment and other hazards.

List of processes, phenomena and factors determining external impacts to NMSF adopted as NMSF design basis shall be presented in the tabulated format (Table 2.2).

Table 2.2

Summary Table on processes, phenomena and factors determining external impacts

No.	Process, phenomenon and event	Source of process, phenomenon and event	Risk	Frequency of occurrence	Impact parameters	Additional information

Information on NMSF location should be presented as the Attachment to Chapter 2. Attachment shall contain NMSF general layout as well as drawings with indication of external impact sources, schemes, tables, diagrams and other necessary cartographic and text data, which characterize NMSF location. The section shall be composed of the one to state changes to location at all NMSF life cycle stages.

It is required to present the results of review and qualitative analysis of probable scenarios of initiating event sequences at the NMSF site, which may be caused by:

- external natural and man-induced impacts;
- internal impacts caused by NMSF on-site accidents.

Probable initiating event sequences as the results of primary and secondary effects shall be described.

It is recommended for more convenience to present the scenario review results in the tabulated format as per Attachment 2.

2.5. NMSF territory protection against hazardous geologic processes

Description and justification of measures to protect NMSF territory against hazardous geological processes shall be given considering RD requirements.

There shall be a list of design documentation containing information on engineered measures to eliminate, mitigate the consequences and monitor HGP development. General road-map for design measures to protect NMSF territory including measures 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.

2.6. Flood protection

There shall be a list of buildings and structures which are to be protected against flood. Measures and means to protect these buildings, structures and systems thereof against flood (water discharge pump systems, bulkhead gate, water tight doors and drainage systems) shall be described with justification of their sufficiency.

2.7. Impacts and loads to buildings, structures, systems and components

Herein, describe impacts and loads to NMSF main buildings, structures, systems and components of safety class 1, 2 and 3 which are considered under design and strength and stability analysis.

There shall be a description of general approaches to the selection of possible combinations of design loads to NMSF buildings, structures, systems and components (loads from external natural and man-induced impacts, internal impacts caused by accidents at the NMSF site and inside NMSF main buildings under normal operation) and selected combinations to analyze strength and stability thereof.

Herein, provide for references to SAR NMSF sections, which describe and justify the choice.

A summary table of impacts and combinations thereof to the main buildings and structures, systems and components shall be presented.

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

Information on methodology for determining listed impacts and loads should be provided for.

2.8. Impacts and loads to buildings, structures, systems and components

Herein, describe design and layout solutions for main buildings, structures and foundations.

Herein, provide for detailed information on each of these buildings and structures. The information shall be presented in the most acceptable way as conditioned by the features of buildings and structures.

There shall be a list of documents containing justification of design solutions for safety important buildings, structures, constructions, basements, foundations.

Herein, justify the choice of materials for buildings, structures and constructions considering normal operation and accidents, compatibility of structural materials with process media.

Herein, present analysis result data (strength, leaktightness, fire-resistance, seismic stability and etc.) regarding external impact resistance of buildings, structures and constructions (levels achieved) as well as stability of their basement and foundation.

Assess life and design life of buildings, structures and constructions.

Provide for the information on availability and contents of test and monitoring programs for operational capability of constructions as well as monitoring of banking, settlements, stress-deformed state, oscillations, foundation condition and measures to reinforce basements of safety important buildings, structures and constructions (if required).

Herein, provide for the results of the analysis of NMSF building and structure strength and resistance to internal impacts including mechanical, thermodynamic, chemical and corrosion impacts.

References to developed quality assurance programs to perform works at all life stages of NMSF buildings and structures shall be made. Provide for the information, which allows to identify compliance of quality assurance programs adopted with RD requirements.

Methods used to justify NMSF building and structure strength and stability shall be described.

Herein, provide for a list of software and software-related information used to justify building and structure stability under external impacts.

2.9. Justification of strength and performance of NMSF systems and components

Herein, list and specify location of all safety important systems (mechanisms, units, equipment) including those, which shall function during and beyond calculated accidents, and mechanical systems and components of equipment and pipelines, electric equipment, I&C, control means, ventilation systems, handling equipment.

There should be information on strength and performance of the above listed equipment presented as subsections of this section.

There shall be information containing the description of approaches to ensure strength, reliability, performance and resistance of NMSF safety important systems and components taking account of the loads caused by various impacts including those of natural and man-induced origin and conveyed through constructions of buildings and structures.

Each subsection is required to list the loads under which equipment performance is ensured. Both normal operation conditions and emergency external and internal impacts should be specified. It is required to list the values of the following parameters: temperature, pressure, specific humidity, radiation, chemical composition and vibration (of non-seismic nature). Herein, specify calculated loads and combination thereof considered for the above systems.

It is required to justify strength, stability and resistance of the equipment and its support structures considering impacts adopted as design basis and listed in section 2.7.

There shall be a justification of equipment performance under the loads. It should be demonstrated that mechanical, I&C and electric systems are capable to perform functions under impacts caused by normal operation, internal impacts as well as in case of combined impact of external conditions considering loads resulted from natural and man-induced impacts and conveyed through constructions of buildings and structures, and (or) references to relevant sections containing this information shall be specified.

Methods and methodologies to verify structural integrity, performance and resistance of the equipment under the loads as well as methods and methodologies to verify resistance of support structures shall be described.

Description of analysis methods used to verify performance, structural and functional integrity, strength and resistance of the equipment as well as evidences of sufficiency thereof shall be presented. There shall be a list of software applied for calculations and information on certification thereof.

CHAPTER 3. NUCLEAR MATERIAL MANAGEMENT SYSTEMS AND RELATED SYSTEMS

The Chapter shall contain information on safe functioning of NM management systems as well as safety important systems (components) ensuring performance thereof.

The information and each system performance analysis shall be based on the designs of NMSF systems and components.

To present system information it is recommended to keep to system description model structure contained in Attachment 3. Specific content of each subsection can be modified depending on system peculiarities.

While presenting the information it is allowed not go beyond the reference to other SAR chapters (sections), which contain detailed data.

There shall be complete lists of alterations and deviations from the approved design documentation during manufacturing of equipment, assembling and SAO, safety impact analysis of these alterations and information on compensatory measures.

The Chapter's preamble shall contain a list of NM management systems, NM storage facilities, safety important systems which ensure NMSF functioning and interaction between them. Each storage facility of NMSF shall be described as specified in sections 3.1 and 3.2 of this report.

3.1. Nuclear materials and packages

The section shall contain data on nuclear material supposed to be stored and NM packages used for storage and transportation.

Herein, for each NM type indicate numerical values required to justify nuclear and radiation safety which may include, depending on NM type:

- physical characteristics (aggregate state, humidity, density, dispersion ability, etc.);
- chemical composition;
- heat release rate;
- initial enrichment and burn-up (for SNF);
- presence of absorber;
- isotopic (nuclide) composition and possible change of isotopic composition over NM specified storage period;
- radiological characteristics (specific and total activity of NM, half-life, NM radiation type, radiation spectrum);
- characteristics related to explosion hazard, self-ignition possibility and conditions;
- presence of organic substances;
- toxicity;
- other safety important characteristics and properties.

The data shall be justified. The most conservative values should be indicated if deviations of the characteristics from the given values are possible due to errors occurred during measurements of these characteristics, calculation errors and etc. A list of calculations and reports on experimental justification of NM characteristics information (if any) shall be provided for.

Herein, list the packages used during storage and transportation including TUK and VTUK.

The purpose and functions of packages (process functions: storage, transportation; protective functions: biological shielding, thermal insulation, strength and etc.) shall be described for each type of package.

A list of RDs, which requirements to be met by the package shall be provided for.

There shall be package design characteristics and requirements thereto including:

- basic characteristics pertaining to weight, size and design of containers;

- information no mechanical strength (permissible static, dynamic and shock loads);
- compatibility of packages and transport and process equipment;
- leaktightness of a packaging, water-resistance, possibility for non-destructive testing of a packaging integrity during storage period;
- durability (stability to corrosion damage, frost-resistance), service life;
- maximum permissible temperature inside and on surface of a packaging, maximum permissible excessive internal pressure;
- availability of free space inside packaging;
- marking/labeling requirements;
- resistance to radiation impacts;
- value of surface contamination, permissible dose rate on the packaging surface;
- rate of NM load (quantity per packaging).

There shall be lists of design initiating events, which were taken account of in the course of the package (vessel) strength properties analysis.

Herein, provide for the information on availability of NM and NM packaging incoming inspection. Describe technique and methods to conduct incoming inspection including packaging identification methods (identification of NM type or category, quantity, enrichment level and level of external surface radiation exposure), verification of compliance of NM packaging with accompanying documents and preset requirements. Provide for the information on metrological certification of NM inspection test methods. Specify the procedure for record keeping of incoming inspection results.

Describe the design and internal arrangements of NM packages (storage vessels): designs of internal vessels and overpacks (if any), spacers, devices for radiation shielding, cooling and thermal insulation, pressurizer, shock absorbers, presence of neutron absorbers inside or outside the packaging. Herein, provide for sketches and necessary drawings. Justify design solutions selected.

Justify selection of structural materials the packages are made of, their physical and chemical characteristics, sorbents, absorber and moderator materials (if any) and other equipment.

Specify processes and phenomena in NM which may take place during NM storage and which may lead to deterioration of container material properties. Describe possible volume, linear and phase changes as well as changes of density, heat capacity, thermal conductivity, mechanical properties and gas release in NM during storage period.

Consider the impact of the following processes and phenomena to package integrity and strength:

- gas release in NM (due to corrosion or radiolysis if solutions or solid nuclear materials are stored in containers manufactured from organic materials) ;
- changes in NM structure;
- changes in NM volume due to thermal expansion, cracking, compression, swelling;
- oxidation of NM;
- interaction of NM with the container material;
- stress thermal creep of NM;
- oxidation of the container material;
- hydration of the container material;
- local and uniform internal and external corrosion of the container structural material;
- stress corrosion cracking;
- other processes.

Herein, justify the sufficiency of processes considered and demonstrate how the impact thereof to protective properties of container structural materials is taken into account.

For the cases where the self-igniting NMs are in storage, provide for the information on how to bring them into the safe condition or justify the possibility of safe storage of such NM.

Herein, provide for the information on package certification, No. of operational instruction, No. of certificates-permissions for design, NM storage and/or NM transportation.

Specify the procedure for dealing with damaged packages or those, which are not in compliance with specifications.

3.2. NM storage system

This section shall contain the information on NM storage system at NMSF specific storage.

3.2.1. Purpose and design bases

There shall be information on the purpose and functions of the NM storage system.

Herein, outline the basic principles and criteria laid as the basis of design of the system with indication of the key safety principles and criteria to be implemented in the design and/or process flow diagram of the system. List safety RDs which requirements are to be met by the system being described.

3.2.2. Description of system

The subsection should describe system design and/or process flow diagram in general and its subsystems, equipment, structures and components performing individual functions.

Provide for and justify layout solutions and location of the equipment in NMSF premises.

Justify selection of building structures of the storage facility, support structures, design of storage nests, fencing, racks, partitions and equipment in use. Provide for detailed drawings, sketches and schemes illustrating the design and functioning of NM storage system and its components, its spatial arrangement and links to other NMSF systems and if NM storage system is linked with NFCI systems specify this interaction.

The process flow diagram of NM storage including loading into storage nests and NM retrieval from storage nests shall be described. Justify selection of NM storage process flow diagram.

Describe a set of handling equipment indicating subsystems, equipment and components, which perform individual functions including:

- a set of equipment for loading operations, transport mechanisms, mechanisms for release and stacking of packagings;
- engineered means to remove heat from NM packagings (if necessary);
- measures to prevent damage, deformation, collapse or drop of packagings;
- measures to prevent impermissible forces to packagings during loading/unloading operation;
- engineered means to prevent drop of NM packagings and FAs in case loss of power;
- limiting protective devices ensuring that the mechanisms move within the permissible boundaries;
- equipment provided for by the design to reliably transfer NM to safe locations in case of a failure or violation of safe operation conditions of reloading mechanisms.

Herein, provide for the information, which confirms that safety requirements are met for relevant process and transport operation equipment of NMSF.

Indicate parameters of storage ambient conditions (ambience, temperature, humidity, chemical composition and etc.) and justify the selection of relevant parameters.

Justify selection of the materials which basic components of NMSF storage system are made of considering normal operation conditions and operational events including emergencies and accidents. Herein, provide for the information on material certification.

There should be a justification of material resistance/stability including absorbing additives to structural materials used at NMSF (if any) under conditions arising during operation including decontamination, operational events and design basis accidents.

Demonstrate compliance with the requirements on incombustibility or poor combustibility of NMSF fencing structures as well as of lining, finishing, sound absorbing, sound insulating, heat insulating materials used for internal finishing of NMSF premises.

Herein, justify the selection of lining materials for SF premise and equipment surface in terms of decontamination.

It is required to demonstrate how the material properties affecting integrity of the leaktight structures during NM storage are taken account of while selecting the material including:

- chemical compatibility with the medium;
- compatibility with material of the contacting components (heat insulation, supports, coatings, sealing parts, etc.);
- cyclic and long-term strength and creep;
- corrosion (including stress corrosion), cyclic corrosion and erosion characteristics;
- radiation damage;
- fatigue, shrinkage, aging,
- radiation induced alterations,
- crack resistance;
- brittle fracture resistance;
- alterations induced by internal gas pressure,
- behavior in abnormal situations

Provide for the information on monitoring of element impurities affecting material performance characteristics as well as on measures limiting such impurities.

Provide for the information on the materials stored including those which manifest hazardous properties in case of fire but which are not a part of packages. Indicate their location specified in the design. Provide for the information on storage inside racks, packaging groups, material stacks, which are effective neutron moderators (if there are any).

Herein, list the systems, which are functionally linked with NM storage system and are safety important. The following systems should be reviewed:

- power supply system;
- ventilation and air-condition system including gas blow-off and gas treatment system;
- cooling system;
- drain system;
- decontamination system;
- control and monitoring systems
- service water drain and water treatment system;
- SCR EAS;
- fire alarm and fire suppression system, smoke removal system;
- regular and emergency lighting system;
- closed circuit television (CCTV).

The following systems should be considered if SNF is stored in cooling ponds:

- water cooling system (except cases when it is justified that design values for storage facility water temperature are not exceeded even without special cooling);
- water treatment system;
- process control system;
- pool in-fill and discharge system;
- leakage monitoring, collection and return-back system;

- other systems (if any).

There shall be data on the location of each system and its interaction with the system in question.

3.2.3. Control and monitoring

This subsection shall contain the information on system control techniques (automated, remote and local control) and system monitoring, list of monitored system parameters and range of their permissible values under each of operational modes.

Herein, list and justify permissible values of monitored system parameters under various operational modes, indicate locations of monitoring points, describe monitoring techniques, provide for requirements to I&C.

Provide for the information on availability of monitoring and alarm systems and devices. It is required to specify all types of monitoring and alarm. Provide for and justify sufficiency of packaging integrity testing means, indicate the criteria for the determining damaged packagings and there shall be a description of actions to detect such damage. It should be demonstrated that the control and monitoring of the system ensure timely diagnostics of defects and revealing deviations in operation to take measures to eliminate them.

Herein, describe how the system is linked with the NMSF controlling systems.

The monitoring and monitoring results documenting procedures are to be described.

Herein, specify administrative measures to monitor NM movements. Indicate the procedure for maintaining, keeping and storing documentation on location, characteristics and quantities of NM, which is received, shipped off-site, stored and transferred on-site.

3.2.4. Tests and inspections

It is required to indicate test program scope, goals and objectives, list of RDs and design documentation which laid the basis for testing and inspections, lists of monitored parameter values and requirements to I&C used in testing.

Provide for a justification of parameter list to be monitored during manufacturing and construction of systems and components and NMSF construction. Provide for the information on techniques, scope and timeframe of NMSF in-service monitoring of conditions and testing of systems, a description of measures provided to this end by the design and demonstrate whether they meet the RD requirements.

Herein, provide for the information on operating regulations and procedure for periodic checks of system (equipment) performance during operation.

3.2.5. Analysis of the system

There shall be an analysis of how the system performs in normal operation, operational events including pre-emergencies and design basis accidents, impact of possible failures of related systems and protection of the system against impacts of such failures. For the design operational modes there shall be operational limits and conditions, safe operation limits and conditions. There shall be a description of the system and components' states and their interaction while performing the designated functions. Relevant calculations and experiment results shall be demonstrated to justify system efficiency.

The following safety aspects shall be considered for normal operation condition (depending on NM stored, storage conditions, NMSF design):

- integrity (leaktightness) of structures, packages and other physical barriers;
- heat removal;
- radiation safety;
- nuclear safety;
- fire and explosion safety.

These issues may be addressed in this section as separate subsections and (or) referred to those sections of SAR NMSF where these problems are discussed in details.

Herein, provide for a justification of the measures adopted in design to ensure strength and leaktightness of the storage facility equipment and structures if no such information is contained in Chapters 2 and 3.

It shall be demonstrated that all equipment and pipelines (if any) withstand static and dynamic loads without collapse. It should be demonstrated that all components of NM storage system are designed considering the possibility to withstand ambient conditions (pressure, corrosion impact of process media, temperature, humidity, radiation and etc.) arising in normal operation, operational event including design basis accidents.

It shall be demonstrated that during NM handling equipment design all loads were considered: those arising in normal operation, due to design initiating events and the stresses arising due to the loads do not exceed permissible limits for various fastening components.

For SIS it shall be demonstrated that their necessary integrity and leaktightness degree are provided for under various loads (static, dynamic, thermal dynamic, etc.) in normal operation conditions and pre-emergencies. Integrity of structures, equipment and components in these conditions shall be confirmed through strength calculations, which considers corresponding loading conditions (stress, temperature, corrosive properties of the medium and other conditions), as well as creep, fatigue, thermal stress, changes in corrosive and physical properties of materials over time (for example, concrete shrinkage).

Integrity of NM packages and other NMSF safety barriers over the design service life of the storage facility or storage period of an individual packaging shall be confirmed through corresponding conclusions.

Measures to prevent precipitations, crystallization, blockage of flow lines and valves shall be described in case of storage of the solutions. Measures to be undertaken in case of solution spillage (trays, safe geometry tanks) shall be also indicated; demonstrate the possibility of radioactive leakage drain and lack of stagnant areas.

Reliability and sufficiency of the stored NM cooling (heat removal) system shall be justified taking account of thermal properties of materials and heat transfer technique (heat conductivity, radiation and convection). While considering heat transfer within NM packaging, FA, shroud, compartment or storage facility as a whole it shall be demonstrated that heat released by NM may be dispersed without an excess of the established temperature limits. The calculations shall take account of all operational modes for the conditions of full loading of storage facility with NM. It shall be demonstrated that NM heat release will not lead to loss of integrity of a packaging during the required period of time.

For SNF cooling pond it is required to demonstrate the following:

- design and hydro-isolation exclude the ingress of RadS into adjacent premises and soil (indicate to what extent cooling pond lining is leaktight);
- storage facility design exclude the possibility of water loss when consumption exceeds make-up in normal conditions and design basis accident;
- the possibility to detect water leakage, location thereof and eliminate it is ensured during storage facility design;
- the possibility to cool SNF is ensured under design basis and beyond design basis accidents;
- cooling pond lining provides for pre-set integrity and resistance to impacts specified in the design; storage facility bottom lining does not lose its integrity in case of FA and shroud drop at maximum height which is possible under transport and process operations;
- lock-gates between cooling pond compartments or ponds (if any) withstand water height from either side in case of its absence on the other side.

There shall be an analysis of system performance in operational event including failures of the system in question and other systems as well as system functioning in case of external and internal impacts.

There shall be results of failure analysis for the system components including personnel errors and that of the failure impact analysis, including common cause failures, with regard to performance of the system under consideration and related systems and to NMSF safety as the whole. For the failures under consideration there shall be a qualitative and quantitative assessment of their consequences.

Depending on specific NMSF the following failures shall be analyzed:

- failures during NM reloading (drop of packagings and loads, shocks);
- failure of passive and active components, damage to the equipment and structures;
- disruption of external power supply;
- failures of the cooling system;
- failures of auxiliary systems (for example, district heating and ventilation);
- disruption of engineering support to maintaining of the required NM storage conditions;
- failures of control and monitoring systems;
- fires (external and internal);
- explosions (external and internal);
- flooding (internal and external);
- strong winds, seismic impacts, aircraft crash;
- personnel errors (erroneous repair, violation of maintenance frequency, equipment replacement).

Evolution of damages (failures) in a packaging, cooling system and structures should be taken into account in the failure analysis.

Herein, analyze how these failures affect performance of NMSF as the whole and demonstrate to what extend they are permissible considering a possibility to carry out corrective actions or repair operations. For each PIE (or a group of failures having common characteristics) there shall be a list of engineered means or measures provided for to eliminate consequences of such failures.

Analysis results shall identify failures which are the initiating events of design basis and beyond design basis accidents to be reviewed in SAR Chapter 8.

In accordance with the RD requirements, the qualitative and quantitative analyses of the system reliability as the whole shall be carried out on the basis of data contained in this section.

The section should also contain the information on software used to analyze system performance and on certification thereof.

3.2.6. Evaluation of design

There shall be conclusions on whether the system complies with the applicable requirements of Federal standards and rules in the field of the use of atomic energy, other safety RDs, as well as safety principles and criteria adopted in NMSF design.

3.3. Transport and process operations system; NMSF on-site transportation of NM, RadS and RW

The section shall contain the information on transport and process operations system, which includes NM receiving, reloading, transfer, on related equipment and conditions for NM, RadS and RW on-site transportation.

The format of system description is similar to the model structure of system description contained in Attachment 3. Descriptions of individual components may be presented in individual subsections having the same structure as the description of the system as the whole. The necessary schemes and drawings shall be attached. It is permitted to refer to other sections.

The section shall contain a description of process flow diagram of transport and process operations (receiving, loading-unloading, transfer, tilting) indicating the equipment, devices and components which perform individual functions. In particular, it is required to present:

- list of transport and process equipment and location thereof; justification of conditions, which provide for safety in handling NM packagings including that during failures and damage;
- list and description of engineered means ensuring heat removal from NM packages (if necessary);
- list and description of measures to prevent a damage, deformation, collapse or drop of packagings;
- list and description of measures to prevent impermissible forces to the packagings during loading-unloading operations;
- list and description of engineered means preventing NM packagings and FAs drop in case of loss of power supply;
- list and description of protective features providing for movement of mechanisms within the permissible boundaries;
- equipment, as envisaged by the detailed design, to reliably transfer NM in the safe locations in case of a failure or violation of the safe operation conditions for reloading mechanisms.

Provide for a justification of strength, stability and resistance of the lifting and transportation equipment to external and internal impacts or provide for a reference to SAR NMSF section which contains detailed information thereof.

It shall be demonstrated, in particular, that the grips of lifting mechanisms are designed so that they reliably lift and transfer NM packagings; that the required accuracy of the lifting mechanism grip positioning over the packaging retention head is ensured, i.e. the grip remains closed in case of a loss of power; that the interlocks are available to prevent a spontaneous release of the grip or release of the grip due to a personnel error.

It shall be demonstrated that under normal operation NM handling equipment design excludes shocks and other loads which may result in damage or change of NM packaging geometrical parameters.

It shall be demonstrated that during NM handling equipment design all loads were considered: those arising in normal operation, due to initiating event in normal operation and accidents. At this, it should be demonstrated that the stresses arising due to the loads do not exceed permissible limits.

There shall be relevant calculations and experiment results to justify system efficiency. Provide for the information on test programs (it is permissible to refer to relevant SAR NMSF section).

Herein, describe the process flow diagram of NMSF on-site transport of NM, RadS and RW. Specify of NM, RadS, RW on-site transportation routs justifying selection thereof (indicate whether transportation routs cross the general-purpose highways).

Provide for a list of vehicles used to transport NM, RadS and RW (indicating sanitary and epidemiological resolutions and period of validity).

There shall be conclusions on whether the system complies with the applicable requirements of Federal standards and rules in the field of the use of atomic energy, other safety RDs, as well as safety principles and criteria adopted in NMSF design.

3.4. Other systems

Other NMSF safety important systems (equipment and structures) which are functionally linked with NM management systems ensuring safe performance thereof and selected for an individual review shall be considered.

The format of system description is similar to the model structure of system description contained in Attachment 3. Descriptions of individual components may be presented in individual subsections having the same structure as the description of the system as the whole. The necessary schemes and drawings shall be attached. It is permitted to refer to other sections.

Tentative list of the systems is contained in paragraph 3.2.2. This list may be changed, shortened or updated to reflect the specific NMSF design. Below there are requirements to a description of some systems to be covered.

Power supply system

The section shall contain the information confirming functional reliability of the power supply systems, sufficiency of the power capacity, availability of multi-channel arrangements, independence, and stability to external and internal impacts, possibility of maintenance, testing and repair.

It shall be demonstrated by the performance analysis results that the safety RD requirements are met in normal operation, operational events and failures of the power supply systems considering personnel errors as well as in design basis and beyond design basis accidents.

The main principles of design and operations conduct of the NMSF power supply systems shall be outlined.

Qualitative and quantitative reliability analyses of the power supply system shall be performed.

Ventilation and air treatment systems

The section shall contain information on the ventilation systems (general and process) which perform different functions:

- to maintain the pre-set air temperature on the premises with the NMSF design operational modes;
- to maintain necessary degree of depressurization, and air flow directions;
- to ensure radiation safety in NMSF rooms and beyond in accordance with the applicable standards;
- to provide for the conditions, as permitted by sanitary standards, for maintenance personnel activities in all design operational modes;
- to create repair and reloading operations.

The basic principles of design and operations conduct of the NMSF ventilation systems shall be outlined.

There shall be the information confirming functional reliability of the ventilation systems, their redundancy degree, stability to external and internal impacts, possibility of maintenance, testing and repair. Qualitative and quantitative reliability analyses of the ventilation systems shall be performed.

It shall be demonstrated by the performance analysis results that the safety RD requirements are met in normal operation, operational violations and failures of the power supply systems considering personnel errors as well as in design basis and beyond design basis accidents.

CHAPTER 4. CONTROL AND MONITORING

The chapter describes technique and means of NMSF control and monitoring during normal operation conditions, operational event and accidents when it is necessary to protect process equipment, NMSF personnel, public and environment from possible radioactive releases and discharges.

The requirements to the information presented in this Chapter apply to safety important systems, which perform controlling and monitoring functions and which may include:

- control room (if available);
- system and means of communications and warning;
- diagnostics systems;
- system and means of control over integrity and operability of physical barriers;
- control over fire suppression systems;
- systems and means for control and monitoring of explosion safety systems;
- systems and means for control and monitoring of physical protection systems;
- systems and means for control and monitoring of radiation situation in the NMSF premises;
- SAC SCR;
- systems and means of environmental monitoring including ARMS information systems;
- information system for NMSF control and accounting of NM, RadS and RW.

The Chapter contains the information on the aspects of control which are safety important as well as peculiarities of NMSF management by operating personnel and safety important functions thereof.

The information shall be presented in scope and detail necessary to justify engineering and organizational safety solutions adopted in the detailed design. While providing the information it is permitted to limit oneself to the reference which may be made to SAR corresponding chapters (sections) where this information is presented in details.

4.1. Identification of safety important control and monitoring systems and means

Herein, list all safety important control and monitoring systems and means. Indicate their names and codes in accordance with the detail design documentation and technical specifications.

Provide for a classification of these systems and means in terms of their purposes and impact to safety.

4.2. Description of control and monitoring systems and means

The information shall be presented in the sequence below.

4.2. X[2]*.1. Purpose and design bases

There shall be information on safety important conditions and constraints to design control system, safety principles and criteria laid as the basis for system design.

4.2.X.2. System description

Information shall be provided to contain a CS description, data on its composition, main technical characteristics, description of functioning during normal operation and operational events taking account of its interaction with other systems and means and related equipment.

There shall be information on including CS automation means including systems and means providing for automated and unattended control over the normal operation systems of NMSF.

There shall be the information related to group communications between CR and NMSF personnel; individual communications between CR and personnel, means providing for

[2]* X – a subsection of a specific system.

information collection, processing, documenting and storing; diagnostics of CS automation means, radiation monitoring systems.

Provide for the information on justification that measures ensuring working conditions for the operating personnel are sufficient in NMSF normal operation and under accidents.

Provide for the information on access procedure to control system rooms as well as to emergency management area in case of normal operation and accident.

For control room and other control and monitoring systems and means when human is involved, provide for the information on ergonomic and anthropometric support of operator's working stations. Justify "man-machine" interaction.

There shall be information on the power supply and grounding, protection against external factors, systems that maintain required working conditions in the CS rooms.

As regards systems and means for warning and emergency alarm of the NMSF employees the description shall also contain:

- a list of warning signals and accompanying visual, audible and other signals to attract the employees' attention;
- technical characteristics of the means to attract attention of employees (blinking frequency, sound pitch, etc.):
- rules of how to use warning signal systems in emergencies;
- information on communications, including back-up, intended for NMSF control and the warning systems for normal operation, design basis and beyond design basis accidents.

Justify solutions made to ensure NMSF safety and functioning during failure of control and monitoring systems and means.

4.2.X.3. Start-up and aligning operations

Justify selection of the methods to test performance of control and monitoring systems and means, their comprehensive alignment, diagnostics and documenting of their characteristics, as well as a justification of their compliance with the specifications.

4.2.X.4. Maintenance

The solutions regarding the diagnostics, periodical inspection of CS and its constituents, means and components' conditions, their periodic checks and functional testing, recording of malfunctions and failures as well as personnel training should be justified.

Indicate measures targeted to eliminate malfunctions and defects during CS maintenance; justify sufficiency thereof.

4.2.X.5. Analysis of the system

There shall be the analysis results of failures of the control and monitoring system and means and impact of failures to NMSF safety; demonstrate to what extend the system and means comply with the design criteria, RD requirements.

The information shall include the system and means response analysis to external and internal impacts (fires, floods, electromagnetic noises, short circuits in the primary power supply system, etc.), the system response to possible failures and malfunctions (degrading of insulation, voltage drops and pick-ups, faulty actuation, loss of controls, etc.), the results of quantitative reliability analysis, the results of the control circuits stability and their safety impact. For control board provide for analysis results proving common cause failure impossibility.

In cases where the input calculation information and analysis depend on personnel actions, there shall be the results of analysis of how incorrect personnel action affect safety, as well as the information on I&C and instrumentation installed to prevent or mitigate consequences of operational events and accidents.

Provide for analysis results of reliability of all elements and components of control system in normal operation, operational event and accidents.

In case of the systems and means, which do not affect safety, there shall be justification, which proves that these systems and means do not affect safety. Similar requirements shall be true for the analysis of how the maintenance operations affect safety.

CHAPTER 5. RADIOACTIVE WASTE MANAGEMENT

The Chapter shall contain the information on RW (LRW, SRW, GRW) generated in the course of NMSF operation along with RW management systems and procedure, RadS releases and discharges.

If NMSF is a part of NFCI it is required to demonstrate interaction of RW management systems and RadS release and discharge with relevant NFCI systems. The information shall be presented taking into account such interaction.

Compliance of RW management principles and techniques with the requirements of federal standards and rules in the field of use of atomic energy shall be demonstrated.

5.1. Radioactive waste generation sources

The section shall describe the sources of gaseous, liquid and solid RW generation during NMSF normal operation (including those related to maintenance and repairs) and operational event including design basis accidents. The latter requires information on RW generation if RW characteristics and volumes are considered as input data for RW management system development. The section shall to analyze the processes and operations (decontamination, maintenance and repair, operation of lean-up facilities, elimination of leaks and spills, etc.) leading to RW generation, provide for data on quantity, qualitative and quantitative radionuclide composition of LRW, SRW and GRW in accordance with the classification. The RW qualitative and quantitative characteristics shall be supported by the calculations.

Provide data on the amount of GRW being generated. Considerations shall be given to the processes and scheduled operations leading to GRW generation. Indicate NMSF systems which may be possible sources of RadS releases into the premises and the environment including ventilation systems of the premises, where personnel works permanently or on part-time basis, and process blow-off systems (if any). List all equipment of the systems where it is possible for hazardous explosive concentrations of gases to form; provide for design pressure values.

Provide data on LRW amount, activity, qualitative and quantitative radionuclide composition. Considerations shall be given to the processes and scheduled operations which may lead to LRW generation or may result in LRW ingress into the premises and RadS release to the environment under normal operation and operational event (including leakage, spills).

Provide data on SRW amount, activity, qualitative and quantitative radionuclide composition. Considerations shall be given to the processes and scheduled operations which may lead to SRW generation or may result in SRW ingress into the premises and to the environment under normal operation and operational event.

Herein, specify the systems which may be possible sources of RadS releases (discharges) during operation or maintenance and which are not referred to RW management systems.

Describe measures to minimize quantities of generated RW (GRW, SRW, LRW), RadS releases and discharges.

5.2. Gaseous radioactive waste management systems

5.2.1. Design basis

There shall be purpose and functions of the system, safety basic principles and criteria adopted in the design for GRW management including measures to reduce GRW volume and activity, releases to the environment.

The basic safety principles and criteria implemented in the design and/or process flow diagram shall be outlined.

5.2.2. Analysis of the system

Describe each GRW management system and gas flow diagrams specifying process equipment, gas flow routes, efficiency of the system and relevant equipment, stand-by

equipment. Herein, for each system present maximum and standard input values of gas flow rate and RadS (radionuclide) concentration for all operational modes. The data are presented in the tabulated format or in the form of diagrams. Description of the system shall be made in accordance with the structure contained in Attachment 3.

Justify explosion preventive measures, which are provided for in the design.

Describe ventilation systems of each building where GRW may occur. The description shall include volumes of buildings, anticipated flow rates in the building ventilation systems, characteristics of filters. Describe both the normal operation mode of each ventilation system and features pertaining to operational event including design basis accidents.

Describe the process instrumentation and controls (including gas analyzers).

Demonstrate that GRW management systems provided for in NMSF design have a sufficient capacity, efficiency and necessary redundancy to ensure the required GRW clean-up level and keeping within the permissible RW release levels in all operational modes including design basis accidents.

It shall be demonstrated that technical solutions selected for GRW management are in compliance with RD requirements.

5.2.3 Radioactive substance release

Provide for existing standards (control levels) for releases.

Provide and justify anticipated values of RadS releases under all NMSF operational modes including design basis accidents and (or) refer to relevant SAR sections where this information is contained. Indicate all sources of RadS releases. Provide for release values for each source indicating radionuclide composition, values of volumetric specific activity of each radionuclide and integrated activity.

Demonstrate compliance of RadS release values with existing standards.

5.3. Liquid radioactive waste management systems

5.3.1. Design basis

Indicate basic safety principles and criteria adopted for LRW management including measures to reduce LRW volume and activity, releases to the environment.

Herein, demonstrate that LRW management systems have sufficient capacity, efficiency and redundancy to provide for LRW reprocessing and the required degree of cleanup of RadS discharges under all design operational modes and design basis accidents.

Provide for calculation criteria for LRW management systems taking into account LRW characteristics, maximum and anticipated quantities of LRW subject to reprocessing, storage or disposal of or removal from NMSF territory, its radionuclide content and activity.

5.3.2. Analysis of the system

Demonstrate the procedure and techniques to be used to collect, reprocess, store and condition LRW and relevant systems for each type of SRW (having different physical and chemical properties, specific activity, radionuclide composition and etc.). System description shall be presented in accordance with system description format contained in Attachment 3.

Provide for process flow diagrams for reprocessing of each LRW type, anticipated composition of LRW and relevant equipment. Provide for the information on RW packaging type, requirements to end-forms of conditioned RW as well as RW form and packagings subject to storage, disposal of and (or) removal from NMSF territory.

The description of each system shall contain process flow diagrams indicating the equipment, system efficiency and relevant equipment components, stand-by equipment and liquid flow routes.

Herein, for each system present maximum and standard input values of LRW flow rate and of volumetric specific activity of LRW radionuclide for all operational modes and design basis accidents. The data are presented in the tabulated format or in the form of diagrams. Provide for initial data to determine above values.

It shall be demonstrated that technical solutions selected for LRW collection, reprocessing, conditioning and storage are in compliance with RD requirements.

5.3.3. Release of radioactive substances

Provide for existing standards (control levels) for discharges.

Provide and justify anticipated values of RadS releases under all NMSF operational modes and operational events including design basis accidents. Indicate all sources of RadS discharges. Provide for discharge values for each source indicating radionuclide composition, values of volumetric specific activity of each radionuclide and integrated activity; indicate RadS discharge locations.

Demonstrate compliance of RadS discharge values with existing standards.

5.4. Solid radioactive waste management system

5.4.1. Design basis

Outline basic principles and criteria implemented in the design and/or process flow diagrams specifying RDs which are the basis for system design.

Provide for calculation criteria for SRW management systems taking into account SRW characteristics, maximum and anticipated quantities of SRW subject to reprocessing, storage or disposal of or removal from NMSF territory, its radionuclide content and activity.

5.4.2. System description

Demonstrate the procedure and techniques to be used to collect, reprocess, store and condition each type of SRW and relevant SRW management systems. System description shall be presented in accordance with system description format contained in Attachment 3.

There shall be process flow diagrams for processing of each SRW type, anticipated composition of SRW, relevant equipment; justify the selection thereof.

Provide for the information on RW packaging type, requirements to end-forms of conditioned RW as well as RW form and packagings subject to storage, disposal of and (or) removal from NMSF territory.

Present layouts of packaging, storage, loading bays and transportation areas designated for different SRW categories.

Describe systems designed for processing of contaminated work clothing, equipment, tools, ventilation filters as well as other pressed and non-pressed RW.

Measures provided for RW container decontamination and transportation to storage sites shall be described along with the analysis of possible operational events including accidents (loss of RW container integrity in case of drop etc.). Describe measures provided for RW collection and a technology for decontamination in case loss of container integrity.

Provide for measures to ensure RW safe storage; describe SRW temporary storage conditions and anticipated site for its long-term storage.

Outline the procedure for SRW removal from NMSF territory (site) for further reprocessing and (or) disposal of. Indicate maximum possible and anticipated annual quantities, radionuclide composition and activity of each SRW category subject to NMSF off-site shipment. Describe RW shipment conditions.

There shall be a demonstration of compliance of selected technical solutions on SRW collection, sorting out, reprocessing, conditioning, storage and transportation to RD requirements.

CHAPTER 6. RADIATION SAFETY

The Chapter shall contain the information on the radiation safety to be ensured for personnel and population under normal operation and accidents at NMSF considering external and internal exposure as well as environmental protection against radiation impact during NMSF operation.

There shall be demonstrated that NMSF radiation impact to personnel, population and the environment does not result in exceeding established limits and is reduced to as low as reasonably achievable (ALARA) under normal operation, operational events including design basis accidents.

There shall be also radiation monitoring programs.

If it is required references may be made to the information presented in other chapters and sections.

Compliance of radiation safety solutions made with the requirements of federal standards and rules in the field of use of atomic energy shall be demonstrated.

6.1. Radiation safety principles and criteria

The section shall describe principles and criteria to protect the personnel, population and environment from impermissible exposure. It shall be demonstrated that engineered means and organizational measures provided for in the design and aimed at radiation safety have been proved by practice and do not lead to an excess of the established dose limit, exclude any unreasonable exposure and ensure that radiation exposure level is reduced down as low as reasonably achievable considering economic and social factors (ALARA principle).

Provide for basic principles of radiation safety including defense-in-depth and ALARA principle.

Herein, provide for a list and quantitative values of the radiation safety criteria adopted in NMSF design (individual annual exposure dose to critical groups of population and some categories of employees under normal operation as well as the permissible values of the air specific volumetric activity in the periodically attended rooms, contamination levels of surfaces in the rooms and that of the equipment present in the periodically attended rooms, dose rate). Indicate radiation safety criteria, which are taken into account during planning and radiation hazardous works including maintenance.

Outline criteria for NMSF zoning

Provide for the list of deviations from the requirements of federal standards and rules in the field of use of atomic energy, assessment of deviation impact to the safety and adopted compensating measures as well as give a reference to the section of the document where these deviations are considered in details.

Demonstrate how the requirements to reduce occupational exposure down to such low level as reasonably achievable are taken into account during operation considering economic and social factors (ALARA principle). There shall be a description of technical and administrative solutions to reduce employee exposure level including during maintenance and repair.

6.2. Radiation sources and radiation hazardous works

Provide for data on characteristics of ionizing radiation sources at the working places in RWSF premises which are taken into account in radiation protection calculations and design and which require protection of personnel against external exposure (in RW and RadS storage, handling, displacement and shipment).

Provide a list of RWSF premises which house ionizing radiation sources including premises for temporary presence thereof.

Provide for a list of NMSF systems (components), which are ionizing radiation sources.

Provide for data on characteristics of radiation sources. Description of radiation sources shall contain tabulated data on a radiation spectrum along with the radiation energy, activity

data, geometrical parameters of the source and input data used for estimation of the above mentioned values. The most conservative values of the above parameters shall be demonstrated.

In particular, the following shall be specified:

- for dealing with open radiation sources: radionuclide, compound, aggregate state, activity at the working place, annual flow rate, type and nature of the scheduled works, class of work;
- for dealing with sealed radiation sources: radionuclide, its type, activity, permissible number of radiation sources at the working place and integrated activity thereof, nature of the scheduled works;
- for dealing with radiation sources of complex radiation characteristic: type of radiation source and its radiation characteristics (radionuclide composition, activity, radiation energy and rate and etc.).

Describe the sources of gaseous RadS release into the ambient of the rooms which are taken into account during the development of protective measures and assessment of occupational doses. Along with sources of normal operation there shall be a description of RadS sources in the form of gas and aerosol in case of maintenance, repair and expected operational events.

Present calculation results of RadS concentration (volumetric activities) in the form of gas and aerosol as a Table.

Models, parameters and input data needed for calculation of ionizing radiation source parameters shall be presented. List software used to calculate ionizing radiation source parameters. Provide for a brief description of calculation techniques, input data for calculation and assumptions made as well as software certification data.

6.3. Design features relevant to radiation protection

6.3.1. Locations and layout of buildings, structures and equipment

Layout of the complex of the NMSF process buildings, structures and premises with indication of the process equipment being a source of radiation.

The following shall be indicated in the layout:

- boundaries of the controlled access area, periodically attended premises, permanently attended premises including administrative and housekeeping premises;
- location of personnel air locks, stationary sanitary locks, special laundry and medical aid posts;
- routes of workers and transport, delivery of clean and removal of contaminated equipment and materials;
- location of places for storage of contaminated equipment, decontamination bays, RW collection and storage places;
- location of sensors and control boards of the radiation monitoring system;
- location of laboratories for analysis of radioactive media samples, laboratory of individual dose monitoring;
- location of external dose measuring laboratories, surveillance and monitoring stations;
- location of premises (places) for collection of non-radioactive waste.

Classification of NMSF zones and premises applied in the design of radiation protection and to prevent RadS air contamination inside the premises of periodically and permanent staying of personnel shall be presented.

6.3.2. Design features of protective systems and equipment components

For each radiation source provide for the information on engineering and technical means for personnel protection against external exposure, its design, layout and shielding materials. The description shall include geometrical size and location, protective material characteristics,

data on special protective devices and equipment (protective casks, stationary and mobile shields, boxes and etc.) as well as methods for determining the shielding parameters.

Special protective means and equipment, which are used for NM, RadS and RW handling and allow reducing occupational exposure down to established level, shall be described including packages, shrouds, shields, loading equipment, remotely controlled equipment and etc.

The description shall include design features that reduce timeframe of radiation-hazardous works including maintenance as well as provide for easy access to working places, remote conduct of operations, reduction of time spent by personnel for operations, and any other measures reducing occupational exposure or there shall be a reference to relevant sections which contain justification.

Demonstrate that presence of personnel in radiation-hazardous areas is excluded or limited to the extent possible by process automation and mechanization, location of equipment, working places, storage areas, use of protective means and other measures.

6.3.3. Personnel protection against external exposure

Calculation results shall be presented including a design level of radiation inside premises of permanent and periodic presence of personnel including administrative and housekeeping buildings during normal operation, operational events including design basis accidents and conduct of planned operations. Calculation results regarding personnel and population protection against external exposure are presented in the form of a table. Demonstrate that the values of design equivalent dose rate for standard duration of personnel presence in NMSF premises do not exceed the values specified in RDs.

Provide for limiting conditions for conduct of operations.

Briefly describe calculation methodology for personnel and population protection against external exposure. Provide for a list of software and software relevant data used to calculate radiation protection. There shall be a brief description of software purpose, software calculation technique, main restrictions and assumptions and data on software certification.

6.3.4. Personnel protection against RadS impact. Ventilation systems

The section shall demonstrate that ventilation systems provide for the protection against radioactive pollution of working room ambient and free air as well as personnel protection against RadS impact. Engineered means for air clean-up from RadS (gases, aerosols) provided for in the design shall be presented in the section including maintenance ventilation.

Describe ventilation systems of each building (which is not addressed in Chapters 3 and 5), layout of the premises, which are used for air clean-up and house ventilation system equipment. Provide for the information on building volume, expected flow rate in building ventilation system, filter properties. For each ventilation system describe normal operation mode and operation peculiarities under operational events including design basis accidents. Characteristics of air clean-up means in use, clean-up factor values assumed in radiation safety analysis shall be presented.

Demonstrate that in the working premises the airflow is directed in the way that it goes from less polluted areas toward more polluted ones.

Describe methods and means determining efficiency of air clean-up. Provide for the characteristics of air clean-up filters in use and filtering element replacement criteria.

Describe and justify ventilation system maintenance conditions as well as system control and testing means.

6.4. Assessment of personnel and population radiation dose

Present an estimate of annual duration of personnel staying in the premises of permanent and periodic presence of personnel and periodic maintenance under normal operation including equipment repair and maintenance.

An estimate of duration of personnel presence in the premises (in man-hours) and estimation of RadS intake by a human body due to inhalation is provided for premises where gas-and-aerosol activity is anticipated.

Present an estimate of the annual effective individual occupational dose and collective occupational dose for normal operation including maintenance and repairs as well as for operational events.

Provide for an estimate of the annual effective individual dose for critical groups of population under normal operation (as a result of releases and discharges) and accidents (within the controlled area boundaries, at the industrial site boundary and NMSF CA considering radiation sources located at NMSF site). If NMSF is a part of NFCI indicate that the impact of NMSF to the population and environment does not exceed the value of corresponding quota.

Briefly describe calculation methodology for personnel and population radiation doses, input data and assumptions. Provide for a list of software and software relevant data used to calculate personnel and population radiation doses. There shall be a brief description of software purpose, software calculation technique, main restrictions and assumptions and data on software certification.

6.5. Radiation monitoring

The section shall demonstrate that engineered means and administrative measures provided for in the design to conduct radiation monitoring cover all main types of ionizing radiation impact to the personnel, population and environment and are in compliance with the requirements to radiation monitoring specified in Radiation Safety Standards.

6.5.1. Organization

Present organizational structure of OO divisions including RS service at the NMFS that provides for radiation monitoring.

Herein, describe organizational and administrative measures for control of personnel presence in the premises, which are attended permanently and periodically, provide for the information on access control system, information on compliance with the procedures for conduct of radiation-hazardous operations.

Present the information on the units providing for radiation situation data receipt under normal operation and accidents.

Describe organizational chart of radiation monitoring system, conditions for storage of radiation monitoring instrumentation, its calibration and metrological qualification.

Demonstrate the procedure provided for in the design for registration and storage of the results of individual occupational dose monitoring.

6.5.2. Radiation monitoring

The section shall demonstrate that radiation monitoring system provided for in NMSF premises, industrial site, CA and surveillance area ensures receipt and processing of the information on monitored parameters which characterize radiation condition of NMSF and the environment.

List radiation monitoring programs, which shall include the following types of radiation monitoring:

- radiation monitoring in NMSF premises and site (process radiation monitoring, health physics monitoring, monitoring of radioactive contamination evolution);
- radiation monitoring of the environment in CA and surveillance area;
- radiation monitoring under operational events including accidents.

For each section of specific radiation monitoring program it is required to provide for the following information: list of the facilities, which are subject to radiation monitoring, types of radiation monitoring, monitoring means including metrological support, monitored parameters, permissible levels of monitored parameters, engineered means and methodological support of

radiation monitoring, methods for information processing, analysis, presentation and transmission, scope and periodicity of radiation and metrological parameter monitoring.

Demonstrate the use of the following engineered means for radiation situation monitoring (for NMSF referred to radiation facilities of category I and II):

- continuous monitoring on the basis of stationary automated systems and stationary engineered means;
- on-line monitoring on the basis of portable and mobile and/or transportable engineered means and installations;
- laboratory analysis on the basis of laboratory hardware, installations, means for sampling and preparation of radioactive samples for analysis.

Provide for the information on availability of radiation monitoring means with sound and light effect alarm devices in the premises of possible SCR as well as in the premises to conduct operations of class I when radiation situation is subject to significant changes during operations.

Location of air sampling points to monitor gas and aerosol activity shall be specified; air sampling system shall be described; criteria and methods for obtaining of representative results of concentration measurements of radioactive gases and aerosols shall be presented.

Capabilities of the engineered means for radiation monitoring shall be described with regard to measuring the radiation situation parameters including high rate radiation and occupational dose rate in case of radiation accident. Necessity for instrumentation and control equipment for such measurements shall be justified.

Describe software for information processing and displaying, collecting, storage and systematization of data on radioactive contamination of the environment and occupational and population doses.

CHAPTER 7. NUCLEAR SAFETY

The section provides for the information for those NMSF which deal (management, storage, transportation and etc.) with plutonium, uranium-233, uranium with enrichment exceeding 1% (mass) by U-235 nuclide if total mass of isotopes of plutonium and U-233, U-235 nuclides of NMSF (NMSF units) does not exceed 300 g. Mass of other NFM shall be regulated and justified. Availability of fissile material and compliance with the requirements limiting its mass shall be confirmed by continuous accounting and records.

The Chapter shall describe engineered means and organizational measures provided for and aimed at preventing SCR during NM storage, handling and transportation and limiting its consequences. There shall be demonstrated that engineered means and organizational measures provided for are sufficient to create and maintain the conditions to ensure nuclear safety.

7.1. Nuclear safety objectives and principles

Provide for nuclear safety objectives and principles adopted in NMSF design.

Provide for a list of RDs the requirements of which are taken into account in the course of the development of engineered means and organizational measures to ensure nuclear safety.

Outline general nuclear safety principles aimed at preventing SCR, uncontrolled and unauthorized NFM (S, N) reprocessing, accumulation, movement, transfer and transportation.

It is required to demonstrate that they are in conformance with the RD requirements on nuclear safety, list the deviations from the RD requirements, evaluate the impact of such deviations to safety and compensating measures undertaken.

7.2. Premises, systems and components with NFM

It is required to present the information on all types of nuclear fissile materials present at NMSF, their locations, NFM (S, N) processes and handling operations.

Provide for a list of premises and equipment where NFM (S, N) may be present.

Provide for a list of process operations related to NFM (S, N) handling.

For the listed nuclear-hazardous areas, systems, equipment including NM packaging and processes present NFM (S, N) characteristics to include its mass, aggregate state, density, isotope, nuclide and chemical composition of fissile materials, presence and mass fraction of neutrons moderators, reflectors and neutron absorbers, etc. in the scope sufficient to justify design and organizational solutions adopted in the design to ensure safety. Describe NMSF equipment and areas (by sketches and drawings), which may cause SCR. Indicate the size and distance, which are significant for nuclear safety analysis.

Provide for a list of systems (components) including packages, which NFM (S, N) is loaded to or may get into, indicating number of equipment item, drawing, equipment type (“B”, “HMC”, “O”).

7.3. Design features preventing SCR initiation

The section shall contain the information on engineered means and organizational measures preventing SCR as provided for in NMSF design.

There shall be the information on which and how nuclear safety requirements listed below are used in NMSF design:

- nuclear safety is ensured by storage facility and packaging design, restrictions on geometric shape, restrictions on a number and location of packagings, restrictions on NM arrangements in packagings, shrouds, racks; restrictions on equipment size, restrictions on FAs number in packagings, shrouds, racks; restrictions on a number of packagings, shrouds, racks in a group; restrictions on the arrangements of groups of packagings, shrouds, racks;
- restrictions on NFM (S, N) mass;

- restrictions on NFM (S, N) concentration;
- application of homogeneous or heterogeneous neutron absorbers;
- monitoring of neutron moderator presence in NFM (S, N), NFM (S, N) humidity;
- monitoring of reflector presence;
- monitoring of equipment layout;
- monitoring of NM, absorbers, packagings, shrouds, racks positioning;
- monitoring of process parameters of NM storage and handling systems;
- combination of the above methods and restrictions.

For each nuclear-hazardous areas and equipment of NMSF (including packagings, groups, stacks, storage nests, storage bays etc.) listed in section 7.2 there shall be restrictions posed on the parameters of NFM, equipment, systems specifying geometry, size, positional relationship of the equipment, packagings, neutron moderating and neutron absorbing features of the structural components and materials.

Values, which are subject to changes during processes, have nuclear safety restrictions posed on and are to be monitored, shall be indicated. The following may be referred to them:

- NFM (S) mass loaded into equipment including package;
- NFM (S) concentration, content of NFN in NFM (S);
- NFM (S, N) mass accumulated in the auxiliary equipment (filters, communications, traps etc.);
- content of neutron moderators;
- NFM (S) humidity;
- SNF burn-up rate;
- concentration of homogeneous neutron absorbers, NFM level and volume, NFM even distribution inside process equipment, installation.

For the above listed nuclear safety parameters, herein, indicate safe (permissible) nuclear safety parameters and standards, error applied to the established values and methods to ensure nuclear safety standards and requirements.

Provide for references to the paragraphs of nuclear safety rules and review conclusions, which are the basis for establishing nuclear safety parameters and standards.

7.4. Techniques and means for nuclear safety parameter monitoring

For each nuclear-hazardous bay, zone, working premises, systems and components of NMSF provide for techniques and means of monitoring of restrictions posed on NFM (S, N) parameters, equipment, equipment layout, packagings indicating parameters, properties and errors of measurement means, location map for nuclear safety parameter monitoring points.

Provide for procedure, techniques and means of monitoring of equipment, system parameters determining geometry, size, positional relationship of the equipment, packagings, neutron moderating and neutron absorbing features of the structural components during equipment manufacture and installation as well as procedure for periodic monitoring of the parameters. Describe techniques for monitoring of packagings, packaging groups, racks, absorbers, FAs as well as for monitoring of moderator presence and quantity and absorber integrity during storage.

Indicate procedure, techniques and means of monitoring of the values, which are subject to changes during processes and have nuclear safety restrictions posed on.

Demonstrate that techniques and means of monitoring of the values having nuclear safety restrictions posed on, reliability of instrumentation control over nuclear safety parameters and preventive measures aimed at maintaining instrument efficiency are in compliance with RD requirements.

7.5. Nuclear safety analysis and justification

The section shall present and justify methods to conduct nuclear safety analysis and provide for the results of nuclear safety analysis, assessments of SCR consequences and measures to limit consequences thereof.

7.5.1. Nuclear safety justification methods

Methods to conduct nuclear safety analysis as well as methods to calculate K_{eff} value shall be considered and justified. The information shall be presented in the scope and detail required to justify engineered and organizational solutions adopted in the design to ensure nuclear safety.

There shall be presented the basis for calculations conducted to justify nuclear safety while setting forth standards, threshold values of monitored parameters with regard to NFM (S, N); references to nuclear safety documents, materials and review conclusions, which contain nuclear safety analysis, shall be indicated. It is required to outline adopted assumptions (as regards NM composition and NM enrichment, presence and composition of absorbers, reflectors, moderators, and capacity of the storage facility assumed for the calculations, etc.). Indicate errors associated with errors of calculation methods, concentration and isotopic composition, absorber properties and manufacturing allowances.

Present a list of calculation methodologies and software specifying certification and applicability thereof. Information on a database including neutron cross-section library used should be provided for.

7.5.2. Nuclear safety analysis results

The nuclear safety analysis results for normal operation, operational events including design basis accidents shall be given.

It shall be demonstrated that at all stages of NM reloading, transfer, transportation and storage during normal operation and operational events including design basis accidents, the configuration of a packaging, stack and stack arrangements are subcritical with a corresponding reliability margin.

In case of normal operation, the calculation shall reflect the design configuration of a packaging loading and, if necessary, presence of the neutron absorbers.

In case of operational event there shall be the analysis of possible significant deviations from the design geometry of NM arrangement and it shall be demonstrated that nuclear safety is ensured in such conditions.

While analyzing nuclear safety of NM storage facilities and transport and process operations there shall be a list of events, violations, failures which may lead to exceeding of safe (permissible) parameters, to SCR initiation, the results of consequence analysis for each piece of equipment (an exemplary list of initiating events is given in the relevant RDs on nuclear safety).

For initiating events it is required to consider the possibility:

- to re-group FA and NM inside shrouds, racks, packagings which leads to growth of neutron multiplication coefficient (effective);
- to change geometric configuration of NM, FA, FE packaging (bends, flattening etc.) as well as FE spacing in FA which leads to growth of neutron multiplication coefficient (effective);
- of water boiling, generation of steam-water mixture which leads to growth of neutron multiplication coefficient (effective);
- of loss of efficiency of heterogeneous or homogeneous neutron absorbers;
- of water or steam-water mixture ingress into the packaging, shroud, fresh and spent nuclear fuel drum, SNF dry storage facility.

Each specific case selected for further consideration shall be covered by a calculation of consequences to confirm that criticality is ensured.

It shall be demonstrated that sub-criticality is provided for even with taking account of the water moderating effects to NM and other possible moderators including snow, condensate, steam or material containing moderator which may get in as a result of some IE including the impact of fire extinguishing means to nuclear safety. If sub-criticality under the conditions in question can not be ensured it should be demonstrated that such conditions are excluded.

The assessment results of SCR consequences shall be given. It shall be demonstrated how these results are taken into account during the development of emergency planning measures. If it is necessary refer to relevant section of SAR NMSF.

7.6. SCR emergency alarm systems

There shall be the information on how nuclear-hazardous bays are equipped with SCR emergency alarm systems. Lack of EAS installation shall be justified.

There shall be EAS description (sensor location scheme, system composition, detecting technique, converters, audible and visible alarm devices) and its performance. The EAS false actuation consequences shall be analyzed.

There shall be information on EAS testing and verification. Present the information on EAS in-service inspection. Indicate periodicity of checks and procedure for result records.

The EAS reliability indicators shall be justified. It shall be demonstrated that reliability and preventive measures aimed at emergency alarm operability are in compliance with RD requirements.

7.7. Nuclear safety work arrangement

Provide for the information on nuclear safety work arrangement.

Present necessary information on availability of nuclear safety documents and justify the compliance of design documentation with RD requirements on nuclear safety. Provide for a list of process regulations and guidelines which requirements shall be met by nuclear safety program.

Describe a structure of NMSF nuclear safety unit, its main functions, personnel qualification requirements.

Describe the procedure for training and examination of personnel involved in nuclear-hazardous operations. Provide for the information on work permit procedure for personnel of the nuclear-hazardous bays and management thereof.

Present the information on the procedure for nuclear safety monitoring as well as content, periodicity and arrangements of nuclear safety verification.

CHAPTER 8. COMMISSIONING

Information on the organization, scope, sequence and dates of alignment activities and tests carried out during NMSF commissioning shall be presented in the Chapter for all safety important structures, equipment, systems and components of NMSF.

8.1. General provisions

Main provisions of a program for NMSF commissioning and quality assurance in commissioning shall be defined and justified including work breakdown into stages and sub-stages, their interactions and coordination, sequence and dates for implementation of each stage or sub-stage, success criteria for their implementation, required administrative and technical measures.

It should be demonstrated that while implementing NMSF commissioning stages transition from one operations stage to the next is carried out considering growth of potential danger of possible accidents.

It is required to demonstrate that:

- requirements of GSP NFCF and other RDs are fully met during commissioning;
- safety is ensured during alignment operations and tests at all stages of NMSF commissioning;
- the required completeness of studies and verification of all modes and parameters of NMSF systems related to its operational safety is provided for;
- design basis and characteristics of systems for normal operation are proved.

8.2. Work conduct

Herein, describe anticipated work organization and system of interaction between OO personnel and representatives of scientific, design, engineering, assembling, constructing and setting-up organizations and suppliers both in preparation for commissioning and during NMSF commissioning. 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 of tasks of commissioning is to be presented. Work routine and recruitment of staff of organizations involved shall comply with RD requirements.

The following matters shall be covered:

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

8.3. Stages of work

The division of the whole period of NMSF commissioning into stages and sub-stages according to a specific nature of any stage and tasks to be solved at each stage (sub-stage) shall be justified. Information on the 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.

The following information shall be presented:

- a description of NMSF commissioning roadmap;
- data on SAO and acceptance tests of SISs.

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

8.4. Test programs

Give a brief description of test programs for each stage (sub-stage) of commissioning shall be presented. Information on test programs for all safety important systems and for individual equipment.

Present the following information for each stage (sub-stage):

- objectives of work and tests, success criteria of their implementation;
- work sequence;
- requirements for readiness of premises, systems and equipment for tests;
- process restrictions, conditions and measures for safe performance of work and tests;
- scope, sequence, 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 to reporting documentation including those for its formatting, submission and keeping, procedure for getting access to it;
- requirements for a number and professional skills of personnel involved in work and tests, allocation of responsibilities including administrative units.

Describe methodologies for assessment of the most important characteristics of SIS, and the basic characteristics of NMSF.

Provide for the information on potentially hazardous operations and measures to prevent accidents.

Indicate procedure for development and approval of NMSF commissioning program, quality assurance program for NMSF commissioning and work programs on the basis of design documentation.

8.5. Work and tests schedule

Present the schedule for NMSF commissioning activities with indication of a starting date for operation.

Indicate main work stages, their preliminary duration on the schedule. A list of all activities and tests is presented for each stage individually. Planned schedules of adjustment and tests of individual structures, systems and components of the NMSF are given.

8.6. Additional requirements to NMSF commissioning

Present additional requirements to be considered in preparation for activities and during their implementation on the NMSF site, including the requirements for:

- conditions for development, coordination and approval of work documentation (operational regulations (or similar operational documents), SAR NMSF, a set of procedures including those for emergency preparedness and response, etc.);

- participation of operating and extra 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 of the obtained characteristics to the design values including the necessity to update the design and operational documentation;
- organization of production and engineering support and document's archiving;
- arrangements for areas with restricted access to the NMSF premises and fenced-off (guarded) areas depending on stages and phases of the NMSF commissioning program;
- organization of fire fighting and fire monitoring services;
- organization of sanitary areas, radiation and dose monitoring services inside the NMSF premises, on its site and within the CA;
- development and introduction of emergency response plans for protection of workers and population in case of accident at NMSF.

8.7. Report on SAO implementation

Brief information on SAO results 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 documentation shall be revised. In the corresponding sections of SAR NMSF it shall be justified whether the non-compliances with regard to conditions ensuring required level of safety and reliability are permitted.

Describe deviations from the sequence and organization in implementation of alignment operations and tests. Analysis of their causes and lessons learnt shall be presented.

Completion of the integrated work schedule of the NMSF commissioning program is analyzed in terms of completeness and milestones. Evaluate the validity of the accepted deviations.

Present the information on additional requirements for commissioning and degree of compliance with them, including information on revision of operational documentation based on the results of the work.

CHAPTER 9. OPERATION

This chapter is required to contain the information on how the NMSF operations are conducted, on preparedness of the personnel and maintaining the operability of the systems and NMSF as the whole.

The information shall demonstrate compliance with the GSP NFCF requirements.

9. 1. Organization of management

9.1.1. Operating organization

The section shall contain the organizational structure of OO and its units involved in NMSF operation support, the information on principles and interaction between NMSF and the OO. There shall be demonstrated that units' structure, distribution of responsibilities and authorities between the OO and NMSF administration as well as different units ensure NMSF efficient management.

It is required to present information on:

- the OO organizational structure with a listing of functions of its main units during NMSF operation and decommissioning;
- the organizational structure of the NMSF operations management with outline of managerial positions in the units, authority of the managers and their responsibilities with regard to nuclear and radiation safety;
- the organizational structure of NMSF nuclear and radiation safety units;
- a list of organizations carrying out activities and rendering services to the OO with their names and availability of the corresponding licenses issued by Rostekhnadzor.

9.1.2. NMSF administration and operations management

Provide for the organizational structure of the NMSF operations management.

The information shall contain: list of the units with their names and functions specifying administrative managerial positions; units' structure, employee (personnel) duties, qualification and responsibilities as well as interaction of units, the OO and Administration.

For each unit it is required to present the structure indicating the positions (from unit head up to employees (personnel) (shift master, shift operators, maintenance and repair staff etc.)), number of shifts as well as staff number considering back-up services.

There shall be a list of job descriptions specifying the rights and responsibilities of NMSF employees (personnel). In particular, the procedure for transfer of responsibilities (including transfer of authorities to issue resolutions and orders of permanent or temporary nature) and NMSF operation responsibility, at least, for three top officials (in case of circumstances of temporary nature) should be indicated.

9.1.3. Operations technical support

There shall be a list of NMSF units which are responsible for organization of:

- engineering and technical support of operations as regards nuclear and radiation safety ensurance and radiological protection;
- maintenance, repair and upgrading of thermal mechanical, electrical equipment and mechanisms, instrumentation and controls and regulators;
- inspections and audits;
- transportation and process operations with NM, RadS and RW;
- handling of NM, RadS and RW including their control and accounting of.

9.2. Training and qualifications of employees (personnel)

This section shall contain the information on staffing, qualifications and training of personnel.

9.2.1 Employees (personnel) qualification

Present the information on employee (personnel) recruiting to the positions indicated in the structures in accordance with required qualification (educational background, operational experience, training) and psycho-physiological indicators.

9.2.2 Employees (personnel) training

Provide for the information demonstrating how RD requirements on personnel training are implemented during NMSF operation and personnel recruiting.

9.2.3 Coordination of personnel training and SAO stages. Personnel recruiting schedule

Provide for employee (personnel) staged training schedule to be followed during NMSF commissioning.

9.3. Procedures

The section shall contain necessary and sufficient information on procedures required to ensure operations, maintenance and repair, tests, checks and inspection of NMSF systems and equipment.

It shall be indicated how all aspects related to NMSF safety are reflected in the adopted procedures.

9.3.1. Job descriptions

Provide for the information on job descriptions of administrative and managerial and operating employees (personnel) including a list thereof.

9.3.2. Operating procedures

9.3.2.1. Process regulations

There shall be the lists of process regulations (or other similar documents: plant standards, general operating rules etc. which contain rules and basic technique of safe operation, safety-related operations general procedure as well as safe operation limits and conditions) and basic provisions of process regulations.

9.3.2.2. System operating procedures

Provide for a list of operating procedures for NMSF systems and system tests; also list the procedures, which the operating employees (personnel) shall know in full scope.

9.3.2.3. Maintenance and repair procedures

Provide for a list of on-site, plant and model procedures to be guided by during maintenance and repair of equipment, systems, inspection of protective devices, automated devices (if any) and other systems specified in appropriate sections of SAR NMSF.

9.3.2.4. Safety-at-work procedures

Present a list of safety-at-work procedures, which shall be available at each working place along with operating procedures.

9.3.2.5. Procedures on maintaining the operations documentation

It is required to indicate a procedure for maintaining the operations documentation by staff-on-duty in the information related to the procedure on maintaining and managing the operations documentation. The actions of NMSF administrative and support employees (personnel) regarding control over keeping the operations documentation should be described.

9.3.2.6. Procedures on nuclear material control and accounting

Provide for a list of procedures which determine how to control and account nuclear materials.

9.3.3. Emergency response procedures

Provide for a list of emergency response procedures:

- procedures on elimination of operational events and accidents including fire safety procedures;
- procedures on elimination of design basis accidents;
- procedures (guidelines) on beyond design basis accident management.

Requirements contained in the procedures shall outline:

- actions of employees (personnel) aimed at identification of emergencies and accidents;
- required number of operating employees (personnel) to carry out corrective measures;
- attributes of success (failure) criteria regarding equipment manipulating actions;
- criteria for transition to accident management

9.3.4. Accident management guidance

Provide the brief information on accident management.

9.4. Maintenance and repair

9.4.1. Annual plans of equipment maintenance and repair

Present plans of equipment maintenance and preventive repair specifying main types and scopes of activity (general maintenance, heavy overhaul, repair and replacement of components, tests, modifications of systems, etc.).

Provide for a schedule for preventive maintenance. It shall be demonstrated how the experience of equipment and system operation is taken into account in developing maintenance and preventive repair schedule.

9.4.2. Maintenance conditions

Present a list of means to ensure maintenance including:

- instrumentation and controls equipment;
- means for decontamination and maintenance of equipment and premises contaminated with radioactive substances and (or) nuclear materials;
- hoisting and conveying equipment;
- special equipment and tools;
- availability of means, materials, spare parts, etc;
- availability of the equipment repair shops.

9.5. Organization of control and submission of information on NMSF safety level

The information on the adopted operational (current) NMSF state control system, on data collection and analysis procedure and also safety data submission shall be presented.

9.5.1. Control by OO representatives

Present the information on activities planned by the OO to check whether NMSF complies with the RD requirements.

Provide for the information on OO units and officials involved in inspections.

9.5.1.1. Inspection program

The planned inspection program shall be presented to indicate:

- type of inspections;
- scope of inspections;

- periodicity of inspections;
- criteria for evaluation of inspection results;
- procedure for documenting inspection results; requirements for keeping and accessing the reporting documentation

9.5.1.2. Organizational chart

Present data on OO units and a number and qualification of officials involved in facility internal inspections.

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

There shall be the information on NMSF current operation monitoring system which is adopted, procedure on data collection and analysis as well as on submission of information on safety and reporting to the regulatory body.

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

9.6. Fire safety

The section shall describe main provisions on NMSF fire and explosion safety during NM management and demonstrate the compliance with RD requirements.

There shall be a concept and basic principles of NMSF fire and explosion safety (building and structure zoning, multi-barriers, SIS redundancy and separation, fire prevention measures, use of fire protection systems etc.).

Present a list of RDs which regulate fire safety requirements, a list of deviations from these RDs and relevant decisions made.

Provide for the evaluation of fire risk for NMSF premises, buildings and structures and process bays indicating their category in terms of explosion and fire risk, zoning by explosion and fire risk (if no relevant data are presented in Chapter 2 of SAR).

Present a list and description of basic fire fighting measures for standard fire load premises including construction and process area as well as ventilation.

Specify a list of fire vulnerable systems (components) which are NMSF safety important and are identified in the analysis as well as fire protection measures of the listed systems (components).

There shall be a description of engineered means and organizational measures aimed at fire prevention and fire protection (detection of fire ignition, monitoring of fire evolution, fire suppression and mitigation of the consequences thereof) including the information on:

- measures to ensure fire safety of personnel: fire detection, notification, personnel evacuation, protection of personnel against fire hazardous impact;
- measures to prevent fire evolution, indicate fire resistance limits of fire protection fences and barriers, use of fire resistance coatings etc;
- measures for fire suppression: type of fire suppression first aids and number of aids, availability and main characteristics of stationary installations for fire suppression supported by internal and external water supply system, outer fire stairs etc.;
- means to notify of fire and safe evacuation routs for personnel, measures provided for in the design to ensure personnel evacuation during fire and smoke suppression in the buildings.

The information should be presented in the tabulated form as it is shown, for instance, in Table 9.2.

The section shall present the results of safety analysis in case of fire and demonstrate that design level of fire safety is ensured in all modes of NMSF operation as well as under

design basis accidents. There shall be qualitative evaluation of fire consequences considering possible failures of fire suppression devices, false actuation of fire suppression means and fire suppression device impact to safety important equipment. It shall be demonstrated that fire occurred at the site (external fire) does not significantly affect the performance of personnel, constructions and safety important buildings and equipment located nearby, which efficiency shall be ensured.

Table 9.2

Premise	Fire risk category	Fire resistance limit of fencing structures	Fire prevention measures for construction and ventilation	Fire detection and suppression devices		
				Fire alarm	Fire suppression	Fire suppression substance

Describe the structure of fire safety unit, its functions, personnel qualification requirements. Provide for the information on arrangements and coordination of NMSF and NFCI fire protection teams.

Provide for the information on preparation and conduct of periodic training of fire team and NMSF personnel in terms of behavior. Provide for the information on action plan in case of fire and (or) provide for a reference to the relevant sections.

Present the information on the procedure of fire safety monitoring as well as scope, periodicity and procedure for fire safety inspection.

Finally it shall be demonstrated that NMSF explosion and fire safety requirements set forth in the relevant RDs are met.

9.7. Engineered safety

- There shall be the information on means and organizational measures which ensure during NFCI operation the acceptable level of personnel, population and environment protection against the impact of such unfavorable factors as explosions, damages, emergency pressure and temperature values, ambient toxicity, electric voltage etc. due to quality and reliability of the equipment and mechanisms in use. Provide separately the information on engineered safety of special equipment and heave load cranes as well as those of general purpose. There shall be separate data for boilers (steam and hot-water boilers) and tanks under pressure as well as steam and hot-water pipelines, heavy load cranes.

The following information shall be presented:

- list of equipment functioning under pressure and heavy load cranes;
- purpose of the equipment and cranes;
- location, references to adjusting and general view drawings;
- design lifetime, resource;
- operational parameters;
- possible malfunctions, impact thereof to nuclear and radiation safety;
- list of RD used for equipment and crane design, engineering, manufacture and operation;
- data on deviations from RD requirements on engineered safety;

references to the documents containing calculation of strength, justification of external impact resistance, equipment and crane reliability under normal operation and operational events including accidents.

9.8. Physical protection

There shall be a demonstration of the main organizational and engineered and technical measures to prevent unauthorized actions of personnel or other persons in relation to NM, RadS and RW or NMSF systems, equipment and devices important for safety, which may result directly or indirectly in accidents and jeopardize health of NMSF personnel and population as a result of radiation impact. Information presented in this Section shall confirm compliance with requirements of NM Physical Protection Rules and applicable existing RDs.

There shall be:

- a list and characteristics of facilities (with indication of categories of nuclear materials in use), which are provided with physical protection; a schematic view shall be attached to show layouts of perimeters of secured, internal and special importance areas;
- a description of engineered and technical means of physical protection; the information of how the requirements of Physical Protection Rules, para. 28, 29, 31 are met;
- in case of NM transport: the information on compliance with the Physical Protection Rules, Section 4;
- a description and composition of the security and guard force of NMSF;
- a list of applicable internal and site specific documents as per the Physical Protection Rules, para. 27 e;
- the information on the vulnerability analysis of the facility to determine internal and external threats and probable ways of their occurrence, identification of vulnerable spots of the nuclear facility, nuclear material storage, processes of the use and storage of nuclear materials;
- the information on assessment of possible environmental damage in case an internal or external threat take place;
- the information on the physical protection efficiency assessment;
- the information on certification of engineered physical protection means;

9.8.1. Composition of physical protection

It is required to determine engineered and technical means and organizational measures on physical protection:

9.8.1.1. Engineered and technical means:

- security alarm systems;
- access control systems;
- video surveillance systems;
- on-line communication systems;
- means detecting carried (transported) nuclear material, explosives and metal products;

physical barriers;

- support systems (power supply, lightning etc.)9.8.1.2. Organizational measures:
- organization of NMSF security, including training of security personnel;
- training of NMSF personnel to be able to respond to extreme situations;

provisions to grant access to permanent and shift NMSF personnel to the protected area and especially important areas;

- organization of system for NM accounting of, storage, use, protection, transportation and control thereof;
- organization of personal and special checks of personnel, persons on-business, visitors and vehicles, etc.

9.8.2. PPS schematic and hierarchy

Present basic schematics of engineered control and alarm means with regard to PPS.

Present principal PPS hierarchy from the point of security arrangements without disclosure of locations of control boards, surveillance and alarm stations.

9.9. NM, RadS and RW control and accounting

There shall be a description of NM, RadS and RW control and accounting of adopted at NMSF. It shall be demonstrated that NFM control and accounting procedures ensure reliable and timely information on their quantities and locations, timely detection of losses and unauthorized use or theft; and NFM control and accounting procedure is in compliance with RD requirements.

The section shall contain the information on the issues related to identification of transport container, identification of NM (type of packaging, FA, serial number, enrichment, etc.), location, time of arrival to the storage facility and release, maintaining of charts and other records as well as distribution of accounting responsibilities.

The section shall include the following information:

- general description of NM, RadS and RW control and accounting operations conduct;
- structure and the staff involved in NM, RadS and RW control and accounting operations;
- number of NM balance areas, boundaries and structure thereof;
- methodologies and measuring devices used for NM, RadS and RW control and accounting;
- a list and format of accounting and reporting documents;
- NM access control;
- procedure for keeping material balance and operational records on MBA;
- procedure for investigation of NM, RadS and RW control and accounting violations;
- procedure for personnel training and work permit for NM, RadS and RW control and accounting operations;
- physical inventory taking procedure

9.10. Emergency planning

There shall be the information about planned measures to protect personnel and population in case of an accident.

Specific content of the section and subsections thereof is determined by potential hazard of NMSF considering possible types of accidents, emergency evolution scenarios and resulted radiation situation and may be changed depending on the specifics of NMSF in question. If NMSF is a part of NFCI it should be demonstrated how action plan for personnel and population protection in case of an accident at NMSF correlates with emergency response measures of NFCF as a whole, distribution of responsibilities and coordination of the efforts.

9.10.1. Personnel and population protection

The section shall reflect basic provisions of the Action Plan for personnel and population protection in case of an accident at NMSF. The information shall confirm that action plans and procedure for implementation thereof are designed considering possible consequences of accident evolution and accident scale. It shall be demonstrated that they are in compliance with GPS NFCF requirements and other RDs on personnel, population and environment protection.

9.10.2. Emergency response management posts

Present the information on emergency response management posts (if any).

It is required to indicate design principles and criteria for emergency response management posts and location thereof. Justify equipment composition (instrumentation fleet, communication, personal protective means, ventilation equipment etc.) as well as its efficiency in case of accidents. Indicate management post staff and its qualification.

9.10.3. Elimination of accident consequences

Present possible accident consequences and appropriate measures to eliminate them as well as describe: decontamination means and methods to be applied with regard to the major and auxiliary equipment, installations, terrain; methods and means to provide help to affected persons including data on sanitary arrangements and medical aid; availability of necessary medicines, bandages and other aids indicating their storage location; methods and means to decontaminate radioactively contaminated areas.

9.10.4. Emergency drills

Herein, present information on emergency response exercises and training including those associated with fire fighting. Herein, present programs, techniques and schedules for emergency response exercises and training specifying those categories of employees (personnel) who participate in mastering appropriate actions to be carried out in case of accidents and elimination of accident consequences.

CHAPTER 10. ACCIDENT ANALYSIS

The NMSF safety assessment shall include an analysis of NMSF systems and structures response to possible initiating events. This analysis is targeted to identify a sequence of events (scenarios) and conditions of their implementation taking into account dependent and independent failures and damages of systems and components or personnel errors.

The Chapter shall define risk sources and factors, IE, scenarios of predicted events and their consequences and also evaluate a possibility of intervention into systems operation with a purpose to control processes.

This analysis shall form a basis for organization of the NMSF systems control in different situations.

For the purposes of the analysis each predicted event can be overlapped by the following:

- independent failures;
- undetected failures;
- common cause failures;
- personnel errors.

Safety analysis should be conducted according to the lists of initiating events which may include various failures of the systems, operator errors, external impacts of natural and man-induces origin. Recommended list of initiating events is presented in Attachment 4.

Based on the analysis of design and beyond design basis accidents there shall be a justification of acceptability of consequences thereof considering the provisions of applicable RD.

10.1. Design basis accidents analysis

Results of design basis accident analysis and its possible radiological consequences shall be presented in the section.

Based on the analysis of possible radiation accidents there shall be a justification of NMSF safety under specific operational conditions and in accordance with RD requirements.

It is recommended to arrange analysis results in the form of a table containing IE, accident sequence scenarios, accident class and representative accident for such class, safety assessment criteria, systems (structures) in question, accident analysis results.

10.1.1. List of initiating events for design basis accidents

Provide for a list of initiating events of design basis accidents.

Each initiating event should be analyzed in combination with different failures and other factors to select the most essential scenario for analysis.

Initiating events shall be selected considering RD requirements to a number and nature of considered failures of the systems based on:

- initiating event characteristics;
- set of systems and structures affecting accident sequence;
- set of systems and structures which may be affected as result of IE.

Initiating events shall be integrated into classes in accordance with their functional effect on NMSF.

Identify specific initial events and consider the courses of their initiation for each class of initiating events. The outmost attention should be paid to events which result in more severe consequences. If as per expert assessments an event does not result in hazard consequences, qualitative description of possible consequences will be sufficient.

10.1.2. Safety assessment criteria

Provide for radiation consequences assessment criteria for the accident in question. For design basis accidents the restrictions to NMSF personnel and population exposure, which are set forth by Radiation Safety Standards, shall be followed after the accident.

10.1.3. Analysis of possible sequences of design basis accident

An analysis of all initiating events as per a list shall be made.

For each IE of design basis accident numeric values of impact parameters taken into account in the analysis and other input data which are necessary for the analysis of design basis accidents and consequences thereof (system design features, parameters characterizing operations mode, physical, chemical, thermo-physical and mechanical properties of the substances and materials etc.) should be presented. The section should contain a reference with indication of the number of section, table and figure showing input data or data may be presented with reference to the information source. Initial data and conditions are described in details to the extent which allows, if required, conducting independent calculations.

Indicate a list of systems and structures which affect an accident sequence as well as systems and structures which can be affected as a result of the accident sequence.

Describe the state of NMSF systems and components at the moment of design basis accident initiation.

Provide for adopted scenario of accident sequence.

Herein, describe functioning of all systems and structures which affect an accident sequence as well as systems and structures which can be exposed to an initiating event, their interaction (considering possible failure). Provide a list of SS functions which shall be realized.

Indicate personnel actions considering possible erroneous efforts.

A quantitative assessment of a possible severity of IE consequences for a case when IE is combined with dependant and independent failures or personnel mistakes (human errors) should be made in a scope set up by the applicable standards. Basing on such assessments for a considered type (group) of initiating events, such sequences (chains) of events and failures that can result in the most severe consequences (change in configuration of packagings, lattice spacing, stacks, minimum heat exchange margin, maximum dose, etc.) are identified.

References to appropriate SAR sections containing description and assessment of NMSF process systems and separate components are permitted.

Provide for the information on techniques, models and software used to calculate possible consequences of postulated accidents indicating data related to certification thereof and applicability conditions.

10.1.4. Results of design basis accident analysis

Herein, present the results of emergency process analysis in case of design SS functioning, systems failures and human errors postulated in accordance with the safety RD requirement and assess radiation consequences of design basis accidents.

Present calculation results for internal and external radiation doses of NMSF personnel and population caused by the accident. Information on operating personnel is presented separately.

Herein, present calculation results of RadS propagation within and beyond NMSF premises. Calculation shall be made taking into account the data on leaktightness of premises and the worst weather conditions. Evaluate the boundaries of radioactive contamination zone in the premises and environment indicating the levels of possible radioactive contamination.

10.1.5. Conclusions

Analysis results of design basis accidents shall be specified. Summary of accident consequences shall be presented, a conclusion on NMSF safety ensured during these accidents shall be made. It shall be demonstrated that technical and organizational arrangements accepted in a design provide for non-exceeding of established doses for internal and external occupational and population exposure and standards for content of radioactive substances in the environment in case of operational events and design basis accidents.

10.2. Analysis of beyond design basis accidents; development of measures to manage beyond design basis accidents

The section shall present the results of beyond design basis accident analysis and possible radiation consequences, provide for the assessment of probability of beyond design basis accidents and determine measures on beyond design basis accident management.

10.2.1. List of beyond design basis accidents and its justification

Provide for a list of scenarios of beyond design basis accidents specifying the accidents which result in exceeding of occupational and population exposure doses and non-compliance with standards on RadS releases and content in the environment established for design basis accidents. Indicate groups where the response of NMSF systems needed to prevent accident progression is the same within one group.

Within each group identify one or several representative scenarios which comply, as a whole, with the following criteria:

- maximum occupational and (or) population exposure dose rate;
- maximum rate (intensity) of radionuclide release;
- maximum integral radionuclide release;
- maximum scale of damages of NMSF systems and equipment.

Provide for a final list of beyond design basis accidents for further analysis.

10.2.2. Analysis of beyond design basis accidents

Provide for the scenarios of beyond design basis accidents. Present a list of main physical phenomena, which determine process evolution.

Provide for a list of input parameters and initial conditions which allow, if required, conducting recalculation (geometric, physical, process input data).

Herein, present calculation results of emergency processes at NMSF in accordance with a scenario of beyond design basis accident, assess release and propagation of RadS. Calculation

results of RadS releases beyond NMSF premises shall be used further to calculate RadS propagation within the NMSF premises and into the environment. Propagation of gaseous, volatile and aerosol RadS, their deposition at surfaces of premises and CfSS filters should be taken into account in calculation. The calculation shall be based on the most unfavorable data on leaktightness of process premises and weather conditions. All possible ways of population exposure (direct exposure by passing cloud, by plume, through inhalation exposure, RadS intake by a body through a food chain) shall be taken into account.

Provide for the information on techniques, models and software used to analyze beyond design basis accidents indicating data related to certification thereof.

10.2.3. Measures on beyond design basis accident management and efficiency assessment

For each type of beyond design basis accident specify and justify measures on beyond design basis accident management.

Demonstrate that implementation of planned strategy for corrective measures in case of beyond design basis accident provide for either interruption in progression of accident processes or considerably mitigates accident consequences.

10.2.4. Conclusions

Basing on information of the section a conclusion with regard to efficiency of developed beyond design basis accidents management measures should be made.

Basing on the calculations of effective and equivalent occupational doses and population doses make a conclusion that the requirements of Radiation Safety Standards are met and that protective measures are required.

CHAPTER 11. SAFE OPERATION LIMITS AND CONDITIONS. OPERATIONAL LIMITS AND CONDITIONS

The Chapter shall present information on safe operation limits and conditions and operational limits and conditions established in a design for safety systems (components) and those important for safety and also for NMSF as the whole, reflect interaction thereof.

The information shall contain consideration of SIS attributed to Classes 1,2 (GSP NFCF) and Class 3 – for systems which contain RadS and perform monitoring functions of radiation protection and also for buildings and structures attributed to Category I and II according to the requirements.

Information of the Chapter shall be adequate to the one contained in process regulation.

References to SAR NMSF sections, which contain necessary details and explanations are permitted to be made.

11.1. Safe operation limits and conditions

List of all controlled parameters, a method and exact point of their measurement shall be presented. Should deviations from limiting values of controlled parameters result in non-compliance with safe operation limits and/or progression of pre-emergency situation, such limiting values shall be specified.

Herein, present SS actuation settings. Accepted values of settings shall be justified, modes (processes) defining whether these values are reached and measured. Warning and emergency alarm actuation settings is required to be presented and justified along with substantiation of an interval before values of SS actuation settings are reached (reference to relevant sections of SAR NMSF is permitted).

Specify permitted modes of normal operation. Provide for a justification of the limits imposed on permitted modes of normal operation with references to relevant sections of SAR NMSF.

The information on composition and state of systems, which operability or availability is required for NMSF operation shall be presented.

11.2. Safe operation conditions

11.2.1. Permitted modes of normal operation

Permitted modes of normal operation shall be specified. Operational limits of main parameters such as compliance of packaging parameters with a design, temperature change rate of a cooling media, packaging temperature change rate 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 a connection of a limiting parameter with directly controlled parameters using appropriate tables or diagrams.

A justification of limits imposed on permitted modes of normal operation with references to appropriate Sections of SAR NMSF shall be presented.

Present the information on composition and state of systems, which operability or availability is required for NMSF operation. Conditions for tests, inspections (examinations), maintenance and repair of safety important systems shall be specified.

11.3. Operational limits and conditions

There shall be limiting values of process parameters corresponding to the marginal values of the safe operation. For each system there shall be limiting parameter values of all equipment comprising the system. The justifications of selected parameters for permitted modes shall be given along with their measurement errors, measurement points etc. (the reference to Chapter 4 of SAR NMSF is permitted).

Values of process parameters, when main process protective means, interlocks and automatic controllers are actuated, shall be specified.

Sufficiency of this list to ensure NMSF systems and equipment safety shall be justified.

11.4. Documenting of data on control of safe operation limits and conditions

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

CHAPTER 12. QUALITY ASSURANCE

The Chapter contains the requirements to the information on quality assurance of the activities and services affecting NMSF safety.

To evaluate acceptability of quality assurance activities at a corresponding stage of licensing there shall be the information on sufficiency of measures in the fields specified in the Requirements to quality assurance program for nuclear fuel cycle facilities.

The Chapter should be divided into subsections under titles corresponding to the areas of quality assurance activity listed in QAP.

Information is required to be prepared taking into account results of QAP development and implementation at a time of SAR NMSF drafting.

For each quality assurance activity area there should be a description of RDs used for development and conduct of quality assurance measures.

In accordance with RD requirements it is required to present the information on the following quality assurance activity areas:

- organizational activities on quality assurance;
- personnel training and qualification;
- design control;
- management of documents;
- control over the purchases of equipment, component parts and materials and also services rendered.
- process activity supervision;
- inspections and tests;
- metrological support;
- assurance of reliability;
- monitoring of non-compliance with the requirements set forth and corrective measures;
- quality assurance documentation;
- audits.

While presenting the information on quality assurance activity areas it is required to provide for a description of the following measures:

- identification of materials, products, works and services which do not comply with the requirements set forth;
- analysis of the impact of identified non-compliances to NFCF safety;
- record of identified non-compliances;
- reporting of identified non-compliances to the managerial staff of the corresponding level;
- determination of causes of identified non-compliances and corrective measures to prevent reoccurrence thereof;
- exclusion of the use (including accidental one) of materials and products as well as works and services which do not comply with the requirements set forth.

There shall be measures reflecting organization management efficiency assessment and implementation of the duties by personnel by specially established commission (service) or external organization.

CHAPTER 13. NMSF DECOMMISSIONING

The Chapter shall contain the information sufficient for adequate understanding of basic solutions provided for in the design to ensure NMSF safe decommissioning.

There shall be demonstrated that the possibility of safe decommissioning is taken into account in NMSF design, construction and operation.

Detailed information on engineered means and organizational measures to ensure safety of NMSF decommissioning is presented in Safety analysis report for NMSF decommissioning based on NMSF decommissioning design documentation, results of integrated survey of NMSF subject to decommissioning considering actual condition of NMSF at the moment of report preparation.

It is required to present NMSF decommissioning concept and basic solutions ensuring safety during decommissioning.

There should be possible options of NMSF decommissioning, NMSF decommissioning procedure (stages), basic measures ensuring NMSF decommissioning safety as well as justification of feasibility of NMSF decommissioning option proposed.

Analysis of possible design solutions ensuring safe decommissioning of NMSF in future shall be conducted.

Design requirements for structures, compliance with which makes a future dismantling easier, are required to be analyzed.

Demonstrate that NMSF decommissioning provides for the possibility of NM retrieval including in case of an accident, NM retrieval technologies are presented. Justify the possibility to remove NM after long-term storage.

Demonstrate that the possibility of NM reloading and transportation from NMSF site is provided for, describe proposed technology for NM reloading and transportation.

It shall be demonstrated that dismantling of process and auxiliary equipment is possible. There shall be a description of possible technologies for dismantling, decontamination, removal and disposal of NMSF equipment, structures and buildings. Demonstrate that dismantling of process and auxiliary equipment is ensured by accepted design solutions.

Assess the quantity and type of RW generated during dismantling. Basing on information (nomenclature of equipment and structures, mass and volumetric characteristics, chemical composition of materials etc.) contained in the previous subsections, conservative calculated assessments of radionuclide content in materials of equipment and structures shall be presented. Indicate management principles for RW generated during decommissioning, RW transportation, reprocessing and on-site storage.

Demonstrate fundamental possibility and indicate proposed methods to decontaminate the surfaces (external and internal), bays to house RW and recycled materials generated during decommissioning and special equipment required for decommissioning.

There shall be a description of possible options and technologies of NMSF site rehabilitation.

ATTACHMENT 1. REQUIREMENTS TO SAR NMSF FORMAT

1. SAR NMSF content shall not require (as practicable as possible) additional review of design, engineering and operational documents by Rostekhnadzor to assess safety.

The information shall be presented in the scope and details required to justify engineered and organizational solutions adopted in the design to ensure safety.

The information should be clearly expressed, avoiding any ambiguity, emotions and verbosity. The information presented shall be in compliance with other sections. Information pertaining to the compliance with the requirements shall not be of a declaration nature. It is necessary to provide for justification of the compliance.

If the information is based on works or documents a reference should be made to them indicating type of the document, authors or organizations, date, archival and reference number.

Avoid repetitions. To prevent excessive repetitions it is required to give references to the relevant sections.

2. The information on the calculations made, calculation analysis shall confirm sufficiency and completeness of the calculations, account of all the factors affecting the results as well as contain data which are necessary to carry out, if required, peer review calculation (schemes, assumptions, input data, results, interpretation thereof, conclusions) and(or) references to the documents or publications containing these data.

Software shall be briefly described to the extent, which is sufficient for understanding and assessment of acceptability thereof, provide for software title and the information on certification or verification according to its purpose.

3. Report format shall be unified for all stages and sections. SAR NMSF is drafted by the Applicant as one volume or as separate volumes by chapters, sections or subsections depending on SAR scope.

Each volume shall indicate NMSF name, full title of SAR NMSF and relevant chapter, section (subsection).

4. Volume I contains:
    - Content of SAR NMSF;
    - Introduction, section I;
    - General information (list of abbreviations, annotation).

    At the beginning of each volume there shall be a table of contents and a list of abbreviations.

    SAR NMSF should be arranged in accordance with the requirements to text document paper work.
5. At the end of each chapter there shall be References and errata page.
6. SAR NMSF sections containing confidential information are presented separately, as appropriate.

ATTACHMENT 2 (recommended). 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
	2	3	4	5	6
	1. External impacts				
	1.1. Earthquake of any nature	Bed plate oscillations, bed plate deformation	1. Fire 2. Loss of external power supply 3. Flooding or water ingress to storage facility 4. Drop of individual packagings at on individual NFM (S, N) locations 5. Loss of integrity of individual packaging. 6. Failures of transport and process equipment in storage facility 7. Leaks of solutions from NFM (S, N) packagings during storage in liquid phase 8. Change in lattice spacing 9. Displacement	All NMSF systems and components	

			of packaging stack		
	1.2., etc.				
	2. Internal impacts caused by on-site accidents				
	2.1. Explosion of explosive gases	1. Air shock wave 2. Projectiles 3. Fire	1. Loss of external power supply 2. Flooding or water ingress to storage facility 3. Drop of individual packagings at on individual NFM (S, N) locations 4. Loss of integrity of individual packaging 5. Failures of transport and process equipment in storage facility 6. Leaks of solutions from NFM (S, N) packagings during storage in liquid phase 7. Change in lattice spacing 8. Displacement of packaging stack	1. Individual systems and components	
	2.2., etc.				
	3. Internal impacts caused by accidents inside NMSF buildings and structures				
	3.1. Explosion of explosive gases	1. Projectiles 2. Fire 3. Air shock wave	1. Loss of external power supply 2. Flooding or water ingress to storage facility 3. Drop of individual packagings at on individual	1.Equipment	

			NFM (S, N) locations 4. Loss of integrity of individual packaging 5. Failures of transport and process equipment in storage facility 6. Leaks of solutions from NFM (S, N) packagings during storage in liquid phase 7. Change in lattice spacing 8. Displacement of packaging stack		
	3.3., etc.				

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

ATTACHMENT 3 (recommended). MODEL STRUCTURE OF SYSTEM DESCRIPTION

While presenting the information on the systems it is recommended to keep to the description structure contained in this section.

A reference to other sections where this information is contained in detail is permitted.

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

It is assumed that some subsections are omitted or extended if this is required by system features.

5.1. Purpose and design basis

There shall be purpose and functions of the system, safety class, seismic stability category, fire and explosion risk category etc.

There shall be a list of safety RDs the requirements of which shall be met by the system in question, a description of basic principles and criteria adopted in system design.

It is required to present the information in the following sequence:

- system's purpose and functions;
- design basis.

5.2. System description

There shall be a description of system structure and (or) process as a whole, its subsystems and components if they perform individual functions. There shall be drawings, sketches and schemes which illustrate system structure and performance, its spatial location and relations with other NMSF systems.

There shall be engineered characteristics of the system and its components, description of system equipment and its location.

There shall be a justification of material selection considering normal operation, operational events including pre-emergencies and accidents as well as information on equipment and material certification.

It is required to present the information in the following sequence:

- a description of system structure and (or) process;
- a description of the equipment and its components;
- location of the equipment (component);
- a description of the materials in use;
- information on equipment and material certification.

5.3. Control and monitoring

The section shall present the information on control means (automated, remote and local) and system monitoring, a list of monitored parameters and a range of permissible values for each of operational modes. There shall be an indication of check points, monitoring technique, information on metrological certification of the methods and means to monitor the parameters and errors thereof, requirements to I&C. Relation of the system with other control systems, sensor redundancy, communication channels shall be specified.

It is required to present the information in the following sequence:

- a description of shields and locks;
- check points;
- safe operation limits and conditions;
- actions of personnel.

5.4. Tests and inspections

It is required to specify test program content and objectives, list of RDs and design documentation which are the basis for tests and inspections, lists of monitored parameter values and requirements to I&C used in testing.

There shall be the information on methods, scope and time period for system monitoring and in-service inspection, characteristics of the measures provided for in the design. There shall be demonstrated that they are in compliance with RD requirements.

5.5. System analysis

It is required to provide for a description of system functioning under normal operation, operational events including pre-emergencies, design basis accidents, interaction with other systems considering possible failure and measures to protect the system against the impact of such failures. Operational limits and conditions, safe operation limits and conditions, SS actuation settings and system and component reliability factors shall be presented for provided modes of performance.

There shall be the results of system component failure analysis, personnel error analysis and analysis of the impact of failure consequences including common cause failure to the efficiency of a system in question and related systems and to NMSF safety as a whole. Qualitative and quantitative characteristics of the consequences shall be given for the failures in question. Safety system description shall analyze the impact of some component failure to system efficiency as a whole.

Failures which are accident initiating events shall be identified as a result of the analysis.

The section shall present a brief description of calculation programs used to analyze system performance, calculation results and conclusions. Experiments are conducted to justify system safety, describe experimental base, metrological support of the experiments. Provide for the interpretation of the results regarding calculation conditions.

It is required to present the information in the following sequence:

- system normal operation;
- safe operation limits and conditions;
- system functioning in case of failure;
- functioning under pre-emergencies and design basis accidents including system functioning under external impacts;
- system reliability analysis.

5.6. Conclusions

There shall be the conclusions on compliance of the system with the requirements of Federal standards and rules in the field of the use of atomic energy, other safety RDs, safety principles and criteria adopted in NMSF design.

ATTACHMENT 4 (recommended). LIST OF ACCIDENTS

INTERNAL EVENTS

1. Loss of equipment integrity, RadS release/leakage from equipment:
- equipment (component) release/leakage through seals;
- loss of integrity of a separate packaging;
- leakage/release from cooling pond or pipeline rupture leading to water level drop;
- leakage/release from tanks containing NM and RW.

.**2.** Violations in NM handling:
- drop of individual NM packagings during transport and process operations;
- drop of heavy goods which can change position and damage integrity of packages, groups of packagings, stacks;
- failures of NM transport and process operations equipment; damage of packagings' fastening during NM transportation.

3. Loss of power supply sources
4. Malfunction of heat removal system**.**
5. Malfunction of ventilation system.
6. Explosion.
7. Fires.
8. Water flooding of NM storage facilities.
9. Release of chemical substance.
10. Personnel errors.

EXTERNAL EVENTS

1. Seismic impacts.
2. Floods:
- seasonal;
- caused by disasters (break of dam).

3. Lightning.
4. External fire.
5. Loss of external power supply.
6. Strong winds, whirlwind.
7. Extreme weather conditions.
8. Shock waves:
- from explosions on NMSF site;
- explosions at other facilities.

LIST OF INITIATING EVENTS OF BEYOND DESIGN BASIS ACCIDENTS

1. SCR initiation for NM storage and management systems.
2. Complete loss of water of SNF storage facility.
3. Drop of process equipment and constructions on NM storage bay floor or NM stored.
4. Flooding of SNF storage facilities of Class 1.