

**TECHNICAL CODE OF  
COMMON PRACTICE**

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**TCP 501-2013 (02300)**

**RULES PREPARATION SAFETY ANALYSIS REPORT FOR  
NUCLEAR MATERIALS STORAGE FACILITIES**

*This technical code draft is not to be implemented before  
its approval*

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**The Ministry of Emergency  
Situations of the Republic of  
Belarus**

**Minsk**

**Key words:** safety justification, nuclear materials storage facilities, nuclear safety, radiation safety, initiating events, design basis accident, beyond design basis accident, quality control, decommissioning

### **Foreword**

Objectives, basic principles, provisions of government regulation and management in the field of output rates setting and technical standardization are determined by the Law of the Republic of Belarus “On technical regulation and standardization”

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## **Introduction**

This technical code of the common practice is developed within the framework of the State program "Scientific Support for the Nuclear Energy Development in the Republic of Belarus for 2009 – 2010 and for the period until 2020". The program was approved by Regulation of the Council of Ministers of August 28, 2009 No.1116 with the provisions taking into account:

- the Law of the Republic of Belarus of January 5, 1998 № 122-3 "On the radiation safety of the population";
- the Law of the Republic of Belarus of July 30, 2008 "On the Use of Nuclear Energy" № 426-3;
- Convention on Nuclear Safety;
- Joint Convention on Safety of Spent Fuel Management and on Safety of Radioactive Waste Management;
- the existing technical legal regulatory acts in the field of Nuclear Energy use.

# TECHNICAL CODE OF THE COMMON PRACTICE

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## RULES AND PREPARATION SAFETY ANALYSIS REPORT FOR NUCLEAR MATERIALS STORAGE FACILITIES

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Introduction date 2014-03-01

### 1 Application Area

1.1 This technical code of the common practice (hereinafter –the Technical Code) determines the requirements for the composition and content of the safety report on the nuclear materials storage facilities, the completeness of the information provided in order to justify the activities, the description structure of nuclear materials storage facilities, as well as the procedure for the report preparation and design.

1.2 The requirements of this Technical Code are applied to the placed, designed, constructed and operated nuclear materials storage facilities, which are not included in the nuclear facilities.

### 2 Normative References

The references to the following technological regulations in the field of technical regulation and standardization (further – TNLA) are used in this Technical Code:

TCP 263-2010 (02300) Accounting of external impacts of natural and anthropogenic origin on the nuclear facilities

TCP 357-2011 (02300) General safety and physical protection during nuclear materials transportation

TCP 360-2011 (02300) The provision of general requirements for the system of nuclear facilities physical protection

TCP 426-2012 (02300) Physical protection regulations for nuclear facilities and nuclear materials in use and storage

Note - when using this Technical Code, it is advisable to check the validity of the TNLA by the catalog compiled as on January 1 of this year, and by the relevant information indexes, published in the current year.

If the reference TNLA were replaced (modified), then using this Technical Code, one shall follow replaced (modified) TNLA. In case the reference TNLA were canceled with no replacement, the provision containing the reference to them shall be applied to the part not affecting this reference.

### 3 Terms and Definitions

The terms, set forth in [1], [2] and TNLA in the field of nuclear energy, are used in this Technical Code.



## **4 Symbols and Abbreviations**

The following symbols and abbreviations are used in this Technical Code:

ARSM - Automated Radiation Monitoring System;

PSA - Probabilistic Safety Analysis;

ITP – Intrabuilding Transport Packaging;

GRW - Gaseous Radioactive Waste;

LRW - Liquid Radioactive Waste;

IE - initiating event;

SI–Supervisory Instruments;

MCE - Maximum Credible Earthquake;

R & D - Research and Development Work;

ED –Experimental Development;

SR NMSF–Safety Report for Nuclear Materials Storage Facilities;

IFA - Irradiated Fuel Assembly;

SNF - Spent Nuclear Fuel;

OBE - Operating Base Earthquake;

BC–Balancing and Commissioning;

QAP- Quality Assurance Program;

SE–Software Environment;

CP - Control Post;

NMSF - Nuclear materials storage facilities;

RW - Radioactive Waste;

RSs - Radioactive Substances;

RS - Radioactive Source;

AS SSCR - Alarm System for Self-Sustaining Nuclear Chain Fission Reaction Occurrence;

SS–Security System;

SCS–Safety-Critical System;

SPZ - Sanitary Protection Zone;

PPS - Physical Protection System;

FA - Fuel Assembly;

SRW - Solid Radioactive Waste;

TNLA – Technical Normative Legal Act;  
TR - Technical Regulation;  
TP - Transport Packaging;  
OO - Operating Organization;  
NFM (S, N) - Nuclear Fissile Material (substance, nuclide);  
NFN - Nuclear Fissile Nuclide;  
NM - Nuclear Material;  
NF - Nuclear Fuel.

## **5 General Provisions**

**5.1** SR NMSF is a document justifying the safety of the NMSF during its location, construction, operation and decommissioning.

**5.2** SR NMSF shall contain the sufficient information for an adequate understanding of the NMSF plan, security concept, NMSF QAP and the basic operation principles.

**5.3** The information in the SR NMSF shall make it possible to assess the conformity of the accepted design, engineering, technical and organizational solutions with requirements of legal, normative acts, and technical regulations that establish safety requirements in the field of nuclear energy.

**5.4** An independent SR shall be developed for each NMSF.

**5.5** The establishing work on the SR NMSF is carried out during placement, construction, commissioning and operation, and decommissioning of NMSF.

**5.6** The information justifying the NMSF safety shall be available in the SR at the stage of NMSF placing. This information is specified in 6.2, 7.1-7.7, 7.10, 8.1, 8.3-8.8, sections 11-13 of this Technical Code and based on the materials for the investment justification, the results of investigation, R&D and ED.

**5.7** The NMSF security justification information shall be submitted at the stage of the NMSF construction. It is specified in sections 7-19 of this Technical Code and based on the feasibility study (design) of NMSF and results of R&D and ED, carried out to justify the NMSF security.

**5.8** The SR shall reflect the actual state of the NMSF, commissioning results and cover all the changes made to the NMSF design after completion of construction, commissioning and operation of the NMSF.

**5.9** Relevant changes and additions shall be made to the SR NMSF, in case some alterations have been made to design, engineering, technological and operational documentation, which affected nuclear and radiation safety. If some

changes to the design documentation were made, it shall be sent for state reexamination and shall be subject to re-approval in the cases provided by law.

The procedure for making changes and additions to the SR NMSF is established by the OO.

## **6 Requirements for execution and content of the report**

### **6.1 Requirements for report execution**

**6.1.1** It is required of the content of the SR NMSF to be, as far as practicable, free from necessity to consider additionally design, construction and operational documents during safety assessment.

The information shall be provided to the extent and to the degree of detail which are required for the justification of the made technical and organizational security decisions in the technical plan.

The information shall be presented clearly, accurately, avoiding ambiguity, verbosity and emotional coloring. The provided information shall be consistent when comparing different subsections. The data on implementation of requirements shall not be declarative in nature. It is required to provide documented justification of their fulfillment.

If the information is based on papers or documents, then there shall be a reference to them, indicating document type, author or organization, year of production, archival or identification number.

The reiteration of information shall be avoided. It is recommended to provide references to the relevant sections in order to avoid non-required reiterations.

**6.1.2** The information on the made calculations, design analysis shall confirm the sufficiency and completeness of calculations volume, consideration of all the factors which affect the result, as well as to contain the data which is required to carry out the expert analysis as required (schemes, adopted assumptions, basic data, results and their interpretation, conclusions), and (or) there shall be references to documents or materials containing these data. The SE shall be briefly described in sufficient amount to understand and assess their acceptability. It is essential to state the SE names and information on certification or verification in accordance with the purpose.

**6.1.3** The design of the report shall be the same for all stages and all sections. The SR NMSF is completed by a declarant in a single volume or in separate volumes on specified sections or subsections provided which SR is of significant extent.

Each volume shall be marked with the name of NMSF, full name of the SR NMSF and relevant section, subsection.

**6.1.4** The information to be specified in the first volume:

- the contents of all SR NMSF;

- introduction, General Description of the NMSF section;
- general information (an abstract, the list of abbreviations).

Full contents of all SR NMSF and the list of abbreviations shall be given at the beginning of each volume.

The SR NMSF shall be prepared in accordance with the requirements to layout of text documents.

**6.1.5** The list of references and a sheet of changes registration shall be placed at the end of each section.

**6.1.6** The SR NMSF sections which contain information of limited distribution are given separately according to the established procedure.

## **6.2 Requirements for the content of the report**

**6.2.1** The introduction shall contain general information on the NMSF plan, the operating organization, provide the information on development stage of the NMSF, and general characteristic of the SR NMSF.

**6.2.2** The brief information on resolutions of the authorized state structures on the Basis for the Design Development section, on virtue of which both design development and NMSF construction are planned.

**6.2.3** The General Characteristics of the NMSF section shall provide the general information on the NMSF, including the name and purpose of NMSF, NMSF site, NMSF category of potential radiation hazard.

**6.2.4** The section "Stage of SR Development" shall specify purpose and summary of SR NMSF and the activities for the safety justification of which the SR NMSF is provided.

**6.2.5** The Section "Information on the Operating Organization and the Organizations Performing Work and Rendering Services" shall contain the information on the OO and developers of individual SR NMSF sections.

One shall state here the list of organizations which perform work and render services respectively for placement, design, construction, manufacture and (or) installation of the NMSF main systems and components important to safety, with a specification of these works (services), and provide the data on work permit of organizations to perform activities and services in the field of nuclear energy use.

**6.2.6** The Section "Information on the Research &Development and Experimental Development" provides brief information on the R&D and ED which were carried out or planned in order to support technology, equipment design, basic design solutions and NMSF safety.

**6.2.7** The Section "NMSF Characteristics" shall estimate completeness of the provided information and its conformity with the requirements of this Technical Code.

## **7 General Description of the Storage Facility for Nuclear Materials**

This section shall provide brief information to highlight the content of all other sections of the SR NMSF. This information is provided for acquaintance with the basic concepts and technical solutions to safeguard of the NMSF.

### **7.1 Characteristics of the placement area and the storage facility for nuclear materials site**

Brief information of the NMSF site and its placement area shall be recorded in this section.

### **7.2 The master plan and layout of the storage facility for nuclear materials**

The master plan with the list of main buildings and structures of the NMSF shall be provided here, including specification of the conditions which determines layout of buildings and structures on the master plan, location of roads and railways, utility systems, and indication of transport, technological, and electrical connections between buildings and structures.

### **7.3 General characteristics of the storage facility for nuclear materials**

The section shall briefly describe the purpose and composition of the NMSF and present main technical characteristics of the NMSF and basic technological processes and procedures. The main technical characteristics of the NMSF:

- conditions of the NMSF site placement;
- composition of the NMSF with the list of all NM storages;
- NM nomenclature;
- storage method for the NM;
- storage class (for the SNF storage);
- NM storage period;
- method of NM delivery to the NMSF and NM removal method, features of the NM on-site transportation;
- maximum design power (capacity) of the NMSF;
- actual filling;
- NMSF operation modes;
- expected schedule of the designed NMSF commissioning;
- NMSF rated working life.

It is required here to identify basic technological processes, operations and procedures carried out in the NMSF (reception and entrance control of the NM, NM overload, NM loading and extracting from storing place, control of the NM during storage and shipment of the NM, transportation on the NMSF site, handling of damaged (defective) NM packages).

The section shall provide main technical solutions which ensure secure storage, reception and overload of the NM, its transportation on the NMSF site. Description of main technical solutions shall be accompanied with flow charts and drawings.

#### **7.4 The safety concept of the storage facility for nuclear materials**

It is required to state the basic principles and safety criteria. The items to be specified:

- the list of legislative and normative legal acts, as well as TNLA, which were used during safety justification and assurance;
- the numerical values of safety criteria underlying the NMSF design;
- the implementation of the defense in depth principle with the description of multi-barrier protection, as well as the properties of internal self-protection;
- the description and justification of the system of technical and organizational measures for protection of personnel, population, and environment;
- information on the design solutions which ensure the appropriate safety level;
- criteria for selection of placement area and a site (for new facilities);
- the description and justification of material selection;
- information on qualification and procedures of training of personnel;
- information on design and beyond design basis accidents (list of analyzed accidents, measures to prevent and limit their consequences);
- information on taking into account the prior experience in designing, construction, installation, operation, testing, confirming sufficiency of technical and organizational decisions which were adopted in order to ensure the NMSF safety.

It shall be shown which technical means and organizational measures assure nuclear safety during storage, loading and unloading and transportation of the NFM (S, N). The data on the presence of the alarm system of the SSCR shall be provided.

The information on assurance of radiological protection of personnel of the NMSF, population and environment shall be provided. The technical means and organizational measures aimed to protect personnel, population and the environment against unacceptable radiation exposure, to eliminate unacceptable exposure (ALARA principle) shall be briefly reported.

The data on technical security assurance during the NMSF operation shall be recorded and the conformity of the made decisions with the TNLA requirements shall be shown. The brief information shall be given to specify the technical means and organizational measures for protection of personnel, population and environment against the adverse effects such as explosions, destruction, environmental toxicity, electric current effects etc. that are possible during the NMSF operation. Also, here the information on safeguarding during use of cranes, boiler plants (steam and hot

water boilers), pressure vessels, steam and hot water conduits (if any) shall be provided.

The brief information on the NMSF fire and explosion safety assurance during storage, loading, unloading and transportation of the NM shall be provided. It is required to show the conformity of the adopted decisions with the TNLA requirements on fire safety.

The information on the NMSF physical protection assurance shall be documented in accordance with [3].

The main provisions of action plans which are developed to protect personnel and population in case of radiation accident at the NMSF, shall be provided.

### **7.5 Results of safety analysis**

A summary of the performed safety analysis regarding all considered groups of accidents shall be provided. The list of the IE for which the NMSF is designed shall be specified, the list of design and beyond design basis accidents, evaluation of design decisions developed to assure the NMSF safety shall be provided.

The results of the PSA shall be presented (if such analyses were carried out).

### **7.6 Effect of the storage facility on the environment**

The summary which reflects the assessment of NMSF radiation exposure on the environment during normal use and accidents in accordance with the requirements [4, 5] shall be provided.

The environmental impact assessment of the NMSF shall be carried out with regard to its actual condition, condition of the environment in the NMSF area, sanitary, biological, anthropogenic and technological characteristics of the biosphere pollution.

### **7.7 Comparison of the storage facility for nuclear materials design with the analogous domestic and foreign ones**

The information allowing comparing this design with analogous domestic and foreign ones of the same NMSF type (given the relevant data) shall be provided.

### **7.8 The schedule for construction of the storage facility**

It is required to specify stages of the NMSF construction (in case the SR NMSF is provided to justify action safety during the NMSF construction).

### **7.9 Principal provisions on the organization and exploitation of the storage facility**

**7.9.1** The summary of the NMSF commissioning, including the information of the BC, test of structures, systems and components when commissioning the NMSF shall be provided.

**7.9.2** The summary of the preparation procedure and reporting documentation retention shall be provided.

**7.9.3** The information on the preparation and organization of the NMSF operation shall be provided. The information shall contain brief data on the organizational structure of the OO and NMSF administration.

**7.9.4** The information on maintenance arrangement and monitoring of the NMSF operational status shall be provided.

**7.9.5** The information on the procedure for establishing limits and conditions of safe operation and supervision of their compliance shall be provided.

**7.9.6** The summary of the key decisions provided by the NMSF design shall be produced in order to ensure safe NMSF decommissioning.

#### **7.10 Quality assurance**

The summary of the measures for the NMSF quality assurance during its placement, construction and operation shall be provided.

### **8 Safety Assurance during Designing of Buildings, Structures, Systems and Components**

#### **8.1 Basic principles, criteria and security requirements implemented in the design of buildings, structures, systems and components**

**8.1.1** The list of TNLA used in the NMSF design, intended for the NMSF security, shall be provided.

**8.1.2** The principles and the safety assurance criteria accepted when designing of the NMSF shall be provided, the selection of these criteria shall be justified, their conformity with the TNLA requirements in the field of nuclear energy use shall be provided.

**8.1.3** The information on execution of basic principles and criteria for the NMSF safety shall be provided, including:

- compliance with the defense in depth principle shall be provided;
- it shall be shown that the design decisions, which are important to safety, were tested with prior experience and research;
- quality assurance at all stages of the NMSF workflow shall be provided;
- radiation safety assurance, radiation exposure limitation for personnel, population and environment, non-exceedance of the established norms for the radioactive substances emissions and discharges into the environment;
- nuclear safety assurance;
- ensuring fire safety;
- physical protection assurance.

Show implementation of safety culture principles.



It is obligatory to provide the information of non-compliance of the NMSF with the TNLA requirements in the field of nuclear energy use (the list, justification of deviations, and compensatory measures adoption).

## **8.2 Classification of buildings, structures, systems and components**

**8.2.1** It is required to provide the list of buildings, structures, systems and components important to safety, classified by safety class. The results shall be presented in the tabular form (Table 1).

**8.2.2** The information on classification of buildings and structures by fire resistance shall be provided, the categories of buildings, structures, premises by explosion-fire and fire hazard, according to [6], shall be specified. The results shall be represented in the tabular form (Table 1).

**8.2.3** The information on the classification of buildings, structures, systems and components by seismic resistance shall be provided. The results shall be represented in tabular form (Table 1).

**8.2.4** The list of buildings, structures, systems and components which are to undergo stability (resistance) analysis regarding effects of natural and anthropogenic origin (Table 1), which were taken into account in the design in composition and extent determined by the TNLA in the field of nuclear energy use shall be provided.

**Table 1 – The list of NMSF buildings, structures, systems and components and their classification**

Conventional sign of building, structure, system and component	Name of building, structure, system and component	Purpose (classification by purpose)	Safety class	Category of building, structure, premises by fire and explosion-fire hazards	Category (subcategory) by seismic resistance	Regard of anthropogenic and natural impacts

## **8.3 The master plan and layout of the storage facility for nuclear materials**

**8.3.1** The NMSF master plan and its specification shall be provided.

**8.3.2** The layout of the main buildings and structures of the NMSF in the master plan taking into consideration the SCS placed in these buildings and structures in terms of the NMSF safety, including external effects, shall be specified.

**8.3.3** The disposition of the NM storage relative to other structures and adjacent systems shall be specified and justified.

**8.3.4** The constructive and layout decisions concerning main buildings, facilities, their building structures and foundations bases shall be provided.

In particular, it shall be shown that in accordance with the requirements [7, 8]:

- the layout of premises and constructive solutions eliminate the possibility of water flooding and other inflows slowing down neutrons of materials into the NM storage facility;

- quick evacuation of personnel is assured from the premises in case of an accident;

- routes to other production facilities do not pass through the NM storage facility.

**8.3.5** The solutions for fire protection in terms of assessment of the NMSF buildings and structures layout conditions, access routes assurance for fire engines, presence of ponds and proper containers shall be described.

**8.3.6** The information on all the transport routes which are used (will be used) for the NM transportation to the NMSF and from the NMSF, indicating the transport routes, which shall be built, shall be provided.

#### **8.4 Description and justification of terms of the storage facility placement**

**8.4.1** The section shall contain the characteristic of the placement area and the NMSF site and the assessment of whether the layout conditions are suitable to place the NMSF shall be provided.

**8.4.2** The external effects, parameters and characteristics of natural and anthropogenic origin, which are possible in the placement area and the NMSF site and were considered in buildings, structures and technological systems design during the NMSF safety analysis and emergency planning, including the planning of population evacuation in case of emergency shall be provided in accordance with TCP 263.

**8.4.3** The data on the NMSF site and its placement area shall include:

- geographical situation, indicating the administrative location, site boundaries, the boundaries of the SPZ and observation area, the land allocation borders;

- topographical conditions;

- meteorological conditions, including climate conditions, the characteristics of extreme impacts of natural origin (flooding, tornadoes, ice formation, thunderstorms, etc.), air temperature, weather conditions which determine radioactive substances transfer during normal and accidental radioactive substances emission, wind roses;

- demographic conditions, including the data on distribution and density of the population round the NMSF location area by radii and directions (with account of population growth prospects during the designated NMSF lifetime);

- seismotectonic characteristics of the NMSF location area, including information on the presence of faults, MCE and OBE levels;

- geological description of the placement area and the NMSF site;

- physical and mechanical properties of soil, justification of site soil stability, assessment of potential impacts of physical and geological phenomena (landslides, avalanches, etc.);

- hydrogeological and hydrological characteristics, including the specification of aquifers, connection with the surface water, chemical composition of underground water, groundwater level, the information of the possible impact of the hydrosphere and hydraulic structures in the NMSF placement area on the NMSF safety;

- the data on anthropogenic conditions of the NMSF location, including the data on the structure and kind of industrial enterprises in the area of the NMSF placement, which may have adverse effects on the NMSF (chemical and oil refineries, storages, mines and quarries, drill rigs and wells, underground gas storages, military installations, transport routes – air, land, water), transport facilities (docks, ports, airports), i.e. the objects, which represent a source of explosion and fire hazard, toxic emissions into the environment and other hazards).

**8.4.4** The list of processes, phenomena and factors which determine external effects on the NMSF included in the NMSF design basis, shall be represented in the tabular form. You may find an exemplary form in Table 2.

**Table 2 – The summary table of data on processes, phenomena and factors which determine external influences**

Process, phenomenon, event	Source of a process, phenomenon, an event	Hazard level	Frequency of happening	Impact characteristics	Additional information

The information on the NMSF local conditions shall be presented as an appendix to the section. The appendix shall include a master plan of the NMSF, as well as the drafts showing the sources of external influences, diagrams, tables, graphs and other required cartographic and textual information which characterizes the NMSF local conditions. The section shall be arranged so that it was possible to record changes of the local conditions at all stages of the NMSF lifecycle.

**8.4.5** It is required to offer the results of a consideration and a qualitative analysis of possible scenarios of the IE development at the NMSF site, which can be triggered by:

- external effects of natural or anthropogenic origin;
- internal exposure caused by accidents on the NMSF site.

Probable sequence of events shall be submitted as results of primary and secondary effects.

It is recommended to enter the results of scenarios consideration in the table, which is given in Appendix A, for convenience of presentation.

## **8.5 Protection of the storage facility territory against dangerous geological processes**

A description and justification of the measures taken for the NMSF territory protection from dangerous geological processes shall be provided. This shall be made in view of the TNLA requirements.

The lists of design materials containing the information of engineering measures for consequences elimination, mitigation and monitoring of dangerous geological processes development shall be provided. An overview map of design measures intended to protect the NMSF territory shall be provided in order to convey more information, including the measures to protect against flooding (flow regulation, surface and ground water removal), mud dams construction, fixation of landslide and undermined slopes, etc. The proofs that the protective measures are sufficient shall be provided.

## **8.6 Protection against flooding**

The list of buildings and structures, which shall be protected against flooding, shall be provided and the security equipment and measures to protect these structures, buildings and systems located inside, against flooding (pumping drainage systems, drainage systems, dewatering pumps, watertight doors, etc.) with justification of their sufficiency shall be provided.

## **8.7 Impacts and load on buildings, structures, systems and components**

**8.7.1** The impacts and load on the main NMSF structures, buildings, systems and components of the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> classes of safety, which are accounted during their design, strength and stability analysis shall be described.

**8.7.2** The overall approach to the choice of possible combinations of design load on the NMSF buildings, structures, systems and components (load of external influences of natural and anthropogenic origin, internal influences caused by accidents on the site, the influences occurrence within the main structures during normal operation) and selected combinations for analysis of their strength and stability shall be described and justified.

**8.7.3** The references to the sections of the SR NMSF containing description and justification of the selection shall be specified.

**8.7.4** A summary table of considered impacts and combinations of influences on the main buildings and structures, systems and components shall be provided.

**8.7.5** All kinds of loads on buildings, structures, systems and components shall be provided in the tabular form.

**8.7.6** The information on assessment procedures of the stated impacts and resulting loads shall be provided.

## **8.8 Safeguarding of strength and stability of the storage facility buildings and constructions**

**8.8.1** Structural and layout solutions for the main buildings, structures, building constructions and foundation bases shall be described.

The detailed information on each of these buildings and structures shall be provided. Form and extent of the provided information are determined in accordance with specific features of buildings and structures.

**8.8.2** The list of documents containing justification of design solutions for buildings, structures, building constructions, bases, foundations, which are important to safety, shall be provided.

**8.8.3** The choice of materials for buildings, constructions and structures, considering normal operation and accidents, construction materials compatibility with the process environment shall be provided.

**8.8.4** The information on the analysis results on stability (strength, tightness, fire and earthquake resistance and so on) to external influences of buildings, their constructions and structures (realized levels), as well as stability of their bases and foundations, shall be provided in the tabular form.

**8.8.5** The durability of constructions, buildings and structures and their service life shall be described.

**8.8.6** The information on availability and content of the test program and serviceability control of building constructions, as well as monitoring of heeling, settling, stress-strain state, oscillations, of the state of their foundations and measures to strengthen bases under foundations of buildings and constructions which are important to safety (if required) shall be provided.

**8.8.7** The analysis results of strength and stability against internal effects of the NMSF buildings, structures, including mechanical, thermodynamic, chemical, corrosive effects shall be provided.

**8.8.8** The references to the developed programs assuring quality of work execution at all stages of service life of the NMSF buildings and structures shall be provided. The information required to determine conformity of the accepted quality assurance programs with the TNLA requirements shall be provided.

**8.8.9** The methods used to assure strength and stability of the NMSF buildings and structures shall be specified.

**8.8.10** The list of the SE and required information on the SE used to assure stability of buildings and structures against external influence shall be provided.

## **8.9 Safeguarding of strength and efficiency of the storage facility systems and components**

**8.9.1** The list, indicating location of all systems (mechanisms, assemblies, machinery) which are important to safety, including lists of those which shall operate

during and after design basis accidents, including mechanical systems, machinery and conduits, electrical equipment, supervisory instruments and controls, ventilation systems, lifting and conveying equipment shall be provided.

The information on strength and operability ensuring of the stated equipment shall be presented in the form of subsections within this section.

**8.9.2** The information containing description of approaches aimed to ensure strength, reliability, operability and stability of the NMSF systems and components which are important to safety, in view of loads triggered by various impacts including those of natural and anthropogenic origin, and transmitted through the constructions of buildings and structures, shall be provided.

**8.9.3** Each subsection shall contain the list of loads, under the influence of which the operability of equipment is assured.

**8.9.4** Both normal operating conditions and abnormal external and internal influences shall be defined. Values of the following parameters shall be provided: temperature, pressure, relative humidity, radiation, chemical composition and vibration (of non-seismic nature). The considered design loads and their combinations for the stated systems shall be provided.

**8.9.5** It is required to assure strength, durability and stability of the equipment and their supporting structures, taking into account the range of influences taken as a design basis and presented in 8.7 of this Technical Code.

**8.9.6** The machinery operability under the determined loads shall be assured. It shall be shown that the mechanical, supervisory and electrical systems are able to function under the impacts which occur during normal operation, abnormal internal influences, as well as under conditions of the combined influence of external effects in view of the loads, caused by natural and anthropogenic impacts and transmitted through the constructions of buildings and structures; and (or) the references to the relevant sections containing this information shall be provided.

**8.9.7** The methods and procedures for inspection of constructional integrity, operability and stability of machinery under the set loads, and methods and procedures for supporting structures strength testing shall be described.

**8.9.8** It is required to provide information of analysis methods used to confirm operability, constructional and functional integrity, machinery strength and stability, as well as to give proofs of their acceptability. The list of the SE used when calculating, and the information on its certification shall be provided.

## **9 Nuclear materials handling systems and related systems**

### **9.1 General requirements**

**9.1.1** This section shall contain the information on safe operation assurance for a complex of then NM handling systems, as well as of the systems (components) important to safety which assure its functioning.

**9.1.2** The information and operation analysis of each system shall be based on the materials of an engineering design of the NMSF systems and components.

**9.1.3** It is recommended to adhere to the type scheme for system description offered in Appendix B. Particular content of any subsection can be changed depending on the system features.

**9.1.4** It is permissible to give merely reference to other SR chapters (sections), where this information is available in further detail, during provision of information.

**9.1.5** The complete lists of changes and deviations from the approved design documentation during equipment fabrication, installation and BC, analysis of the impact of these deviations on safety, and information of compensation measures shall be provided.

**9.1.6** The precise composition of the NM handling complex shall be submitted in the introductory part of this section, as well as the lists of NM storages, the list of safety-relevant systems which ensure the NMSF operation and their interconnection. For each storage facility, forming part of the NMSF, the data shall be given in accordance with the specification structure, offered in 9.2 and 9.3.

## **9.2 Nuclear materials and packaging**

**9.2.1** This section shall provide the data on the NM supposed for storage and on the NM packaging used for storage and transportation.

**9.2.2** Numerical values of characteristics, which are important in view of nuclear and radiation safety assurance, shall be specified for each NM type. Depending on the NM type they may include:

- physical characteristics (aggregate state, humidity, density, dispersiveness, and others);
- chemical composition;
- heat release level;
- initial enrichment and degree of burn-up (as regards SNF);
- presence of absorber;
- isotopic (nuclide) composition and its possible change for the determined NM storage period;
- radioactive properties (specific and total activity of the NM, half-life period, type of NM radiation, emission spectrum);
- explosive hazard characteristics, possibilities and conditions of spontaneous combustion;
- presence of organic substances;
- toxicity;
- other safety-related characteristics and properties.

**9.2.3** The data shall be justified. If there is any possibility of characteristics deviation from the set values due to errors when measuring these characteristics, errors in calculations, etc., then their most conservative values shall be given. The list of calculations and reports on experimental justification for the data of the NM characteristics (if any) shall be provided.

**9.2.4** The list of packaging sets used for storage and transportation, including TP and ITP, shall be provided.

**9.2.5** Purpose and functions shall be indicated for each package type (technological functions - storage, transportation; security functions - radiation protection, thermal insulation, strength, etc.).

**9.2.6** The list of the TNLA, which determine the requirements to the packages, shall be provided.

**9.2.7** The design characteristics of packaging sets and requirements for packing shall be provided, including:

- basic characteristics related to weight, size and design of packaging sets;
- data on mechanical strength (permissible static, dynamic, impact loads);
- packaging compatibility with transport and processing equipment;
- packaging tightness, water resistance, the ability of non-destructive testing of packaging tightness during storage period;
- durability (resistance to corrosion attack, to frost), service life;
- maximum temperature inside and on the surface of the package, maximum permissible internal pressure;
- free space availability inside of packaging;
- marking requirements;
- radiation exposure resistance;
- surface contamination value, the permissible dose size at the surface of the package;
- rate of the NM loading (NM amount per package).

**9.2.8** The lists of design IE, which were considered during the analysis of packaging strength properties, shall be provided.

**9.2.9** The information concerning the presence of the incoming control of the NM and NM packages shall be provided. The methods and procedures of incoming control, including methods of identification of packages (identification of NM type or category, amount, the degree of enrichment and radiation level at the external surface), verifications of NM packaging contents compliance with the data of accompanying documents and the established requirements shall be provided. The information on metrological certification of the NM incoming control methods shall be



provided. The information on the documentation order for the data on incoming control results shall be provided.

**9.2.10** The construction and internal design of the NM packaging sets: the construction of internal and external containers (if any), spacing structures, devices for protection against radiation, for cooling and thermal insulation, protection devices against overpressure, shock absorbers, the presence of neutron absorbers inside or around packages shall be provided. The required pictures and drafts shall be provided. The choice of design solutions shall be justified.

**9.2.11** The selection of constructional materials for packaging sets, their physicochemical characteristics, sorbent material, the material of absorbers and moderators (if any), and other facilities shall be provided.

**9.2.12** The processes and phenomena occurring in the NM, which can appear during the NM storage period and are able to cause quality deterioration of the container material shall be described. The possible volume, linear and phase changes, alteration of density, thermal capacity, thermal conduction, mechanical properties, and gas release in the NM during the storage period shall be described.

**9.2.13** The effect of the following processes and phenomena on tightness and strength of packaging sets shall be considered:

- gas release of NM (due to corrosion or radiolysis in case of solutions and solid NM storage in containers fabricated of organic materials);
- change in the NM structure;
- change in the volume of NM due to thermal expansion, cracking, consolidation and inflation;
- NM oxidation;
- NM interaction with container material;
- thermal creep of NM under tension;
- container material oxidation;
- hydrogenation of container material;
- local and uniform internal and external corrosion of container material;
- stress corrosion cracking;
- other processes.

**9.2.14** The adequacy of the list of the considered processes shall be considered and it shall be shown how they take into account the effect on the protective properties of the materials of construction of the container caused by these processes.

**9.2.15** In case of self-inflammable NM storage, the information on bringing them to a safe state or justification of the possibility of secure storage of such NM shall be provided.

**9.2.16** The information on the certification of packaging sets shall be provided; the numbers of operating instructions for them, the numbers of certificates which authorize their construction, storage and (or) transportation of NM shall be offered.

**9.2.17** The order of handling of packages which are damaged or do not correspond to the TR shall be provided.

### **9.3 Nuclear materials storage system**

The section shall provide the information on the NM storage system in a precise storage, which is a part of the NMSF.

#### **9.3.1 Purpose, design basis**

**9.3.1.1** The information regarding the purpose of the system identifying all of its functions shall be provided.

**9.3.1.2** The basic principles and criteria underlying the system design, highlight basic safety principles and criteria which shall be implemented in design and (or) technological scheme of the system shall be provided.

**9.3.1.3** The list of TNLA, the requirements of which shall be met by the described system, shall be provided.

#### **9.3.2 Description of the system**

**9.3.2.1** This section shall contain the description of structure and (or) technological scheme of the whole system and its subsystems, equipment, structures and components, if they have separate functions.

**9.3.2.2** The layout solutions and location of the equipment in the NMSF premises shall be provided and justified.

**9.3.2.3** The selection of design constructions for storage, supporting and building structures, construction of separate compartments, storage slots, barriers, shelf stands, partitions, and the used equipment shall be provided. The drafts, pictures and schemes illustrating the construction and operation of the NM storage system and its elements, its spatial layout and connection with the other NMSF systems shall be provided.

**9.3.2.4** The technological scheme of the NM storage, including loading of NM in storage slots and NM unloading from the storage slots shall be provided. The justification of selection of the NM technological storage scheme shall be provided.

**9.3.2.5** The structure of materials handling equipment identifying the subsystems which have separate functions, equipment and components shall be provided, including:

- structure of the equipment for loading works, transport mechanisms, uncoupling and stacking mechanisms for packages, etc.;
- technical facilities for heat removal from the NM package (if required);
- measures to prevent damage, deformation, disruption or falling of packages;
- measures to prevent unacceptable force exertion to packages during handling operations;
- technical facilities preventing falling of NM packages, IFA during loss of electricity supply;
- available protective devices assuring acceptable movement limitation for devices;
- the equipment specified in the technical design to assure reliable transportation of NM to safe places in case of failure or violation of safe operation conditions of transfer devices.

**9.3.2.6** The information confirming compliance of the relevant NMSF transport and handling equipment with the technical safety requirements shall be provided.

**9.3.2.7** The storage environment parameters (atmosphere, temperature, humidity, chemical composition, etc.) shall be specified and the choice of these parameters shall be justified.

**9.3.2.8** The selection of the materials for the basic elements of NM storage system, in consideration of normal operating conditions, violations of normal operation, including emergencies and accidents shall be specified; the information on materials certification shall be provided.

**9.3.2.9** It is required to justify durability of materials, including absorbing additives in the composition of NMSF structural materials (if any), in the conditions which occur in the process of operation, including deactivation, violations of normal operation, inclusive of design basis accidents.

**9.3.2.10** The fulfillment of fireproof or slow burning requirements to the NMSF envelope buildings, as well as facing, decoration, sound-absorbing, sound- and heat-insulating materials used for the NMSF interior finish shall be provided.

**9.3.2.11** The choice of facing materials for surface of SF premises and equipment in terms of a deactivation process shall be justified.

**9.3.2.12** It is required to show that some properties were taken into account when selecting materials which affect hermetic structures integrity during NM storage period, such as:

- chemical compatibility with the environment;
- compatibility with material of contacting components (insulation, supports, coating, details of seal assemblies, etc.);
- cyclical and continuous strength and creep;

- corrosive (including stress corrosion), cyclical corrosive and erosion characteristics;

- radiation damage;
- fatigue, shrinkage, deterioration;
- alterations caused by radiation;
- fracture strength;
- brittle fracture resistance;
- alterations caused by internal gas pressure;
- behavior in case of emergency.

**9.3.2.13** The data on the monitoring of elements impurity which adversely affects performance characteristics of materials, and the limitation measures for such impurities shall be provided.

**9.3.2.14** The information on the materials within the storage facility, including those which have hazardous characteristics in case of fire and are not a part of packaging sets shall be provided, the regulation of their location according to the design shall be justified. The information on groups of packages, stacks of materials stored inside the shelf stands, which are effective neutron moderators (if any), shall be provided.

**9.3.2.15** The systems which are important to safety and functionally related to the NM storage system shall be listed. The following systems shall be considered:

- power supply system;
- ventilation, air conditioning, gas vent and gas cleaning systems;
- cooling system;
- drainage system;
- deactivation system;
- management and control system;
- system of radioactive drain and water treatment;
- AS of SRCR origin;
- the system of fire alarm and extinguishment, smoke removal system;
- the system of work and emergency lighting;
- industrial television system.

**9.3.2.16** The following systems shall be also considered when storing SNF in cooling ponds:

- water-cooling system (except the cases when it is proved which design values excess of water temperature in the storage is impossible even without special cooling);

- water purifying system;
- process monitoring system;
- system of filling and emptying of a pond;
- leakage monitoring, collection, and return system;
- other systems (if required).

The information on the location of each system and its interconnection with the considered system shall be provided.

### **9.3.3 Control and monitoring**

**9.3.3.1** This subsection shall provide the information on the system control methods (automatic, remote, and local control) and system monitoring, the list of monitored parameters of the system and the range of permissible values in each operating mode.

The subsection shall contain the list of permissible values of the monitored system parameters and justify them in all operating modes, as well as specify the location of control points, describe control procedures, and submit the requirements to supervisory equipment.

**9.3.3.2** The information on the availability of facilities and systems for monitoring and signaling shall be provided.

The data on all kinds of monitoring and signaling shall be provided. The sufficiency of devices for packages integrity monitoring shall be provided and justified, the criteria of damaged packaging detection shall be specified and the actions to be taken in case of fault detection shall be described. It shall be shown that control and monitoring of the system assure timely diagnosis of defects and disfunction identification to take measures for their elimination.

**9.3.3.3** The description of communication between the system and NMSF control systems shall be provided.

**9.3.3.4** The procedure and means for monitoring and recording of the supervision results shall be provided.

**9.3.3.5** The administrative controls of the NM movement shall be provided.

**9.3.3.6** The procedure for maintaining and storage of documents which contain the data on location, characteristics and quantity of incoming, outgoing, stored, transported over the site NM shall be specified.

### **9.3.4 Tests and verifications**

**9.3.4.1** It is required to specify content of the test program, its objectives, the list of TNLA and design documentation, on the basis of which tests and verifications are implemented, lists of values of monitored parameters, and requirements to the SI used for tests.

**9.3.4.2** The justification of the list of monitored parameters during production of equipment and components and NM storage construction shall be provided. The information on the methods, scope and timing of condition monitoring and the system testing during NMSF operation, the description of activities specified for these purposes by the design shall be provided, and their conformity with the requirements of TNLA shall be shown.

**9.3.4.3** The information on the regulations and procedures for periodic verification of system (equipment) availability when operating shall be provided.

### **9.3.5 System Analysis**

**9.3.5.1** The analysis of system functioning shall be submitted: during normal operation, violations of normal operation, including pre-emergency situations and design basis accidents, the impact of possible failures of interconnected systems and protection against the influence of these failures. Operational limits and conditions, limits and conditions of safe operation shall be a given for the prescribed modes of operation. The description of the system and its elements state and their interaction in the process of the determined functions fulfillment shall be provided. The relevant calculations and experimental results shall be given in order to justify the availability of the systems.

**9.3.5.2** For normal operating conditions, the following security aspects shall be considered (depending on the stored NM, storage conditions, NMSF design):

- assurance of integrity of constructions, packaging sets and other physical barriers;
- presence of heat removal;
- radiation safety assurance;
- nuclear safety assurance;
- fire and explosion safety assurance.

These issues can be examined in this section. They can be divided into individual subsections and (or) the reference to the sections of the SR NMSF, where these issues are described in detail, shall be provided.

**9.3.5.3** In case of absence of relevant information in the sections "Safety justifications in the design of buildings, structures, systems and components" and "Nuclear materials handling systems and related systems" the accepted design measures, developed to ensure strength and integrity of equipment and storage constructions shall be justified.

**9.3.5.4** It shall be shown that all the equipment and conduits (if any) can endure static and dynamic loads without breaking. It is required to show that all the elements of the NM storage system were designed in view of the ability to endure the environmental conditions for all operating life (pressure, corrosive attack of processing medium, temperature, humidity, radiation, etc.), resulting from normal operation, normal operation violations, including design basis accidents.

**9.3.5.5** For materials handling equipment, it shall be shown that the equipment design takes into account all the stresses produced during normal operation and as a result of design IE, and the stress, resulting from impact of loads, do not exceed the permissible limits for the various holding elements.

**9.3.5.6** For SCS, the integrity and its required degree assurance, determined by various loads (static, dynamic, thermodynamic, and others) in normal operating conditions and pre-emergency situations shall be shown. The integrity of structures, equipment and components in these conditions shall be proved by strength calculation which takes into account the relevant load conditions (strain, temperature, corrosion characteristics of the medium and other conditions), as well as creep, fatigue, thermal stresses, changes of corrosion and physical properties of materials over time (e.g. concrete shrinkage).

**9.3.5.7** The integrity of NM packaging sets and other NMSF security barriers during designed operating life of the storage or shelf life of a particular package shall be affirmed by the appropriate conclusions.

**9.3.5.8** In case of decision-making, the measures to prevent formation of sediments, crystallization, blocking of conveying channel and valves shall be provided. The measures developed for a solution spill case (pallets, storage tanks of secure geometry) shall be specified, the availability of radioactive leakage drainage and absence of stagnant zones shall be justified.

**9.3.5.9** If the cooling of NM is planned, the cooling system (heat removal) reliability shall be justified, as well as its functionality in view of the thermal properties of materials and heat transfer method (heat conductivity, radiation and convection). When considering heat conductivity inside the NM package, FA, a cover, a compartment or storage facility, it shall be generally demonstrated that the heat, released by the NM, may be dissipated with no excess of the determined temperature limits. The calculations shall be made with allowance for all operational modes for the condition of NM storage full load. It shall be demonstrated that NM heat release will not result in packages integrity violation for the required period.

**9.3.5.10** It is required to show the following regarding a cooling pond for SNF:

- construction and waterproofing exclude ingress of radioactive substances into the adjacent premises and the ground (indicate the degree of the cooling pond facing integrity);

- storage construction eliminates the possibility of water loss of the rate exceeding the charge flow during normal operating conditions and design basis accident;

- when designing the storage facility, the ability to detect water leakage, find leaks and eliminate them was realized;

- SNF cooling is enabled for the cases of design and beyond design basis accidents;

- facing of the cooling pond assures the desired degree of integrity and force impact perception, specified in the design; facing of the storage bottom stays hermetic in case of FA fall, a cover fall from maximum height which is possible during transportation and technological operations;

- if there are sluice gates between the compartments of the cooling pond or pounds, they can endure water pressure from each side provided which there is no water on the further one.

**9.3.5.11** The results of the system functioning analysis during violations of normal operation, including failures of the given system, other systems, as well as in the system operation under internal and external influences shall be provided.

**9.3.5.12** The analysis results of the system element failures, including mistakes of personnel, and the analysis of failure influence, including common cause, on functionality of the given system, and general impact of the related systems on the NMSF safety shall be provided. Both qualitative and quantitative characteristics of consequences shall be given for the examined failures.

**9.3.5.13** The following failure kinds shall be considered, with regard to the particular NMSF:

- NM overload failures (fall of packages and loads, strikes);
- failure of passive and active components, damage to equipment and constructions;
- external power supply interruption;
- failures of the heat removal system;
- failures of backup systems (e.g. heating and ventilation);
- violations in technical maintenance of appropriate conditions for NM storing;
- failure of control and monitoring systems;
- fires (external and internal);
- explosions (external and internal);
- flooding (internal and external);
- high wind, seismic effects, an aircraft fall;



- errors of personnel (including incorrect repair works, periodicity violation of technical maintenance and repairs, replacement of equipment).

When analyzing failures, it is important to take into account damage (failure) development of the package, cooling system, and building constructions.

**9.3.5.14** The impact of these failures on the NMSF functionality in general shall be analyzed and their admissibility, inclusive of the availability of corrective action or repair works shall be demonstrated. The applied technical means or organizational arrangements, provided for elimination of the consequences of such failures, shall be listed for each postulated IE (or a failure group with common characteristics).

**9.3.5.15** The analysis shall highlight the failures, which are the IE of design and beyond design basis accidents, to be considered in the Commissioning section of SR.

**9.3.5.16** Based on the data in this section, qualitative and quantitative analyses of the system reliability shall be performed in accordance with the requirement of TNLA.

**9.3.5.17** This section shall also give the information on the SE used for the system operation analysis, their certification.

#### **9.4 Transport technological system, transportation of nuclear materials, radioactive substances and radioactive waste on site**

**9.4.1** The section shall provide the information on the transport technological system which provides reception, transfer, movement of NM, on the composition of transport technological equipment and transportation conditions of radioactive substances, RM and RW at the site of the NMSF.

**9.4.2** Structure of the information delivery is similar to a standard system description structure provided in Appendix B. Description of the individual elements can be separated into independent subsections of the same structure as in the description of the system in general. The required schemes and drafts shall be attached. It is required to refer to the other sections when providing information.

**9.4.3** In the section a description of the technological scheme of transport technological operations (reception, loading and unloading, transportation, canting) with specification of the equipment, devices, components which perform independent functions shall be provided. In particular, the following shall be submitted:

- nomenclature of transport technological equipment with the specification of its location. The conditions which ensure safe NM package handling, including failures and damage shall be justified;

- the list and description of the technical means to assure heat removal from the NM packaging (if required);

- the list and description of the measures to prevent damage, deformation, destruction or falling of packages;

- the list and description of the measures to prevent an unacceptable force application to packages during loading and unloading operations;

- the list and description of the technical means to prevent fall of packages with NM, FA during power failure;

- the list and description of the protective devices to ensure movement of equipment within the allowed range;

- the equipment specified by the technical design, for reliable NM transportation to a safe place in the event of a failure or violation of the conditions of safe operation with transfer devices.

**9.4.4** The justification for strength, durability and stability of materials handling equipment with regard to external and internal influences shall be provided, or a reference to the section of the SR NMSF, where this information is described in detail, shall be provided.

In particular, according to the requirements [9], it shall be demonstrated which pinchers of lifting mechanisms are designed so that they lift and move NM packages securely, the required accuracy is ensured in placement of lifting mechanism pinchers above a gripping device of a package; it remains closed in the event of power supply failure, blocking is provided to prevent self-induced or personnel related release of pinchers.

**9.4.5** It shall be shown that the design of equipment for NM handling eliminates strikes and other loads which may cause damage or alteration in geometric parameters of NM packages during normal operation.

**9.4.6** It shall be demonstrated that the design of equipment for NM handling is optimized for all loads during normal operation, as result of the IE during normal operation and accidents. It is required to show that the stresses resulting from influence of loads do not exceed the permissible limits.

**9.4.7** The data on the relevant calculations, used SE, and results of the experiments conducted in order to justify operability of the systems shall be provided. The information on test programs (the references to the relevant section of SR NMSF are permitted) shall be provided.

**9.4.8** The technological scheme of radioactive substances, RM, and RW transportation at the site of the NMSF shall be described. The transportation routes of the NM, radioactive substances, and RW at the site of the NMSF, with justification of the route choice (state whether transport routes intersect with general roads) shall be described.

**9.4.9** The list of the vehicles used for NM, radioactive substances and RW transportation (indicate sanitary passports and their validity periods) shall be provided.

**9.4.10** Lastly, the conclusion shall be made whether the system comply with the requirements of TNLA in the field of nuclear energy use, and the other TNLP on safety and security principles and criteria, adopted in the NMSF design.

## **9.5 Other systems related to nuclear materials handling systems**

**9.5.1** The other systems important to security (equipment and facilities) of the NMSF which are functionally connected with the NM handling systems and assure their safe operation, and separated for special consideration shall be considered.

**9.5.2** System description structure is similar to the standard system description structure, provided in Appendix B. Description of the individual elements can be separated into independent subsections of the same structure as in the description of the system in general. The required schemes and drafts shall be attached.

It is permitted to give references to other sections.

**9.5.3** The approximate list of systems is given in 9.3.2. The list can be changed, reduced or supplemented in accordance with the NMSF specifications. The requirements designed to describe some of systems are below.

### **9.5.4 Power Supply System**

**9.5.4.1** The section shall contain the information on the power supply system.

**9.5.4.2** The basic principles of designing and preparation for operation of the NMSF electrical systems shall be stated.

**9.5.4.3** The information presented in the section shall prove functional reliability of power supply systems, sufficient amount of power, multi channeling, independence, resistance to external and internal effects, availability of maintenance, testing, and repair.

**9.5.4.4** The compliance with TNLA requirements, based on the analysis of their functioning during normal operation, violations of normal operation, and failures of power supply systems, taking into consideration the errors of personnel, as well as during design and beyond design basis accidents shall be shown.

### **9.5.5 Ventilation and air purification systems**

**9.5.5.1** The section shall provide the information on ventilation systems (general and process ones) which carry out the following functions:

- maintenance of the established air temperature within the premises under designed NMSF operating modes;

- assurance of the required vacuum degree, assurance of directed air streams movement;

- radiation safety assurance in the NMSF premises and outside in accordance with the current standards;

- assurance of working conditions which comply with permissible sanitary standards for personnel in all designed operating modes;

- arrangement of conditions for repair and transfer works.

**9.5.5.2** The basic principles of design and operational organization of ventilation systems shall be outlined.

**9.5.5.3** The information confirming functional reliability of ventilation systems, redundancy level, resistance to external and internal influences, availability of maintenance, testing, and repair shall be provided.

**9.5.5.4** The execution of the TNLA requirements based on the analysis of their functioning during normal operation, violations of normal operation and failures with regard to errors of personnel, during design and beyond design basis accidents.

## **10 Management and Control**

### **10.1 General**

**10.1.1** The section focuses on methods and tools for monitoring and control of the nuclear material storage facility during normal operation, violations of normal operations, including accidents.

**10.1.2** Requirements for the information provided in the section are applicable to the systems which perform management and control functions important to safety, which may include:

- control center;
- system and equipment of communication and notification;
- diagnostic systems;
- systems and equipment of control of integrity and performance of physical barriers;
- management of fire extinguishing systems;
- systems and equipment of control and management of explosion protection systems;
- systems and equipment of control and management of physical protection systems;
- systems and equipment of control of radiation situation in the premises of the nuclear material storage facility;
- emergency alarm systems on the self-sustaining chain reaction occurrence;
- systems and equipment of environmental control, including information systems of the automated radiation monitoring system;
- information system of accounting and control of nuclear materials, radioactive substances and waste in the nuclear material storage facility.

**10.1.3** The section provides the information on the management aspects which are important to safety and the nature of the management organization of the nuclear material storage facility operational personnel and functions which are important to safety.

**10.1.4** The information shall be provided to the extent and to the degree of detail required for the justification of the technical and organizational security

solutions adopted in the design. During presentation of information it is acceptable to be limited by the reference to other sections of the safety report, where the information is provided in more details.

## **10.2 Definition of systems and equipment of management control important to safety**

The list of systems, monitoring and control equipment important to safety shall be provided. Their names and designations in accordance with the technical design documentation and specifications shall be specified.

Classification of these systems and equipment on the purpose and on the impact on safety shall be provided.

## **10.3 Description of systems and equipment of control and management**

The information on each considered system shall be provided in the following sequence.

### **10.3. X\*.1 Purpose and design basis**

Note - X \* - subsection of specific system.

The information on the conditions and limitations important to safety, on the basis of which the management system is designed, principles and safety criteria underlying the system design shall be provided.

### **10.3.X.2 System description**

The information shall be provided, including: description of the management system, information on its composition, on main technical characteristics, description of the operating principle of the system during normal operation and its violations based on the interaction with other systems and equipment and related equipment.

The information on the automation equipment belonging to the management systems composition, including systems and means, providing the automated and automatic management of systems in conditions of normal operation of the nuclear material storage facility shall be provided.

The information on the group communication media between the control center and personnel of the nuclear material storage facility; personal communication between the control center and personnel, on the equipment ensuring collection, processing, documentation and storage of information shall be provided;

diagnostics of condition and operation modes;

diagnostics of automation equipment as a part of management systems, radiation control systems.

The sufficiency of measures to ensure the conditions for work of operating personnel both during normal operation of the nuclear material storage facility, and in case of accidents shall be justified.

The information on the procedure of access to premises of management systems and control center, as well as to the operational management zones both for normal operation and in the accident conditions shall be provided.

For control center and other systems and equipment of management and control associated with human involvement, the information on the ergonomic and

anthropometric provision of the operator workplaces shall be provided. The organization of interaction of "human-machine" shall be justified.

The information on power supply and grounding, protection from external influencing factors, systems providing maintenance of conditions in the premises where the management system is located shall be submitted.

The description of systems and equipment of preventive and emergency notification of personnel of the nuclear material storage facility shall include:

- the list of warning signals indicating the support by light, sound and other equipment of attraction of attention of personnel;
- technical characteristics of the ways of attraction of attention of personnel (flashing frequency, color, pitch, etc.);
- rules for the use of warning signals of the system in case of the accident;
- information on the equipment of communication, including duplicate, intended for the organization of management of the nuclear material storage facility, and notification systems in normal operation modes, at the design and beyond design basis accidents.

The decisions made of assurance of safety, performance of the nuclear material storage facility in case of failures of the management systems and management and control equipment shall be justified.

#### **10.3.X.3 Commissioning works**

The choice of methods of management system performance testing in terms of functions, their integrated set-up, diagnostics and documentation of their characteristics, as well as justification of their compliance with the specification shall be justified.

#### **10.3.X.4 Maintenance**

It is required to justify the decision on the diagnostics, periodic monitoring of the management system and its parts, equipment and components, and their periodic inspections and functional testing, registration and documentation of faults and failures, as well as training of personnel.

The troubleshooting measures and remedial actions in the process of service of management system shall be specified and their sufficiency shall be justified.

#### **10.3.X.5 System analysis**

The results of analysis of failures of management systems and management and control equipment and the impact of failures on safety of the nuclear material storage facility shall be provided, the compliance with the design criteria, the requirements of technical regulations shall be shown.

The information shall contain the results of analysis of reactions of management systems and management and control equipment on external and internal effects (fires, flooding, electromagnetic interferences, short-circuit of the primary power supply network, etc.), system responses to possible failures and faults (loss of insulation quality, voltage drop, false positives, loss of control, etc.), the reliability of the quantitative analysis, the results of analysis of the stability of control loops and their impact on safety. For the control centers (boards) the analysis results proving which the common cause failure of management is excluded shall be provided.

In cases, if the initial design information and analysis are related to the actions of personnel, the results of analysis of the influence of wrong actions of personnel on safety, as well as the information on the instrumentation provided in order to prevent or mitigate the consequences of violation of conditions of normal operation and accidents shall be provided.

The results of analysis of reliability of all elements and components of the management system during normal operation, violations of normal operation and accidents shall be provided.

For systems and equipment which do not affect safety, the justification which these systems and equipment have no effect on safety shall be provided. Similar requirements are applicable to the analysis of the impact of maintenance on safety.

## **11 Radioactive Waste Management**

The section shall provide information on the formation of radioactive waste (liquid radioactive waste, solid radioactive waste, and gaseous radioactive waste) during the operation of the nuclear material storage facility, procedures and radioactive waste management systems in accordance with the requirements [10], discharges and emissions of radioactive substances.

The compliance of decisions and principles of radioactive waste management with the requirements of technical regulations in the field of nuclear energy and radiation safety shall be shown.

### **11.1 Sources of radioactive waste**

**11.1.1** The section shall describe the sources of gaseous, liquid and solid radioactive waste which are generated during normal operation of the nuclear material storage facility (including maintenance and repair) and in case of violations of normal operation, including design basis accidents. In the latter case, the information on the formation of radioactive waste when the characteristics and the volumes of waste generated serve as initial data for the development of management systems of radioactive waste shall be provided. The section shall provide the list of processes and works (decontamination, maintenance and repair, operation of sewage treatment plants, elimination of leaks, spills, etc.), leading to the formation of radioactive waste, the information on the number, quality and quantity of radionuclide composition of liquid, solid and gaseous radioactive waste in compliance with the adopted classification as well as the scheme of management of radioactive waste in compliance with [11]. Quantitative and qualitative characteristics of radioactive waste shall be justified by calculations.

**11.1.2** The information on the number, radionuclide composition and activity of gaseous radioactive waste shall be provided. Technological processes and maintenance work, leading to the formation of gaseous radioactive waste shall be considered. The nuclear material storage facility systems, which may be potential sources of radioactive substances emissions in the premises and environment, including the premises of the ventilation system of permanent and periodical residence of personnel and technology blowing-off systems (if any) shall be specified. The systems equipment, which can form explosive gas concentrations, shall be specified, their design pressure values shall be provided.

**11.1.3** The information on the amount of liquid radioactive waste generated, their activity, qualitative and quantitative radionuclide composition shall be provided. The technological processes and maintenance work, which lead to the formation of liquid radioactive waste, or may be accompanied by the intake of liquid radioactive waste in the premises and emission of radioactive waste into the environment during normal operation and disturbances of normal operation (including leaks, spills), shall be considered.

**11.1.4** The information on the amount of generated solid radioactive waste, their activity, qualitative and quantitative radionuclide composition shall be provided. The technological processes and maintenance work, which lead to the formation of solid radioactive waste or may be accompanied by the intake of solid radioactive waste in the premises and environment during normal operation and normal operation violations shall be considered.

**11.1.5** The systems, which in the course of their operation or maintenance may serve as possible sources of emissions (discharges) of radioactive substances and are not related to the systems of radioactive waste management, shall be specified.

**11.1.6** The measures to minimize the amount of generated waste (liquid radioactive waste, solid radioactive waste, and gaseous radioactive waste), discharges and emissions of radioactive substances shall be provided.

## **11.2 Systems of gaseous radioactive waste management**

### **11.2.1 Design basis**

**11.2.1.1** The purpose and functions of the system shall be provided; the basic safety principles and criteria adopted in the design during management of gaseous radioactive waste, including measures to reduce the volume and activity of generated radioactive waste, emissions into the environment shall be outlined.

**11.2.1.2** The main principles and criteria implemented in the design and (or) flowsheets of systems shall be specified.

### **11.2.2 System analysis**

**11.2.2.1** The descriptions of each system of gaseous radioactive waste management and schemes of gas flows, showing the technological equipment, the path of motion of gases in the system, the system performance and related equipment, backup equipment shall be provided. Normal and maximum intake flow rate of gases and concentration of radioactive substances (radionuclides) for all operating conditions shall be provided for each system in the form of tables or diagrams. Description of systems shall be carried out in compliance with the structure provided in Appendix B.

**11.2.2.2** The measures to prevent explosions provided by the design shall be justified.

**11.2.2.3** The ventilation systems of each of the buildings in which we can expect the occurrence of gaseous radioactive waste shall be described. The volumes of the buildings, the expected costs in the buildings ventilation system, filter characteristics shall be provided. The normal mode of operation for each of the ventilation system and features of operation in violation of normal operation, including design basis accidents, shall be described.

**11.2.2.4** The technological instrumentation (including gas analyzers) shall be described.

**11.2.2.5** It shall be shown which gaseous radioactive waste management systems provided by the design of the nuclear material storage facility have sufficient capacity, efficiency and redundancy required to assure the required degree of



purification of gaseous radioactive waste and non-exceeding of the permissible norms on radioactive substances discharges in all operating conditions, including the design-basis accidents.

**11.2.2.6** The compliance of the chosen technical solutions for the management of the gaseous radioactive waste with the requirements of technical regulation shall be shown.

### **11.2.3 Discharges of radioactive substances**

**11.2.3.1** The accepted norms and control levels of discharges shall be provided.

**11.2.3.2** The expected value of radioactive substances discharges in all operating modes of the nuclear material storage facility, including design basis accidents, shall be provided and justified, and (or) the relevant sections of the safety report, where this information is available, shall be referred to. All sources of radioactive substances discharges shall be provided. The discharges values for each source indicating the radionuclide composition, the value of the volume of specific activity of each radionuclide and total activity shall be provided in the form of a table.

**11.2.3.3** The compliance of the radioactive substances discharge values with the limits established by the norms of radiation safety shall be demonstrated.

## **11.3 Systems of liquid radioactive waste management**

### **11.3.1 Design basis**

**11.3.1.1** The basic safety principles and criteria adopted during the management of liquid radioactive waste, including measures to reduce the volume and activity of the resulting liquid radioactive waste, discharges to the environment shall be specified.

**11.3.1.2** It shall be shown which the liquid radioactive waste management systems have sufficient performance, efficiency and redundancy required to ensure the liquid radioactive waste processing and the desired degree of purification of radioactive substances discharges in all design modes of operation and design basis accidents.

**11.3.1.3** The criteria for calculating of the management systems of liquid radioactive waste, taking into account the characteristics of liquid radioactive waste, and the maximum amount of liquid radioactive waste expected to be processed, stored or disposed or removed from the territory of the nuclear material storage facility, their radionuclide composition and activity shall be provided.

### **11.3.2 System analysis**

**11.3.2.1** The procedure and methods of collection, processing, storage and conditioning of liquid radioactive waste and corresponding systems for each type of liquid radioactive waste (having different physical and chemical properties, specific activity, radionuclide composition, and so on) shall be provided. The description of systems shall be carried out in accordance with the structure set out in Appendix B.

**11.3.2.2** The process schemes of processing for each type of liquid radioactive waste, the estimated composition of liquid radioactive waste and related equipment shall be specified. The information on the types of packaging of radioactive waste, the requirements for the final form of conditioned radioactive waste, as well as the shape and packages of radioactive waste subject to storage, disposal and (or) removal from the territory of the nuclear material storage facility shall be provided.

**11.3.2.3** In the description of each system, the flow diagrams specifying the equipment, system performance and associated elements of equipment, backup equipment, the direction of fluid flows shall be provided.

**11.3.2.4** For each system normal and maximum intake values of liquid radioactive waste flow and the specific volume activity of radionuclides in liquid radioactive waste for all operating conditions and design basis accidents shall be provided in the form of a table. The initial data shall be provided to determine these values.

**11.3.2.5** The compliance of the chosen technical solutions for the collection, processing, storage and conditioning of liquid radioactive waste with the requirements of technical regulations shall be shown.

### **11.3.3 Discharges of radioactive substances**

**11.3.3.1** The required standards and reference levels of discharges shall be provided.

**11.3.3.2** The expected values of radioactive waste discharges in all operating modes of the nuclear material storage facility and in case of violations of normal operation, including design basis accidents, shall be provided and justified. All sources of radioactive substances discharges shall be specified. The discharge values for each source indicating the radionuclide composition, the value of the volume of the specific activity of each radionuclide and total activity shall be provided in the form of a table, the points of radioactive substances discharges shall be specified.

**11.3.3.3** The compliance of values of discharges of radioactive substances with established limits shall be demonstrated.

## **11.4 Systems of solid radioactive waste management**

### **11.4.1 Design basis**

**11.4.1.1** The main principles and criteria implemented in the design and (or) process schemes of systems, indicating the technical regulations, on the basis of which the systems were designed, shall be specified.

**11.4.1.2** The criteria of calculation of the solid radioactive waste management taking into account the solid radioactive waste characteristics and maximum and expected amount of solid radioactive waste subject to processing, storage, disposal, or removal from the territory of the nuclear material storage facility, their radionuclide composition and activity shall be provided.

### **11.4.2 Description of systems**

**11.4.2.1** The procedures and methods of collection, processing, storage and conditioning for each type of solid radioactive waste and appropriate systems of management of solid radioactive waste shall be provided. The description of systems shall be carried out in accordance with the structure of description of systems provided in Appendix B.

**11.4.2.2** The process schemes of processing for each type of solid radioactive waste, the estimated composition of solid radioactive waste and appropriate equipment shall be provided and justified.

**11.4.2.3** The information on the types of packaging of radioactive waste, the requirements for the final form of conditioned radioactive waste, as well as the shape and packaging of waste subject to storage, disposal and (or) removal from the territory of the nuclear material storage facility shall be provided.

**11.4.2.4** The schemes of areas of packaging, storage, loading and transportation of different categories of radioactive waste shall be provided.

**11.4.2.5** The systems for processing of contaminated clothing, equipment, tools, filters of ventilation systems and other compressible and non-compressible radioactive waste shall be described.

**11.4.2.6** The measures for decontamination of containers with radioactive waste and transportation of containers with radioactive waste to storage areas shall be provided. Possible violations of normal operation, including accidents (depressurization of containers of radioactive waste in case of their falling, etc.) shall be analyzed. The measures provided for collection of radioactive waste and decontamination technology in case of depressurization of containers shall be described.

**11.4.2.7** Measures to ensure the safe storage of radioactive waste shall be provided, conditions of temporary storage of solid radioactive waste and estimated area of their storage shall be described.

**11.4.2.8** The procedure for removal of solid radioactive waste from the territory (site) of the nuclear material storage facility for further processing and (or) disposal shall be outlined. The maximum possible and expected annual amounts, radionuclide composition and activity of each category of solid radioactive waste subject to removal from the site (territory) of the nuclear material storage facility shall be provided. The conditions for transporting of solid radioactive waste shall be specified.

**11.4.2.9** The compliance of chosen technical solutions for the collection, sorting, treatment, conditioning, storage and transportation of solid radioactive waste with the requirements of technical regulations shall be shown.

## **12. Radiation Safety**

### **12.1 General requirements**

**12.1.1** The section shall provide information on the radiation safety of personnel and population during normal operation and in case of accidents in the nuclear material storage facility considering external and internal exposure, as well as protection of environment from the radiation effect during the operation of the nuclear material storage facility according to the requirements of radiation safety and sanitary-hygienic standards.

**12.1.2** It shall be shown which the radiation effect of the nuclear material storage facility on the personnel, population and environment during normal operation, violations of normal operation, including design basis accidents, does not result in exceeding of the prescribed limits and is reduced to the lowest reasonably achievable level (ALARA principle).

**12.1.3** The radiation monitoring programmes shall also be presented.

**12.1.4** If appropriate, references to the information contained in other chapters and sections can be made.

**12.1.5** The compliance of the adopted radiation safety solutions with the requirements of technical regulations shall be shown.

### **12.2 Principles and criteria of radiation safety assurance**

**12.2.1** The section shall provide the principles and criteria for the protection of personnel, population and environment against harmful effects of radiation. It shall be shown which the use of technical means and organizational measures envisaged by the design and aimed at the radiation safety assurance is justified by the practice, does not result in exceeding of the established dose limit, excludes the unreasoned exposure and reduces the radiation exposure to the reasonably achievable level, taking into account the economic and social factors (ALARA principle).

**12.2.3** The list and quantitative values of the radiation safety criteria adopted in the design of the nuclear material storage facility (individual annual dose for the critical groups of population and for certain categories of personnel during normal operation, the allowable values of specific derived air concentration in periodically serviced rooms, impurity levels of surfaces of premises and equipment in periodically serviced premises, dose rate) according to the requirements of the radiation safety standards and sanitary-hygienic standards shall be provided. The radiation safety criteria considered when planning and carrying out of radiation hazardous works, including maintenance, shall be specified.

**12.2.4** The criteria for the nuclear material storage facility zoning shall be provided.

**12.2.5** The list of deviations from the technical regulations requirements in the field of nuclear energy, radiation safety, and assessment of the effect of deviations on the safety and adopted compensatory measures, as well as a reference to the document section where these deviations are considered in detail shall be provided.

**12.2.6** The compliance with the requirements for reduction of occupational exposure to such a low level which is reasonably achievable taking into account economic and social factors (ALARA principle) shall be displayed.

**12.2.7** Technical and organizational solutions to reduce the level of exposure of personnel, including when carrying out maintenance and repairs, shall be described.

### **12.3 Radiation sources and radiation hazardous works**

**12.3.1** The data on characteristics of ionizing radiation sources at the workplaces in the premises (sites) of the nuclear material storage facility, which are included in the calculation and design of radiation protection and maintenance of which requires the protection of personnel from external exposure (during storage, handling, moving and transportation of radioactive substances and waste) shall be provided.

**12.3.2** The list of premises of the nuclear material storage facility, in which the sources of ionizing radiation are placed, including the premises of their temporary placement shall be provided.

**12.3.3** The list of systems (elements) of the nuclear material storage facility which are the sources of ionizing radiation shall be provided.

**12.3.4** The information on characteristics of the radiation sources shall be provided. The description of the radiation sources shall include information on the radiation spectrum indicating the radiation energy groups, data on the activity, geometric parameters of the source, as well as the input data for the given values determining in a tabular form. When submitting the information the most conservative values of the specified parameters shall be provided.

In particular, the following shall be specified:

- during works with the open sources of radiation: radionuclide, composition, aggregate state, activity at the workplace, annual consumption, kind and nature of planned works, class of works;
- during works with the closed sources of radiation: radionuclide, its type, activity, maximum number of radiation sources in the workplace and their total activity, nature of planned activities;
- during works with the radiation sources with a complex radiation characteristic: type of the radiation source and its radiation characteristics (radionuclide composition, activity, energy and radiation intensity, etc.).

**12.3.5** The sources of burden of gaseous radioactive substances into the atmosphere of premises, taken into account in the development of protective measures and assessment of occupational exposure shall be described. In addition to the sources existing under normal operating conditions, the sources of the radioactive substances in the form of gases and aerosols during maintenance, repair and expected violations of normal operation shall be described.

**12.3.6** The results of calculations of concentrations (volumetric activity) of radioactive substances in the form of gases and aerosols shall be provided in a tabular form.

**12.3.7** The models, parameters and initial data required for calculation of concentration of radioactive gases and aerosols shall be provided. The list of software used for the calculation shall be provided. A brief description of the calculation methods, the initial data for the calculation and the assumptions, as well as information on the software certification shall be given.

## **12.4 Features of the radiation safety assurance design**

### **12.4.1 Layout plan and configuration of buildings, structures and equipment**

**12.4.1.1** Submit the plan of the complex of industrial buildings, structures and premises of the nuclear material storage facility with the layout of the process equipment, being a source of radiation. The plan shall display:

- boundaries of the controlled area, periodically serviced premises, premises of permanent residence of personnel, including office and utility rooms;
- layout of personnel airlocks, stationary cleanrooms, special laundries and medical stations;
- routings of personnel, transport, delivery of clean and removal of contaminated equipment and materials;
- layout of premises (sites) for storage of contaminated equipment, decontamination areas, places of radioactive waste collection and storage;
- arrangement of sensors and radiation monitoring system control panels;
- layout of laboratories for the analysis of samples of radioactive environments, the laboratories of personal monitoring;
- layout of external dosimetry laboratories, observation and check points;
- layout of premises (places) of collection of non-radioactive waste.

**12.4.1.2** Classification of zones and premises of the nuclear material storage facility adopted in the design of radiation protection shall be provided.

### **12.4.2 Design features of systems and components of radiation protection equipment**

**12.4.2.1** The information on the engineering and technical means of radiation protection of personnel from external exposure for each of the radiation sources, their design, layout and materials of the radiation protection shall be provided. The description shall include the dimensions and layout plan of protection, characteristics of protective materials, information on special protective devices and equipment (protective containers, stationary and mobile screens, boxes, etc.), as well as methods for determination of protection parameters.

**12.4.2.2** Special protective devices and equipment, including packaging, covers, screens, loading equipment, equipment with remote control which are used for handling of nuclear materials, radioactive substances and waste and allow to reduce the exposure of personnel up to the specified level.

**12.4.2.3** The description shall include the design features which reduce the time of radiation hazardous works carrying out, including maintenance, as well as provide easy access to the workplaces, remote execution of operations, reduction of duration of stay of personnel, as well as other measures reducing the exposure of personnel, or references to the relevant sections in which this information is presented, shall be provided.

**12.4.2.4** It shall be shown which the need for personnel presence in the radiation hazardous areas is excluded or limited as much as possible by means of automation and mechanization of production processes, the appropriate layout of equipment, workplaces, places of storage, the use of protective equipment and other measures.

#### **12.4.3 Protection of personnel from external exposure**

**12.4.3.1** The calculation data, including the design level of emissions in the areas of permanent and periodical presence of personnel, including the administrative and service building, in the course of normal operation, in case of violation of normal operation, including design basis accidents, and carrying out of planned activities shall be provided. The data of calculation of the equivalent dose rate of the external exposure of workers and population shall be provided in tabular form.

**12.4.3.2** It shall be shown which the values of the design equivalent dose rate for the standard length of presence of workers in the premises of the nuclear material storage facility do not exceed the values established by the radiation safety standards.

**12.4.3.3** The restrictive conditions of work performance shall be provided.

**12.4.3.4** The method of calculation of protection of workers and population from the external exposure shall be briefly described. The list of software and the required information on the software used to calculate the radiation protection shall be provided.

**12.4.3.5** The brief description of the purpose of the software, the calculation method implemented by the program, the main constraints and assumptions, information on the software certification shall be provided.

#### **12.4.4 Protection of personnel from the effects of radioactive substances. Ventilation systems**

**12.4.4.1** The section shall show which the ventilation systems provide protection from radioactive contamination of the air of working premises and atmospheric air, as well as the protection of personnel from the effect of the radioactive substances in accordance with sanitary-hygienic standards. Planned technical means for the air purification of the radioactive substances in the form of gases and aerosols, including repair ventilation, shall be provided.

**12.4.4.2** The ventilation systems of each of the buildings (not included in the description of the "Systems of handling of nuclear materials and related systems" and "Radioactive waste handling" sections) shall be described, the plan of premises, where the air purification is performed and ventilation equipment is located, shall be provided. The volume of the buildings, the expected costs in the buildings ventilation system, filter characteristics shall be provided.

**12.4.4.3** The mode of normal operation for each of the ventilation system and features of operation in case of violation of normal operation, including design basis accidents shall be described. The characteristics of the applied air cleaning means, cleanup factor values accepted in the process of analysis of radiation safety shall be provided.

**12.4.4.4** It shall be shown which the air flow direction from the less contaminated areas to the more contaminated ones is provided in the work rooms.

**12.4.4.5** The methods and means of determination of the effectiveness of air purification shall be described. The characteristics of filters used for the air purification and criteria for the replacement of the filter elements shall be provided.

**12.4.4.6** The conditions of service of ventilation systems shall be described and justified, as well as the description of monitoring and system testing means shall be provided.

## **12.5 Assessment of exposure doses of personnel and population.**

**12.5.1** The annual assessment of the duration of presence of personnel in the premises of permanent and periodical residence of personnel during normal operation, including maintenance and repair shall be provided.

**12.5.2** For premises where gas and aerosol activity is expected, the assessment of duration of the presence of personnel (in person-hours) and assessment of the radioactive substance intake value into the body as a result of the inhalation shall be provided.

**12.5.3** The assessment of the annual effective individual dose of exposure of personnel, as well as the collective dose of exposure of personnel during the operation, including maintenance and repair, as well as in case of violation of normal operation, shall be provided.

**12.5.4** The assessment of the annual effective individual dose for the critical groups of population during normal operation (as a result of discharges and emissions) and in case of accidents (on the border of the controlled area, on the border of the site and the controlled access area of the nuclear material storage facility taking into account the radiation sources located on the site of the nuclear material storage facility) shall be provided.

**12.5.5** The method of calculation of exposure doses of personnel and population, the initial data for the calculation and the assumptions made shall be briefly described. The list of software used in the calculation of the exposure doses of personnel and population shall be provided. The summary of the appointment of the software, the implemented calculation methods, the main restrictions and assumptions, as well as the information on the software certification shall be provided.

**12.5.6** The results of calculations of exposure doses of personnel and population shall be provided in the tabular form. It shall be shown which the doses of radiation exposure of personnel and population do not exceed the values set by the radiation safety standards.

## **12.6 Radiation monitoring**

The section shall show which the technical means and organizational measures provided by the design for radiation monitoring carrying out cover all the main types of effect of the ionizing radiation of personnel, population and environment and meet the requirements for radiation monitoring, set by the radiation safety standards.

### **12.6.1 Organization**

**12.6.1.1** The organizational structure of units of the operating organization, including the service of radiation safety in the nuclear material storage facility, which provides the radiation monitoring, shall be provided.

**12.6.2** The organizational and administrative measures to control the presence of personnel in the premises of permanent and periodic residence, information on the access control system, information on the implementation of instructions for carrying out of radiation hazardous works shall be provided.

**12.6.3** The information on the units, providing information on the radiation environment during normal operation and in case of accidents, shall be submitted.

**12.6.4** The organizational structure of the system and the storage conditions of radiation monitoring devices, their calibration and metrological certification shall be described.

**12.6.5** Procedure of registration and storage of the results of individual monitoring of exposure doses of personnel in accordance with the requirements [12] shall be provided.

#### **12.6.2 Provision of radiation monitoring**

**12.6.2.1** The section shall show which the provided radiation monitoring system in the premises of the nuclear material storage facility, on its site, in the controlled access area and the supervised area provides reception and processing of information on the monitored parameters which characterize the radiation state of the nuclear material storage facility and environment.

**12.6.2.2** The radiation monitoring programs, which shall include the following types of radiation monitoring, shall be specified:

- radiation monitoring in the premises and on the site of the nuclear material storage facility (radiation operational control, radiation monitoring, control of the dispersion of contamination);
- radiation monitoring of the environment in the controlled access area and the supervised area;
- radiation monitoring in case of violations of normal operation, including accidents.

**12.6.2.3** For each section of the specific program of radiation monitoring it is required to provide the following information: the list of objects of radiation monitoring, types of radiation monitoring, monitoring means, including their metrological support, monitored parameters, allowable levels of the monitored parameters, technical means and methodical maintenance of the radiation monitoring, methods of treatment, analysis, provision and transmission of information, the amount and frequency of monitoring of radiation and meteorological parameters.

**12.6.2.4** For the nuclear material storage facility related to the radiation objects of categories I and II, the use of the following technical means of radiation monitoring shall be shown:

- continuous monitoring on the basis of stationary automated systems and stationary devices;
- operational monitoring based on portable, transportable and (or) nonfixed devices, facilities;
- laboratory analysis on the basis of laboratory devices, facilities, means of selection and preparation of radioactive samples for analysis.

**12.6.2.5** The information on the presence of means of radiation monitoring with sound and light signaling devices in the premises where the self-sustaining nuclear chain reaction occurrence is possible, as well as in the premises where the works of class I are performed and the radiation environment during the performance of works may vary significantly, shall be provided.



**12.6.2.6** The location of the air sampling points for the monitoring of gas and aerosol activity shall be shown, the air sampling system shall be described, the criteria and methods of obtaining of representative measurement results of concentration of radioactive gases and aerosols shall be provided.

**12.6.2.7** The radiation monitoring technical means capabilities of the radiation parameters measurement, including high power radiation and doses of radiation of personnel in case of a radiation accident shall be described, the necessity of the use of instrumentation for such measurements shall be described.

**12.6.2.8** The information on the software, used for processing and presentation of information, on the procedure of collection, storage and systematization of information on radiation contamination of environment and doses of exposure of personnel and population shall be provided.

## **13 Nuclear Safety**

### **13.1 General requirements**

The information is provided for the nuclear material storage facilities, in which the works (treatment, storage, transportation, etc.) with plutonium, uranium-233, uranium, whose enrichment with uranium-235 is higher than 1% (mass), if the total mass of plutonium isotopes and uranium-233 and uranium-235 nuclides, which are at any time in the nuclear material storage facility (the units of the nuclear material storage facilities) exceeds 300 g, are carried out. The weight of other nuclear fissile nuclides shall be regulated and justified. The presence of fissile material and performance of the requirement for limitation of its weight shall be supported by the conduction of permanent accounting and documented.

The section shall describe the envisaged technical means and organizational measures aimed at prevention of the occurrence of the self-sustaining chain reaction during storage, handling and transportation of nuclear materials and limitation of its consequences. It shall be shown which the provided technical means and organizational measures are sufficient for creation and maintenance of conditions aimed at the assurance of nuclear safety.

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### **13.2 Objectives and principles of nuclear safety assurance**

**13.2.1** The objectives and principles of the nuclear safety assurance accepted by the design of the nuclear material storage facility shall be provided.

**13.2.2** The list of technical regulations, the requirements of which are taken into account in the development of technical means and organizational measures for the nuclear safety assurance shall be provided.

**13.2.3** The general principles of nuclear safety assurance, aimed at prevention of the occurrence of self-sustaining chain reactions, prevention of uncontrolled and unauthorized overtimes, storing, movements, transfers, transportation of the nuclear fissile materials (substance, nuclide) shall be provided.

**13.2.4** It is required to demonstrate their compliance with the requirements of technical regulations on nuclear safety, provide the list of waivers of the technical

regulations requirements, assess the impact of the waivers on safety and adopted compensatory measures.

### **13.3 Premises, systems and components with nuclear fissile materials**

**13.3.1** The section shall provide information on all nuclear fissile materials, located in the nuclear fissile materials storage facilities, areas of their location, processes and operations for the nuclear fissile materials (substance, nuclide) handling.

**13.3.2** The list of premises and equipment of possible location of the nuclear fissile materials (substance, nuclide) shall be provided.

**13.3.3** The list of technological operations on the handling of the nuclear fissile materials (substance, nuclide) shall be provided.

**13.3.4** The characteristics of the nuclear fissile materials (substance, nuclide) with the indication of their weight, state of aggregation, density, isotopic, nuclide and chemical composition of the fissile materials, the availability and mass fraction of the moderator, reflectors, neutron absorbers, etc. to the extent required to justify technical and organizational security solutions accepted by the design shall be provided for each of the selected nuclear hazardous sites, systems, equipment, including the packages of the nuclear materials, as well as manufacturing operations. The equipment and those areas of the nuclear material storage facility, on which there is a risk of occurrence of the self-sustaining chain reaction, shall be described with the appropriate sketches and drawings. The dimensions and distances relevant for the analysis of nuclear safety shall be specified.

**13.3.5** The list of systems (components), including the packages, into which the nuclear fissile materials (substance, nuclide) are loaded or may get, with the specification of the number of equipment items, drawing number, the type of equipment ("B" ("Б"), "PKZ" ("ПКЗ"), "O" ("О")).

### **13.4 Features of the design to prevent the occurrence of the self-sustaining chain reaction**

**13.4.1** The section shall provide the information on the technical means and organizational measures to prevent the occurrence of the self-sustaining nuclear chain reaction occurrence provided by the design of the nuclear material storage facility.

**13.4.2** The information on which of the following requirements for assurance of nuclear safety and how are used in the design of the nuclear material storage facility shall be provided:

- the assurance of the nuclear safety by means of the design of storage facilities and packages, geometric shape limitations, limitations imposed on the number and placement of the packages, limitations imposed on the placement of nuclear materials in packages, cases, racks, on the equipment dimensions, the number of fuel assemblies in packages, cases, racks; limitation of the number of packages, cases in the group, limitations on the placement of groups of packages, cases, racks;
- the mass limitations of the nuclear fissile materials (substance, nuclide);
- the limitation of the concentration of the nuclear fissile materials;
- the use of homogeneous and heterogeneous neutron absorbers;
- monitoring for the availability of the neutron moderators in the nuclear fissile materials (substance, nuclide), humidity of the nuclear fissile materials (substance, nuclide);

- monitoring for the reflector availability;
- monitoring for the layout of equipment;
- monitoring for the layout of nuclear materials, absorbers, packages, cases, racks;
- monitoring for the technological parameters of the complex of nuclear materials storage and handling systems;
- combination of the above mentioned methods and restrictions.

**13.4.3** For each of the nuclear-hazardous areas, equipment of the nuclear material storage facility (including packages, groups, stacks, storage slot, storage compartments and so on) listed in section 7.2 the restrictions imposed on the parameters of the fissile nuclear materials, equipment, systems defining the geometry, dimensions, relative layout of equipment, packages, neutron moderating and neutron absorbing properties of structural elements and materials shall be provided.

**13.4.4** The values varying in the course of technological processes, for which the nuclear safety limitations are set and which shall be monitored shall be specified. These may include:

- the mass of the fissile nuclear material (substance) loaded into the equipment, including the packaging set;
- the concentration, content of the nuclear fissile nuclides in the nuclear fissile material (substance);
- the mass of the nuclear fissile materials (substance, nuclide), accumulated in the auxiliary equipment (filters, communications, traps, etc.);
- the content of neutron moderators;
- humidity of the fissile nuclear material (substance);
- the burn-up degree of spent fuel;
- concentration of homogeneous neutron absorbers, level, volume of the nuclear fissile material, uniform distribution of the nuclear fissile materials in terms of internal volume of the process equipment, apparatus.

**13.4.5** For the above mentioned nuclear safety parameters, safe (acceptable) parameters and nuclear safety standards, errors, which the normalized values are measured with, and ways of assurance of nuclear safety standards and requirements shall be specified.

**13.4.6** The references to paragraphs of regulations, conclusions on the nuclear safety based on which the options and nuclear safety standards are set shall be provided.

### **13.5 Methods and means of monitoring of nuclear safety parameters**

**13.5.1** For each nuclear-hazardous area, zones, workrooms, systems and components of the nuclear material storage facility the methods and means of monitoring for the limitations imposed on the parameters of the nuclear fissile materials (substance, nuclide), equipment, equipment layout, packages, specifying the parameters, properties and errors of measuring devices, the layout of monitoring points of nuclear safety parameters shall be provided.

**13.5.2** The procedure, methods and tools for monitoring of parameters of equipment, systems, defining the geometry, dimensions, relative layout of equipment, packages, neutron moderating and neutron absorbing properties of structural

components in the manufacture and installation of equipment, procedure of periodic monitoring of parameters envisaged by the design shall be provided.

**13.5.3** The monitoring procedures for the layout of packages, packages groups, racks, absorbers, fuel assemblies as well as monitoring methods for the presence and amount of moderators and absorbers integrity during storage shall be described.

**13.5.4** The order, methods and means of monitoring of values, changing in the course of technological processes, for which the restrictions on nuclear safety are set, shall be specified.

**13.5.5** It shall be shown which the methods and means of measurement of values, for which the limits on nuclear safety are set, the reliability of the instrument monitoring of nuclear safety parameters and preventive measures aimed at assurance of functionality of devices, meet the requirements of technical regulations.

### **13.6 Analysis of the nuclear safety and justification of nuclear safety**

The methods of analysis of nuclear safety shall be provided and justified and the results of the analysis of nuclear safety, assessment of the effects of occurrence of self-sustaining chain reaction and measures to limit these effects shall be provided in the section.

#### **13.6.1 Methods of justification of nuclear safety**

**13.6.1.1** The methods of carrying out of safety analysis, calculation methods of K-effective shall be considered and justified. The information shall be provided to the extent and with the degree of specification required for the justification of technical and organizational solutions on assurance of nuclear safety provided by the design.

**13.6.1.2** Basis of calculations carried out in support of nuclear safety in the process of setting of standards, thresholds of monitored nuclear safety parameters with references to documents, materials, conclusions on nuclear safety, which contain its analysis shall be provided. The accepted assumptions (about the composition of nuclear material, the degree of enrichment of nuclear material, the presence and composition of absorbers, reflectors, moderators, the estimated storage capacity, etc.) shall be specified, fiducial fissile environments used in the calculations shall be justified. The errors associated with the error of calculation methods, the definition of concentration and isotopic composition, absorber properties, tolerances during manufacturing shall be specified.

**13.6.1.3** The list of methods and software specifying the information on their certification and applicability shall be provided. The information on the databases, including the applied library of neutron cross-sections, shall be provided.

#### **13.6.2 The results of the analysis of nuclear safety**

**13.6.2.1** The results of the analysis of nuclear safety under normal operating conditions and violations of normal operation, including design basis accidents, shall be provided.

**13.6.2.2** It shall be shown which at all stages of nuclear materials reload, transfer, transportation and storage of nuclear materials under normal operation and violations of normal operation, including design basis accidents, configuration of package, stacks and stacks layout remains subcritical with the appropriate assurance factor.

**13.6.2.3** For normal operation the calculations shall reflect the design configuration of package loading and, if required, the availability of neutron absorbers.

**13.6.2.4** For conditions of violation of normal operation, possible deviations from the design geometry and placement of nuclear materials shall be analyzed and nuclear safety assurance in these conditions shall be shown.

In the analysis of the nuclear safety of nuclear materials storage facilities and transport and technological operations the list of considered events, violations, failures which can lead to exceeding of safe (acceptable) parameters and occurrence of the self-sustained chain reaction shall be provided. The analysis of the effects of the considered situations on each hardware position (the approximate list of initiating events is given in the respective technical regulations on nuclear safety).

**13.6.2.5** When analyzing the initiating events the following capability shall be considered:

- of rearrangement of fuel assemblies and nuclear materials inside the covers, racks, packages, leading to the increase in the effective neutron multiplication factor;
- of changing of the geometric configuration of package of nuclear materials, fuel assemblies and fuel elements (bendings, flattening, etc.), as well as the step of the fuel element in the fuel assembly, which leads to the increase in the effective neutron multiplication factor;
- of boiling of water, occurrence of steam and water mixture and thereby increasing of the effective neutron multiplication factor, reduction of the protective layer of water;
- of the loss of efficiency of heterogeneous and homogeneous neutron absorbers;
- of penetration of water or steam and water mixture into the package, case, the drum of fresh and spent nuclear fuel, dry storage facility of spent nuclear fuel.

**13.6.2.3** In each case, selected for further consideration, the calculation of consequences shall be conducted to confirm the assurance of subcriticality.

**13.6.2.4** It shall be shown which the subcriticality is ensured even taking into account the slowing effect of water on the nuclear material, as well as other potential moderators, including snow, condensation, steam or material containing the moderator, which can get into as a result of some of the initiating events, including the effect of fire extinguishers on the nuclear safety. If subcriticality can not be guaranteed under the above mentioned conditions, it shall be shown which the occurrence of such conditions is excluded.

**13.6.2.5** The results of assessment of the consequences of occurrence of the self-sustaining chain reaction shall be provided. It shall be shown how these results are taken into account in the development of emergency planning measures. If appropriate, a reference to the relevant section of the nuclear material storage facility safety analysis report shall be provided.

### **13.7 Emergency alarm systems on the self-sustaining chain reaction occurrence**

**13.7.1** The information on the equipment of nuclear hazardous areas with the alarm systems on the self-sustained chain reactions occurrence shall be provided. Refusal of installation of the emergency alarm system shall be justified.

**13.7.2** The description of the emergency alarm system (sensors layout, composition of the system, detection methods, transducers, and devices of sound and light alarm) and its functioning shall be provided. The consequences of a false alarm of the emergency alarm system shall be analyzed.

**13.7.3** The information on the tests and inspections of the emergency alarm system shall be provided. The information on the check of the emergency alarm

system functional ability in service shall be provided, as well as the frequency of inspections and the procedure for documenting of their results shall be specified.

**13.7.4** The indicators of the emergency alarm system reliability shall be justified. It shall be shown which the degree of safety and preventive measures on assurance of the emergency alarm performance satisfy the requirements of technical regulations.

### **13.8 Organization of works on nuclear safety assurance**

**13.8.1** The information on the organization of works on nuclear safety assurance.

**13.8.2** The required information on the availability of documents on nuclear safety shall be provided as well as the conformity with the technical documentation of the technical regulations in the field of nuclear energy shall be justified. The list of technological rules and regulations, the requirements of which the nuclear safety assurance program shall comply with, shall be provided.

**13.8.3** The structure of the nuclear safety service of the nuclear material storage facility, its main responsibilities, and qualification requirements for personnel shall be described.

**13.8.4** The information on the preparation and verification of knowledge of personnel, conducting nuclear hazardous works, shall be provided. The information on the procedure for the admission of personnel to works on nuclear hazardous sites and to the management of the specified works shall be provided.

**13.8.5** The information on the procedure for the monitoring of nuclear safety assurance, information on the content, frequency and procedure of verifications of nuclear safety condition shall be provided.

## **14 Commissioning**

The section shall provide information on the organization, scope, sequence and timing of adjustment works and testing carried out during the commissioning of the nuclear material storage facility for all facilities, equipment, systems and components of the nuclear material storage facility important to safety.

### **14.1 General terms**

The main provisions of programs of commissioning of the nuclear material storage facility and quality assurance during commissioning, including the division of the works into stages and substages, their relationship, the order and timing of each step or substep, the criteria for their successful completion, the required organizational and technical measures shall be defined and justified.

It shall be shown which during the implementation of the stages of commissioning of the nuclear material storage facility the transition from one stage to the subsequent one is carried out taking into account the increase in the potential danger of possible accidents.

It shall also be pointed out which:

- the commissioning fully complies with the requirements of technical regulations;
- safety during the adjustment works and testing at all stages of the commissioning of the nuclear material storage facility is assured;
- the required completeness of the research and verification of all modes and characteristics of the nuclear material storage facility systems related to security during its operation is assured;

- the design basis and the characteristics of normal operation systems shall be verified.

## **14.2 Organization of works**

**14.2.1** The expected pattern of organization of works and structure of the interaction between the personnel of the operating organization and representatives of research, design, engineering, installation, construction, commissioning organizations and vendors both in preparation for commissioning, and in the process of commissioning of the nuclear material storage facility shall be described. The distribution of governing and executive functions and responsibilities, aimed at achievement of the objectives and solving of problems of commissioning both between the organizations involved in the works, as well as between contractors of different levels shall be shown. The compliance of works organization and selection of personnel involved in the works with the requirements of technical regulations shall be shown.

**14.2.2** During the presentation of the information the following shall be reflected:

- the organizational structure of the operational organization, rights and duties of personnel, the qualification requirements (information shall be provided in case if for the duration of the commissioning of the nuclear material storage facility differences from the organizational structure of the operational organization are envisaged);
- the organizational activities carried out by the operational organization, the design developers, equipment suppliers and other organizations involved in the implementation of works;
- the description of functions of various organizations, their interaction and sharing of responsibilities;
- the plans for involvement of additional personnel for each of the commissioning stage, their qualification requirements;
- the description of organizational security measures, including radiation protection, nuclear, fire and industrial safety, appropriate medical care, health and hygiene requirements, etc.;
- the description of functioning of physical protection.

## **14.3 Work stages**

**14.3.1** The division of the entire period of commissioning of the nuclear material storage facility into the stages and substages, taking into account the features of specific stage and problems solved at each stage (substage) shall be justified, and the information on the content of the basic commissioning stages shall be provided.

**14.3.2** The choice of the optimal sequence of works, execution and (or) testing combining, measures to ensure the quality control of their implementation shall be explained, the acceptance criteria shall be clearly defined.

**14.3.3** The network schedule of commissioning of the nuclear material storage facility, information on commissioning works and acceptance testing of the systems important to safety shall be provided.

**14.3.4** A brief description and the amount of works for each of the stages and substages of commissioning and testing shall be provided, as well as the specific purpose and stages (substages) shall be reflected.

## **14.4 Testing programs**

**14.4.1** The summary of the test programs at each stage (substage) of commissioning and information on testing programs for all systems important to safety, and for the separate equipment shall be provided.

**14.4.2** For each stage (substage) it shall be reflected the following:

- the objectives of works and testing, success performance criteria;
- the sequence of works performance;
- requirements for the availability of premises, systems and equipment for conduction of testing;
- technological restrictions, conditions and measures for the safe carrying out of works and testing;
- composition, consistency, correlation and duration of testing;
- the fundamental provisions of methods of work performance, at which more detailed description of the preparation to the testing and methods of testing of equipment which has no analogues with the indication of its acceptance criteria shall be provided;
- requirements for the reporting documentation, including design, presentation and storage, order of access to it;
- requirements for the number and qualifications of personnel involved in the works and testing, distribution of responsibilities, including administrative structures.

**14.4.3** The methodology for assessment of the most important characteristics of the systems elements important to safety, and the main characteristics of the nuclear material storage facility shall be described.

**14.4.4** The information on potentially hazardous works and measures to prevent accidents shall be provided.

**14.4.5** The order of development and approval of the commissioning programs of the nuclear material storage facility, quality assurance during commissioning and work programs on the basis of design documentation shall be specified.

## **14.5 Schedule of works and testing**

The work schedule for commissioning of the nuclear material storage facility indicating the envisaged date of commencement of operation shall be provided.

The main work stages, their approximate duration, the list of all types of works and testing for each of the stages separately shall be provided on the graph. The planned schedules of adjustment and testing of separate structures, systems or components of the nuclear material storage facility shall be provided.

## **14.6 Additional requirements for the commissioning of the nuclear material storage facility**

The additional requirements which shall be considered during preparation to works and in the process of their carrying out on the site of the nuclear material storage facility shall be stated, including the following:

- for the conditions of the preparation, coordination and approval of working documentation (process operating rules (or similar operational documents); safety report of the nuclear material storage facility; a set of instructions, including for the activities in case of accident, etc.);
- for the participation of operational and additionally involved personnel (workers) in the conduction of work and testing and issuance of



- documentation, including reporting one (including requirements for the form of reporting documentation);
- for organizational and technical measures and actions in case of non-compliance of the characteristics obtained with the design values, including the need to correct the design and operational documentation;
  - for the organization of service of production and industrial maintenance and archiving of documents;
  - for the organization of zones of restricted access to the premises of the nuclear material storage facility and protected areas, depending on the stages and phases of the commissioning program of the nuclear material storage facility;
  - for the organization of fire security and monitoring services;
  - for the organization of sanitary zones, radiation and dosimetry control services in the premises of the nuclear material storage facility, on the site of the nuclear material storage facility and in the controlled access area;
  - for the development and implementation of plans of emergency measures and protection of workers and population in case of an accident in the nuclear material storage facility.

#### **14.7 Report on the implementation of commissioning works**

**14.7.1** The summary of the results of implementation of commissioning and testing shall be provided. On the basis of the reporting materials on the results of performed works and testing it is required to evidence the execution of planned activities and requirements, as well as the conformity of the structures, systems and components with the design and technical regulations.

**14.7.2** In case of deviations from the design and technical regulations the design documentation shall be adjusted with the justification of admissibility of deviations according to the conditions of provision of the required level of safety and reliability in the respective sections of the safety report of the nuclear material storage facility.

**14.7.3** The deviations from the order and deviations in the organization which have occurred in the performance of commissioning and testing, with the analysis of the reasons for these deviations and conclusions for the future, shall be described.

**14.7.4** It is required to analyze and demonstrate how a comprehensive work schedule of commissioning programs of the nuclear material storage facility is performed in terms of completeness and timing, to assess the validity of permitted deviations.

**14.7.5** It shall be specified which additional requirements for commissioning, and with what degree of adequacy have been implemented, including amendments to the operational documentation on the results of works.

### **15 Organization of Operation**

The section shall provide the information on the organization of operation of the nuclear material storage facility, training of personnel and maintenance of systems availability and the nuclear material storage facility as a whole.

#### **15.1 Management organization**

##### **15.1.1 Operating organization**

**15.1.1.1** The subsection shall provide the organizational chart of the operating organization and its units, which are aimed at provision of the support of operation of the nuclear material storage facility, and information on the principles and scheme of interaction between the administration of the nuclear material storage facility and the operating organization. It shall be shown which the structure of units, distribution of responsibilities and powers between the operating organization and administration of the nuclear material storage facility, as well as various units provides effective management of the nuclear material storage facility.

**15.1.1.2** The following shall be provided:

- the information on the organizational structure of the operating organization and specification of the main functions of its units in the operation of the nuclear material storage facility and its decommissioning;
- the information on the organizational structure of the management of operation of the nuclear material storage facility with the specification of the list of its units, senior management positions of the units, powers of the administrators and their responsibility for assurance of nuclear and radiation safety;
- the information on the organizational structure of the service of nuclear and radiation safety of the nuclear material storage facility;
- the list of organizations executing the works and providing services of the operating organization, indicating their names and the availability of appropriate licenses to operate in the field of nuclear energy and ionizing radiation sources.

#### **15.1.2 Administration of the nuclear material storage facility and operational management**

**15.1.2.1** The organizational structure of the operational management of the nuclear material storage facility shall be provided.

The information shall contain the list of units with their names, functions indicating the governing administrative positions; units structure; duties of personnel, their qualification and responsibility, as well as the procedure for interaction between the units, the operating organization and administration.

**15.1.2.2** For each unit it is required to provide its structure with specification of positions - from the head of the unit to the personnel (shift supervisors, relieving operators, maintenance personnel, etc.), number of shifts, as well as the number of members for each position, taking into account the reserve (stand-by).

**15.1.2.3** The list of job descriptions, which define the rights and duties of personnel of the nuclear material storage facility, shall be provided. In particular, the order of transfer of authority (including the transfer of the right to issue permanent or temporary orders and instructions) and responsibility for the operation of the nuclear material storage facility, at least for three authorities (in case of circumstances of a temporary nature) shall be provided.

#### **15.1.3 Engineering support of operation**

The list of services of the nuclear material storage facility, competent to provide the organization of provision of:

- the engineering support of operation in the solution of problems of nuclear and radiation safety;
- maintenance, repair and modification of thermal mechanical, electrical equipment and machinery, instrumentation and controls;
- inspections and audits;

- transportation and installation of nuclear materials, radioactive substances and radioactive waste;
- management of nuclear materials, radioactive substances and waste, provision of accounting and monitoring of nuclear materials, radioactive substances and waste.

## **15.2 Training and qualification of personnel**

The section shall provide information on the deployment, qualification and training of personnel.

### **15.2.1 Qualification of personnel**

The information on the selection of personnel for the positions indicated in the block diagrams in accordance with the required qualification (education, work experience, training) and psychophysiological indicators shall be provided.

### **15.2.2 Organization of training of personnel**

The information indicating how the requirements of the technical regulations are implemented during the personnel training in the process of operation of the nuclear material storage facility and selection of personnel for the positions.

### **15.2.3 Coordination (ratio of stages) of training of personnel with the stages of commissioning. Manning schedule**

The schedule of training of personnel by stages during commissioning of the nuclear material storage facility shall be provided.

### **15.2.4 Maintenance of the qualification level of personnel**

The system of qualification control of personnel according to [13] and measures to maintain the required qualification, including periodic training and exercises to simulate the conditions in normal operation and in case of accidents shall be demonstrated.

## **15.3 Instructions**

The required and sufficient information on the instructions required for the operation, maintenance, repair, testing, verification and inspection of systems and equipment of the nuclear material storage facility shall be provided in the section.

The account of all safety aspects of the nuclear material storage facility in the adopted instructions shall be shown.

### **15.3.1 Job descriptions**

The information on the job descriptions of administrative, managerial and operational personnel, including the list of them, shall be provided.

### **15.3.2 Operating instructions**

#### **15.3.2.1 Technological regulations**

The lists of technological regulations (or other similar documents of the enterprise: the enterprise standards, common rules of operation, etc., which contain the rules and the basic techniques of safe operation, the general order of operations related to security, as well as the limits and safe operation conditions for the nuclear material storage facility) and the main provisions of technological regulations shall be provided.

#### **15.3.2.2 Systems operating instructions**

The list of operating instructions for the systems of the nuclear material storage facility, instructions for systems testing shall be provided, the instructions which the operational personnel shall know in full shall be listed.

### **15.3.2.3 Instructions for maintenance and repair**

The lists of object, factory and standard instructions to be followed when carrying out maintenance and repair of equipment of systems, security checks, automatic devices (if any) and other systems mentioned in the relevant sections of the safety report of the nuclear material storage facility shall be provided.

### **15.3.2.4 Safety instructions**

The list of safety instructions, which shall be available in the workplaces, along with the operating instructions shall be provided.

### **15.3.2.5 Instructions for keeping of operative documentation**

In the information relating to instructions for keeping and management of operational documentation, the prescribed procedure for keeping of operational documentation by personnel shall be specified. The actions of the administrative and technical personnel of the nuclear material storage facility on the monitoring of keeping of the operational documentation shall be described.

### **15.3.2.6 Instructions for accounting and control of nuclear materials**

The list of instructions determining the procedure for accounting and control of nuclear materials shall be provided.

### **15.3.3 Accident-prevention instructions**

The list of accident-prevention instructions shall be provided:

- instructions for elimination of violations of conditions of normal operation and accidents, including fire safety instructions;
- instructions for elimination of design basis accidents;
- instructions (manuals) for the management of beyond design basis accidents.

The requirements given in the instructions shall contain:

- actions of personnel on the identification of emergency situations and accidents;
- the amount of operational personnel required for performance of corrective actions;
- specific signs of success (failure) in the implementation of activities with equipment;
- the criteria for the transition to actions on the accident management manual.

### **15.3.4 Accident management manual**

The brief information on the management of accidents shall be provided.

## **15.4 Maintenance and repair**

### **15.4.1 Annual equipment maintenance and repair plans**

The annual plans of equipment maintenance and outage, specifying the types and scope of activity (general maintenance, overhaul, repair and replacement of components, testing, modification of systems, etc.) shall be provided.

The schedule of preventive maintenance shall be provided. It shall be shown, how experience in operating equipment and facility systems is taken into account during scheduling of maintenance and outage.

### **15.4.2 Conditions for maintenance**

The list of resources to support maintenance shall be provided, including:

- control equipment;
- means of provision of decontamination and maintenance of equipment and facilities contaminated with radioactive substances and (or) nuclear materials;
- lifting equipment;
- special equipment and tools;
- provision of tools, materials, spare parts, etc.;

- the availability of workshops for the repair of equipment.

## **15.5 Organization of monitoring and reporting on the security of nuclear material storage facilities**

The information on the adopted system of monitoring of operational (current) state of the nuclear material storage facility, procedures of data collection and analysis, as well as on provision of information on safety of the nuclear material storage facility.

### **15.5.1 Monitoring by the representatives of the operating organization**

The information on the operating organization planned activities on carrying out of verifications of conformity of the nuclear material storage facility with the requirements of technical regulations shall be provided.

The information on the units of the operating organization and officials carrying out the verifications shall be provided.

#### **15.5.1.1 Verifications program**

The planned program of verifications shall be provided, indicating:

- the type of verifications;
- the scope of verifications;
- the frequency of verifications;
- the criteria for assessment of the results of verifications;
- the order of registration of the results of verifications, requirements for storage and access to accounting documentation.

#### **15.5.1.2 Organizational structure**

The information on the operating organization units and officials carrying out the program of internal audits, including their qualifications.

## **15.5.2 Preparation and submission of periodic information on the current security level**

The information on the adopted system of control over operational (current) state of the nuclear material storage facility, procedure of data collection and analysis, as well as for information on safety and order of informing of the public security organs on regulation of the use of nuclear energy shall be provided.

The information shall comply with the provisions of the annual assessment reports of the current operational safety level of the nuclear material storage facility and of the investigation and registration of failures in the nuclear material storage facility operation.

## **15.6 Fire safety**

**15.6.1** The section shall set out the main provisions to ensure fire and explosion safety of the nuclear material storage facility during handling of nuclear materials in the nuclear material storage facility and show their compliance with the technical regulations on fire safety.

**15.6.2** The concept and basic principles of fire safety of the nuclear material storage facility (zoning of the buildings and structures, multi-barrier, reservation of the systems important to safety, division of systems important to safety, prevention of fire, the use of fire protection systems, etc.) shall be provided.

**15.6.3** The list of technical regulations on fire safety, the list of deviations from these technical regulations and decisions adopted in these cases shall be provided.

**15.6.4** The assessment of fire hazard of premises, buildings and structures, as well as technological sites of the nuclear material storage facility indicating their category by explosion and fire hazard, the classification of zones by explosion and

fire hazard (in the absence of relevant information in the "Safety justification in the design of buildings, structures, systems and components" of the safety report).

**15.6.5** The list of fire exposed systems (components) important to safety of the nuclear material storage facility, which are identified in the analysis as well as measures for fire protection of these systems (components), shall be provided.

**15.6.6** Technical means and organizational measures aimed at prevention of fires and fire protection (detection of ignition, control over the spread of fire, fire-fighting and limitation of its consequences) provided by the nuclear material storage facility shall be described, including those to be submitted:

- information on the complex of measures to ensure the safety of personnel in case of fire: fire detection, fire alarm, the possibility of evacuation of personnel, the protection of personnel from the consequences of fire hazards;

- information on the set of measures to prevent the spread of fire, fire resistance of fire barriers, the use of flame retardants, etc.;

- information on the complex of measures for fire-fighting: the type of primary fire extinguishing equipment, and their number, the availability and main characteristics of the stationary fire-extinguishing plants of indoor and outdoor fire water systems, external fire escapes, etc.;

- information on the means of notification of fire reporting facilities and safe ways of evacuation of personnel, activities provided by the design to assure their evacuation during a fire and to ensure smoke protection of buildings.

The information shall be presented in the tabular form, for example, as shown in Table 3.

**Table 3 - Information on fire safety assurance**

Name of spaces	Fire hazard category	Limit of fire resistance of enclosures	Fire prevention measures in the construction part and ventilation	Equipping with detection and fire fighting plants		
				Fire alarm availability	Fire fighting plants availability	Extinguishing substance

**15.6.7** The section shall provide the security analysis results in case of fire and demonstrate the assurance of the design level of fire safety in all modes of operation of the nuclear material storage facility, as well as during design basis accidents. The qualitative assessment of the consequences of fire, taking into account the possible failure in the work of extinguishing systems, false triggers of extinguishing plants and the impacts of extinguishing substances on the equipment important to safety shall be carried out. It shall be shown which in case of fire on the site (external fires), they do not seriously affect the work of personnel, building structures of buildings and equipment important to safety located near the fire, the performance of which shall be assured in this period.

**15.6.8** The fire safety service structure, its main responsibilities, qualification requirements for personnel shall be described. The information on the organization and coordination of fire protection forces of the nuclear material storage facility shall be provided.

**15.6.9** The information on the procedure of training and conduction of drills of personnel of the fire brigade and the personnel of the nuclear material storage facility on simulation of actions in case of fire shall be provided. The information on the

availability of the action plan in case of fire and (or) references to the relevant section shall be provided.

**15.6.10** The information on the procedure of fire safety monitoring, on the content, frequency and manner of inspections of fire safety conditions shall be provided.

## **15.7 Technical safety**

**15.7.1** The information on the technical safety assurance shall be provided. The information on assurance of technical safety of special equipment and special cranes as well as industrial equipment and general industrial cranes in accordance with the requirements [14-17] is provided separately.

**15.7.2** The information shall be performed as certificates with the name titles (if the appropriate equipment is available):

- general information;
- boilers (steam and hot water boilers);
- vessels operating under pressure;
- steam and hot water pipelines;
- cranes.

**15.7.3** The following information shall be provided:

- the list of equipment, working under pressure, and cranes;
- the purpose of the equipment and cranes;
- location areas;
- references to the installation drawings, outline drawings;
- life cycle, endurance;
- operating parameters;
- possible malfunctions, their impact on the assurance of nuclear and radiation safety;
- the list of technical regulations, used for the design, engineering, manufacture and operation of the equipment and cranes;
- information on deviations from the requirements of technical regulations on industrial safety.

**15.7.4** The references to the documents containing the strength calculations, study of resistance to external effects, the reliability of equipment and valves during normal operation, violations of normal operating conditions, including accidents shall be provided.

**15.7.5** With regard to each type of equipment and cranes as a part of the relevant certificates the information on the organization of institutional control, the requirements for qualification of personnel, maintenance equipment and (or) cranes, the organization of works on repair and maintenance of programs for quality assurance and quality control is provided.

## **15.8 Physical protection**

### **15.8.1 General requirements**

**15.8.1.1** The basic engineering and technical means and organizational measures aimed at prevention of unauthorized activities of personnel or other people in terms of nuclear material, radioactive substances and waste, or systems, equipment and devices of the nuclear material storage facility, important to security which can directly or indirectly lead to accidents and endanger the health of personnel of the nuclear material storage facility and population as a result of radiation exposure shall be shown. The information presented in the section shall

confirm the fulfillment of the requirements of the technical code of common practice TCP 360.

**15.8.1.2** The following shall be provided:

- the list and characteristics of objects (with the indication of the nuclear material categories), provided by physical protection, with the application of graphic plan, inscribed with the configuration of the perimeters of secure, internal and critical areas;
- the description of engineering and technical means of physical protection, information on the implementation of the TCP 360 requirements;
- in case of the transportation of nuclear materials - the information on the implementation of the requirements of the TCP 357;
- the description of the structure and composition of security service and protection forces of the nuclear material storage facility;
- the list of existing local normative legal acts in accordance with the requirements of the TCP 360 and TCP 426;
- information on the analysis of the vulnerability of the object in order to identify internal and external threats and possible ways of their implementation, identification of vulnerable areas of the nuclear material storage facility, processes of use and storage of nuclear materials;
- information on the assessment of possible damage when implementing internal and external threats;
- information on the assessment of the effectiveness of the physical protection system;
- information on the certification of technical means used in the physical protection system.

### **15.8.2 Composition of physical protection**

The section defines the following engineering means and organizational measures for the physical protection.

**15.8.2.1** Engineering means:

- technical means of security alarm;
- means for accessing;
- supervision tool;
- means of communication;
- means of detection of radioactive substances;
- tamper indicating device;
- building constructions (buildings) and specially designed structures;
- support systems (power supply, lighting, etc.);
- checkpoint for the passage of people and traffic checkpoints.

**15.8.2.2** Administrative procedure:

- creation of the security service and assurance of its functioning;
- organization of security of the nuclear material storage facility and radioactive substances, including training of security service workers;
- training of personnel of the nuclear material storage facility to act in emergency situations;
- compensatory measures in case of failure of any part of the technical means of physical protection system of the nuclear material storage facility, radioactive substances;
- development and approval of documents on the organization and assurance of physical protection of the nuclear material storage facility, radioactive substances;



- monitoring of compliance with the requirements of the system of physical protection of the nuclear material storage facility, radioactive substances;
- limitation of the number of persons authorized to carry out operations with radioactive sources, substances and wastes;
- implementation of the two-person rule;
- maintenance of the access authorization system of personnel, secondees, visitors and vehicles to the territory of the nuclear material storage facility, into protected premises, buildings and maintenance of the authorization system of access to the works, documents and information;
- organization of the system of account, storage, use, protection, transportation of nuclear materials and control of nuclear materials;
- organization of personal and special examinations of personnel, secondees, visitors and vehicles, etc.

### **15.8.3 Diagrams and structural construction of physical protection systems**

The basic schemes of engineering means of control and signaling of physical protection systems shall be provided. The fundamental structural construction of physical protection systems on the organization of protection, without revealing the location of the controls, alarm and supervised posts shall be provided.

## **15.9 Accounting and control of nuclear materials, radioactive substances and radioactive waste**

**15.9.1** The section shall provide information on the organization of accounting and control of nuclear materials, radioactive substances and waste. It shall be shown which the accounting and control procedures of fissile nuclear materials provide accurate and timely information on their amount and placement, timely detection of the loss, misuse or theft, on compliance with arrangements for accounting and control of nuclear materials, radioactive substances and waste with the requirements of [9, 18, 19].

**15.9.2** The section shall provide information, including issues of identification of the transport container, identification of nuclear materials (type of package, fuel assembly, number, enrichment, etc.), places of installation (placing), fixing of the time of arrival to the storage and dispensing, maintenance and other accounting documentation, as well as the distribution of responsibility for the maintenance of account.

**15.9.3** The section shall contain the following information:

- general description of the organization of works on accounting and control of nuclear materials, radioactive substances and waste;
- the structure and composition of personnel responsible for accounting and control of nuclear materials, radioactive substances and waste;
- the number of balance areas of nuclear materials, their boundaries and structure;
- the applied methods and measuring instruments for accounting and control of nuclear materials, radioactive substances and waste;
- control means of access to nuclear materials;
- the list and forms of accounting and reporting documents;
- the procedure for monitoring of the state of accounting and control of nuclear material in the material balance areas;
- the procedure for the investigation of anomalies in accounting and control of nuclear materials, radioactive substances and waste;

- the procedure for preparation and admission of personnel to work on accounting and control of nuclear materials, radioactive substances and waste;
- the procedure for the physical inventories.

### **15.10 Emergency planning**

The information on the planned activities for the protection of personnel and population in case of the accident, according to [1, 2, 20], shall be provided.

The specific content of this section and its subsections is identified by potential hazard of the nuclear material storage facility as a radiation facility, taking into account the probable accident types, emergency scenarios and the development of the emerging radiation environment and can be changed depending on the characteristics of the particular nuclear material storage facility.

#### **15.10.1 Protection of personnel and population**

The section shall reflect the basic provisions of the action plans on the protection of personnel and population in case of the accident in the nuclear material storage facility.

The information shall confirm which action plans and the procedure for their implementation are developed taking into account possible accident events sequences and the extent of the consequences of accidents. Their compliance with the requirements of the current legislation on the protection of personnel, population and environment shall be demonstrated.

#### **15.10.2 Accident-prevention actions control units**

The information on the emergency actions control units (if available) shall be provided.

The principles and criteria for designing of the emergency actions control unit, its location shall be specified. The structure of equipment (instrumentation pool, communication, personal protective equipment, equipment of the ventilation system, etc.), as well as assurance of its efficiency under conditions of the accident shall be justified. The control room staff and its qualifications shall be specified.

#### **15.10.3 Rectification of consequences of accidents**

The possible consequences of accidents and appropriate measures for their rectification shall be provided as well as the methods and means of deactivation of the main and auxiliary equipment, facilities, areas, methods and means of provision of assistance to victims, including data on sanitary processing and medical care, the availability of required medicines, bandages and other aids with an indication of their storage sites shall be described. The methods and means of decontamination of contaminated areas shall be provided.

#### **15.10.4 Emergency response drills**

The information on conduction of emergency response drills and exercises including fire fighting ones shall be provided. The programs, methods and schedules for conduction of emergency response drills and exercises, organized in accordance with the requirements [21, 22], as well as the categories of personnel who are involved in working out of the appropriate actions in case of accidents and during the rectification of consequences of accidents.

### **15.11 Implementation of environmental protection measures**

The section shall provide information on the technical and organizational measures to assure the protection of the environment, as well as the system of radiation monitoring on the site of the nuclear material storage facility, in the controlled access area and supervised area.

## **16 Analysis of Accidents**

### **16.1 General**

Safety analysis of the nuclear material storage facility shall include the analysis of the reactions of systems and structures of the nuclear material storage facility for possible initiating events, definition of the sequence of events (scenarios) and their conditions of implementation, taking into account the dependent and independent failures, damages of the systems and components, personnel errors.

The section shall define the sources and risk factors, initiating events, scenarios of development of designed events and their consequences, as well as assess the possibility of intervention in the operation of the systems in order to control the processes running.

This analysis shall be the basis of the organization of the management of the systems of the nuclear material storage facility in different situations.

The analysis shall take into account which for each designed initiating event the following can be imposed:

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

The safety analysis shall be carried out according to the lists of the initiating events which can include a variety of system failures, operator errors, and external effects of natural and man-made origin. The recommended exemplary initiating events are listed in the Appendix C.

The analysis of possible design and beyond design basis accidents shall provide justification of the acceptability of the consequences set by the radiation safety standards.

### **16.2 Analysis of design basis accidents**

The subsection shall provide the analysis of design-basis accidents and their possible radiological consequences. Based on the analysis of possible radiation accidents the nuclear material storage facility safety shall be confirmed in specific conditions of operation and in accordance with the requirements of the technical regulations.

The results of analysis are recommended to issue in the form of a table, which will specify the initiating events, accident scenarios, the class of the accident and the accident representative for this class, the safety assessment criteria, the systems (constructions) under consideration, the results of the analysis of the accident.

#### **16.2.1 The list of initiating events of design basis accidents**

**16.2.1.1** The list of the initiating events of the design basis accidents shall be provided taken into account the requirements [7, 8].

**16.2.1.2** Each initiating event shall be analyzed in conjunction with the various failures and other factors in order to select the most significant scenarios for analysis.

**16.2.1.3** Selection of the initiating events shall be performed taken into account the requirements of the technical regulations on the number and nature of simultaneously accounted systems failures based on the consideration of:

- the initiating event characteristics;
- a set of systems and structures which affect the occurrence of accidents;
- a set of systems and structures which may be affected as a result of the initiating events.

**16.2.1.4** The initiating events shall be integrated into classes according to their functional effects on the nuclear material storage facility. For each class of the initiating events the specific initiating events shall be defined and their causes shall be considered; the greatest attention shall be paid to the events leading to more serious consequences. If according to expert estimates the initiating event does not lead to dangerous consequences, the qualitative description of possible consequences is efficient.

**16.2.2 Criteria of security assessment**

The criteria for assessment of the radiological consequences of the considered specific accident shall be provided. For the design basis accidents the exposure limits of personnel of the nuclear material storage facility and population after the accident, which are set by the radiation safety standards, shall be observed.

**16.2.3 Analysis of possible ways of development of the design basis accident**

**16.2.3.1** The analysis of all initiating events according to their list shall be carried out.

**16.2.3.2** For each initiating event of the design basis accident numerical values of the parameters of exposure taken into account in the analysis, and other initial data required for the analysis of the design-basis accidents and their consequences (design characteristics of the systems, the parameters characterizing their mode of operation, physical, chemical, thermal and the mechanical properties of substances and materials, etc.) shall be provided. The reference with specification of the appropriate section, table number, figure, which shows the original data, shall be provided, or the information referring to the sources of information shall be provided in the section. The description of initial information and initial conditions is carried out with a degree of specification which allows performing of the independent calculations, if required.

**16.2.3.3** The list of systems and structures affecting the course of the accident, as well as systems and structures which may be affected as a result of an accident shall be specified.

**16.2.3.4** The initial state of systems and components of the nuclear material storage facility at the time of the design basis accident shall be described.

**16.2.3.5** The accepted scenario of the accident shall be provided.

**16.2.3.6** The functioning of all systems and structures which affect the course of the accident, as well as of systems and structures which may be affected as a result of the initiating event and their interaction (taking into account possible failures) shall be described. The list of safety system functions which shall be implemented shall be listed.

**16.2.3.7** The local normative legal acts, which determine the actions of personnel in view of their possible erroneous actions shall be specified.

**16.2.3.8** The qualitative assessment of the possible severity of the initiating event consequences imposing on it the independent and dependent failures or erroneous actions of personnel shall be performed. On the basis of these assessments for the considered type (group) of the initiating events, such sequences (chains) of events and failures which can have the most serious consequences (change of packages layout, mesh spacing, pile of packages, the smallest margin of heat exchange, the highest dose, etc.) shall be outlined.

**16.2.3.9** The references to the relevant sections of the safety report, containing description and analysis of the functioning of technological systems and separate elements of the nuclear material storage facility are accepted.

**16.2.3.10** The information on the methods, models and software used to calculate the possible consequences of postulated accidents, with details of their assessment and conditions of applicability shall be provided.

#### **16.2.4 The results of analysis of the design basis accident**

**16.2.4.1** The results of analysis of emergency processes at the design operation of systems important to safety, system faults and errors of personnel, postulated in accordance with the requirements of the technical regulations shall be provided, and assessment of the radiological consequences of the design basis accidents shall be performed.

**16.2.4.2** The results of calculation of doses of external and internal exposure of personnel of the nuclear material storage facility and the population as a result of the accident shall be provided. The data for operational personnel shall be submitted separately.

**16.2.4.3** The results of calculation of dispersion of radioactive substances in the premises of the nuclear material storage facility and beyond shall be provided. The calculation shall be carried out taking into account the information on facilities integrity and the worst weather conditions. The border zones of radioactive contamination areas of premises and environment indicating possible contamination levels shall be assessed.

#### **16.2.5 Conclusions**

The results of analysis of design-basis accidents shall be provided. The consequences of accidents shall be briefly outlined, the conclusion on safety assurance of the nuclear material storage facility in these accidents shall be drawn. It shall be shown which as a result of the design provided technical facilities and arrangements the non-exceedance of pre-set doses of internal and external exposure of personnel and population and regulations on the content of radioactive substances in the environment in case of violation of normal operation and design basis accidents is assured.

### **16.3 Analysis of beyond design basis accidents. Development of beyond design basis accidents management measures**

The subsection shall provide the results of analysis of beyond design basis accidents and their possible radiological consequences, assessment of the probability of beyond design basis accidents occurrence as well as the management measures shall be defined.

#### **16.3.1 The list of beyond design basis accidents and its justification**

**16.3.1.1** The list of beyond design basis accident scenarios, highlighting the accidents, which can lead to exceeding of doses of personnel and population exposure, emission and radioactive substances content regulations in the environment established for the design-basis accidents shall be provided.

**16.3.1.2** Within each group of beyond design basis accidents one or more representative scenarios which meet the following criteria shall be outlined:

- maximum power of personnel and (or) population exposure doses;
- the highest intensity of emission of radionuclides;
- the largest integrated discharge of radionuclides;
- the highest scale of damage to systems and equipment of the nuclear material storage facility.

**16.3.1.3** The list of representative beyond design basis accidents defined in accordance with paragraph 16.3.1.2 shall be provided for further analysis.

#### **16.3.2 Analysis of beyond design basis accidents**

**16.3.2.1** The scenarios of the beyond design basis accident shall be provided. The main physical phenomena which determine the course of the process shall be listed.

**16.3.2.2** The list of input parameters and initial conditions which allow performing, if required, re-calculation (geometric, physical, technological initial data) shall be provided.

**16.3.2.3** The results of calculations of emergency processes in the nuclear material storage facility, in accordance with the scenario of the beyond design basis accident shall be provided, the discharge and dispersion of radioactive substances shall be assessed.

The results of discharge calculation outside the premises of the nuclear material storage facility shall be used further to calculate the dispersion of the radioactive substances in the premises of the nuclear material storage facility and environment. The calculation shall take into account the distribution of gaseous, volatile and aerosol radioactive substances, their deposition on the surfaces of buildings, on the ventilation system filters. It is required to consider all possible ways of population exposure (direct cloud shine, from cloud trace, inhalation exposure, and radioactive substance intake into the human body through the food chains).

**16.3.2.4** The information on methods, models and software used for the analysis of beyond design basis accidents, with details of their certification, shall be provided.

### **16.3.3 Measures for management of beyond design basis accidents and assessment of their effectiveness**

**16.3.3.1** For each type of beyond design basis accidents the measures for the management of beyond design basis accidents shall be specified and justified.

**16.3.3.2** It shall be shown which the implementation of the planned activities in conditions of the beyond design basis accident provides either a termination of the emergency processes, or significantly weakens the effects of the accident.

### **16.3.4 Conclusions**

**16.3.4.1** On the basis of the material above mentioned in the section the conclusion on the effectiveness of measures designed for beyond design basis accident management shall be drawn.

**16.3.4.2** On the basis of the calculation of effective and equivalent doses of exposure of personnel and population the conclusion on the implementation of the requirements of the radiation safety standards, the need for protective measures shall be drawn.

## **17 Limits and Conditions of Safe Operation. The Operational Limits and Conditions**

The section shall provide information on the limits and conditions of safe operation, operational limits and conditions set out in the design to the safety systems and systems important to safety, the nuclear material storage facility as a whole, as well as the reference between them shall be reflected.

The information in this section shall be adequate to the information contained in the technological regulations.

The references to the sections of the safety report of the nuclear material storage facility, which include the required information and explanations, are provided.

## **17.1 Limits and conditions of safe operation**

**17.1.1** The list of all controlled parameters, method and place of their measurement shall be provided. It is required to specify the limit values of controlled parameters, deviation from which leads to disruption of safe operation limits and (or) development of pre-emergency situation.

**17.1.2** The safety system response settings (if available) shall be specified. The adopted setting values shall be justified, the modes (processes), determining their achievement and their measurement conditions shall be specified. It is required to provide the values of the response settings of the warning and emergency alarm with the justification of the interval to the safety system response setting values (the reference to the relevant sections of the safety report of the nuclear material storage facility may be provided).

**17.1.3** The information on permitted normal operating conditions shall be provided. The imposed restrictions on permitted normal operation modes with reference to the relevant sections of the safety report of the nuclear material storage facility shall be justified.

**17.1.4** The information on the composition and state of systems, performance or state of readiness of which is required for the operation of the nuclear material storage facility shall be provided. The conditions for testing, inspections, maintenance and repair of systems important to safety shall be specified.

## **17.2 Operational limits and conditions**

**17.2.1** The limits of process parameters corresponding to the boundary values of normal operation area shall be provided. For each system, the limit values of the parameters for all equipment, which is a part of the system, shall be specified. The justification of the selected parameters in the authorized modes, accuracy of their measurements, measurement places, etc. (the reference to the section "Management and control" of the safety report of the nuclear material storage facility is acceptable) shall be provided.

**17.2.2** The values of process parameters under which main technological protections, blockings and automatic controllers trigger, shall be provided.

**17.2.3** The operational conditions of the nuclear material storage facility shall be defined and justified.

## **17.3 Documentation of information on the monitoring of limits and conditions of safe operation**

The information on the documenting and storing of information concerning the limits and conditions of safe operation, in accordance with the requirements of the technical regulations shall be provided.

## **18 Quality Assurance**

**18.1** The section provides requirements to the information on the assurance of the quality of works and services related to safety of the nuclear material storage facility.

**18.2** To assess the acceptability of quality assurance activities at the appropriate stage of licensing the information on the sufficiency of measures in the areas of quality assurance activity shall be provided.

**18.3** The section shall be divided into subsections by names, relevant to the areas of quality assurance activity, provided in the quality assurance program.

**18.4** The information shall be prepared taking into account the quality assurance programs and their implementation at the time of development of the safety report of the nuclear material storage facility.

**18.5** For each area of quality assurance activities the technical regulations, used in the development and implementation of quality assurance measures in this area, shall be specified.

**18.6** It is required to provide the information on the following areas of quality assurance activities in accordance with the requirements of the technical regulations:

- organizational quality assurance activities;
- training of personnel and their qualification;
- design monitoring;
- management of documents;
- monitoring of supply of equipment, components and materials, as well as the provision of services;
- monitoring of production activities;
- supervisory audit and testing;
- metrological support;
- reliability assurance;
- monitoring of non-compliance with the requirements and corrective actions;
- documentation on the quality assurance;
- inspections.

**18.7** When providing information on quality assurance activities the description of the following measures shall be provided:

- identification of materials, products, works and services which do not meet the established requirements;
- registration of non-compliances;
- notification of the appropriate level of management of the non-compliances;
- determination of the causes of the non-compliances and adoption of corrective measures to prevent their recurrence;
- exclusion of use (including accidental) of materials and products, as well as the execution of works and services which do not meet the established requirements.

**18.8** The measures, reflecting the assessment of efficiency of management of activities of the organization and performance of duties by personnel shall be specified by the specially created commission (service) or a third party.

## **19 Decommissioning of the Nuclear Material Storage Facility**

**19.1** The section shall contain the sufficient information for the adequate understanding of the main solutions provided by the design to assure the safe decommissioning of the nuclear material storage facility.

**19.2** It shall be shown which during the design, construction and operation of the nuclear material storage facility the possibility of safe decommissioning is taken into account.

**19.3** Detailed information on the technical means and organizational measures of assurance of safety of decommissioning of the nuclear material storage facility is developed in the safety report during the decommissioning of the nuclear material storage facility based on the materials of the design of decommissioning of the nuclear material storage facility, results of a comprehensive survey of the decommissioned nuclear material storage facility, taking into account the actual state of the nuclear material storage facility at the time of the report.



**19.4** It is required to provide the concept of decommissioning of the nuclear material storage facility and basic safety assurance solutions during decommissioning.

**19.5** It is required to specify the options for decommissioning of the nuclear material storage facility, determine the procedure (steps) of decommissioning, basic safety measures during decommissioning of the nuclear material storage facility, as well as justify the technical feasibility of the proposed option of decommissioning of the nuclear material storage facility.

**19.6** The analysis of the possible design solutions assuring the safe execution of future works on decommissioning of the nuclear material storage facility shall be provided.

**19.7** It shall be shown which the decommissioning of the nuclear material storage facility envisages the opportunity of the nuclear material extraction, including in the event of accidents, and provides the alleged nuclear material extraction technology. The possibility of discharge of the nuclear materials after the long-term storage shall be justified.

**19.9** It shall be shown which the opportunity of recharging and transportation of nuclear materials from the nuclear material storage facility is envisaged, the description of the proposed technology of recharging and transportation of nuclear materials shall be provided.

**19.10** The information on the possible dismantling of process and auxiliary equipment shall be provided, the description of the possible dismantling technologies, decontamination, removal and disposal of equipment, structures and buildings of the nuclear material storage facility shall be provided. It shall be shown which the dismantling of process and auxiliary equipment is provided by accepted design solutions.

**19.11** The assessment of the quantity and type of radioactive wastes generated during the dismantling shall be performed. Based on the information (range of equipment and structures, mass-volume characteristics, chemical composition of materials, etc.) represented in the previous sections, the conservative assessments of radionuclides in equipment and buildings materials shall be provided. The principles of handling of radioactive wastes, generated during the decommissioning of the storage facility, transportation of radioactive wastes, their processing and on-site storage shall be specified.

**19.12** The fundamental possibility shall be demonstrated and the supposed methods of decontamination of surfaces (external and internal), provided areas to accommodate the radioactive wastes and recycling materials generated during decommissioning, and special equipment required for decommissioning shall be specified.

**19.13** The description of possible options and rehabilitation technologies of the nuclear material storage facility site shall be provided.

## Appendix A

(advisory)

### Results of analysis of scenarios of initiating events of natural and man-made origin

**Table A.1**

Initiating event	Primary effects	Secondary effects	The list of buildings, structures, systems and components, which can be affected	Mark of the need for sustainability analysis
<b>1 External effects</b>				
1.1 Earthquake of any origin	Fluctuations of the base, the base strain	1 Fire 2 Loss of external power supply 3 Flooding or water entering the storage facility 4 Falling of individual packages on the places of location of nuclear fissile materials (substance, nuclide) 5 Loss of individual package integrity 6 Failures of equipment for transport and process operations in the storage facility 7 Leaks of solutions of packages during storage of the nuclear fissile materials (substance, nuclide) in the liquid phase 8 Change of the mesh spacing 9 Displacement of stacks of packages	All systems and components of the nuclear material storage facility	
1.2 and so on				
<b>2 Internal effects caused by emergency situations on the site</b>				
2.1 Explosion of explosive gases	1 Air shock wave 2 Flying objects 3 Fire	1 Loss of external power supply 2 Flooding or water entering the storage facility 3 Falling of individual packages on the places of location of nuclear fissile materials (substance, nuclide) 4 Loss of individual package integrity 5 Failures of equipment for transport and	Separate systems and components of the nuclear material storage facility	

Continuation of Table A.1

Initiating event	Primary effects	Secondary effects	The list of buildings, structures, systems and components, which can be affected	Mark of the need for sustainability analysis
<b>1 External effects</b>				
		process operations in the storage facility 6 Leaks of solutions of packages during storage of the nuclear fissile materials (substance, nuclide) in the liquid phase 7 Change of the mesh spacing 8 Displacement of stacks of packages		
2.2 and so on				
<b>3 Internal effects caused by the emergency situations inside the buildings and structures of the nuclear material storage facility</b>				
3.1 Explosion of explosive gases	1 Air shock wave 2 Flying objects 3 Fire	1 Loss of external power supply 2 Flooding or water entering the storage facility 3 Falling of individual packages on the places of location of nuclear fissile materials (substance, nuclide) 4 Loss of individual package integrity 5 Failures of equipment for transport and process operations in the storage facility 6 Leaks of solutions of packages during storage of the nuclear fissile materials (substance, nuclide) in the liquid phase 7 Change of the mesh spacing 8 Displacement of stacks of packages	Equipment of the nuclear material storage facility	
3.2 and so on				
Note - If the 4th column contains the systems important to safety, in the 5th column "Yes" is written. According to the mark made in the 5th column, the safety report shall provide the results of quality (if possible quantitative) assessment of the probabilities of events, parameters of effects on the affected systems and components, and conclusions on the sustainability of these systems and components to the effects in the relevant sections.				

## Appendix B

(advisory)

### Typical structure of systems description

When providing the information on the systems it is recommended to adhere to description structure provided in this section.

The references to other sections where this information is shown more detailed are acceptable.

The specific content of each sub-section may be changed depending on the characteristics of the system.

It is allowed to omit individual subsections or complete them with other, if it is determined by the characteristics of the system.

#### **B.1 Purpose, design basis**

Purpose and system functions shall be specified, safety class in accordance with the general safety regulations of the open nuclear fuel cycle, category according to seismic resistance, fire and explosion hazard and so on shall be provided.

The list of safety technical regulations, which shall meet the requirements of the described system shall be provided, as well as the principles and criteria of the system design.

The material shall be provided in the following sequence:

- the purpose and the functions of the system;
- design basis.

#### **B.2 Description of the system**

The description of the structure and (or) process scheme of the whole system, its subsystems and components if they perform separate functions shall be provided.

The drawings, figures and diagrams illustrating the structure and operation of the system, its spatial arrangement and relationship with other nuclear material storage facility systems shall be provided.

Technical characteristics of the system and its elements, the description of the system equipment and its layout shall be provided.

It is required to justify the choice of materials subject to the conditions of normal operation, violations of normal operation, including pre-emergency situations and accidents, as well as the information on the certification of equipment and materials.

The material shall be provided in the following sequence:

- description of structure and (or) process scheme;
- description of equipment and components;
- layout of equipment (elements);
- description of materials used;
- information on certification of equipment and materials.

#### **B.3 Management and control**

The section shall provide information on the control methods (automatic, remote and local control) and control system, the list of controlled parameters of the system and the range of allowable values in each of the operating modes. The location of the control points and methods of control shall be specified, the information on the metrological certification of the methods and means of control of parameters and their inaccuracy, the requirements for test equipment shall be provided.

The connection of the system with other management systems, sensors redundancy, and communication channels shall be reflected.

The material shall be presented in the following sequence:

- description of protections and interlocks;
- control points;
- limits and conditions of safe operation;
- actions of personnel.

#### **B.4 Tests and inspections**

It is required to specify the structure of the test program, its objectives, the list of technical regulations and design documentation, on the basis of which the tests and inspections are carried out, the lists of controlled parameters and requirements for the instrumentation used in the tests.

The information on methods, scope and timing of the condition monitoring and system testing in the process of operation of the nuclear material storage facility, characteristic of the activities envisaged by the design for these purposes shall be provided, and their compliance with the technical regulations shall be shown.

#### **B.5 System analysis**

It is required to provide the description of the system during normal operation, violations of normal operations, including pre-emergency situations, design basis accidents, the interaction with other systems in view of their possible failures and measures to protect the system from the effects of these failures. For the specified operating modes the operational limits and conditions, limits and conditions of safe operation, safety system response settings, indicators of reliability and performance of the system and its elements shall be provided.

The results of analysis of failures of system elements, personnel faults analysis and analysis of influence of failure consequences, including common cause, on the performance of the system and related systems on safety of the nuclear material storage facility as a whole shall be provided. For the considered failures the qualitative and quantitative characteristics of their consequences shall be provided.

As a result of consideration the failures which are the initiating events of the accidents shall be outlined.

The section shall provide a brief description of the calculation programs used for the analysis of the system, the results of calculations and conclusions. If for the justification of safety of the system the experiments were conducted, the description of conditions of experiments shall be provided, and their compliance with the terms of the design conditions shall be shown, the experimental base, metrological provision of the experiments shall be described, the interpretation of the results with respect to the design conditions shall be provided.

The material shall be provided in the following sequence:

- normal operation of the system;
- limits and conditions of safe operation;
- operation of the system in case of failure;
- functioning at pre-emergency situations and design basis accidents, including operation of the system in case of external influences;
- analysis of the reliability of the system.

#### **B.6 Conclusions**

The conclusions on the system compliance with the technical regulations requirements in the field of the use of nuclear energy, other safety technical regulations, safety principles and criteria adopted in the design of the nuclear material storage facility shall be drawn.

## Appendix C

(advisory)

### The list of initiating events of design and beyond design basis accidents

#### The list of initiating events of design basis accidents

##### Internal events

1 Loss of sealing of equipment, discharge/leakage of radioactive substances out of equipment:

- flow/leakage out of equipment (elements) through the seals;
- loss of tightness of a single package;
- leaks from the cooling pond or burst of pipelines leading to the decrease of the water level;
- leaks and discharges from tanks containing nuclear materials and radioactive waste.

2 Disfunctions during transport and technological operations with the nuclear materials:

- falling of individual packages with nuclear materials during transport and technological operations;
- falling of heavy objects which may change their location and cause damage to the integrity of the packages, groups of packages, stacks;
- failure of equipment, performing transport operations;
- spent nuclear fuel bridging in the hall of the cooling pond or in other premises in case of recharging;
- breach of fixtures of packages during transportation of nuclear materials.

3 Disfunction in the power supply system.

4 Disfunction in the heat removal system.

5 Disfunction in the ventilation system.

6 Explosion.

7 Fire.

8 Internal flooding.

9 Emissions of chemicals.

10 Errors of personnel.

##### External events

1 Seismic effects.

2 Flooding:

- seasonal;
- caused by disasters (dam failures).

3 Lightning.

4 External fire.

5 Loss of external power supply.

6 Strong winds, tornado.

7 Extreme weather conditions.

8 Shock waves:

- of explosion on the site of the nuclear material storage facility;
- explosions on other sites.

#### The list of initiating events of beyond design basis accidents

The occurrence of the self-sustaining chain reaction for the systems of storage and management of nuclear materials.

Complete dewatering of the spent nuclear fuel storage facility.

Falling of the process equipment and building structures on the ceiling of the storage compartments or stored nuclear materials.

Water flooding of the spent nuclear fuel storage facilities of class 1.

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