THE TECHNICAL CODE
OF COMMON PRACTICE

TCP 294-2010 (02300)

REQUIREMENTS TO THE CONTENT OF THE SAFETY ANALYSIS REPORT FOR A NUCLEAR POWER PLANT WITH A VVER REACTOR

This technical code draft is not applicable unless approved

Ministry of Emergency Situations of the Republic of

Belarus Minsk

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Key words: safety analysis report, nuclear power plant, reactor, safety, survey, operation, physical commissioning, power commissioning, radioactive waste, fuel element

Foreword

The goals, basic principles and provisions of the state regulation and management in the area of technical norms and standards have been set forth by the Law of the Republic of Belarus “About Technical Normalization and Standardization”.

1 THIS DOCUMENT HAS BEEN DEVELOPED BY: the State Scientific Institution “The Joint Institute of Power and Nuclear Research - Sosny” under the National Academy of Sciences of the Republic of Belarus.

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TECHNICAL COAE OF ROUTINE PRACTICES

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Effective date_________________

1 Application scope

The present technical code of common practice (further – the technical code) sets forth the rules of elaboration and the requirements to safety analysis report for a nuclear power plant with VVER reactor (further – NPP SAR).

The provisions of this technical code are compulsory for fulfillment by organizations, companies and institutions exercising activities relating to development, construction, commissioning, operating and decommissioning of nuclear power plant power units on the entire territory of the Republic of Belarus.

2 References to regulatory technical and legal acts

References to the following regulatory and legal acts in the area of technical normalization and standardization (further - TNLA) have been used in this technical code:

TCP 097-2007 (02300) Nuclear power plants location. The basic criteria and requirements to safety substantiation.

TCP 098-2007 (02250/02300) Nuclear power plants location. The basic criteria and requirements to the structure and scope of study and research for choosing a nuclear power plant location and site.

TCP 099-2007 (02120/02300) Nuclear power plants location. Nuclear power plants ecological safety case elaboration and content manual.

TCP 101-2007 (02230/02250/02300) Nuclear power plants location. The procedure of development of a general program for a nuclear power plant quality assurance.

TCP 170-2009 (02300) General provisions on nuclear power plants safety assurance.

TCP 171-2009 (02300) Nuclear safety rules for reactor installations of nuclear power plants.

TCP 112-2007 (02300) Engineering measures of civil defense.

TCP 254-2010 (02300) Nuclear power plants fire safety. General requirements.

TCP 2 6 3 -2010 (02300) Account of external effects of natural and technogenic origin on nuclear facilities.

TCP xxx-20xx (02300) Requirements to nuclear power plants quality assurance program.

RNNPE RNNPE-5.6 Norms of construction design for nuclear power plants with various types of reactors.

ND-031-01 Norms of construction design for earthquake-resistant nuclear power plants

ND-068-05 Pipeline accessories of nuclear power plants. General requirements.

PNAE G -7-008-89 Rules of design and safe operation of equipment and pipelines of nuclear power installations.

PNAE G -7-009-89 Equipment and pipelines of nuclear power installations. Welding and surfacing. The basic provisions. The USSR State Committee for Safe Operation in the Nuclear Power Engineering.

PNAE G -7-010-89 Equipment and pipelines of nuclear power installations. Welded connections and surfacing. The Rules of the USSR State Committee for Safe Operation in the Nuclear Power Engineering.

PNAE G -7-013-89 Rules of design and safe operation of actuation devices of function elements affecting reactivity.

PNAE G -10-007-89 Norms of design of reinforced concrete structures of nuclear power plants localizing safety systems.

PNAE G -10-012-89 Rules of calculating the strength of steel containments.

RRB NPP-89 Radiation safety rules in nuclear power plants operation.

VSN AS-90 Rules of acceptance of NPP power units finished as construction projects

NRB-2000 Radiation safety norms
BSR-2002 Basic sanitary rules for radiation safety
SR NPP-2010 Hygienic requirements to design and operation of nuclear power plants
STB 1951-2009 Electrical cables and wires. Fire hazard indicators and test methods.

Notes
1 While referring to a TNLA, it is advisable to check its validity in the catalogue compiled as of 1 January of the current year and the relevant informational indexes published in the current year.
2 Shall the referred to TNLA be replaced (amended), using this technical code, it is necessary to be guided by the replaced (amended) TNLA. Shall the referred to TNLA be cancelled without replacement, the provision referring to those TNLA shall be applied to the extent not affecting that reference.

3 Terms and definitions

The following terms with the relevant definitions are used in this technical code:

3.1 accident: A disruption of nuclear power plant normal operation at which a release of radioactive substances and (or) ionizing radioactive radiation beyond the NPP designed limits for normal operation in the quantities exceeding the set limits of safe operation has occurred. An accident is characterized by the initiating event, propagation paths and consequences.

3.2 nuclear power plant: A nuclear installation for production of electric and thermal energy within the set modes and conditions of application, located within a definite area on which for that purpose a nuclear reactor (reactors) and a complex of the necessary for its functioning systems, devices, equipment and facilities are used.

3.3 nuclear power plant commissioning: The process during which the systems and components of a built nuclear power plant are brought to operable state and their conformity to the nuclear power plant project design is assessed.

3.4 NPP probabalistic safety analysis (NPP PSA): System analysis of a NPP power unit safety during which probabilistic models are developed and probabilistic safety indicators values area determined, the results of which are used in qualititative and quantitative assessments of the NPP power unit safety level and elaboration of solutions for designing and operating the NPP power unit.

3.5 internal self-protection: The ability to assure safety based on natural feedback and processes.

3.6 main electric circuit diagram: The diagram of electrical connections providing transfer of the full power from the operating NPP power unit to the NPP power system and electric power supply for the given NPP power unit own needs.

3.7 in-depth protection: A protection based on the use of a system of barriers on the way of propagation of ionizing radiation and radioactive substances into the surrounding natural environment and a multi-level system of engineering and organizational steps aimed at protection of the barriers and maintaining their effectiveness as well as protection of population.

3.8 power unit "hot" condition: NPP power unit state at which the turbine housing metal temperature is not lower than 180°C in the steam inlet area.

3.9 fire area boundary: The boundary behind which there shall be no inflammation or behind which the fire area will be assigned to another fire hazard category.

3.10 beyond design basis accident: An accident caused by the initiating events not stipulated for design basis accidents or aggravated by additional failures beyond a single-failure case as compared with those of design basis accidents, resulted by wrong decisions of the in-plant personnel.

3.11 initiating event: A single failure in a nuclear installation systems (elements), external action or in-plant (employees) personnel error, which lead to disruption of the normal operation and may result in violation of the limits and (or) conditions of safety operation. It includes all dependent failures coming out as its consequence.

3.12 normal operation: Nuclear power plant operation within the operating limits and conditions determined by the project design.

3.13 determining imposition : An array of events, which may lead to fire safety degradation of facilities.

3.14 NPP safety analysis report: A document substantiating the NPP safety assurance at all stages of its life cycle

3.15 passive part of emergency cooldown system: A part of emergency cooldown system functioning without operator interference at complete electric power supply cut- off.

3.16 coolant circuit density: The condition of a circuit (coolant circuit) preventing the reaction mass escape from the circuit or penetrating the circuit.

3.17 reactor subcriticality: A reactor core condition characterized by the effective neutron multiplication factor less than one.

3.18 fire hazard area: Room (section of the room), group of rooms, section of a NPP industrial site where, regularly or periodically, including the cases of violation of the flow, flammable substances and materials are stored (handled) and which are separated from other rooms (sections of the rooms), groups of rooms, sections industrial site by safe (extreme) distances or fire prevention barriers.

3.19. ALARA principle: The principle implying maintenance of the lowest possible and achievable level of both individual radiation exposure (below the limits set by the valid norms) and collective radiation exposure taking into account the social and economic factors. Law of the Republic of Belarus "On radiation safety of the population", Article 3, paragraph 4 – the optimization principle.

3.20 single-failure principle: The principle in accordance with which the system shall perform the set functions in any initiating event requiring its work as well as in case of not depending on the initiating event failure of one of active or passive elements having movable mechanical parts.

3.21 design basis accident: An accident for which initiating events and final conditions are determined by the project and safety systems are stipulated to ensure, taking into account the safety system single-failure principle or one not depending on the initiating event error of the employees (in-plant personnel), minimization of its consequences by the limits set for such accidents.

3.22. project design essentials: An array of initial data on the required parameters and technical specifications of a nuclear power use facility (NPUF), its systems, elements, buildings, structures, including the data on the conditions of their operation, operating modes parameters and postulated external events necessary for the NPUF designing, manufacturing its equipment, systems and devices, their installation and adjustment, the NPUF construction, ensuring its normal operation within the set service life as well as decommissioning.

3.23 coolant circuit strength: Coolant circuit condition withstanding design and beyond design basis loads.

3.24 reactor installation cooldown: Automatic or standard activation of special systems with forced coolant circulation through heat exchangers removing the reactor coolant circuit thermal energy outside the containment.

3.25 reactor installation: A complex of systems and components of a nuclear power plant designed for transformation of nuclear energy to thermal energy, comprised of reactor and systems directly connected with it, necessary for its normal operation, emergency cooldown, emergency protection and keeping in the safe condition, provided the required auxiliary and assurance functions are performed by other nuclear power plant systems. Reactor installation boundaries are outlined in every individual nuclear power plant project design.

3.26 control and protection system: An array of means of engineering, software and information support aimed at ensuring the safe flow of fission chain reaction. Control and protection system is a safety critical system combining the functions of normal operation and safety and comprising the elements of controlling systems of normal operation, protection systems, safety control and assurance systems.

3.27 fuel assembly: A mechanical engineering item containing nuclear materials and designed for production of thermal energy by way of controlled nuclear reaction.

3.28 fuel element: A separate assembly unit containing nuclear materials and designed for production of thermal energy in a nuclear reactor by way of controlled nuclear fission reaction and (or) for accumulation of nuclides.

3.29 physical commissioning: The stage of a nuclear power plant power unit putting into operation including charging of the nuclear reactor with nuclear fuel, attaining the critical state of reactor, carrying out the necessary physical measurements on the level of power at which heat is removed from the reactor by way of natural loss of heat (dissipation).

3.30 power unit “cold condition: An NPP power unit state at which the turbine housing

metal temperature is not higher than 80°C in the steam inlet area.

3.31 experimental loop: An Independent circulation circuit of reactor installation having one or more channels designed for experimental research and testing of new types of fuel elements and other elements.

3.32 nuclear power plant operating organization: An organization maintaining activities, on its own or in association with other organizations, aimed at placement, construction, commissioning, operation, limitation of operating parameters, extension of operating life and decommissioning of a nuclear installation and (or) a storage facility, as well as the activities for management of nuclear materials, spent nuclear materials and (or) that of operating radioactive waste.

3.33 power commissioning: The stage of a nuclear power plant power unit putting into operation from the physical commissioning to the start of electric power generation.

4 Designations and abbreviations

The following designations and abbreviations are applied in this technical code:

ALARA – as low as reasonably achievable; ASA – automatic standby activation;

EP – emergency protection;

NPP – nuclear power plant;

ARSMS – automated radiation situation monitoring system;

ASRAS – automated scientific research systems (programs applied in engineering calculations, design and research work);

APCS– automated process-control system; CP – cooling pond;

RASDF – rapid steam dumping facility;

RASDF-A – rapid steam dumping into the atmosphere facility;

RASDF-C – rapid steam dumping into turbine condenser facility;

PUCS – power unit control station; PUCB – power unit control board; PSA– probabalistic safety analysis; ES – explosive substances;

SI – vessel internals; IPM– in-pile monitoring;

IPTSC – in-plant transport and storage container;

ABW – air blast waves;

WCC – NPP water chemistry condition; MCC– main circulation circuit;

MCP– main circulation pump; MBA – material balance area;

ALA – accident localization area;

IRAS – ionizing radiation source; AM – actuating mechanism;

PC – pressure compensator;

CMI – control and measuring instruments;

CMI and A – control and measuring instruments and equipment; LSS – localizing safety systems;

MCL – minimum controllable level;

MCE – maximum credible earthquake;

MES – Ministry of Emergency Situations of the Republic of Belarus; DM – deflected mode;

NLA – normative legal acts;

NOC – normal operating conditions;

EIA – environmental impact assessment; HGP– hazardous geological processes;

NPP SAR – nuclear power plant safety analysis report; SAS – safety assurance systems;

SNF – spent nuclear fuel;

WEP – warning emergency protection; NA – natural impacts;

SG – steam generator;

DBE – design basis earthquake; SV – safety valve;

PC – pre-commissioning;

QAP – quality assurance program ;

NPP QAP – nuclear power plant quality assurance programs; RAP – reliability assurance program;

PSAR – preliminary safety analysis report; SPM – scheduled preventive maintenance; RPS– radiation-proof shelter;

ST – software tools;

PSD – passive sprinkling device; AE – absorber element;

RAW – radioactive waste; RAS – radioactive substances;

SAEEPGS – standby diesel engine electric power generation set; AE – adjusting element;

RCS – reserve control station; RI– reactor installation;

RCB – reserve control board;

AICS – area emergency cooldown system; CADS – computer aided design system;

EPESS – electric power emergency supply system; SS – safety systems;

SCS – safety critical systems; SES – sealed enclosure system;

SPZ – sanitary protection zone;

PUCMS – power unit control and manipulation system; PHRAS – passive heat removal system;

CPS – control and protection system; PPS– physical protection system;

AI– technogenic impacts;

FA – fuel assembly; FE – fuel element;

SCC – short-circuit current;

TNLA – technical normative legal acts; TFP – turbine feed pump;

TC – technical conditions;

TSC – transport and storage container; TI – turbine installation;

CSS – controlling security systems; SFSI – spent fuel storage installation; FFSF– fresh fuel storage facility;

OO – operating organization;

NM – nuclear materials;

NRHF – nuclear and radiation hazardous facilities; NF – nuclear fuel;

NPI – nuclear power installation.

5 General requirements to the content of safety analysis report for a nuclear power plant

5.1 The purpose and scope of safety analysis report for a nuclear power plant

5.1.1 Development of NPP SAR is maintained by the operating organization with participation of a NPP engineering project developers. NPP SAR is submitted by a license seeker (licensee) (further – Applicant) to the MES when filing an application for a special permission (license) in the field of nuclear energy use and ИИИ, what concerns the activities in the field of nuclear energy use (further - license) (making amendments and (or) addenda in the license) as part of the documents substantiating nuclear and radiological safety in carrying out activities in the field of nuclear energy use (further – safety substantiation documents).

The information provided in a NPP SAR shall be based on calculations, NPP engineering project materials, technical documentation for RI and safety critical systems.

5.1.2 NPP SAR shall present sufficiently full information for adequate understanding of a NPP project design, concept of safety on which the project is based, programs for quality assurance and the basic operating principles proposed by the Applicant.

Based on the information presented in the NPP SAR, the MES shall be able to assess the sufficiency of substantiation of location, construction, commissioning, operating and decommissioning of a NPP on a specific site in order to avoid exceeding the set in-plant personnel and population exposure limits and the norms of RAS emission and contents in the environment in normal operation and design basis accidents as well as the possibility of limitation of those impacts in beyond design basis accidents.

5.1.3 A separate NPP SAR shall be developed for each power unit of a multi-unit NPP.

5.2 The procedure of preparation of safety analysis report for a nuclear power plant

5.2.1 The work on a NPP SAR preparation, development and maintenance shall be conducted at all stages of a NPP life cycle.

A NPP SAR shall comply with a NPP condition in respect of both the project documentation and its actual embodiment.

5.2.2 The stage of creating a DRAFT NPP SAR is necessary for a NPP SAR development and updating at all stages of a NPP life cycle.

In its turn, updating a NPP SAR is admissible. The periodicity of NPP SAR updates as well as the completeness of the materials provided for updating are determined by the requirements to the construction, fuel charging and physical commissioning, NPP power unit power commissioning and operating etc.

5.2.3 Among the documents substantiating the safety with regard to NPP construction, a draft NPP SAR shall be submitted. The information presented in a draft NPP SAR shall be based on the materials of a NPP project design, RI engineering projects and SCS.

The information presented in a NPP SAR, submitted as part of documentation substantiating the safety with regard to a NPP operation, shall comply with the actual NPP condition because of construction, manufacture, installation, pre-commissioning and checks, physical and power commissioning.

5.2.4 By the moment of the first fuel charging in reactor, a NPP SAR reflecting the required in NPP SAR information on a NPP condition at the beginning of the first fuel charging

shall be ready.

5.2.5 All amendments in the initial project made during modernizations after the first submission of NPP SAR shall be reflected in the Report and assessed from the point of their affect on a NPP safety.

5.3 The requirements to the content and form of a nuclear power plant safety analysis report and its maintenance

5.3.1 NPP SAR contents shall be such, as far as it is actually possible, that a state authority regulating safety matters in nuclear energy use would not need additional study of project and operating materials to assess the safety. Along with NPP SAR, all project and other documentation (scientific reports) referenced by NPP SAR shall be submitted.

A NPP SAR introductory section shall contain the information at the NPP and its project, NPP and NPP SAR project developers details, the project current stage of

development in general as well as the NPP SAR general description.

5.3.2 The NPP SAR structure ad contents shall comply with the present technical code requirements.

5.3.3 Shall the extent of information materials readiness not comply with the

requirements of the present technical code at the NPP SAR development stage, the information provided in the NPP SAR shall reflect the actual level of safety development and substantiation. Provided additionally shall be:

- criteria adopted for development as well as the list of data and assumptions substantiating their attainment;
- proposed design solutions and alternative choices;
- work completion schedule with the time frame for provision of the

necessary information.

5.3.4 The information shall be presented in a clear and precise manner avoiding ambiguity and verbosity. The details on the requirements fulfillment shall not carry declarative nature. It is necessary to provide documented confirmation of their implementation.

Duplication of information shall be avoided. Shall the same information be required in various NPP SAR sections relating to various NPP parts, it shall be placed in the main section and referred to in other sections.

5.3.5 The information on performed calculations and calculation analysis shall confirm the sufficiency and completeness of the scope of calculations done, account of all the factors influencing the result, as well as contain the data sufficient, if necessary, for doing expert calculations (diagrams, adopted assumptions, initial data, results, their interpretation, conclusions).

All software tools, mentioned in a NPP SAR shall be briefly described to the extent

sufficient for their understanding and assessment of their acceptability, their titles and certification data shall be provided.

5.3.6 The information provided in a NPP SAR shall reflect the actual level of development

and substantiation of safety.

Upon submission of a NPP SAR as part of a set of safety assurance documents, the scope and extent of information substantiation are considered in accordance with the present technical code, proceeding from the condition of sufficiency of the provided substantiation materials at this stage.

The information on the performed calculations and calculation analysis shall confirm the sufficiency and completeness of the scope of calculations done, account of all the factors influencing the result.

5.3.7 C The structure of systems description in a NPP SAR is given in Supplement A.

5.3.8 Each NPP SAR describing an independent NPP part shall contain:

- information on the development stage corresponding to the actual NPP state at the moment of NPP SAR submission;
- information on the project and operating materials based on which the current NPP SAR edition has been developed;
- list of literature referred to in the NPP SAR and supplementing the information contained in it;
- requirements to NPP SAR form and contents.

5.3.9 A printed NPP SAR shall be placed by an applicant in folders according to separate

sections and subsections. The beginning of each section shall bear full table of contents of the entire NPP SAR, "Introduction" section and abbreviations list. Each folder shall bear the NPP name, full NPP SAR title and that of the relevant section.

5.3.10. It is advisable to print NPP SAR out using computer printing and graphic devices on one or two sides of A4 format, State Standard 9327, paper sheets with one and a half interval, the

letters and digits height shall not be less than 1,8 mm. The text of Report shall have margins: left, right, top, bottom – correspondingly 30,10,15,20 mm.

5.3.11. The quality of the text information shall allow reading it without eyestrain. The NPP SAR shall have clear, nonspreading lines, letters, numbers, symbols. All the lines, letters, numbers and symbols shall be equally clear as for the paint brightness. It is necessary to keep uniform density and contrast throughout the entire NPP SAR. The graphic material placed in a NPP SAR shall be produced in a scale comfortable for reading. The designations in the graphic material shall match the description of elements, systems and structures mentioned in a section and exclude variant reading.

5.3.12 The pagination shall be done according to sections and subsections representing independent

parts. At that, a page number shall include the number of section/subsection and the page number properly and be depicted on the top page margin in the format "nn.n" for a section and "nn.n-n" for a subsection.

5.3.13 Changes in a NPP SAR text shall be made by the way of pages replacement. Making changes by text editing is not permissible. When replacing individual pages, it is necessary to place the sequence number of edition and the date of replacement (month, year) in the upper right corner on the margins of each of them. With the need of changing the pagination of the subsequent pages in a section, the whole section shall be replaced. At that, the record of edition sequence number and the replacement date shall be placed on the first page of section. Placed in the end of each section shall be a list of registered changes.

5.3.14 NPP SAR updating shall be done (if necessary) before the moment of submission of substantiating materials for the issue (making amendments and (or) addenda) of license (further – issue of license).

NPP SAR updating is done by way of releasing topical reports on specific sections.

6 The requirements to the content of the introductory section of a nuclear power plant safety analysis report

The “Introduction” section provides general information on a NNP and its developers, the plant and NPP SAR developers’ personal details, the project development stage in general as well as the NPP SAR general description. The introductory section shall contain the following information:

- reason for the project development, i.e. brief information on the official decisions of the authorities of state administration based on which the NPP construction is expected;
- NPP general characteristic, including the planned output, number of power units, modes of use, type of reactor etc.;
- NPP SAR development stage, information on the actual at the moment of the NPP SAR creation stage of development of project and operating documentation;
- NPP SAR developers details, i.e. details of the applicant submitting the NPP SAR to a state regulation authority and the developers of specific independent NPP SAR sections, including the information on the availability of their experience in the concerned area etc.;
- NPP SAR characteristic, i.e. the scope of completeness of the submitted information and its compliance with the requirements of the present technical code shall be characterized.

If the project development is at one of the initial stages and due to that reason the submitted information does not meet to the full extent the requirements of the present technical code, this shall be stated in this NPP SAR subsection. At that, a schedule of the work completion with the period for provision of the necessary information shall be submitted additionally.

7 Nuclear power plant general description

This section shall provide the information on a NPP briefly reflecting the contents of all the other NPP SAR sections.

The specific feature of the information contained in this section is that there shall be a possibility of its independent use irregardless of the other NPP SAR sections, including the opportunity for the authorities of state administration, public organizations and the population to get familiar with the concept and engineering solutions aimed at the NPP safety assurance. Therefore, the style of information presentation shall be simple and accessible. This shall be not mechanically shortened information from the other sections, but an independent simplified description with the wide use of tables, diagrams and drawings.

7.1 Nuclear power plant construction conditions

This NPP SAR section shall provide brief information on a NPP site and area of location, including:

- climatic conditions;
- atmosphere characteristics;
- ambient air temperatures: average monthly for several years, extreme for a year, extreme out of the average monthly, average decade and once-only;
- ultimate heat sink temperatures: average monthly for several years, extreme for a year, extreme out of the average monthly, average decade, extreme out of the average;

- geological, hydrogeological and seismo-tectonic characteristics;
- seismicity of a NPP site and area of location with regard to MCE and DBE levels, - boundaries of a one-piece facility, where no seismic deformation will be present, including those in case of MCE;
- soils characteristics to the depth of not less than 100 m with the indication of emission

of compressible (clay, sand) and non-compressible (rock, half-rock) soils;
- depth of the first from the surface aquifer and its connection with surface waters;
- information on the density of the population living in the area with the radius of 25 km around the NPP, including the in-plant operating personnel;
- information on the local and regional settlement systems;
- information on the sanitary protection zone and the number of settlements to be moved before a NPP commissioning;
- characteristics of extreme natural impacts (hurricanes, dust storms, icing, flooding etc.);
- hazards from industrial, transport and military facilities located near the NPP;
- characteristics of water facilities;
- description of wild animals populations and the ways of their migration.

7.2 Nuclear power plant layout

In this NPP SAR section it is necessary to:
- provide brief description of the NPP site location area, including brief description and location of industrial enterprises, water ducts, pumping stations, water storage basins, irrigation canals, hydraulic power plant dumbs, air fields, motor highways and railways with their data association with the SPZ and the supervised area;
- provide brief description of water intakes, waterways, gas mains, products pipelines, gas emission stations and description of the air space use within the radius of 30 km around the NPP;
- provide the NPP site relief and inclination towards water basins characteristics, provide brief information on the use of land;
- show the directions of the NPP high voltage electric power relay lines, approach railways and motor highways and the expected dwelling area location;
- show fire and explosion hazard facilities and industrial enterprises emitting and discharging pollutants into the environment. The layout diagram shall be provided in the scale of 1:25000.

7.3 Nuclear power plant schematic diagram description

This NPP SAR section shall provide the nuclear power plant schematic diagram showing:
- primary coolant circuit;
- reactor;
- main circulation pump;
- steam generator;
- pressure compensator;
- coolant purification system;
- security systems;
- charging basin and its cooling;
- purge – recharge system;
- steam pipelines;
- steam turbine installation;
- recharge duct;
- aftercooling and residual heat removal system;
- process water supply system for normal operation and SS systems;
- NPP own needs power supply from external sources;

The diagram shall be supported by brief description of systems and elements interaction. Shown on the diagram shall be the conventional boundaries of localizing systems. The schematic diagram shall be supplemented by the list of safety critical systems and elements with their basic characteristics and classification by safety, seismic stability and fire safety.

7.4 Nuclear power plant basic technical specifications

This NPP SAR section shall provide the NPP basic technical specifications, including:

- number of power units;
- reactor installation, steam turbine installation service life;
- NPP electrical and thermal power;
- heat power;
- designed power utilization coefficient;
- electric power consumption for own needs;
- fuel charging;
- basic parameters of the primary and secondary circuits coolants;
- other parameters necessary for understanding of the NPP basic characteristics.

7.5 Power system characteristics

This NPP SAR section shall provide the diagram of the power system in which the NPP will operate as well as the following power system characteristics:

- voltage in the power system circuits;
- power system condition by the time of NPP commissioning with the indication of the type and output of electric power plants in the power system;
- power system total levels of electricity consumption and load maximums (24 hours, weekly, seasonal and by years), power reserve with reference to load maximums;
- power system automatics and protection operating modes influencing the NPP operation mode;
- NPP operation modes related with the power system operation abnormalities leading to loads shedding down to own needs level;

The number of cycles of expected abnormalities taking into account DBE, MCE, strong winds, hurricanes etc. shall be determined. It is necessary to determine the time for electricity supply recovery from external source for NPP own needs in the event of the expected abnormalities.

7.6 Nuclear power plant operating modes

This NPP SAR section shall provide the information at the NPP main specific operating modes, including the NPP operating modes under external impacts occurring once in 100 years as well as in cases of the NPP influenced by MCE, blast wave and aircraft crash as described in TCP 263.

Base and maneuvering operating modes shall be singled out, determined shall be the lists and quantities of normal operating modes, normal operation failures, including emergency situations and design basis accidents.

7.7 Nuclear power plant safety assurance concept

7.7.1 The basic nuclear power plant safety principles and criteria

This NPP SAR shall provide:

- The list of the current valid safety TNLA for compliance with which the nuclear power plant SAR has been developed;
- the information on the internal self-protection principle application in the project, means it is implemented by;
- the description of the NPP safety assurance by way of consistent implementation of the in-depth protection principle based on the use a system of barriers on the way of propagation of ionizing radiation and RAS into the surrounding environment and a multi-level system of engineering and organizational measures aimed at those barriers protection and maintaining their effectiveness as well as the population protection; information as to due to which solutions implemented in the NPP project design the relevant protection level is maintained, the basic functions performed by SS;
- SS structure and its compliance with the requirements of TNLA in the field of nuclear energy use. This information shall be supported by a principal structural diagram featuring SS organization in the NPP project design;
- the confirmation of compliance with the basic principles of SS building, in particular: passiveness, single-failure, multi-channel, physical separation, diversity;
- a proof of SS resistance to failures of general nature (fires, electricity cut-off, external natural and technogenic impacts);

- a proof of SS resistance to operator errors;
- the information on the basic provisions enabling the SS to fulfill its functions under the influence of earthquake, blast wave, aircraft crash etc. at the NPP.
- the information on beyond design basis accidents: list of studied beyond design basis accidents, actions diminishing the consequences of beyond design basis accidents; measurements for severe accidents management.

7.7.2 Nuclear safety assurance

This SAR subsection shall set forth the goals of nuclear safety and show with the help of what systems they are achieved.

7.7.2.1 Keeping control of chain reaction in a reactor core. Show to what extent nuclear safety is supported by the use of reactor internal self-protection features.

Provide the data on balance reactivity for all possible operating states, emergency situations and design basis accidents. The data shall be presented in the form of table. Provide analysis of the possibility of emerging positive reactivity effects in accidents and assessment of their possible consequences.

Present the structure of the provided engineering means of influence on the reactivity, functions of specific systems and subsystems and their reliability. Show how fulfillment of 5.2.12 TCP 171 requirements is maintained.

Present the proof of effectiveness, reliability and speed of reactor emergency protection (EP).

7.7.2.2 Assurance of heat removal from reactor core.

Present the schematic diagram and description of reactor core cooling at normal operation, normal operation violations, including emergency situations and design basis accidents.

Assess the extent of passiveness of heat removal systems adopted in the project from the state-of-the-art viewpoint.

7.7.2.3 Describe the measures aimed at prevention of local criticality during NF transloading, transporting and storage. Present brief information on local criticality prevention during performance of the above-mentioned kinds of work.

7.7.3 Radiological safety assurance

This SAR subsection shall determine with the help of what engineering means and organizational activities the protection of in-plant personnel, population and the surrounding natural environment from the unacceptable exposure is maintained. It shall be proved that the use of the proposed means and carrying out the said activities is justified by the experience and does not lead to exceeding the established exposure limits, excludes any unreasonable exposure, and the existing radiological impact is maintained on the level as low as reasonably achievable (the ALARA principle) taking into account the economy and social factors. It is necessary to show the extent of safety systems effectiveness and that they are sufficient for insignificant increase of the risk to health or other damage to in-plant personnel, population and natural environment as compared with the risks in case of possible alternative productions.

7.7.4 Fire safety assurance

This SAR subsection shall provide the information on account of the following provisions and criteria aimed at fire safety assurance:

- presence in the NPP project design of systematic approach to fire safety assurance and stage-by-stage planning of fire safety measures for a facility;
- classification of the main NPP buildings as for fire resistance, explosion and fire safety;
- maintaining the project stipulated fire safety level by following the uniform safety criteria in all power unit operating modes as well as in the event of design basis and beyond design basis accidents;
- regarding fire as an initiating event with the probability of fire assessment for various equipment. Fulfillment of fire impact forecast for safety critical equipment and analysis of the possible failures chain as the consequence of the fire;
- performing probabilistic analysis of the possibility of fire coincidence with other events that may take place irregardless of the initiating event “fire” and analysis of the consequences of such coincidence taking into account the NPP safety assurance in these

cases;

- extreme impacts on fire detection and fighting as well as fire localization means;
- regarding fire as the consequence of an accident or emergency situations. In this case the safety analysis shall be performed taking into account the fire emerged and a chain of successive failures coming as the consequence of the fire;
- the assessment of fire consequences taking into account the possible failures of firefighting facilities;
- the substantiation of the principle of building active firefighting systems, their reliability level, analysis of those systems ability to sustain the influence of single failures of equipment;
- basic firefighting principles: multi-barrier type, optimal correlation of passive and active protection, reservation and duplication of safety channels, their physical separation etc.;
- power unit operating order in the event of fire in the rooms accommodating safety critical equipment and the rooms in which an emerging fire leads to the necessity of the RI shutdown. Substantiation of the impossibility of simultaneous loss of control from PUCS and RCS in the event of fire;
- the data confirming that in case of false actuation of firefighting facilities the impact of firefighting means on the safety critical equipment will not entail dangerous consequences from the general safety viewpoint;
- the determination of project designed quantity of simultaneous fires on the industrial site; ;
- keeping to the principle of buildings zoning (division into fire zones and compartments) and fire localization by separate compartments approach;
- it shall be shown that fires occurring on the industrial site (external fires) will not exert serious influence on the work of in-plant personnel, structures of the buildings located near the fire and safety critical equipment the operability of which shall be assured within that period.

7.7.5 Nuclear power plant safety assurance against the impact of natural and technogenic origin

This subsection shall contain the following information:

- for important safety critical facilities, units, equipment and systems there shall be a list of extreme impacts occurring with the periodicity of 10^{-2} 1/year (winds, hurricanes, whirlwinds, extreme temperatures, floods, icing etc.) with the indication of the magnitude as well as the magnitude of aircraft crash, flying objects and blast wave and the measures protecting from those impacts;
- earthquakes magnitudes, a list of parameters characterizing specific magnitudes, their account in designing buildings and facilities of the first and second categories. Information shall be provided on the systems of anti-seismic protection.
- Hazards from industrial, transport and military facilities located close to the NPP. Information on the sources of potentially possible accidents with explosion and ABW impact parameters;
- normative basics of designing protection from external impacts.

This subsection shall also contain the information on the methods and calculation programs for assessment of external impacts and the necessary protective measures.

7.7.6 Action plans for protection of in-plant personnel and population in case of accidents

This SAR subsection shall contain the basic provisions of action plans for in-plant personnel and population protection in the event of radiological accident at the NPP.

These provisions shall show the order of notification of the population and describe organizational activities in the event of accidents, including coordination of the NPP in-plant personnel activities with the MES agencies, medical institutions, local authorities, ministries and bodies taking part in the population protection and elimination of the accident consequences It is necessary to provide information on the internal emergency centre located on the site as well as on the external (reserve) emergency centre located in such a place where it will be not subjected to the impact of the accident simultaneously with the main centre.

7.8 Quantitative safety analysis results

7.8.1 Reliability of equipment and other elements

This SAR subsection shall provide the information on SCS equipment and elements reliability, including:

- A list (nomenclature) of reliability indicators for each type of equipment requiring substantiation of reliability;
- results of reliability indicators substantiation (experiment-calculated);
- conclusions on the indicators compliance with the requirements of TNLA;
- results of qualititative analysis of reliability;
- an assessment of uncertainties of reliability analysis results;
- an assessment of possible influence of incompleteness of the factors taken into account in the calculation;
- a list of elements important from the point of view of their contribution in the systems reliability;
- references to applied calculation methods and programs;
- characteristics of the initial reliability data;

The necessary information shall be presented in the form of tables for each type of equipment.

7.8.2 Deterministic safety analysis

This subsection shall provide brief information on the performed safety analyses the detailed description of which is given in section 21.

The information shall be provided for all groups of the considered emergency modes and contain the following data for each group:

- the number of considered modes;
- the reason for the choice of the modes and the purposes of analysis;
- the description of the results received and assessment of their conservatism.

In case of beyond design basis accidents, when substantiating the choice of the list considered in the project, special attention shall be paid to assessment of completeness and representativeness of that list for development of an instruction manual on beyond design basis accidents management.

This subsection shall be finished with a summary table of the main results and their general assessment as well as the assessment of the completeness and sufficiency of the obtained results for substantiation of the NPP safety.

7.8.3 Probabalistic safety analysis

This subsection shall provide information on the results of the performed PSA, including:

- a description of source database of reliability;
- a list of considered initiating events and its substantiation;
- information on the performed qualititative and quantitative systems reliability analyses. The results of systems interconnections shall be presented in the form of tables;
- information on the applied fault trees models and events trees models, including the information on the used success criteria for the main systems;
- information on the account of faults by common cause;
- information on the account of in-plant personnel actions and errors;
- information on the account of external events;
- information on assessment of sensitivity and uncertainties;
- final results of PSA with a table of dominant minimal cross sections and assessments of the results compliance with the requirements of TCP 170.

It is necessary to provide the information on the project balance and the amendments that have been made in it based on PSA to attain the balance; show the main contributors to the risk of severe accident and the emission of their shares of the relative contributions.

7.9 The basic technical solutions

7.9.1 The reactor, primary coolant circuit and its related systems

This SAR subsection shall provide the following information:

- the general description of reactor, primary coolant circuit and the systems relating to it, including reactor installation in a pit, biological and radiological protection, purpose of specific parts and elements;
- the classification of systems and elements within reactor, primary coolant circuit and systems relating to it;
- basic operating specifications of systems and elements;
- the principles and criteria laid down in the project.

That information shall be supported by engineering process diagrams, drawings of reactor installation in the pit, reactor assembly, core cross section, core basic elements, reactor vessel MCPSG, PC, accumulators, CPS drive kinematic diagram.

7.9.2 Steam turbine installation

This NPP SAR subsection shall provide the information on the steam turbine installation and the systems relating to it.

The said information shall briefly describe the components and boundaries of the steam turbine plant and especially its influence on the RI. Simultaneously, it is necessary to provide brief information on the steam turbine interconnection with the RI, both technologically through the parameters and through the control and protection system.

It is necessary to show the possibility (in the event of deviation from the normal operation, emergency situations and accidents of the turbine properly) of leak, accumulation of RAS.

It is necessary to provide a description of the possibility of formation of objects flying from

the steam turbine installation (turbine units, high pressure pipelines and vessels) which may cause destruction or damage of SS or cable routings. The information shall show and explain the protection from such impacts.

It is necessary to provide substantiation of the strength, stability and operability of the steam turbine installation and the systems relating to it under external natural and technogenic

impacts according to their classification.

It is necessary to specify an earthquake magnitude at which the steam turbine installation operability shall be preserved.

It is necessary to attach the steam turbine installation flow chart, layout drawings (plane views and cross sections).

This subsection shall be finished with qualititative and quantitative assessment of the project, the information on compliance with the requirements of TNLA in the field nuclear energy use, deviations from the TNLA requirements and the ways of their compensation.

7.9.3 Circulation and process water supply system

This subsection shall provide brief description of:

- process water supply sources (water storage basins, rivers, lakes);
- circulation water supply systems;
- process water supply systems.

The description shall contain: classification of systems, buildings, structures, basic thermo- hydraulic and design specifications of systems and equipment (inlet and outlet channels, water intake devices, pumping, cooling towers, systems and sources of circulation systems make-up), fundamental principles and criteria laid down in the project, operating modes, including those applied in the event of disruption of normal operation, design basis accidents and external impacts.

Flow diagrams shall be attached to the description.

7.9.4 Electrical systems

This subsection shall provide brief description of electrical systems, including:

- system components, each system function and classification of systems and elements;

- power emission diagram, number of lines, voltage;
- NPP own needs electricity supply from external and internal sources; ;
- protection, automatics and control system;
- normal operating mode electrical systems and elements safety class;
- electrical devices fire protection;
- electrical system operation at normal operation disruption, accidents and external natural and technogenic impacts;
- criteria of equipment selection.

Attached to the electrical systems description shall be the following circuit diagrams:

- NPP to electrical system connections diagram;
- main wiring circuit;
- own needs electricity supply schematic diagram;
- protection structure diagram;
- control and automatics structural diagram;
- communications structural diagram.

7.9.5 Nuclear power plant water chemistry condition

7.9.5.1 This subsection shall show that:

- the norms of WCC ensure such physicochemical condition of process media and surfaces of NPP equipment that allows to maintain the in-plant personnel exposure on as low as

reasonably attainable level taking into account the social and economy factors;

- the norms of WCC ensure the integrity of protective barriers on the way of propagation of radioactivity by way of minimization of corrosion processes of constructional materials in all operating modes. It is necessary to show in what way the protection of barriers from corrosion of constructional materials is maintained.
- the norms of WCC ensure such physicochemical condition of process media that brings to the minimum the degradation of project design specifications of heat transmitting surfaces in the process of operation.

7.9.5.2 While considering protection of the materials of fuel elements blankets from the influence of aggressive impurities, it is necessary to have in mind the possibility of sediment formations on fuel elements caused by penetration of Ca, Mg, Al and Si compounds as well as the products of constructional materials corrosion into fuel element. It is also necessary to take into account the possibility of zirconium alloys hydrogenation. The norms shall stipulate minimizing of the fuel elements blankets integrity violation caused by the above-mentioned factors.

7.9.5.3 When describing coolant circuit equipment metal protection, it is necessary to be aware of the results of analysis of the selected constructional materials, taking into account the physicochemical characteristics of process medium in which equipment operates and the stresses emerging in the metal.

It is necessary to provide analysis of the used materials taking into account the activation of impurities contained in them. At that, the ways of limiting the formation and mass transfer of long- lived radionuclides Co-60, Ag-110m shall be shown.

It is necessary to show how the coolant quality control in all nuclear power plant operating modes is maintained: hydraulic testing, circulation flushing, hot running-in, power unit start, power

operation, power unit shutdown and standby mode.

It is necessary to show which coolant quality parameters are controllable and diagnosable. Show what operating limits and limits of safe operation are set and what actions shall be taken in the event of the set limits going beyond the set values.

Periodicity of measurements shall be shown for all controllable and diagnosable parameters.

7.9.6 Fuel management system (outside the reactor)

As for the complex of NF storage and management (outside the reactor), this subsection requires to:

- provide the list of all NF storage facilities, both fresh and spent;
- provide specifications of the fresh NF used for the given NPP as well as those of the fuel removed from the reactor core with the indication of the nuclear fuel depletion detection method;
- specify the maximal design capacity (storage capacity) of each storage facility

and the number of places reserved for emergency core offload and storage of rejected NF, both fresh and spent correspondingly.

- briefly describe nuclear fuel storage methods, both for FFSF and SFSI, indicate the availability of absorber elements in the storage facility materials and the coolant;
- specify the method of NF delivery to the NPP and the method of SNF evacuation from the NPP, provide the information on the expected periodicity of transportation and the used types of transport and storage packs;
- provide information on the in-plant material handling (kinds of transport and storage packs);
- provide information on rejected NF management, both fresh and spent, including the rejection method;
- provide the list of initiating events for which the NF (SNF) storage and management systems complex has been designed with the analysis of emergency situations and design basis accidents.

7.9.7 Radioactive waste management

7.9.7.1 Provide brief description of the liquid radioactive waste management system, the basic goals, criteria and principles of its designing. Show the means of attaining those goals.

7.9.7.2 Provide brief description of the solid radioactive waste management system, the basic goals, criteria and principles of its designing. Show the means of attaining those goals.

7.9.7.3 Provide brief description of the gaseous radioactive waste management system, the basic goals, criteria and principles of its designing. Show the means of attaining those goals.

7.9.7.4 This subsection shall describe all systems of special gas purification used for reduction of emissions of radioactive sprays, various forms of iodine (aerosol, vapour and organic) and inert radioactive gases into the atmosphere and the NPP premises. Provide the purification coefficients for each system separately.

7.9.8 Nuclear power plant process control system

7.9.8.1 This subsection shall contain brief information on a NPP power unit APCS, including that on a NPP power unit APCS structure, classification of NPP power unit process control subsystems, arrangement of the premises for APCS in a NPP power unit building, NPP power unit control centres, warning and emergency notification signals system for a power unit personnel.

7.9.8.2 The following information shall be provided with regard to the APCS subsystems:

- the reactor shutdown control system at normal operation;
- reactivity control system, including the reactor EP system;
- safety control systems;
- safety critical information operator display system;
- other safety critical control systems.

7.9.9 Safety systems

This subsection shall provide the list of protective, localizing, supporting and controlling safety systems containing the following information:

- system functions and components;
- design basis accidents assured by the relevant system;
- compliance with the principles and criteria of safety;
- criteria of performing its functions by the system;
- brief system description: flow diagram, layout, protection from internal and external impacts, management and control;
- system condition at normal operation, full-scale system testing, checking;
- system operation in accidents.

7.9.10 Nuclear power plant master plan and layout

7.9.10.1 This subsection shall provide the drawing of the master plan with the list of the main NPP buildings and structures.

The following information shall be presented:

- conditions determining the location on the master plan of the main buildings and structures (flow interconnections, natural lay of land, direction of the dominating winds, geological and hydrological site conditions, power units construction order etc.);
- main NPP buildings orientation;
- distances between the main buildings and structures and their substantiation;
- substantiation of placing on the master plan of waterworks, open emission facilities, auxiliary buildings and structures;
- motor ways and railways, conditions of entry into the main buildings and structures;
- site surface relief inclination;
- site layout marks;
- industrial site protection from surface water inflow;
- engineering pipelines and networks, transport, flow and electrical communications between the main buildings and structures, between the restricted and free access areas.

7.9.10.2 What concerns the principles of laying out the main structures and equipment, the following information shall be provided:

- "building block" principle and positioning of the seismic resistant engineering process systems and equipment of the 1st and 2nd categories;
- the division of the main building structures into restricted and free access areas with regard to technical maintenance conditions.

7.9.10.3 Concerning the list of the main buildings, structures and their functions, the

following information shall be provided:

- basic layout solutions;
- list of systems and equipment of the first, second and third safety classes placed in the building;

Provide information on the materials used for NPP buildings and structures, main buildings and structures scope of construction. Provide the main buildings and structures plane view and cross-section drawings at the scale of 1:1000.

7.9.11 Ventilation systems

This subsection shall provide information on the project design criteria and description of ventilation systems.

7.9.11.1 The following project design criteria information shall be provided:

- assuring maintenance of the predetermined ambient air temperature in the premises within the NPP designed operating conditions;
- assuring radiological safety in the NPP premises and outside them in compliance with the

current valid regulations;

- providing working conditions for in-plant personnel complying with the sanitary norms in all design basis operating modes;
- creating conditions for conducting repair and recharge work. Provide the main systems list and their functions description:
- intake and exhaust systems;
- recirculation systems;
- air conditioning systems.

7.9.11.2 The ventilation systems description shall contain brief information on the following systems:

- normal operation systems critical for safety;
- systems relating to safety assurance systems;
- systems assuring radiological safety of the surrounding natural environment;
- in-plant personnel radiological safety assuring systems; The description shall contain:
- each system function;
- system components;
- design criteria;
- operating modes.

Diagrams with the list of equipment and its basic specifications shall be attached to the description.

7.9.12 Radiation protection and control

This subsection shall present the adopted in the project design classification of NPP areas and premises making the basis for designing biological protection from penetrating radiation and prevention of the serviced premises air from radioactive fission products contamination.

General information on biological protection from the main radiation sources mentioned in sections 16 and 17.2 of this technical code shall be presented.

It is necessary to present the criteria of selecting the engineering means of radiation survey, creating the diagram of the points of selection and location of equipment (instruments). Provide general description of stipulated by the project design engineering means of radiation survey and ARSMS system.

7.9.13 Physical protection system

This subsection shall provide the information on PPS composition and requirements to it as well as the structural diagram and organizational description of PPS.

7.9.13.1 This subsection shall present the components and description of engineering subsystems, at that, it is necessary to describe:

- security alarm systems;
- access control systems;
- video surveillance systems;
- rapid communication systems;
- security engineering means;
- auxiliary systems and means assuring physical protection operation.

7.9.13.2 Describing the organizational measures, it is necessary to indicate the subsystems of organizational actions for the NPP physical protection, in particular:

- organization of NPP security;
- NPP personnel training for actions in extreme situations;
- organizing access of the NPP permanent and alternate personnel to the protected area and special importance areas;
- organizing personal and special inspections of the NPP personnel, seconded specialists, visitors, vehicles and other measures;
- organizing PPS operability checks and checks of engineering means included in it.

This subsection shall show that the PPS, as the one related to the SCS, complies with the basic principles: independence, multi-channel character, fire safety, operability and reliability assurance in the conditions of extreme external and internal impacts.

7.9.13.3 This subsection shall describe the scheme and structural organization of PPS. It is necessary to provide the basic functional diagrams of the PPS control and alarm engineering means. Apart from that, it is necessary to present the PPS structural diagram of the NPP security organization.

The PPS in this subsection of NPP SAR shall be presented only in principle, without disclosing the locations of control boards, alarm and surveillance pulpits. The detailed information shall be provided confidentially.

7.9.14 Fire safety measures

This subsection shall contain brief information on implementation of actions aimed at fire safety assurance. It shall include the following information:

- the division of a power unit main buildings into fire protection areas and their fire resistance
boundaries;
- the list of premises in main buildings of a power unit with the indication of premises categories with regard to explosion-fire and fire safety, fire resistance limits for fire prevention barriers (kind and type of barrier), premises equipment with fire alarm systems, automatic fire extinguishing facilities, kind of fire extinguishing agent. The information on this item is given in Table 1;
- the list of the main fire prevention measures in the architecture, construction and engineering process parts of the project design for maintaining the operation of the NPP systems and elements critical for safety in the event of fire in a power unit;
- the physical separation of individual SS channels equipment by building constructions with specified fire resistance limit;
- SS channels emission for the premises accommodating safety critical equipment;

- providing oil trays and casings for oil containing equipment and pipelines etc.;
- equipping the premises with firefighting facilities;
- key criteria for analysis of combustion load on main structures of power unit with explosion and fire hazard specifications of substances and materials;
- hydrogen safety systems;
- loading protection of cable passages;
- facilities (premises, equipment) fires extinguishing of which may directly or indirectly affect safety critical equipment;
- kinds of fires which are determinative for designing of firefighting systems;
- in-plant personnel evacuation routes, engineering means of fire alarm notification of people and evacuation control;
- external water supply for industrial site and main power unit facilities, assurance of availability of water intake from various water basins and vessels for mobile firefighting equipment, providing the buildings with internal fire prevention water pipelines;
- fire detection and warning alarm systems;
- fire hazard analysis for power unit main facilities, forecast of fires consequences with regard to safety assurance, including the fires in the event of destruction of buildings, facilities and those caused by external impacts.

Table 1 – Fire prevention measures and equipping power unit main buildings premises with fire detecting and extinguishing facilities.

Room name	Category	Fire resistance limits for anti-fire barriers (kind and type of barrier)	Availability of fire detecting and extinguishing facilities		
			Fire alarm signalization	Firefighting facilities	Fire extinguishing agent
1		3	4	5	6

7.10 Brief description of nuclear power plant operation

This section shall provide a brief description of specific NPP stages of operation.

7.10.1 Preparing a power unit for commissioning

This subsection shall provide brief description of specific stages of RI preparation for commissioning:
- RI specific elements and components condition;
- primary coolant circuit charge and charge duration;
- MCP (main circulation pump) commissioning;
- primary and secondary coolant circuits strength and density testing;
- passive AICS part testing.

It is necessary to provide the boundary pressure and temperature specifications of the primary and secondary coolant circuits characterizing the relevant stage of preparation for commissioning, the stage implementation duration.

7.10.2 Power unit start from cold to full power

This subsection shall provide brief information on the stages of power unit commissioning from cold condition to full power:
- method of reactor core heatup after reload;
- reactor core state monitoring;
- strength checks (periodicity of equipment checking for strength in compliance with the requirements of the current valid TNLA, but not rarer than once in four years);
- steam generator check for strength and density with the second coolant circuit (similar to the previous testing);
- checking protections and blockings in compliance with the RI operation and maintenance manual;
- CPS overall checking;
- taking measurements of reactor core neutron-physical characteristics after reactor putting to the MCL;
- coolant heatup, heatup methods, preparing turbine generator for commissioning, main steam pipelines heatup;
- position of EP control elements groups;

- boron acid removal;
- RI putting to full power.

The following information shall be provided: primary circuit coolant boundary parameters (pressure and temperature), secondary circuit pressure, heatup rates, conditions of RI heatup end, conditions of rector putting to the MCL, reactor power at which the turbine connection is possible, coolant parameters at attaining the RI rated output.

Heatup schedule shall be attached.

7.10.3 Power operation

This subsection shall provide the following information:

- power operation ranges taking into account the accuracy of power maintenance by the control system;
- RI main parameters at rated output;
- steam turbine main parameters;
- main flow systems operating conditions in the primary and secondary coolant circuits at power unit power operation;
- compensation of slow reactivity changes, keeping the reactor in the critical state in the load shedding and transitional modes;
- conditions of emerging and Xe-oscilations characteristics and their suppression algorithm;
- primary coolant circuit make-up-purging main characteristics;
- main SG purging system characteristics.

7.10.4 Power unit power adjustment

This subsection shall provide brief information on the operation of the main RI and TI regulators.

7.10.5 Transitional modes

In this subsection, when describing each transitional mode, it is necessary to provide brief description of the RI initial state. Apart from that, there shall be the following information provided for each mode:

- scheduled outage of MCP (mode running, RI power reduction value depending on the number of disabled MCP, MCP and SG disabling order);
- activation of an earlier disabled loop (brief mode running characteristic, RI power value before MCP activation);
- scheduled TFP outage (mode running, including the TI initial state, preliminary power reduction, RI power value depending on the number of running TFP);
- turbine generator disconnection from supply network (mode running, including: TI initial state, order of RASDF-К and RASDF-A actuation, movement of CPS) CPS rods working group movement towards the reactor core, RI power stabilization);
- accelerated power unit discharge;
- high pressure heater switching-off/on;
- turbine generator load shedding down to the own needs level.

7.10.6 Power unit shutdown from full power to hot condition

This subsection shall provide brief mode running information, including:

- “hot shutdown” definition;
- primary and secondary coolant circuits systems operation order;
- the cooldown rate;
- cooldown and residual heat removal method;
- reactor subcriticality, methods of its attainment;
- turbine generator discharge, RI power reduction, main controllable parameters;
- RI cooldown after turbine generator discharge down to 10-15% level, SG level adjustment, RASDF-К activation;
- reactor transfer to hot condition with the preceding reactor subcriticality assurance;
- SG pulse protective device actuation trial, method of testing;
- pressure compensator pulse protective device actuation trial, method of testing.

It is necessary to provide information on the boundary parameters of each cooldown stage for the primary and secondary coolant circuits.

A cooldown schedule shall be provided.

7.10.7 Power unit operation in hot condition and permissible maintenance work

This subsection shall provide the following information:

- coolant temperature and pressure taking into account the brittle strength condition assurance;
- a short list of faults causing the “hot” shutdown;
- possibilities of defects elimination and RI maintenance in the “hot shutdown” situation.

7.10.8 Power unit cooling down to cold condition

This subsection shall provide brief information on the mode running, including:

- the definition of the “cold condition” mode;
- primary and secondary coolant circuits systems operation order;
- the cooldown rate;
- cooldown and residual heat removal method;
- reactor subcriticality, methods of its attainment;
- turbine generator discharge, RI power reduction, main controllable parameters;
- RI cooldown after turbine generator discharge down to 10-15% level, SG level adjustment, RASDF-К activation;
- reactor transfer to hot condition with the preceding reactor subcriticality assurance;
- SG pulse protective device actuation trial, method of testing;
- pressure compensator pulse protective device actuation trial, method of testing
- RI cooldown, feed water temperature reduction, ammonium feed into pressure compensator, MCP disabling, ammonium discharge from the pressure compensator;
- end of cooldown.

It is necessary to provide the information on the boundary parameters of each stage of the primary and secondary coolant circuits cooldown.

Cooldown schedule shall be provided.

7.10.9 Power unit operation in cold condition without opening primary coolant circuit

This subsection shall provide the following information:

- reactor subcriticality conditions;
- reactor brittle strength assurance conditions;
- a list of the main emergency modes causing the necessity of “cold shutdown”, for example: a) undeliberate opening of pressure compensator SV;

b) accidents causing coolant lost through small breaks;
c) regulating unit ejection after the CPS drive casing break;
d) MCP shaft break;
e) the steam pipeline damage;
f) accidents with loss of coolant;
i) opening and not shutting the SV, SG etc.

7.10.10 Recharge

This subsection shall provide brief information on the rules of fuel recharge, including:

- actions for reactor decompaction;
- actions for the SNF discharge from reactor to the CP;
- fuel reshuffle inside the reactor core and fresh fuel charge;
- fuel elements hermeticity control;
- scope of control at recharge;
- residual heat removal at fuel recharging.

A typical recharge period timetable as well as the list of nuclear hazardous work operations shall be provided.

It is necessary to provide the list of work operations for technical maintenance and repair at recharge.

All cooldown, heatup and fuel recharge schedules shall be supported by brief comments on each stage.

7.11 Nuclear power plant impact on the environment

7.11.1 This subsection shall provide brief information on the project design solutions adopted with the aim of minimization of the NPP harmful impacts on the environment discovered in the process of assessment of the impact on the environment, including chemical impact; radiological impact; thermal contamination; electromagnetic impact; acoustic impact.

7.11.2 The following shall be stressed out:

- at NPP construction expropriation of certain territories takes place, the natural landscape is changed, certain changes are brought to the social and economy conditions of the area of the NPP location. Assessment of the NPP impact on the natural environment shall be conducted specifically for each kind of impact, taking into account all diversity of the biosphere, i.e. the influence of each kind of impact on the ecological systems, the biota, the flora, the fauna, and man.
- the assurance of radiological safety of man and radio-ecological safety of natural environment

is the main goal in a NPP designing.

- the assessment of the NPP impact on the surrounding natural environment shall be conducted with the account of the actual ecological situation in the NPP location area, the existing hygiene and sanitary, biological, technogenic and technogenic characteristics of the biosphere pollution.

7.11.3 While assessing the NPP impact on the environment, it is necessary to take into account and provide the list of all engineering and organizational measures aimed at prevention or reduction of the negative impact of the NPP on the biosphere.

This shall include:

- the creation of protective barriers to the possible ways of spreading of radionuclides;
- the creation of closed hermetic circuits for the systems with radioactive media;
- the creation of a complex of operating systems and SS of high reliability level reducing the probability of emergency situations and diminishing their consequences;
- the organization of collection, cleaning and recycling of all kinds of radioactive waste and industrial chemical waste;
- creation of effective systems for cleaning and disposal of non-radioactive waste (domestic waste water sewerage and storm water drainage systems);
- the creation of closed circular systems of process water supply, the maximal use of low potential heat removed from the NPP;
- the reservation of as small as possible areas for RAW and SNF storage facilities;
- the organization of SPZ and NPP survey zone;
- maximal reduction of consumption of natural resources and reduction of industrial waste generated by the use of low-waste and non-waste technologies and recycling of industrial waste;
- organization of integrated environmental monitoring system;
- solving a complex of issues relating to the NPP decommissioning.

7.11.4 It is necessary to take into account the changes of the surrounding natural environment resulted by the NPP construction, which embrace the following issues:

- preserving the natural landscape;
- assuring surface water runoff;
- assuring industrial effluent and domestic waste water sewerage cleaning;
- minimizing the damage to the ecology when carrying out the work (excavation, hydro- engineering etc.);
- preventing pollution of the atmosphere, soil, water basins and water passages with industrial waste;
- using natural resources rationally;
- integrated monitoring of the construction process, compliance with the project design solutions and norms and ecological safety requirements;
- assuring safety (nuclear, ecological, industrial).

7.11.5 The results of assessment of the NPP impact on the environment shall be presented in the materials about the possible changes of the natural environment during the NPP construction, operation and decommissioning; about the consequences for the ecological systems and population of the region; about the planned nature protection, social and economic measures aimed at the preservation, sanitation and improving the biosphere condition.

7.11.6 It necessary to evaluate the cost of environmental protection measures, conduct assessment of ecological damage, substantiate the sustainability of natural systems to the NPP impact. Assessment of the consequences of the NPP impact on the natural environment shall have an integrated character.

7.11.7 It is necessary to provide an integrated assessment of the risk to the population and ecological systems.

7.12 Comparison with the analogues

7.12.1 This section shall provide comparison with the selected NPP project design analogues, at that:

- as an NPP analogue may be an NPP using the same type of RI and implementing the same or close principle of NPP safety assurance, control and protection;
- with unavailability of the necessary analogue, an NPP may be compared with an NPP by

the type of reactor close in the rated output and control;

- the comparison may be done with an NPP having the same type of reactor.

While doing the comparison, it shall be reasonably proved that the new NPP project design, as for its concept and adopted engineering solutions, has essential advantages and complies with the latest TNLA requirements.

7.12.2 The proposed NPP project design shall be compared with the analogue along all normal operation systems and SS. For the purpose of comparison, the necessary typical layout drawings of the proposed project design and those of the analogue and the analogue schematic diagrams in the scale of 1:1000 shall be presented.

7.13 Nuclear power plant construction schedule, partners, contractors

7.13.1 This section shall provide an activity network of the NPP construction, names and addresses of all participants of the project design development and subcontractors for the NPP construction.

7.13.2 It is necessary to present the information on the operating organization providing the NPP safety guarantee, partners, contractors and the scope of their responsibility.

7.14 The principal provisions on the organization of nuclear power plant operation

7.14.1 Nuclear power plant commissioning

This section shall provide brief information on the PC (pre-commissioning) program embracing the testing of structures, systems and elements during the NPP commissioning.

Mentioned in the information shall be the main stages of commissioning testing with the

description of the plan of their performing, which will allow to assess the possibility of successful PC and the criteria of successful fulfillment of all the items of the said plan. It is necessary to indicate the goal of each stage, which shall be attained in the process of checks and testing.

It is necessary to show the sufficiency of the number of skilled personnel for performing the testing, the organizational structure of the pre-commissioning company and the participants' interaction in the course of commissioning. It shall be shown as to what extent it is planned to use the information on the experience of commissioning of the analogous NPPs or NPPs with other type of reactor and how this information substantiates the relevant stages, methods and criteria of acceptance of the program under description.

The brief information on the pre-commissioning (PC) program shall provide the main

engineering process limitations and instructions, limits, conditions and measures for safe performance of work and testing.

The NPP SAR shall contain the procedures and methods applied for the analysis of obtained results and definitions of determining the goals as well as brief information on assessment of the results of attaining the initial criticality, stage-by-stage power rise as well as the most important characteristics of the RI equipment and the NPP safety systems.

In this section, it is necessary to provide the description of the order of issue, submission and keeping the report documentation with the indication of the conditions of access to it.

7.14.2 Nuclear power plant operation management

This section shall provide information on the preparation and organization of the NPP operation. It shall contain brief description of the operating organization structure with the accent on responsibility of specified persons and structural units for the nuclear power plant operation. The operating organization (OO) description shall embrace all key issues of personnel training to the required skills (availability of training centers, training programs, training timeliness, order of certification and admission to independent work).

It is necessary to show the effectiveness of the actions for technical maintenance and control of the plant operating condition (current). In particular, it is necessary to show how the results of checks and tests are accounted in the programs of assessment of the NPP operating safety level, how the experience of operation is accounted in drawing the technical maintenance schedules, what the order of preparation and submission of periodical information on the current safety level is etc.

7.14.3 Safe operation limits and conditions

This subsection shall provide the most important values of safe operation limits as well as the conditions of safe operation for the most safety critical systems.

It is necessary to show the range of normal operation on the example of one of controllable parameters, with the indication of the areas of stable operation and process protection setpoints and blockings, the range of expected deviations from the normal operation with the area of SS setpoints and the range corresponding to emergency situations and accidents staying beyond the boundary of safe operation limit.

7.14.4 Nuclear power unit decommissioning

This subsection shall contain the basic provisions of NPP power unit decommissioning concept.

It is necessary to describe the supposed order of actions during the NPP power unit decommissioning and radiological safety assurance while carrying out those actions.

It is necessary to show how it is supposed to assure the radiological safety of the in-plant personnel, population and the natural environment at the stage of preserving (post-defueling monitored storage), the stage of burial (limited use of site) and power unit dismantling (unlimited use of site).

It is necessary to show how at all stages of NPP decommissioning they assure the minimal amounts of RAW and reduction of exposure of the in-plant personnel and population, achieve the reduction of radioactive products discharge into the natural environment down to as low as a reasonably attainable level.

7.15 Quality assurance

This section shall provide brief information on the activities of the participants of the work at the NPP creation confirming the capability of those organizations to assure the quality of all the work and services influencing the NPP safety.

It is necessary to provide the description of the scheme of general organization of the quality assurance system during the NPP creation showing the interaction of the operating organization, the organizations developing the NPP project design and other enterprises, the emission of the work and responsibility between them.

It is necessary to point to the responsibility of each organization administration for assurance of quality, reliability and safety of the created NPP.

It is necessary to reflect availability at the operating organization and head companies of departments of independent control of assurance of quality of all the work, products or services influencing the safety.

This section shall provide the information on the state of development, implementation and functioning of the quality assurance system at the operating organization and other companies.

It is necessary to provide the information on the state of development and implementation, at the moment of the NPP SAR submission, of quality assurance programs at the operating organization and other enterprises.

It is necessary to specify the main principles of quality assurance allowing organizing the work in such a way that all quality problems are prevented, not discovered upon their arising.

8 Description of the area and the site of a nuclear power plant location

This SAR section shall provide the information on the geographical, topographical, hydrological, meteorological, seismological, geological and engineering-geological conditions of the NPP location, the existing and prospective emission of population, use of lands for agricultural development.

It is necessary to substantiate the completeness and sufficiency of study and survey carried out in the NPP area of location and on the site in order to find and obtain the true characteristics of the territory, which shall be taken into account in the project design essentials at all stages of the NPP life cycle and in emergency planning for organization of evacuation of the in-plant personnel and the population from the NPP area of location.

It is necessary to determine:

- the list of parameters and characteristics of external impacts at the NPP from the side of the surrounding natural environment and those resulting from the events relating to human activities;
- the list of parameters and characteristics of the NPP impact on the environment in the NPP area of location.

The project design solutions and engineering measures, with reference to the conditions of the NPP area of location and the site, shall be described in special NPP SAR sections.

The NPP SAR shall contain the information for the selected and approved site only. At

providing materials on the competing sites, the scope of information on each site shall comply with the present document

When preparing materials for a section, it is necessary to show the compliance with the requirements of TNLA the list of which shall be provided in a supplement.

In case of unavailability of special TNLA the requirements shall be determined with the

account of the latest achievements of science and engineering, and engineering solutions shall be substantiated in every specific case.

8.1 Description of the area of location of a nuclear power plant site

It is necessary to be guided by the following values of the territory coverage radii taking the NPP main building (reactor core compartment) as the NPP site centre:

- district – not less than 300 km;
- settlement – not less than 30 km;
- site – not less than 3 km;
- SPZ and supervised area are established upon the results of radiological safety analysis.

8.1.1 Geographical position

The NPP location shall be recorded by latitude, longitude and the mark (elevation) in the common system of coordinates and altitudes.

This section shall specify:

- NPP site administrative affiliation (region, district);
- name of the administrative centre;
- distance to the administrative centre;
- distance to the nearest administrative borders;
- distance to the nearest state borders and the names of the nearest states;
- site location relative to the natural and man-made landmarks (settlements, rivers, airports, railway stations, river ports etc.);
- nearest industrial facilities (factories, chemical plants, gas and oil pipelines, food industry facilities etc.);
- nearest military facilities;
- distance to the boundaries of specially protected natural territories, recreation areas, restricted areas etc.;

8.1.2 Topographical conditions

This section shall provide the list of materials featuring the results of engineering and geodetic surveys and studies as well as the analysis of those results.

A description of the intended NPP location area and the site land relief shall be provided. At that, it is necessary to specify:

- maximum and minimum elevation marks at the NPP location territory;
- land surface inclination and its direction;
- presence of special land relief elements (ravines, cliffs, lowerings, sinkholes etc.);
- presence of wetlands;
- presence of forest, arable land and other land usage areas etc.;

The topographic and geodetic materials (maps, elevation marks etc.) shall be presented in the common system of coordinates and altitudes.

For a facility to be placed within the radius of not less than 30 km from the main NPP building, it is necessary to provide the following documents:

- a topographic map in the scale of 1:25000-1:10000;
- materials of current crustal dynamics survey (survey diagram);
- a topographic map (plan) in the scale of 1:10000 (1:5000) on the site.

A topographic map (plan) in the scale 1:10000 (1:5000) shall be provided for the site.

8.1.3 Demography

The data provided in this section shall be based on the results of the latest population census and take into account the population migration and growth, the requirements of effective evacuation of the population of the NPP location area as well as the population travelling along transport communications.

This section shall specify:

- density of population in the area with the radius of 30 km relative to the NPP location site for the period before the beginning construction, for the period of construction and the entire period of the NPP operation;
- distance from the cities with the population exceeding 100 000 people for a zone in the radius of 100 km from the NPP site;
- emission of population on the map by sectors (rings) around the NPP limited by the radii of 1-5 km, 5-10 km, 10-15 km, 15-20 km, 20-30 km divided into 8 rhumbs;

Provided for emergency situations shall be:

- information on the specific groups of population: permanent and temporary dwellers, age groups (children, elderly people), hard to evacuate (ill people, prisoners etc.);
- population food ration, share of imported and local foodstuffs;
- domestic water consumption, sources of water supply;
- daily and seasonal migration of population;
- duration of population stay in the open areas and (separately for city and village dwellers);
- means of transport, communications, parameters of means of transport.
-

8.2 Technogenic conditions of nuclear power plant location area

8.2.1 The basic data for determining quantitative and probabalistic characteristics and parameters of external impacts of technogenic origin

The provided data shall be sufficient for substantiation of the probability of external impacts and forecasting the impacts parameters and characteristics. They shall be presented in the form of text information and maps.

It is necessary to provide detailed information, as a minimum, with reference to the cases in the items 8.2.1.1 – 8.2.1.6.

8.2.1.1 Aircraft and other flying objects crash

Information on location of airports, positioning of air corridors, crossings of air routes in the NPP location area (on a review map).

Information on the kinds of air traffic, types of aircraft and their specifications, flights frequency.

Aircraft take-off, landing and parking diagrams.

Presence at a distance of 300 km away from the NPP site of military facilities or air space used as a training ground for bombing and the information on all possible kinds of flying objects, their characteristics and frequency of the hazard implementation.

Air crushes archive data.

8.2.1.2 Fire by external causes

a) Shown on the district review map shall be;

- forest areas;
- ES warehouses (solid, liquid, gaseous);
- products pipelines, oil and gas pipelines;
- railways and motor ways, river and sea ways;
- airfields, air communications and flight lines;
- dwelling areas;
- industrial enterprises;
- coal and peat extraction production;
- peat deposits areas.

b) Archive information on fires in the district.

c) information on flammable materials deposits in the fire hazard sources specified in the listing 8.2.1.2a).

d) wind rose.

8.2.1.3 Explosions at facilities

The following information shall be provided:

a) the distance from the NPP to stationary and mobile sources of possible explosions, including:

- warehouses, storage facilities, vehicles with ES;
- vessels and installations of high pressure with gases or overheated liquids;
- buildings, structures, enterprises where hazardous technologies are applied and internal explosions are possible;
- motorways and railways, water transport with the provision of all data of the transported ES;
- products pipelines, oil and gas pipelines;
- military facilities.

b) information on ES stocks.

c) Archive and statistical information on explosions in the district.

8.2.1.4 Breakthrough of natural and man-made water reservoirs

Present the diagram of location of water reservoirs and nuclear and radiation hazardous facilities.

Probabalistic characteristics of reliability of waterworks under external impacts of natural and technogenic origin.

Statistical data obtained as the result of processing of hydro-meteorological information in the long-term context (not less than 50 years) containing the lines of yearly values of the parameters as well as the information on the extreme maximums.

The data of yearly measurements of water levels in the upper pond. Statistical evaluation of the maximal water deposits in the upper pond.

Data of the measurements done according to the standard programs of hydro-meteorological survey with the hourly frequency of measurements on the site.

8.2.1.5 Corrosive liquid discharges to surface and ground water

Provide the results of chemical analysis of water and ground samples taken in the site location area in compliance with the requirements of TNLA.

Provide description of the site hydrogeology, including brief description of aquifers, chemical composition of the underground water, its variations in time, possible flooding of the NPP underground facilities, the conditions for perched water emerging; determine the extent of aggressive impact of the soil below the underground water level.

Provide the statistical data on the probability of discharge of corrosive substances, stored, produced or transported in the NPP area.

The information on incidents shall be provided.

8.2.1.6 Discharge of explosion hazardous, flammable, toxic vapours,

gases and sprays into the atmosphere

It is necessary to provide:

- distance from the NPP to industrial enterprises using chlorine, hydrogen sulphide, ammonium, sulphur dioxide and other active chemical substances; the chemical discharge location;
- diagrams of movement of mobile sources of toxic hazard;
- statistical data on incidents.

8.2.1.7 Other external impacts of technogenic origin.

8.2.1.8 It is necessary to provide the summaries of organizations who have legally confirmed the information on the sources of technogenic hazard.

8.2.1.9 Based on the study of the area and the NPP construction site, it is required to draw a consolidated list of the processes and factors of external impacts of technogenic origin.

It is allowed to ignore (with the appropriate substantiation) those impacts, which are characterized by low probability values (below 10^{-6} event in a year) or insignificant intensity and (or) long distance from the source (seat) of impact (safe distances and intensity values, which may be considered insignificant for certain kinds of impact are determined by special norms).

8.2.2 Methods of forecasting characteristics and parameters of external impacts of technogenic origin

This section shall provide description of the methods and techniques of calculation of the basic parameters and characteristics of external impacts of technogenic origin.

8.2.3 Results of assessment of characteristics and parameters of external impacts of technogenic origin

It is necessary, as a minimum, to determine the parameters and characteristics of external impacts as below:

8.2.2.1 In the event of an aircraft crash it is necessary to determine:

- The stiffness characteristics of the colliding bodies;
- the masses of the bodies;
- the mass of fuel;
- the impact velocity;
- the angle of the impact with the structure;
- the direction of the impact;
- the impact area;
- the probability of the event.

8.2.2.2 In case of fire emerged by external reasons it is necessary to determine:

- the likely area of the territory damaged by fire;
- heat flux in the fire source and changes of its direction relative to the NPP;
- distance from the NPP;
- wind speed and direction taken into account.

8.2.2.3 In case of explosion at facilities it is necessary to determine:

- excessive pressure in the ABW front;
- TNT equivalent;
- distance to the NPP;
- estimated concentration of toxic discharge at the NPP site.

8.2.2.4 For discharges of explosive, flammable, toxic vapours, gases and sprays into the atmosphere it is necessary to determine:

- the amount of substance that may be involved in the event;
- the initial concentration in the area of discharge, dispersion of discharge in the atmosphere, concentration from the primary sources and secondary effects of nuclear damage; duration of impact.
- wind speed and direction taken into account;
- presence and strength of fire source;
- concentration at the cloud approach to the NPP.

8.2.2.5 In case of a breakthrough of natural and man-made water reservoirs it is necessary to determine:

- wave height ;
- wave speed;
- territory flooding time.

8.2.2.6 For corrosive liquid discharges to surface and ground waters it is necessary to determine:

- the initial concentration;
- the possible concentration of corrosive media near the NPP systems;
- the impact duration.

8.2.2.7 For electromagnetic pulses and radiation it is necessary to determine:

- the distance to the source;
- the intensity of electric and magnetic fields.

8.2.2.8 In case of other external impacts of technogenic origin it is necessary to determine the intensity and frequency of events.

8.3 Hydro-meteorological conditions

8.3.1 Regional climatology

This section shall contain the hydro-meteorological description of the NPP area of location allowing taking decision on the principal possibility of location of the NPP in a given area as well as the engineering protection from unfavourable hydro-meteorological impacts

It is necessary to provide the following data:

- the direction, speed and permanency of a wind (wind rose);
- average and extreme values of air saturation with water vapours (absolute and relative humidity), diurnal fluctuations of humidity;
- average and extreme amount of falls (rain, snow), duration of falls, their emission by intensity and monthly wind roses bringing the falls;
- average and maximal values of repeatability and duration of fogs, smogs, thunderstorms, snowstorms, hail, glaze;
- average and extreme values of air temperature;
- average and extreme values of soil temperature on the surface and in standard depths;
- average and extreme values of the atmospheric pressure;
- pollution, dustiness and corrosive activity of the atmosphere;
- chemical composition of on-land and underground water resources, description of ability of surface layers to disperse, dissolve or concentrate waste;
- yearly estimates of the probability of hazardous hydrological and meteorological phenomena;
- aerological conditions (repeatability of wind directions, average wind speeds in 16 rhumbs at the altitudes of 100 m and 200 m, average values of the vertical temperature gradient in the layers 0- 300, 0-600 and 0-900 m, repeatability and average values of strength and intensity of ground surface inversions, repeatability and average values of strength and intensity of raised inversions in the 0-2 km layer, stability of atmosphere, atmospheric dispersion of impurities).

8.3.2 Meteorological and hydrological conditions

This subsection shall provide the results of analysis of meteorological and hydrological conditions at the NPP site of location, including:

- determining the list of hydro-meteorological and processes and phenomena;
- well-founded conclusion on the presence or absence of various processes and phenomena at the NPP site.

The information shall be provided separately for each process and phenomenon. The conclusions on the intensity and frequency of processes and phenomena shall be supported by the proof in the form of description of the results of special surveys, calculations and analyses of statistical data.

8.3.3 The basic data for determining quantitative and probabalistic characteristics and parameters of hydro-meteorological processes and phenomena

This subsection shall contain the list of materials according to which quantitative-probabalistic characteristics and parameters of hydro-meteorological impacts have been determined, further named “the basic parameters”, obtained as the result of study and survey aimed at finding and collection of statistical data on hydro-meteorological processes and phenomena taken into account for compiling of the full list of external impacts from hydro-meteorological processes and phenomena expected in the NPP area of construction, in particular

- historical data obtained from annals, archives, photographs and newspapers;
- eyewitnesses information;
- climatic topographic, geological engineering maps;
- systematic data collected, as a minimum, within a year in the area around the site the dimensions of which are sufficient for account of all peculiarities of the territory, and the factors affecting the climate of the given area;
- data of the measurements done in compliance with the standard programs of a hydrometeorologigal survey with the hourly frequency of measurements on the site;
- initial information used for determining the calculated parameters having the probabilistic nature of emission in a many years context (up to 50 years as recommended by IAEA) shall contain the lines of yearly values of the parameters as well as the data on the occurring maximum values obtained from the above specified sources of information;
- values of the calculated probabilities and parameters of impacts.

8.3.4 Methods of calculating characteristics and parameters of hydro-meteorological processes and phenomena

This subsection shall provide the methods of calculation of the basic parameters and characteristics as well as the loads on structures, units and systems caused by the following hydro-meteorological processes and phenomena (items 8.3.4.1-8.3.4.5).

8.3.4.1 Wind

Provide the calculation of wind speed, the intervals of its repetition, the vertical speed cross sections and the gust coefficient.

Provide the descriptions of the methods applied for the transformation of the wind speed into effective pressure on the wind exposed surfaces of structures, the results of calculation of wind loads, the applied coefficients of the forms of structures wobbling, the emission of wind pressure over the height of structures.

8.3.4.2 Whirlwind

It is necessary to provide the initial data for calculation of the loads caused by a whirlwind:

- speed of progressive motion;
- tangential speed;
- pressure drop and the corresponding time intervals;
- the characteristics of fragments and flying objects caused by a whirlwind. Provide description of the methods applied:
- hurricane wind transformation into effective pressure on the surface of structures;
- the transformation of the drop of pressure caused by whirlwind into effective reduced pressure, if structures ventilation into the atmosphere is used;
- the transformation of the loads from the hurricane caused fragments, which are considered dynamic impact loads, into effective loads.

Provide information on the shape factor and pressure emission over flat surfaces and round structures of the NPP containment type and the combination of the above-specified loads with singling out of those, which will lead to the most unfavourable cumulative effect of whirlwind on the power installation structures.

8.3.4.3 Extreme snowfalls and snow deposits

Provide the substantiation of extreme height of snow cover on a horizontal surface.

Provide the schemes of snow load emission and the coefficients of transition from the snow mass load to the snow load on the cover.

8.3.4.4 Glaze

Provide the calculation of the normative value of linear glaze load for circular cross-section elements.

Provide the calculation of the normative value of linear glaze load for other elements.

8.3.4.5 Air temperature

The following information shall be provided:

- the calculation of the average temperature change in time and the temperature gradient over an element cross-section in the warm and cold seasons of the year;
- the calculation of the average diurnal outside air temperatures in the warm and

cold seasons of the year;

- the calculation of temperature rise;
- the calculation of initial temperature relevant to a structure or its part closure into a finished system in the warm and cold seasons of the year;

8.3.4.6 Flood

8.3.4.7 Extreme amounts of falls

8.3.4.8 Ice phenomena on water passages (obstructions, jams)

8.3.4.9 Water resources changing (extremely low runoff, abnormal water level drop)

Consider subsections 8.3.4.6 - 8.3.4.9 from the point of view of the water level rise or drop on the site, at that:

- it is necessary to substantiate the possibility of flooding based on the water level calculation at flood and (or) ground water level rise;
- provide calculations for the high level, peak water consumption caused by falls, floods, ice
jams, natural or man-made water reservoirs breakthrough;
- provide calculations of the possible water level drop caused by severe drought, ice jams, set-down and other phenomena;
- out of all studied events, it is necessary to single out those taken into account in the NPP project design and provide the characteristics of their impact the NPP structures and systems;
- provide calculation of the loads derived by those impacts on the structures that shall be designed for those impacts.

8.4 Geological, hydrogeological, seismo-tectonic and engineering-geological conditions

This subsection shall provide the necessary and sufficient for substantiation of the NPP safety results of engineering survey (geological topography based) as well as those of study of seismo-tectonic conditions of the area of the NPP construction, other HGP (karst, subsidence, off- motions of shores, slopes and riverbeds, underground washout, cryogenic processes, dips, shrinks, territory flooding) and their combinations. Apart from that, it is necessary to provide the forecasts of those unfavourable changes in the geological, hydrogeological and seismic conditions, which may become activated during the periods of construction, operation, decommissioning and conservation of the NPP.

8.4.1The basic data for analysis of geological, hydrogeological, seismo-tectonic and engineering-geological conditions on a nuclear power plant site

This subsection shall provide the list of materials (further – basic materials) developed as the result of surveys and studies in the area with the purpose of finding the geological, hydrogeological, seismo-tectonic and engineering geological conditions at the NPP site.

8.4.2 Results of analysis of geological, hydrogeological, seismo-tectonic and engineering-geological conditions

This subsection shall provide the results of analysis of the basic materials presented in item 8.4.1 with the conclusion on the presence or absence of HGP at the NPP site, determination of their quantitative and probabilistic characteristics and parameters, which shall be taken into account when designing the NPP.

For each specific kind of processes and phenomena, the information shall be presented separately in the following order:

- disruptive seismo-tectonic shifts, seismic dislocations, seismo-tectonic rise, earth outer crust blocks sink;
- current differentiated earth crust movements, including tectonic creep;
- a residual seismic deformation of earth crust;
- earthquakes of any genesis;
- washout of shores, slopes and riverbeds;
- dips and shrinks of territory;
- underground washouts, including karst exposure;

- the deformation of specific grounds.

It is necessary to consider separately the possible associations of interacting and mutually dependent processes and phenomena of natural and technogenic origin.

The conclusions on the classification of processes and phenomena by the extent of hazard, their intensity and frequency of occurrence shall be supported by proofs in the form descriptions, graphic materials (profiles, plane views, cross-sectional views, drillhole posts, maps and photographs), the results of their analysis as well as special field or laboratory studies, laboratory analyses.

8.4.2.1 The information to be provided for the construction area:

- an analysis of the archival and library materials;
- mapping schemes and archives in the scale of 1:100000 - 1:500000 of the geological, tectonic, the latest and current movements, including the seismo-tectonic map or the map of geological criteria of seismicity, the map of detailed seismic zoning, schematic map of areas of possible sources of earthquakes with an indication of the expected maximum magnitude and its repeatability, the map of earthquake seat effective depth in each zone; historical information on earthquakes, other geological and engineering geological events;
- the description of lithology and stratigraphy of the area, composition and thickness of quaternary deposits, structure and depth of crystalline basement;
- schematic maps of zoning by the extent of hazard of development of exogenous geological processes;
- the data: depth of frost penetration and thickness of the active layer, landslides, subsidence and cave- in, karst and gully formations; possible ground movements caused by extraction of gas, liquid and solid natural resources and resulted by technogenic loads on the Earth surface (water reservoirs, dense multi-storey building areas, seismic explosions in quarries etc.); the observed subsidence and heeling of buildings and structures; results of geodetic surveys of the current earth crust movements;
- hydrogeological conditions data: depth and variation of ground water levels; aquifers connections between themselves and surface water; areas of recharge and discharge of aquifers;

assessment of hydrogeological dispersion in ground water. The hydrogeological maps shall bear the data on the ground water depth and level with the 10% rate of supply and seasonal variations of the level, direction and speed of the flow as well as the coefficient of soil filtration in various layers of the section;

- the results of microseismic and instrumental seismic studies in the area;
- the description of the ground types, their positioning at the NPP site;
- geological and geophysical profiles and structural diagrams of the key reference levels to the depth of the first hundreds of meters in the scale of: 1:100000 - 1:500000 horizontally, 1:5000 - 1:20000 vertically (for the construction part: 1:20000 - 1:50000 horizontally, 1:1000 - 1:5000 vertically);
- decripted aerial and space satellite photographs;
- the results of high-precision repeated geodetic measurements of the current earth crust movements.

8.4.2.2 As for the NPP construction site, it is necessary to provide the maps of the site engineering- geological zoning and seismic micro-zoning with drawing on them of geological sections, key wells and the basic facilities from the master plan (horizontal scale - 1:2000 - 1:10000, vertical scale - 1:200 -1:1000), as well the engineering-geological sections, strip logs drilled on the site in the locations of key structures, and additional sections built along the lines of axes of key structures (horizontal scale - 1:500 - 1:2000, vertical scale 1:50 - 1:200).

It is necessary to highlight and describe all the layers on those sections (engineering geological elements), provide the normative, physical and mechanical characteristics and dynamic properties of soils in the natural and water-saturated states, as for permafrost grounds – those in the natural and thawed state under dynamic impacts and the static impact of the mass of structures. It is necessary to specify the presence in the section of unstable soils with unstable connections and properties.

The recommendations on improving the soils properties shall be provided in this section.

8.4.2.3 To describe the site seismo-tectonic conditions, it is necessary to provide:

- the grade for the medium category of soils according to the MSK-64 scale;

- MCE and DBE for the specific site locations with the account of technogenic changes (the territory layout, melioration, underflooding etc);
- Calculated accelerograms and generalized spectra of soil reaction in graphic and digital form with a given probability
-

8.4.3 Methods and techniques of identifying geological and engineering-geological processes and phenomena and determining the characteristics of soil and groundwater

8.4.3.1 This subsection shall provide description of methods and techniques, instruments and testing equipment for;

- seismic prospecting, electrical prospecting and other geological and physical studies of

the NPP site stipulated by the regulations for detection of engineering-geological and geological processes, phenomena and factors;

- analysis of physical and mechanical properties of soils, specific properties of subcident, swelling, fluid and very soft soils, weak and permafrost soils in each of the layers of the explored thickness of the upper part of geological section down to the depth of not less than 120 m, chemical composition of the underground waters.

8.4.3.2 It is necessary to provide proving the exactness of the obtained information specifications of accuracy of the instruments, techniques and methods applied for geological, geophysical and laboratory studies of the area of location, settlement area and the site in order to supplement, clarify and specify the data on engineering-geological and seismic microzoning of the site chosen for the NPP location.

8.4.4 Methods of forecasting the characteristics and parameters of factors and processes

This subsection shall provide information on the methods applied in forecasting the characteristics and parameters of factors and processes, substantiating the credibility of the methods applied.

8.5 Nuclear power plant impact on the environment and population

8.5.1 This NPP SAR subsection shall provide information on the area of the NPP site location necessary for assessment of the NPP impact on the environment. The key information to be placed in this subsection are the data on the impact of radioactive, chemical and thermodynamic pollution on the environment, as well as the concentration of radioactive products getting in human organism.

8.5.2 The provided information shall include the following data:

- the natural radioactivity of the area;
- the routes of agricultural products sales;
- demographic data;
- the radioactive contamination of natural environment;
- the pollution of natural environment by chemical products;
- the violation of thermal regime of natural environment;
- critical ways of radioactive and chemical product penetration into human organism.

8.5.3 This subsection shall provide assessment of:

- possible consequences of radionuclides discharge into the atmosphere;
- possible consequences of radionuclides discharge into surface and ground water;
- methods of natural environment and agricultural lands survey in the NPP location area;
- methods of determining the “zero background” of radiation in the NPP location area;
- transboundary impact on the environment at NPP normal operation.

8.6 Survey programs

8.6.1 List of programs

This NPP SAR subsection shall list the following programs of survey of natural phenomena for the period of designing, construction and operation of the NPP:

- current movements of earth crust;

- vertical and horizontal shifts of earth surface in the areas of expected earthquake and dangerous tectonic creep as well as on unstable slopes and the basements of key structures – geodetic monitoring;
- seismic phenomena (natural and caused by seismicity and explosions seismics) – seismic monitoring;
- ground water dynamics;
- surface water dynamics (hydrology);
- meteorological survey;
- for soils: hazardous changes of ground water level, humidity, density, bearing capacity of soils – geotechnical monitoring;
- other natural phenomena in the area of the site location, for example, landslide phenomena, formation of karst sinkholes etc.

It is necessary to present the programs of these surveys with a list of the kinds of surveys.

8.6.2 Survey programs description

It is necessary to provide description of each program of survey on the site during the pre-commissioning and operating periods from the listing given in 8.6.1, including:

- lists of surveyed processes, phenomena and factors and the kinds of surveys;
- positioning and marking of places of measurement;
- industrial measurements;
- brief description measurement methods and specifications of instruments and testing facilities (references are allowed to item 8.4.3);
- registration systems and their positioning;
- information analysis procedure;
- reporting forms.

8.7 Assuring life activity of the in-plant personnel and population in the area of the nuclear power plant location and their evacuation under emergency impact

This SAR NPP section shall provide the results of analysis of emergency situations at the NPP and in the NPP area of location caused by severe earthquakes and other extreme external impacts and their combinations as well as planning of actions in cases of these emergency situations. It is necessary to provide description of organizational and engineering measures for assurance of safety of escape routes, including consideration of the cases of damage of transport communications, airfields, bridges and tunnels resulted by fractures, dips, overthrusts and other deformations of surface.

In conclusion, it is necessary to provide recommendations on the possibility of use of the existing approach ways in emergency situations, the necessity of relocation or reconstruction of roads, bridges etc., construction of new transport ways taking into account the possibility of approach to the NPP along three-four directions.

8.8 Summary table with the list of external impacts on a nuclear power plant site

This section shall contain a summary table with a list of external impacts at the NPP location site selected for consideration in the project design, including:

- characteristics and parameters of impacts of technogenic origin obtained as the result of calculations and analyses provided in item 8.2;
- characteristics and parameters of hydro-meteorological processes and phenomena obtained as the result of calculations and analyses provided in item 8.3;
- characteristics and parameters of geological, hydrogeological, seismo-tectonic and engineering-geological factors and processes, as well as discovered and expected in the process of operation physical and mechanical properties of soils, taking into account the possible hazardous processes and phenomena.

An example of the summary table columns is given in Table 2.

In Column 1, all processes, phenomena and factors of external impacts of natural and technogenic origin mentioned in the previous SAR NPP sections are registered.

Apart from that, it is necessary to form in this section the list of initiating events that shall be taken into consideration while planning for the event of emergency situations.

Table 2 – Summary table with the list of external impacts on a nuclear power plant site

Process, phenomenon, factor	Hazard source, genesis of process, phenomenon or factor	Absence on the site or degree of danger	Frequency of occurrence	Quantitative values of impacts parameters and characteristics	Additional information
1	2	3	4	5	6

8.9 Documenting data on the conditions of a nuclear power plant location

This section shall be made in the form of supplement to the NPP SAR section "Nuclear power plant general description" and contain the NPP master plan, a set of maps, schematic diagrams, tables, graphs and other necessary cartographic and text materials describing the conditions of the NPP location with regard to the presence on the site of processes, phenomena and factors of natural and technogenic origin affecting the NPP.

It is recommended to document the key information on the conditions of the NPP location according to the form provided in Supplement B. The preparation of the supplement shall be started at the stage of compiling the NPP SAR and shall be updated every 10 years

9. General provisions and approaches to designing buildings, structures, systems and elements

9.1. The basic normative criteria and principles of designing buildings, structures, systems and elements

9.1.1 List of the main applied technical normative legal acts

A list of TNLA in the field of nuclear energy use, regulating safety requirements in generation and use of nuclear energy, management of nuclear materials, radioactive substances and nuclear-based products, shall be provided in this section of NPP SAR.

9.1.2 Assessment of compliance with the requirements

Basic principles and criteria of safety assurance at the NPP shall be provided in this SAR NPP subsection, as well as the ways of their implementation, pursuant to the requirements of TCP 170, including:

- following the safety culture principle, assurance of safety priority in the designing process (4.12);
- - It is necessary to show how the operating organization assures the responsibility for the NPP safety of NPP (4.13, 4.14);it is necessary to show the compliance with the principle of in-depth protection in the form of application of barriers system on the way of emission of ionizing radiation and radioactive materials into the atmosphere and implementation of technical and organizational measures system, including the measures accidents management (4.4–4.8, 4.16–4.22);
- it is necessary to show how testing in practice through experience, studies, corresponding of the design to the requirements (4.9);
- it is necessary to show how the quality on each phase of the NPP lifecycle is provided (4.10, 4.11, 4.15);
- it is necessary to show the approach to considering the human factor in order to exclude errors or mitigate their consequences, connected with the activity of NPP personnel, including those arising in the course of technical maintenance (7.1.9);
- it is necessary to show the measures assuring non-exceedance of the established standards on emissions and discharges of radioactive materials into the atmosphere (4.2);
- it is necessary to show the measures for fire protection assurance (4.29);
- To provide organizational resolutions with regard to physical protection (4.29).

9.1.3. Deviations made, their substantiation and compensation measures taken

In this Subsection of NPP SAR a list of deviations from requirements of technical code of common practice 170, assessment of these deviations and taken compensatory measures shall be stated, as well as the reference to the section of the NPP SAR, where the safety with regard to these deviations is thoroughly grounded.

9.2 Applied classification of structures, systems and elements

9.2.1 Classification of structures, systems and elements by impact on safety.

In this section the information on classification of systems and elements that are of importance for safety, pursuant to the requirements of section 5 of the technical code of common practice, is provided.

The results shall be presented in the form of table 3 using the identification marks, provided in 5.12–5.15 of TCP 170.

If pursuant to the TCP 170, the system is not the system, influencing safety, the elements, included into such system, shall be assigned with class 4 and this result is recorded in the table 4.

9.2.2 Classification of equipment and pipelines by quality groups.

The information on classification of elements, important for safety, by quality groups, pursuant to the established requirements of the Rules and Standards of Atomic Energy Industry G-7-008-89 to the design and safe operation of equipment and pipelines of nuclear power installations.

The results shall be recorded into table 3 using the identification marks, provided by the requirements of the Rules and Standards of Atomic Energy Industry G-7-008-89.

9.2.3. Classification by seismic stability

In this subsection the information on classification of elements by seismic resistance, performed pursuant to the requirements of Rules and Regulations for Nuclear Power Industry-5.6 shall be provided. Identification marks for categories (subcategories) of seismic resistance shall be stated correspondingly for the elements that are of importance for safety in table 3, and for the elements having no influence on safety in table 4.

9.2.3 The list of structures, systems and elements subject to analysis for stability against external impact of natural and technogenic origin

In tables 3 and 4 correspondingly, it is necessary to show the necessity of analysis of resistance against external influence of natural and industrial character of the relevant structures, systems and elements. In case of necessity of analysis, letters EN (external natural) and (or) EI (external industrial) are put in the tables, if there is no such necessity, a dash is put in the table.

Table 3 – The list of the NPP safety critical structures, systems and elements.

Structure, system and elemen	Structure, system and element	ystem function	Safety class	uality gr	Category (subcategory) of seismic	Account of natural and industrial origin
1	2		4		6	7

Table 4 – The list of the NPP structures, systems and elements having no impact on safety and their classification

Structure, system and element	Structure, system and element	Safety class	Quality	Category (subcategory) of seismic	Account of natural and industrial origin impacts
1	2	3	4	5	6

Note – Data in column 6 of table 4 and in column 7 of table 3 shall result from the analysis performed in 9.4.

9.3 Description and substantiation of layout solutions on a nuclear power plant site.

In this subsection the NPP general layout shall be presented, as well as its description and substantiation of territorial positioning of structures and buildings from the standpoint of NPP operability assurance in all modes and under all extreme impacts laid down in the project design.

In the NPP general layout they shall present the location of water supply and communication channels, as well as other links, that are of importance for safety, approach roads, water supply facilities, open emission devices, ground and underground storages of diesel fuel and oil, transformer platforms, storages of flammable and explosive materials, pressure vessels.

In the subsection they shall present the description and substantiation of parameters and engineering and technical solutions for such basic constructions as:

- the reactor installation, including the containment;
- the engine compartment;
- the special building;
- SDEEPGS;
- process water pumping facility;
- PUCB and RCB;
- PHRAS;
- the location of inlet and outlet channels (circulation, cable and other SCS communications);
- the sprinkling basin or the cooling tower;
- RAW storage facility or warehouse;
- the demineralized water storage tank;
- core cooling tanks (passive systems);
- the main NPP building foundation plate and other SS structures;
- the fire elimination pumping facility;
- accident management center;
- civil defense facilities;
- buildings, structures and the NPP enclosure relating to the NPP physical protection.

Listed in this subsection shall be also the systems of normal operation, that are of importance for safety, situated in these buildings and structures and circumstances that could arise out of the damage of these buildings and structures.

This subsection shall contain description of the NPP fire prevention measures.

9.4 Probable scenarios of the consequences of occurrence of initiating events of natural and technogenic origin on a nuclear power plant site

The results of study and qualitative analysis of possible consequences of implementation of the initiating events on the nuclear power plant site shall be stated in this subsection of NPP SAR, the reasons of which could be as follows:

- external impact of natural or industrial origin, arising out of the environment, including the results of district development and other activities (section 8);
- impact caused by accidents at the NPP site (9.5).

At that, all possible primary and secondary effects shall as well be considered.

Not just the buildings and structures classified as structures of the first, second and third safety classes shall be considered, but also those buildings and structures, the damage of which could be the source of secondary impact defects. The constructions for analysis of resistance shall include the cable and pipelines laying channels, waste storage facilities, exhaust stacks, water extraction installations, pumping facilities, water extraction wells, cooling towers, concrete quay piers, wharfs, tunnels etc.

While considering the possible scenarios, the master plan and the information provided in section 7, subsections 9.2 and 9.5 of the present technical code shall be used.

Describing the NPP master plan, they shall list all possible sources of accidents, initiating events on the site that could result in mechanical, radioactive, thermal, chemical or corrosive impacts on the containment or other buildings and structures. For the sources shall be considered all buildings and structures, communications, auxiliary structures, where dangerous technological processes are taking place, explosive, inflammable and toxic substances (gases, aerosols) and materials being transported, exploited or stored. For their elimination from consideration they shall presented their safety proofs, including those in the context of external impact of natural and technological origin, defined in the section 8 of the present technical code. For each emergency under consideration shall be provided the list of possible additional factors, arising out of emergency, that could influence NPP safety.

While analyzing object safety in the context of external impact it is required to follow by the scheme, provided in the annex B. For due analysis of consequences at the NPP arising out of internal impact this analysis scheme shall also be applicable.

For convenience, the results of the analysis shall be presented in the form of a table.

Table 5 – The results of the consideration and analysis of possible consequences of the implementation of initiating events on NPP site

Initiating event	Primary impacts on NNP	Secondary impacts on NNP	The list of systems and elements that may be influenced	Mark on the necessity of quantitative analysis of impact consequences
	2	3	4	5
I External impact				
1.1 Earthquake of any origin	Base vibration and deformation	Damage of buildings and structures: 1. flying objects 2. others	All systems pursuant to the classifications by categories of seismic resistance c	Yes
II Internal impact, caused by emergencies at the NPP site				
2.1 Damage of receivers with hydrogen	Explosion: 1. ABW 2. flying objects 3. fire 4. others	Damages of buildings and structures: 1 Main building 2 Turbine island 3 Communication lines	1 Main Circulation Circuit 2 others	Yes
2.2 Others				

III Internal impact, caused by emergencies within the limits of NPI that is internal towards NPP containment

3.1 Fire in the machinery building	Fire load	Explosion: 1. ABW 2. flying objects	1. Protective vessel 2. Pipelines 2.1. Feed water	Yes
3.2 Etc.				
IV Internal impact, caused by emergencies inside the containment				
4.1		Explosion: 1 ABW 2 flying objects		
4.2 Etc.				

If in the column 4 there are systems, important for safety, the column 5 shall be marked with “Yes”. In accordance with the mark in the column 5, the results of qualitative assessment of possible consequences, parameters of impact on systems and elements and indicators of resistance to the impacts of systems and elements shall be presented in NPP SAR in the corresponding subsections and subsections.

9.5 Parameters of the impact caused by emergency situations occurring on a nuclear power plant site

9.5.1 Impact caused by emergency situations on a nuclear power plant site outside the main building

9.5.1.1 While examining mechanical and thermodynamical impacts it is required to examine kind of impacts that are listed below, resulting from accidents:

a) ABWs.

The description and analysis of possible sources and causes of explosions resulting from destruction of vessels operating under pressure, containers with liquefied and compressed gas, fires and explosions in storages of fuel and lubrication materials and so on shall be provided. If in such cases there is a possibility of ABWs, it is required to provide design parameters, applied as the source ones while assessing the impact of ABWs. It is required to provide the descriptions of methods applied for transforming the parameters of ABW into effective loads on constructions and buildings (the references to the corresponding subsections of the Subsection 8 are allowed).

At least, the following information shall be contained:

- Methods for transforming the ABW parameters into effective pressure on buildings and structures surfaces;
- Methods for assessment of dynamic loads resulting from flying objects, caused by ABW.

Proofs for the efficiency of preventive and protective measures shall be presented here or in the respective subsections.

b) Flying objects.

The possibility of flying objects occurrence resulting from emergencies shall be analyzed.

They shall consider about the flying objects that appear by the destruction of the equipment under pressure, having rotating elements, as a result of exceeding the speed of rotation or by high pressure subsystem accident.

For certain flying objects they shall determine dimensions, weight, energy, speed and other parameters, required for defining its penetrating power. Foundation for determining certain flying objects shall also be provided. They shall consider about the flying objects that may appear by the destruction of buildings, constructions, storages with materials, warehouses with liquefied and compressed gas, pipelines and other equipment, placed at the NPP site. The target areas of possible hitting of flying objects shall be distinctly shown on the plans and vertical sections of buildings and structures.

The descriptions of mathematic models, applied for the analysis of flying objects occurrence and determining their characteristics and flight lines.

c) Dynamic impacts, arising out of pipelines rupture.

It is required to provide the description and classification of all possible impacts on constructions, systems and NPP equipment, arising out of pipelines rupture:

- It is required to provide schemes of pipeline route diagrams of high and medium pressure specifying the systems, equipment and constructions that are of importance for safety, disposed near pipeline network.

If the accidents of the pipelines of high and medium pressure result in vapor breakthrough on the nearest constructions that are of importance for safety, in other buildings and bays of the building, the analysis of impact of vapor on the operation of equipment, construction, systems suffering from it shall be provided and maximum permissible conditions, allowing their further operation, shall be determined;

- Points of rupture of pipelines of high and medium pressure, for which enclosure or safe placement could not be applied, shall be stated, and the place of application of arising loads on the equipment, constructions and other systems and elements shall be determined. The criteria of determining points of rupture and leakages in pipelines shall be provided.

Provide the analysis of possibility of occurring and influence from the side of the secondary flying objects in such systems.

Provide the routes diagrams of all pipelines, that are supposed to be protected without external support due to their location;

- Provide the description of methods, applied for determining forcing functions, required for dynamic analysis of pipeline whip due to their partial or full rupture.

The description shall include the direction, thrust coefficients, ramp time, magnitude, time length and initial terms, which sufficiently characterize jet stream dynamics and pressure difference in the system.

Show the influence of damping devices, if any, on dynamic behavior of the pipelines.

Present mathematic models, applied for the dynamic analysis of response reactions, and to justify all dynamics coefficients applied in the assessment;

- Present methods, applied for the assessment of shock impact and load, resulting from the pipeline rupture or air leakage, on the systems and the equipment. Additionally, they shall implement methods on checking durability of the equipment under pressure resulting from the pipelines rupture.

In case there are some boundaries of pipeline whip (dampers) the description of typical boundary, applied in the system shall be made as well as the combination of loads and criteria of boundary assessment;

- It is required to perform description of protective aggregates or protective pipes (devises for restriction of pressure boost in the space between the pipeline and containment penetration piping) that shall be applied in the pipe penetration through the containment;

- perform description of the ways to place the inspection ports and access to them for providing periodical checking all welded joints of the pipelines, as required by technical testing program in the period of implementation of construction operations.

9.5.1.2 With regard to the chemical compound and pH resultant in the environment in the pipelines that are under potential risk of destruction, analysis of chemical and corrosion impact shall be performed. For potential emergencies reactions of interaction of the environment and its vapors with the equipment metal, concrete, plastic and isolation covers, paints shall be considered, as well as the products of such interactions from the point of view of their toxicity, flammability, explosiveness, chemical and corrosion activity shall be assessed. Based on these assessments, the levels of corrosive damage of the equipment material, important for safety, and its structural components shall be determined and it is required to demonstrate that these levels do not exceed threshold limit values.

9.5.1.3 With regard to the impact of toxic gases and aerosols, analysis of potential toxic gases and aerosols emission into the atmosphere as a result of emergency shall be performed. Provide the methods of assessment and toxicity indicators level values for these emergencies. Analyze the possibility of gases and aerosols entry into the premises and to assess their impact on personnel safety.

9.5.1.4 For radiation exposure shall be determined the radiation intensity as well as the parameters of dissemination of radionuclides into the atmosphere, surface and ground waters, if as a result of emergencies at the NPP site there are possibility of destruction of buildings and (or) constructions containing radioactive materials. It is required to analyze the radioactive resistance of the systems and elements that could be influenced by a radioactive impact, as well as the impact of safety of NPP personnel, population and environment.

9.5.1.5 With regard to fire load it is required to provide the methods of its formation and define the combination of loads it could be involved in. It shall be stated, with regard to which constructions the coefficients of safety margin shall be founded with due regard to the fire loads. The results of the consideration and analysis shall be presented in the corresponding subsections of the safety report on Nuclear Power Plant (NPP)

9.5.2 Impact caused by emergency situations within the main building outside the containment

9.5.2.1 Mechanical and thermodynamic impacts.

Information with regard to the ABWs, described in the subsection, shall be provided to the extent not less than the one, listed in a) 9.5.1.1.

Information with regard to the flying objects, provided in this subsection, shall be provided to the extent not less than the one, listed in b) 9.5.1.

While providing information about flying objects, occurred by the destruction of turbines, the references to the materials of section 12 are allowed. The following information shall be provided:

- Location and orientation of the turbine shall be demonstrated on the drawings (schemes) of placement of electric power plant;
- On the scheme and vertical section of the machinery room shall be demonstrated the projectile drop out areas with dimensions +/– 25 degrees with regard to the cylinder crowns of law pressure for each turbine;
- Places of potential flying objects collapse (target areas) shall be demonstrated on the scheme and vertical sections with regard to each system of normal operation, important for safety;
- Characteristics of flying objects shall be presented. A description of the potential flying objects, formed by the destruction of the turbines shall include such characteristics as their weight, shape, cross-sectional area, turbine speed of destruction, as well as critical angles of flying objects fight, formed by the destruction of the turbine;
- The description of the mathematical models applied by the analysis of the formation of flying objects, turbine engine breakthrough and the track of flying objects shall be provided;
- It is required to analyze the probability of intrusion of flying objects into power generation system installations and to provide a brief description of the calculation methods.

All the assumptions applied by the analysis and validation the original data on which these assumptions are based shall be stated.

The numerical results of the analysis shall be presented in tables indicating the possibility of collision with flying objects for each relevant section of the equipment under consideration.

The probability of collapse from the side of each turbine installation (including those not connected with nuclear power plants) both on the site and in its surroundings shall be considered.

The table shall also include the total collapse probabilities that are related to a common area of injury to vital systems for each turbine installation.

In case of destruction of the turbine due to exceeding of speed, it is required to provide the analysis based on the assumption of failure of just one disk.

By assessing the probability of the second disk failure due to the destruction caused by the accident of the first disk, the characteristics of the acceleration of the turbine by exceeding of speed, the statistical emission of speeds of the emergency turbine destruction and other information relating to the matter shall be considered.

The information in the subsection dealing with the dynamic effects arising out of the rupture of pipelines shall be provided to the extent not less than the one, listed in c) 9.5.1.1.

9.5.2.2 The information with regard to the chemical and corrosion impact shall be provided to the extent not less than the one, stated in the 9.5.1.2.

9.5.2.3 The information in the subsection dealing with the toxic gases and aerosols impact shall be provided to the extent not less than the one, stated in 9.5.1.3.

9.5.2.4 The information in the subsection dealing with the radioactive impact shall be provided to the extent not less than the one, stated in 9.5.1.4.

9.5.2.5 The information in the subsection dealing with fire load shall be provided to the extent not less than the one, stated in 9.5.1.5.

9.5.3 Impact caused by emergency situations within the containment

9.5.3.1 Mechanical and thermodynamic impacts

The information about the ABWs, provided in the subsection, shall be provided to the extent not less than the one, listed in a) 9.5.1.1.

The information about the flying objects, provided in the subsection, shall be provided to the extent not less than the one, listed in б) 9.5.1.1.

The information about the dynamic impacts, arising out of the pipelines rupture, provided in the subsection, shall be provided to the extent not less than the one, listed in c) 9.5.1.1.

Composing this section on the thermodynamic impacts (increase in pressure and temperature) allows the references to the materials of the section 21.

For justification of strength of systems and elements shall be performed tests of pressure and temperature increase by design and beyond design basis accidents, with due regard to humidity in the premises.

Maximum impacts on the construction fence and containment shall be demonstrated.

A description of methods applied for the structural analysis and the obtained results shall be provided.

Special regard and foundation shall be given to the influence of fuel melt on the other systems and support structures, as well as the way of melt retention.

9.5.3.2 The information about the chemical and corrosion impact, provided in the subsection, shall be provided to the extent not less than the one, stated in the 9.5.1.2.

9.5.3.3 The information about the toxic gases and aerosols impact, provided in the subsection, shall be provided to the extent not less than the one, stated in 9.5.1.3.

9.5.3.4 The information about the radioactive impact, provided in the subsection, shall be provided to the extent not less than the one, stated in 9.5.1.4.

9.5.3.5 The information about the fire load, provided in the subsection, shall be provided to the extent not less than the one, stated in 9.5.1.5.

9.6 Impacts emerging in normal operating conditions and transitional modes, their parameters

In this section they shall provide a list and analysis of all modes of operation of constructions, buildings, structures, including containment and NPP containment vessel:

- In NOC, including power variation transient modes, switching operations;
- By entering NPP into operation;
- By decommissioning NPP, as well as by other modes leading to additional loads on structures that are subject to consideration in the design process.

The number of cycles and the parameters of load variation, expected for the life cycle of each mode, with due substantiation of the given parameters shall be demonstrated. The sections of NPP SAR, containing the results of calculations regarding determination of the parameters of transient modes for systems and elements shall be stated. The exposure to the buildings, structures and constructions, their quantitative characteristics and parameters in the form in which they will be applied further shall be provided in the subsection for analysis.

9.7. Estimated combinations of load on structures, buildings and equipment of a nuclear power plant

In this section of NPP SAR it is required to describe the combination of loads from external impacts of natural and technogenic origin, arising from the environment, internal influences caused by emergencies at the NPP site and within the limits of main building (external or internal with respect to the containment) impacts, arising under normal operating conditions, including transient modes. It shall be demonstrated that the load combinations, chosen for assessment, are applied in accordance with the applicable technical regulations.

The following shall be provided:

- Design combinations of loads on NPP constructions, systems and elements of the first safety class;

- Design combinations of loads on NPP constructions, systems and elements of the second safety class;

- Design combinations of loads on NPP constructions, systems and elements of the third safety class;

They shall provide in the table form all types of loads on buildings, constructions and systems.

It is required to consider various combinations of the above-mentioned loads, which can lead to more adverse cumulative effects; to analyze the impact of the destructions of systems and elements not designed for the loads, listed in section 8 and 9.5 of the present technical code of the Load on Buildings and Constructions, where the systems important to safety are located.

The section shall indicate in what structures and buildings and for which grades shall be received floor accelerograms and response spectra for further analysis of resistance towards external influences of the equipment, pipelines and other elements.

9.8. Protection of the territory from dangerous geological processes

In this s ubsection it is required to provide a description and justification of measures for protection of the territory from dangerous geological processes that have to be taken pursuant to the requirements of technical regulations. It is necessary to submit the lists of design materials containing information about engineering measures for elimination, mitigation and monitoring of the development of dangerous geological processes, which are described in section 8 of the present technical code. It is necessary to provide an overview map of the design activities for the protection of the NPP territory, including measures to protect against flooding (flow regulation, removal of surface and groundwater), the consolidation of landslide tempted slopes, etc. Also they shall provide a proof of the adequacy of protective measures and characteristics modified because of external influences protection.

9.9. Protection from high water

In this section they shall describe the measures for the protection of structures, systems and elements, important for safety, from flooding. Thus, it is necessary:

- To describe the constructions, where important safety equipment is placed. It shall be specified, which inlets and passages, placed below the design level of the flood;
- To identify systems and elements, necessary to be protected from flood, to demonstrate the relationship between the flood levels and terms and conditions of their normal functioning;
- To describe the methods, which help to determine static and dynamic influences of the design basis flood and ground water (section 8) for important for safety structures, systems and elements. To identify systems and elements, important for NPP safety, that can function properly, being partially or completely flooded. For structures, systems and elements that may have suffer such influence, it is required to take into account the overall design of static and dynamic loads, including the potential hydrostatic load, matching the direction of wind loads, etc.
- In case of a necessity to protect the equipment from flood, it is recommended to describe the means of its supply (e.g. pumping drainage systems, dam gates, watertight doors, drainage systems). It is necessary to describe a protection providing resistance to

water due to the presence of cracks in the walls of buildings, elimination of water leaks and the effects of wind waves (including splashing). In the schemes of NPP constructions they shall specify individual cameras, cells and compartments, where the equipment, important for safety, is located, and that are natural barriers to their potential flood;

- To provide ways to protect from floods with assessment of time, necessary to ensure protection;
- To provide a description of the applied techniques and indicate time, required for complete shutdown and cooling down of nuclear reactor in conditions of flood, and to compare that time to the time required for compliance with the requirements of flood protection.

9.10 Methods of substantiation of stability of buildings, structures and operability of nuclear power plant systems and elements

In this section it is necessary to describe all applied methods for substantiation and providing durability of NPP buildings and structures in order to ensure their acceptability in estimations of buildings and NPP constructions in accordance with the classification by categories and types of impacts.

9.10.1 Buildings, structures, building structures and foundation

In this subsection of NPP SAR they shall provide the descriptions of methods of design basis justification of NPP buildings, structures, constructions and foundations with regard to:

- External impacts, described in the section 8;
- Impacts, caused by emergencies on NPP site, external in relation to the containment (9.5);
- Impacts listed in 9.6.

It is required to describe all the common methods and techniques as well as methods considering the specifics of buildings, structures and their elements (containments, sealed rooms, foundations, structures) or provide references to the relevant sections of NPP SAR, where they are set out in detail.

For all the above listed cases shall be formulated criteria of resistance (strength, tightness, fire resistance, earthquake resistance etc.). The relevant subsections of NPP SAR shall demonstrate that these requirements are met.

It is also necessary to demonstrate that the applied methods of justification of the resistance of NPP buildings, structures, constructions and foundations to the external actions correspond to the current developments of science and technology. By applying the simplified methods their suitability shall be proved. The same goes for line-spectral methods.

9.10.2 Hydrotechnical and geotechnical facilities, units and channels

It is required to describe the requirements for hydraulic and geotechnical structures, sites and channels in terms of their stability under static and dynamic loads for each type of effects and their possible combinations.

This subsection shall describe the methods and techniques applied for the analysis of stability with respect to each type of impacts and to selected design combinations of loads and provide the results of the analysis.

9.10.3. Software applied

This subsection shall provide a list of software, applied in justifying the resistance of NPP buildings and structures, including those with regard to external impacts.

The following information shall be provided for each program:

– A brief description of the purpose of the program;

– Estimation method implemented by the program;

– Basic assumptions and limitations imposed by the program on this class of problems;

– Information about the certification program;

– Verification of the results of the program by analytical and experimental methods.

9.10.4. Methods of bench testing and field observation of buildings, structures and constructions

If in line with the estimation methods of analyze of buildings and structures are applied model test methods, the section shall provide the following information:

- Criteria and applied modeling techniques;
- Description of the methodology of the benchmark tests with regard to buildings, constructions and structures;
- Stands description;
- Techniques and methods of determining dynamic characteristics of buildings, constructions and structures;
- Methods for setting and determining the level of impact loads;
- Criteria for determining buildings resistance according to the test results;
- Test methods for evaluating adequacy and accuracy of the results.

For a full-scale research of NPP buildings and structures they shall provide the following information:

- Description of methods and benchmark tests of constructions and structures;
- Methods of impact assignment;
- Criteria for the selection of points to record the reactions;
- Techniques and methods for the determination of dynamic characteristics of buildings, constructions and structures;
- Criteria for determining buildings resistance according to the test results;
- Equipment and devices;
- Ways of assessment research errors and reliability of the obtained results.

9.10.5 Stability criteria for nuclear power plant buildings and structures

There shall be provided a list of buildings and structures under consideration, and extreme limit states with specification of their values shall be set. Extreme limit states shall be considered as a performance criterion. This data shall be made in the form of tables. A typical form of the table is presented below.

Table 6 – Extreme limit states for buildings, structures and constructions

Name of buildings, structures and constructions	Extreme limit states		
	Name of values	Numerical value	Other values
1	2	3	4

9.11 Estimating the loads transferred to nuclear power plant equipment, pipelines, systems and elements by the outer and inner dynamic impacts through the building structures

This subsection requires describing the methods applied for defining of the loads on NPP system and elements in order to provide a more detailed analysis of their resistance to external and internal dynamic effects.

9.11.1 Initial data for dynamic calculations

In this Subsection shall be analyzed the approach to the NPP structures layout, for which the dynamic analysis is carried out, the possibility of separating structures into independent subsystems. The following information shall be provided for each structure:

– The main characteristics of the construction: the geometric dimensions; total weight; mass emission of the subsystems;

– Foundation slabs layout description (the structures having common foundation slab shall be stated);

– Mutual arrangement of individual foundations for assessment of their impact on the stress state of the grounds.

9.11.1.1 Accelerograms (seismic assessment).

A set of accelerograms applied by DBE and MCE for horizontal and vertical ground motion shall be provided.

Basic parameters: the maximum acceleration, the fundamental frequency, the effective duration of the accelerograms, amplitude rise and decrease time shall be determined.

All design accelerograms, selected from the available records of the earthquakes, occurred or obtained through known methods of synthesizing accelerograms by response modes, shall be accompanied with corresponding justification. It is necessary to specify the methods, to select the accelerograms for the calculations and to provide justification for their acceptability.

Maximum residual displacement shall be specified for accelerograms.

With respect to the accelerograms, selected for impact analysis they shall submit corresponding response spectra for different damping values used in the design of structures, systems and components. It is required to specify the frequency intervals, for which the spectral values were calculated.

Comparison of response spectra, obtained in free field on the surface of the ground, and at the level of buildings foundation, important for safety, with the design spectra shall be carried out for each value of damping used in the design of structures.

It shall be demonstrated that the design accelerograms are compatible with the calculated spectra of response in accordance with the requirement 9.11.1.2 of the present technical code.

It is necessary to describe the method of applying the selected set of accelerograms for systems and elements.

9.11.1.2 Response spectra (seismic assessment).

There shall be submitted spectra response, applied to justify the earthquake resistance of buildings and structures on the sites of placement of NPP buildings of the first seismic category, on the ground and at the level of the foundations of buildings.

Spectra response shall be provided for different attenuation coefficients by horizontal and vertical ground motion.

They shall indicate the sources based on which the choice of the calculated spectra response is made and justification of this choice shall be provided.

The description of the method of applying the design spectra by dynamic response analysis shall be provided.

9.11.1.3 Ground modeling.

It is required to describe the grounds based on each structure of the first seismic category. The description shall contain the depth of foundation immersion, the basic geometric dimensions of the foundation, the soil thickness over bedrock, the characteristics of the soil strata, total weight of the structure. Describe mathematical model of the soil applied by further dynamic assessments. In case a multi-layer base model with underlying half-space is applied, they shall specify the following characteristics for each layer of soil: the speed of the shear wave, relative weight, the thickness of the layers, the Poisson's ratio and damping.

The information shall be provided to the extent necessary to assess the interaction between ground and structures using finite element method or the method of equivalent elasticity.

9.11.1.4 Attenuation coefficients.

The data and justification of attenuation coefficients for the grounds, as well as for the structures, important for safety, and their internal structures shall be provided, including the description of the ways and methods for determining damping coefficients or indication of the sources, on the basis of which the choice of the attenuation coefficients is made.

9.11.2 Structure dynamic behavior analysis methods

This section of NPP SAR shall provide a description of the methods applied for analysis of the dynamic behavior of buildings and structures of the first seismic category. Furthermore, the section shall include special information listed in the following subsections.

9.11.2.1 Methods of analysis.

The description of typical mathematical models, applied by the calculation of oscillation properties of buildings and structures of the first seismic category, specifying the characteristics, applied by modeling shall be provided. It is necessary to provide justification for the choice of a particular model.

The method applied by the analysis of seismic resistance for determining the maximum relative displacement of supports shall be demonstrated.

If a modal analysis method is applied, they shall provide the criteria for the selection of fundamental forms sufficient for analysis.

In addition, it is necessary to demonstrate other important factors that are taken into account in the analysis of seismic resistance (e.g., hydrodynamic effects and non-linear characteristics).

9.11.2.2 Modeling techniques.

It is necessary to introduce criteria and methods applied in the assessment schemes in the framework of the chosen model.

With regard to all structures of the first seismic category, they shall provide a description of the assessment schemes, applied for determination of their dynamic characteristics. The choice of the specific design schemes shall be justified. In case by the calculations for various external influences have been applied different models or design construction schemes, it is required to provide a description of each one. The comparison of the results obtained for the various construction models (schemes) shall be performed.

With regard to each structure, it is necessary to provide basic obtained dynamic characteristics. If for the calculations a modal analysis has been applied, then for every mode the following information shall be provided: frequency, modal mass, modal damping. It is necessary to assess the results of the error introduced by the truncation of the modes quantity, applied in the calculations.

It is necessary to introduce dynamic characteristics of the structures, obtained for ground-based schemes and for the ones with fixed base. It is necessary to assess the impact of the effects of the interaction between the ground and the construction on basic dynamic characteristics.

It is required to demonstrate the peculiarities of the construction modeling by the calculation of their dynamic characteristics separately for each dynamic effect.

It is necessary to provide the criteria and source data, required for defining the necessity of examination of the assembly either as part of the system under analysis or as an independent subsystem.

9.11.2.3 The interaction of the ground and structures.

They shall provide a description of the assessment methods of interaction of the ground and structures, as well as justification of application of such methods.

By application of the equivalent elasticity method they shall include the description of methods of receipt of the parameters, applied by the analysis. In addition, they shall provide the methods through which the analysis account for ground layers stress-strain properties, attitude of strata and soil modification. It is necessary to justify the applicability of the equivalent elasticity method for the specific site conditions.

Any other methods, applied for analysis of the interaction of the ground and constructions, or the rationale for rejection of such an analysis shall be explained. Analyzing the interaction between the ground and structures they also shall present the criteria and methods, applied for the assessment of influence of adjacent foundations on the response of the construction under consideration.

9.11.2.4 Interaction of structures.

In the Subsection shall be provided a description of approaches towards interaction of structures, located on common or individual foundations. It is necessary to provide the criteria, applied to the consideration of joint seismic vibrations of buildings or their parts, including those non-referring to the first seismic category, in seismic assessment of buildings of the first seismic category or their parts.

9.11.2.5 Impact of earthquakes in three mutually perpendicular directions.

In the Subsection shall be clarified, how the assessment of the impact of the earthquakes in three mutually perpendicular directions by defining seismic responses of structures, systems and components is performed, and how it meets the requirements of TNLA, including Rules and Regulations for Nuclear Power Industry-5.6.

If the analysis of seismic resistance of structures, for vertical direction applies the static method, and for the horizontal one the method of dynamic analysis or linear-spectrum is involved, it is necessary to justify the applicability of such an approach.

9.11.2.6 Method applied for assessment of torsional impact from earthquakes.

If by the assessment of structures of the first seismic category static method or any other method of approximation is applied, instead of sharing dynamic analysis of structures from the vertical, horizontal and torsional effects, the possibility of application of such methods shall be justified. It is necessary to provide description of the method, applied for assessment of torsional effect by the analysis of seismic stability of constructions of the first seismic category.

9.11.2.7 The combination of natural modes.

In the application of linear-spectral method, it is required to provide a description of the methodology, applied to summarize the relevant waveforms and defining the power factor and displacement factors (changes, moments of stress, deflections and accelerations).

9.11.2.8 With regard to the main results of the dynamic analysis shall be presented:

– Dynamic characteristics of the structures, obtained for ground based schemes and the ones with fixed base;

– Data on the impact of the effects of the interaction of ground and construction on the basic dynamic characteristics;

– Parameters of buildings and structures vibrations;

– The dependence of the maximum displacement from the elevation;

– The dependence of maximum acceleration from the elevation.

9.11.2.9. Floor accelerograms and response spectra.

The description of the techniques, designed for production of floor accelerograms and response spectra taking into account three components of ground motion shall be provided. In case when for floor spectra determination the modal response method is applied, it is necessary to provide justification of conservatism of such method with respect to the method of direct integration in time. It is necessary to provide a description of methods of estimation of floor response spectra (enveloping obtaining criteria, their smoothing, expansion peaks, etc.).

It is necessary to provide the description of methods for determining design floor accelerograms, corresponding to design spectra response.

The selection criteria of loads, obtained from various external influences, for their further operation by the analysis of stability of systems and NPP components shall be provided and justified.

It is necessary to include the description of methods, applied for assessment of influence of the indeterminacy of the structural, physical and mechanical properties of grounds on the interaction of ground and structures, on floor response spectra or floor accelerograms.

As an annex to the section shall be presented obtained sets of floor accelerograms and response spectra for all structures of the first seismic category under dynamic loads, selected for the assessment (in accordance with the requirements of sections 8 and 9.5 of the technical code) and defined with regard to the interaction of the construction with the foundation.

9.11.2.10 Seismic isolation and other events, correcting oscillation parameters.

The section shall contain a description of seismic isolation of structures, including those of the reactor compartment, applied for reducing dynamic, seismic, shock and vibration effects on the system and the elements located in them, justification of its reliability, as well as operation acceptance rules, monitoring in the course of operation.

With regard to other installations of the first category, where there is no technical means of seismic isolation, it is required to provide the description of the foundation immersion depth, the depth of the soil above the bedrock, the foundation width, total weight of the structures, as well as soil characteristics, such as the rate of shear waves, the shear modulus and the density, and to make conclusions (based on the analysis of the interaction of soils and constructions) on inexpedience of seismic isolation.

The section shall include the description of all the ways of protecting structures of the first seismic category from seismic and other dynamic effects, the volume of compensatory measures, as well as evaluation of the effectiveness of seismic isolation of the reactor compartment.

It is required to provide a technical description of the applied technical means (seismic isolators, hydraulic shock absorbers), their characteristics and methods of installation, repair and testing.

As an annex to the section of NPP SAR they shall provide floor response spectra of structures and constructions of the main building with regard to all combinations of impacts for seismic isolation applications.

9.11.3 Dynamic loads caused by impact of non-seismic origin

For dynamic loads of non-seismic origin, such as aircraft strike, the blast wave, etc., selected for the assessment they shall provide methods of determining the dependence of the resulting loads from time.

With regard to impact of the "aircraft crash" type they shall present the methods applied for determination of the load at the point of strike (methods of solution of the contact problem of collision of two bodies).

In case a type of nonlinear interaction is applied, it is required to provide:

- Justification for its choice;
- Criteria and rationale for the choice of directions and places of the load application.

With regard to impact of the "explosive blast" type it is required:

- To provide a description of the methods applied for determination of the load;
- To specify the criteria for selecting areas and places of application of the load.

9.12 Buildings, structures, building structures, substructures and foundations

The subsection shall provide a description of constructive solutions with regard to the buildings, structures, constructions and grounds of the foundations, summary of the results of justifying their strength, tightness, fire resistance and resistance to external influences, as well as the listing and justification of measures for strengthening grounds under the foundations of buildings and structures, important for nuclear safety.

A complete list of documents containing the justification of constructive solutions with regard to buildings, structures, constructions, foundations, bases, seismic isolation, descriptions of test programs and control over operational suitability of constructions shall be provided. It is necessary to provide justification for the strength of buildings, structures and constructions of the first and the second seismic category.

9.12.1 Analysis of compliance with the requirements of technical normative legal acts

This subsection shall demonstrate the compliance with the requirements of TNLA.

9.12.2 Main building

9.12.2.1 Describing houses, constructions and structures of the main building they shall analyze an approach to the layout of houses that make up the main building. The following information shall be provided for each construction:

a) Basic characteristics of the building:

- Geometric dimensions;
- The volume;
- Total weight;
- Mass emission by subsystems.

b) Description of the foundation slabs layout (indicating the structures having common foundation slab).

c) Interposition of individual foundations for assessment of their impact on the stress state grounds.

g) Thermal, sedimental, seismic joints in constructions between the footway and junctions.

This section shall contain information indicating the size, build-up factors, applied materials, constructive pairing units, concrete grades, classes and types of valves, the project design specifications of materials for all elements of construction:

- Foundations;
- The power of carcasses;
- Protecting designs;
- Ceilings and partitions.

In the section they shall provide for the information on all installations of the first category of the reactor compartment, contained in 9.1.

Information about all the constructions of the second category mentioned in 9.1, is allowed not be presented. It may be requested additionally.

9.12.2.2 Summary table of impacts and their combinations on buildings and structures of the main building.

A summary table of impacts and their combinations, which are taken into account by construction of main building, in correspondence with the requirements 9.11 of the present technical code, shall be presented.

9.12.2.3 Ensuring sustainability of the construction bases and foundations.

Justification and information about engineering measures, required for ensuring such sustainability of grounds, in which the displacement and buildings tilt of relevant NPP constructions do not exceed the stipulated values, shall be provided.

Measures to prevent harmful deformations of the grounds due to possible lifting the groundwater level, under the influence of static and dynamic loads, soil liquefaction (drainage, grouting, etc.), as well as other geological processes and phenomena classified as dangerous ones, shall be taken.

Information on the transfer of loads and forces on the main surface of the foundation shall be provided, whereas detailed information on the interaction of the support surface with the foundation soils shall be presented.

It is necessary to demonstrate the relative position of other foundations and structures, which may affect the stress condition of the foundation under consideration.

The following information about the foundation structure shall be provided:

- The main reinforcement, lined with floor anchoring system;
- The system of internal structures anchoring to the base plate (also options for anchoring through the lining);
- Mechanics of foundation shear strain by horizontal loads (e.g., seismic impacts), a method for transmitting the horizontal loads on the shock-absorbing device.
- The location plan of damping devices;
- Assessment of the ability to perceive the foundation of shear forces in the presence of waterproofing.

9.12.2.4 Evaluation of interaction structures with bases.

The interaction between the bearing foundation surfaces with the grounds shall be presented in detail. Particular attention shall be given to assessment limits for various parameters that are applied for determination of the structural stability of each structure and its foundation, including differential subsidence and safety factors against overturning and sliding.

The section shall provide the results of calculations of deformation and bearing capacity with a description of the method of calculation of the precipitation, building tilt, sustainability (sediment predictive modeling for the periods of construction and operation, with due regard to the of load escalation in time periods).

It is necessary to demonstrate the compliance with the requirements with regard to the building tilt, setting and depositions of the buildings before start-up of NPP and their (building tilt, setting and deposition) further predictive modeling. It shall be demonstrated that buildings tilt of the first category of works do not exceed 1/1000 roll according to Rules and Regulations for Nuclear Power Industry-5.6. Building tilt up to 3/1000It is allowed by assessment of the rare external effects.

9.12.2.5 Inspections and monitoring of foundations.

If under geological conditions there is a necessity of continuous inspection and monitoring over foundations, it is required to perform the programs of these surveys and observations, as well as to describe technical means of monitoring over the state of foundations. A graph of load growth on the base of the foundation in time limits shall be provided.

The section shall set out the requirements for testing and monitoring the stress state of the ground base and foundation setting forecast.

It shall contain information on the program of monitoring over foundation setting and deposition of structure in the course of NPP construction and operation process, as well as the application of technical means of observation.

9.12.2.6 Protective vessels.

They shall present the results of ensuring strength, tightness, fire resistance and resistance to external and internal influences of the containment.

Making the subsection they shall include the list of basic materials, including reports on the performed studies, similar reports on other stations and other materials, including the results of experimental research, testing, conclusions on technical solutions, etc.

The subsection shall contain the following information on the concrete reactor containment (on hermetic steel lining and concrete structure of the containment) or steel containment:

- The appointment, description and construction features;
- Norms, standards and specifications used by the assessment;
- Loading and their combinations;
- Methods of assessment and analysis;
- Assessment of the effectiveness of the chosen design solutions;
- Materials, quality control programs, special manufacturing methods;
- Integrated test and operational control;
- Measures to ensure the serviceability of the structures of the containment in the course of operation (the reference to the materials of the relevant Subsections of NPP SAR is allowed).

a) Hermetic steel lining.

1) Description of the hermetic steel lining construction.

Provide a description of the metal lining general construction, what elements it is consists of; constructions ensuring the tightness, in particular welded joints of metal lining, produced at the factories, on Pre-Assembly Site and by installation; flashings, arranged above the welded joints; ways of attaching pieces of equipment and components to metal lining sheet; stiffening structure; other structural elements.

Provide construction drawings.

Describe which constructions ensure tightness in the bottom of the exit areas of anchor rods, designed for attachment to the bottom of the internal structures, supports under equipment.

Specify how the thickness of hermetic steel lining has been selected, which thickness level has been applied on the vessel.

Provide detailed description of the construction of metal lining fastening in concrete block of the bottom, cylinder and dome.

Assessment and analysis methods

Provide detailed description of assessment and analysis methods with regard to lining behavior analysis, assessment program. Define made errors, information on program certification.

Provide detailed description of new programs. It shall be stated, whether the comparative analysis with other programs has been performed.

If the there are no assessment programs for determination of the relevant characteristics, the results of the experimental studies, the accuracy of which is to be justified, shall be provided.

Demonstrate whether metal lining loses its stability under compression and elevated temperature, provide the values of the critical force determining the stability of metal lining under corresponding impacts.

Provide load values of shearing and separation at the junction of dowel and lining.

Compare critical efforts with operating ones (with given pitches of anchor rods or angles) under all influences and their combinations (especially under temperature and compression influences).

Provide design resistance of metal lining material with regard to tension and shearing-off in the place of disposition of anchoring devices. Provide characteristics of welds the ability of saving density by buckling failure of metal lining.

Assurance coefficients by loss of lining stability under all influences and their combinations (especially under temperature and compression influences) shall be provided. The relative deformations occurring by compression, compressive stress in metal lining under simultaneous efforts for various membrane areas shall be provided. The information shall provide the indication of the lining throughout the entire surface and its operation in various (most intense) points.

1) Materials, quality control, and special manufacturing methods.

Specify the lining materials. Provide a brief description of the mechanical properties of the applied materials, where it is necessary to specify the steel properties for such structures as metal lining, dowel pins, inserts, bearings, beams, brackets and penetration seal of different diameters.

Provide a description of quality control program by producing metal lining on the plant, assembly site and by mounting, including tests in order to determine physical and mechanical properties of the lining.

b) Reinforced concrete structure of the containment.

Identify the purpose and to provide a description of the design features of the reinforced concrete containment, its geometry, and the most relevant structural elements, such as the upper and lower assembly. The description shall include the drawings in order to confirm the ability of the vessel structure of basic elements to carry out their protective functions. They shall be chosen in such a way so that the cross sections could represent the construction in at least two orthogonal directions.

You shall also provide the location of the cover in the system of surrounding structures. Overall description shall reflect the following construction details:

– base foundation frame, including basic non-tensioned reinforcement, supporting structures for dead-end anchorage;

– Cylinder course, including main reinforcement and bunches for prestressing pretension (if the containment possesses a pre-stress), large diameter holes and their enhancement (under hatches for equipment, personnel and main pipelines), as well as major construction fasteners that pass through metal lining sheet and mounted on a concrete wall. In this case, one can talk about the supporting beams, mounting for brackets and pipelines, external supports, which are fastened to the wall for support of the external structures for various purposes;

– spherical vault and annular beam, if any, including the main reinforcement and prestressing pretension communication; vessel-plate, its fastening and system stiffening; other elements, attached to the cover sheet cladding.

General description shall contain:

– Information on design norms, standards, technical specifications, general design criteria, guidelines that are used by assessments, in manufacturing, construction, testing and operational control over DM of reactor containment;

– Calculation methods and analysis, applied in containment design, also shall be provided the assumptions, made by the choice of borderline condition. These shall not be deemed the design details.

It is required to demonstrate the method of loads assessment, including general and local coordinate systems.

It is necessary to provide the description of assessment methods in crawling deformation analysis, concrete shrinkage, crack formation and deformation occurring during the cracks opening.

It is required to specify applied programs and calculations and to provide information about their certification.

It is required to provide detailed descriptions of the recently developed programs for confirmation of their suitability. Also shall be developed adequacy of measures, taken to verify the compliance of the results, obtained in this program, with the results obtained in other programs, or with the traditional problem solving methods.

In case when with regard to certain structures it is impossible to create assessment programs, an experimental justification of the corresponding solutions with an analysis of the relevant solutions of the methodology and the results of experimental work.

It is required to provide information characterizing evaluation of the impact of potential changes, man-made assumptions and materials properties, based on the results of the assessment, description of the methods for calculating the locations of the largest openings and their impact on the DM of the reactor protective case. It is necessary to provide a description of the techniques and methods of analysis of the obtained DM, including the analysis of stress blocks emission in concrete and non-prestressed reinforcement.

Limit states of the cover and prestressed reinforcement shall be identified.

The correspondence to the established norms of the Rules and Regulations for Nuclear Power Industry Г-7- 008-89 shall be demonstrated.

Provided information shall show a containment as a whole unit. The most important parts of containment, including openings, hatches, fixing sites zones, shall be evaluated from the view of the stockage to the limit state of the cover.

It is necessary to demonstrate the materials applied by the construction of the containment, considering the compliance with Rules and Regulations for Nuclear Power Industry T-10-007-89. To provide a brief description of the mechanical properties of materials and physical and mechanical properties of construction materials for the following main elements: concrete components; reinforcing bars, including their welds; prestressing pretension system; fixings for poles, beams, brackets, pipelines, etc.; anticorrosion compositions used for protecting bundles.

It is required to provide a description of the proposed program of quality control in the manufacture and assembly of the reactor containment (a reference to the relevant section of the materials of NPP SAR is allowed).

The description shall demonstrate how the quality control program provides for material testing, including tests for determination of the physical and mechanical properties of concrete, reinforcing steel fasteners. It is required to provide methods of controlling the prestressing pretension system, if applicable; laying concrete. It is necessary to provide armature assembly tolerance and description of prestressing pretension systems.

In case it is presupposed to be some special new or unique construction methods, it is required to provide a separate description for them. Furthermore, demonstrated shall be the impact that these methods may have on the construction of the containment structure strength as a whole, test requirements, operational control and diagnostic methods of building structures.

A test and operational control program with regard to the containment shall be provided (a reference to the relevant section of the materials of NPP SAR is allowed). It is necessary to consider the degree of conformity of the program to the Rules of Testing and Acceptance of Nuclear Power Plant Protective vessels into Operation, as well as to the tests during operation. It is necessary to provide integrated testing program in order to validate design assumptions, construction and control methods by the construction of the containment, as well as the ability to work without violating the criteria of limiting conditions. It is necessary to show compliance with the requirements of these tests in-service inspection programs.

The information on the inclusion of in-service inspection programs in the technical specifications shall be provided. It is necessary to define the final objective of testing and approved evaluation criteria. By applying new construction methods the volumes of additional tests and operational controls shall be determined.

To provide the description of diagnostics of building structures of the containment, including the monitoring of the banks, precipitation, DM. The information on the equipment of the containment with marks, leveling points, devices shall be provided and the methods of data recording and processing shall be described.

c) Steel protecting cover.

To indicate the purpose and to submit the design description.

Diagrams and drawings with the necessary cuts and sections, sufficient to determine the structural features of the elements that influence the core functions of the containment, shall support it.

The configuration of the containment, its interdependence and interaction with the surrounding protective structures. It is required for determining what impact these structures can have on the boundary conditions in the assessment and the expected behavior of the cover under the influence of the design loads.

The information about the following elements of designs of the containment shall be provided:

– The foundation of the containment of the reactor: if the bottom of the steel containment has the form of inverted spherical vault, the manner in which the inverted spherical vault and its supports are fixed to a concrete foundation shall be described. If the steel course of the containment does not end with the bottom and the concrete slab on which internal support and external structures are based and is covered with a sheet of lining and is used as a foundation, the method of fastening the walls of a cylindrical steel course to the bottom of the concrete slab shall be described, especially the junctions between the sheet lining of the floor and a steel course;

– A cylindrical part of the cover, including main mounting structures. These shall include (if any) base beams, pipeline supports, brackets and cover stiffening ribs, located around its perimeter and in the vertical direction;

– Steel cover spherical vault, including any fittings on the junction of the spherical vault with the course, holes or inner fastening such as containment irrigation pipeline supports and all spherical vault stiffening ribs;

– Protective vessel main holes. These holes could include rigid and flexible pipeline holes, mechanical systems such as pipes for loading fuel, electrical cables, as well as access hatches for personnel and hatches for loading and unloading equipment. Similar information shall be provided for non-cylindrical containments;

– Method of calculation and analysis.

To provide the description of assessment and analysis methods regarding steel containments. Attention shall be paid to the following issues:

– Assessment of constructive solutions.

Limit states and their corresponding parameters shall be set.

The criteria shall not be linked to a strained state of the cover under the influence of various load combinations. They shall be stated as numerical values of the limit states;

– Materials, quality control, and special construction methods.

To provide a description of the materials applied by manufacturing containment steel.

g) Protective vessel auxiliary building.

In the subsection they shall provide a description of the containment auxiliary building, its joints and foundation; plans and major sections; purpose and requirements for auxiliary building. Loads and load combinations towards structural elements of the auxiliary buildings shall be provided in the form of a table.

It is required to provide a description of the assessment models of auxiliary building structures with justification of the man-made assumptions. Accepted design models shall comply with the construction design scheme and the scheme of reinforcement.

It is required to describe the characteristics of the documentation materials in accordance with the national standards and other TNLA; concrete and its components (cement, gravel, sand, water); reinforcing steel, it jointing and welding; structural unit anchoring.

Interrelation of the individual auxiliary buildings components through the interface nodes, including efforts and loads, transmitted to the foundations.

They shall approve the applied certified calculation programs, and for the newly developed programs shall be provided information, sufficient for determination of their suitability.

On the basis of comparison of the assessment results with regard to the adopted models with regulatory criteria shall be provided conclusions on strength, deformability, fracture toughness of individual structures and buildings in general.

Provided information on the strength and stability of the containment auxiliary building shall be within the scope of the requirements with regard to the steel containment (if its foundation is separated from the containment).

For assessment of the effectiveness of design solutions, based on the assessment results with regard to the combination of loads, assurance coefficients with regard to the tensions and stresses in the reinforcement and concrete, to the deformations and fracture resistance shall be determined. It shall be formulated a conclusion on the effectiveness and economic feasibility of a constructive solutions.

A description of construction methods and information about applied structural materials, forecast changes in their properties in the course of operation shall be provided.

On architectural drawings and in the description shall be provided a list of the hidden works, according to which building codes and regulations provide preparing acts on acceptance of works with regard to all the required criteria.

If it is planned to apply new or unique construction methods, such as the free forming, they shall be described. Furthermore, requirements on auxiliary buildings shall be provided and impact that these construction methods may have on structural strength shall be demonstrated.

Load and load combinations to the structural elements of auxiliary buildings shall be demonstrated in the form of a table.

In the subsection they shall provide a reference to the designed program for quality control of materials and producing works.

Information allowing determination of the compliance of the applied programs for quality control with requirements of the current TNLA shall be provided.

To provide a description of the materials quality control program, including tests with the objective to define physical and mechanical properties of concrete, reinforcing steel, fasteners, trim sheets and anchor links. Prestressing pretension system control methods, if any, shall be provided.

A description of the requirements for testing and inspection in the course of structures operation shall be provided.

It is necessary to define the ultimate goal of testing and adopted evaluation criteria. By applying new, not applied previously methods of construction, the volume of additional tests and performance checks shall be determined.

In the subsection they shall determine the degree of compliance of such tests with the requirements of performance check programs. The information on the inclusion of performance check programs in technical specifications shall be provided.

d) Internal constructions of the reactor compartment.

It is required to provide a list of internal constructions of reactor compartment, loads and load combinations, limit states.

For the most important structures of the central part of the reactor compartment for reactor, cooled by pressurized water, shall be considered at least the following:

- Reactor support system;
- SG support system;
- Main circulator support system;
- Reactor cavity;
- Secondary shielding walls;
- Floor structural system;
- Supporting structures and crane trestle circular crane.

The list may be supplemented and detailed for each specific design.

The description of layout and design solutions for the reactor compartment shall be provided in the subsection, including internal structures drawings. The references to materials, in which the strength and durability of the internal structures is founded, shall be provided.

The internal circuit design of building structures with a justification of the accepted assumptions and conclusions on the results of the dynamic forces assessment of internal building structures of the reactor compartment shall be contained in the subsection. The information on the materials, reinforcement, stress on the equipment, installed on these structures.

Information about the design justification of structural strength shall be provided to the extent required in 9.8.

It is also required to provide a list of all the premises in which a fire is possible, with an indication of the potential causes of fire.

The subsection shall contain justified information on the implementation of the fire resistance requirements with regard to the internal structures.

It shall also present the program of operational monitoring of the behavior of internal building structures of the reactor compartment. The volume of testing and operational control by applying methods of construction that have not been applied previously shall be determined.

9.12.3 Other nuclear power plant buildings and structures

This subsection shall include the description and justification of strength, tightness, fire resistance and resistance to external influences of other buildings and structures of the first category, their foundations and internal building structures, as well as individual buildings and structures of the second category.

In this subsection is included information for buildings, where SS and SCS are located, in the following order:

– Machine room building;
– SDEEPGS;
– Pump building for technical water supply of NPP consumers building;
– Spray ponds for water supply of NPP responsible consumers;
– Special building;
– Intakes, tunnels, canals;
– Underground storage of diesel fuel;
– PHRAS structures (reinforced concrete structures, designed for heat rejection to the end absorber);
– Building the filter installation with the release out of the containment;
– The building of power supply source of the first category (battery, inverters, uninterruptible power supply units);
– Construction of emergency power tanks and reactor system cooling;
– Control center building for non–design basis accident and storing information about the parameters, important for safety;
– Buildings and structures of PPS of NPP (building controls, alarm and monitoring stations, protective structures);
– Storage facilities for RAW (burial grounds);
– Buildings and constructions of fire pumping station of safety system.

This list shall be considered as a draft one and may be supplemented and updated for each specific NPP. It shall be provided detailed information about each of these buildings and structures. Information shall be presented with regard to the structure that is the most appropriate according to the specific features of the buildings and structures; it shall contain the conclusion on the stability of the foundations.

In case of presence in the surroundings of the NPP of dams, banks and other structures, creating a threat to the NPP, the results of evaluation of resilience for each structure, as well as measures to strengthen the foundation, shall be provided.

Based on assessment and analysis results a conclusion on all buildings, structures and constructions with regard to their strength and durability shall be provided in the conclusions to the present subsection.

9.12.4. Building structures diagnostics

In this subsection they shall describe all diagnostics systems for structures and constructions, including monitoring of changing direction, precipitation, DM, fluctuations of the state of their foundations. It is required to determine specific constructions and designs that are required for diagnostics, to identify problems that shall be solved in order to ensure NPP safety. The information on the equipment of buildings and structures of NPP with benchmarks in accordance with the Rules and Regulations for Nuclear Power Industry-5.6, systems of monitoring the changes of direction, precipitation, fluctuations of buildings and structures, the foundations states, as well as their DM. With regard to these observations in the section they shall provide the information on the surveillance program in accordance with the current guidelines.

It is required to present the results of the following observations in the form of the table in the subsection after installation of the equipment before the fuel loading based on the current state of constructions and after performing tests:

- Yield of the building foundation;
- Buildings and constructions tilt;
- Stresses in structures and foundations;
- Deformations (for sealed and reinforced concrete covers after their testing for strength and tightness).

9.12.5 Research program and action plans for inspection of a nuclear power plant critical buildings and structures

In the subsection it is necessary to provide the list of prospective studies and inspections of the foundations, buildings, structures, constructions, soil, groundwater state, control over the general condition of constructions and radiation leaks in wells. It is necessary to provide a brief description of such investigations and inspections.

9.12.6 Actions for assurance of the containment frame filling serviceability in the operating process

This subsection shall provide a description of activities to support the design level indicators characterizing the operational integrity of the containment.

9.13 Methods of substantiation of the strength and operability of a nuclear power plant equipment, pipelines, systems and elements taking into account the loads caused by natural and technogenic impacts and transferred through the construction elements of buildings and structures

This Subsection shall include the information containing the assessment bases for determining the mechanical, monitoring and test and electrical systems capability to perform their functions with combined influence of external conditions, emergency internal influences, impacts in the course of normal operation.

9.13.1 Account of external conditions in designing mechanical and electrical equipment

It is necessary to provide information on the environmental conditions with regard to which mechanical, monitoring and test and electric part of the equipment, ensuring the security of the radioactive assembly, and reactor protection system is assessed, and (or) provide references to the relevant sections containing this information.

9.13.1.1 Identification of the equipment and external conditions.

Determine and indicate the location of all the mechanisms and components that provide safety (e.g. motors, cables, filters, pumps, seals and shields) placed inside the reactor containment or other areas that shall function in the course and after any design accidents. With regard to the equipment inside the containment it shall be indicated, whether it is located inside or outside of the screen, protecting from flying objects.

For each type of the equipment both normal and emergency conditions shall be determined. It shall provide the following parameters: temperature, pressure, relative humidity, radiation levels, the chemical composition and vibration (of non-seismic origin). With regard to the emergency conditions these external parameters shall be submitted according to the time periods and the reasons for the occurring such external conditions shall be stated (e.g. loss of coolant accident or other steam line break.).

They shall also indicate the possible duration of each mechanism in emergency environments.

9.13.1.2 Provide a description of tests and studies that are carried out or would be carried out for each mechanism in order to check such its performance under terms of a set of influences such as temperature, pressure, humidity, chemical composition and radiation. It is necessary to indicate their specific values.

9.13.1.3 In the final report they shall submit the test results with regard to each type of the equipment.

9.13.2 Mechanical systems, equipment and pipelines

9.13.2.1 Individual elements of mechanical systems and the equipment.

Describe the methods of analysis of the strength and durability of the mechanical system elements, equipment and pipelines.

a) Assessment of transient states.

Provide a list of transient modes to be used in the assessment of cyclic durability of all mechanical systems, equipment, pipelines and support structures or provide references to the relevant sections of NPP SAR.

Examples of transient modes are commissioning and decommissioning of the nuclear power plant, changing the power level operation, switching the main equipment, emergency modes, equipment failures or nodes, transient states as a result of operator error and seismic effects.

All transient modes or a combination thereof shall be classified in accordance to the categories of operating conditions of the equipment according to the definitions set out in TCP 170.

Demonstrate the number of events for each transient mode and the number of cycles within the transitional regime in order to justify the correctness of the provided values. Indicate the sources containing all the assessment, made for determination of the parameters of transient modes.

b) Computational programs, applied in the calculations.

To provide a list of computational programs, applied for static and dynamic analyses, carried out to determine the structural and functional integrity of all systems, components, equipment and support structures of the first seismic category. A brief description of the program, its capabilities, application, and information about the certification program or verification of the calculated, analytical or experimental methods shall be included.

c) The experimental stress analysis.

It is necessary to provide information confirming the validity of experimental stress analysis methods in case when these methods are applied instead of analytical methods for calculating the equipment belonging to the first seismic category.

g) Evaluation of emergency conditions.

Describe the analytical methods (e.g., elastic or elastic-plastic assessment), applied for the assessment of equipment stress of the first seismic category in an emergency conditions. The description shall include the rationale for the compatibility of these methods to the type of dynamic analysis systems.

It is necessary to demonstrate and justify the relationship, applied by the analysis of strength of the equipment, between the stresses and strains, to provide breaking stress values.

In case when for the estimates are applied methods, based on elastic, elastic-plastic solutions or analysis of limiting state of some elements of systems or equipment simultaneously with the analysis within the range of elasticity of the whole system, it is necessary to present highlights of applied analytical methods in order to confirm that the calculated deformation and displacement of individual elements or their supports do not exceed the relevant limits and do not go beyond the assumptions upon which the applied method of analysis of the entire system is based.

If in emergency cases on the equipment there may occur creep deformation, the methods, applied in this case for determination of the strain and stress, as well as the criteria adopted, shall be described.

9.13.2.2 Dynamic states and analysis.

The subsection shall present criteria, test procedures and dynamic analysis, applied for confirmation of structural and functional integrity systems, pipelines, mechanical equipment and internals of a nuclear reactor, experiencing the impact of vibration loads, including loads, caused by coolant flow and seismic effects.

a) Pre-operational, vibration and dynamic testing of pipelines.

Provide information for all the pipeline systems of the first, second, third security classes, relating to the pre-operational testing of the pipelines that are under influence of vibration and dynamic loads that will occur in the course of functional tests within the period of energy input fitting.

The purpose of these tests is confirmation of the fact that the calculated degree of security of pipeline systems, dampers, components and bearings is sufficient for withstanding the dynamic forces arising out of the coolant flow by transient states and steady-state operating conditions, supposed within the lifetime of the power plant.

The test program shall include the lists of various flow modes, visual inspection of selected locations and measurement criteria for acceptance of systems and possible actions to limit any excessive vibrations.

b) Tests of seismic stability of mechanical equipment, important to safety.

It is required to provide a description of the tests on the seismic stability of the mechanical equipment, to confirm the structural integrity and serviceability during and after the seismic effects. The following information shall be included in the preliminary report:

– Seismic resistance criteria, test methods and basic parameters of the test modes, the methods of accounting the influence of the height of the location of the equipment on the parameters of selectable test modes, as well as the rationale for determining the adequacy of the program of seismic characteristics. In designing the verification of seismic stability programs it shall be taken into account the availability of broadband seismic excitation, an arbitrary orientation of the seismic action and the dynamic relationship between seismic loads in different directions;

– Methods and techniques, applied to test mechanical equipment of the first seismic category in the course and after the impact of MCE and to confirm the structural and functional integrity of the equipment after a n exposure to several DBE in combination with normal operational loads. This applies to mechanical equipment such as fans, pumps, motors, heat exchangers, tube bundles, valve drives, shelves for batteries and tools, control panels, control panels and cable trays;

– Methods and analysis techniques, testing of mechanical equipment supports of the first seismic category, as well as test methods, applied for assessment of the potential increase in the design loads (amplitude and frequency) in terms of seismic vibrations. In the final report they shall submit the test results and analysis in order to confirm the correctness of the criteria, adopted in the current regulatory technical documentation, as well as the proof of the test sufficiency.

c) Dynamic analysis of the characteristics of the reactor internals under transient and steady- state modes.

They shall provide a description of the method of dynamic analysis, applied to study the behavior of structural elements, located inside the reactor vessel, under transient and steady coolant circulation mode.

This analysis is performed in order to confirm the accuracy of the assessment of normal operation of a SI, for the determination of power loads, influencing on the part of coolant for these devices, and to predict the vibration characteristics of the SI in order to conduct pre-operational testing of the reactor vibration.

In addition, the data, showing specifics of the point location, for which characteristics are assessed, as well as considerations for choosing a mathematical model and criteria for acceptance of designs.

9.13.2.3 Pre-operational testing of SI to the vibration, caused by the circulation of coolant.

The information on the pre-operational testing of SI to vibration loads from the coolant circulation by performing functional tests of the program when entering a nuclear power plant into operation, provided by the Regulations for the Trial and Testing, Instructions for Operation of the Reactor, shall be provided.

9.13.3 Electrical equipment

In this section they shall provide a description of methods of working efficiency justification with regard to electrical equipment, to provide information indicating compliance with the specifications and methods of testing by applicable TNLA.

9.13.3.1 The criteria for testing electrical equipment performance under dynamic loads shall be provided.

It is necessary to provide the entire range of electrical equipment belonging to the first seismic category.

The criteria of seismic resistance testing shall be provided, including the criteria for the selection of special tests or analysis methods, definitions of input parameters fluctuations, as well as justification of efficiency of resistance testing program to dynamic loads.

It is required to submit a list of the loads, by exposure of which the efficiency of the equipment is checked.

9.13.3.2 Methods and techniques of inspection of equipment durability and performance under dynamic loads shall be provided.

Provide methods and procedures, applied for verification of seismic resistance of electrical equipment of the first seismic category.

It is also necessary to demonstrate that these instruments and equipment perform their safety functions in the course or after MCE and maintain their efficiency after the passage of several DBE.

Electrical equipment of the first seismic category includes electrical equipment of the reactor protection system and emergency power mains.

9.13.3.3 To present methods and types of analysis or testing electrical resistance of supporting structures of the first seismic category to the dynamic loads and test procedures, applied in order to account for the possible increase in the design loads (amplitude and frequency) in terms of dynamic effects. The supporting structures include such equipment as supports of accumulator batteries and control panels, cabinets, panels and cable trays.

9.13.4 Electrical power equipment

In this section a list of all power equipment, related to the first, second, third security class shall be provided. Define the criteria applied in tests or analytical investigations, in order to justify the performance of electric power equipment. Describe the characteristics of the test programs and the calculation methods, applied in load combinations.

Provide the main results of strength assessments, confirming the efficiency of electric power equipment.

It is necessary to introduce methods and techniques of inspection of supporting structures durability with regard to power equipment at selected combinations of operating loads, including external influences.

9.13.5 Pumping units and fittings

It is required to submit a list of all existing pumps and valves of the first, second, third security classes. Provide the criteria applied in tests or analyses, in order to justify the performance of pumps and valves. To describe the characteristics of the test programs and the calculation methods, applied in load combinations.

It is necessary to bring the resulting implementation of programs of tests or analyzes maximum levels of stress and strain, as well as the results of the inspection performance pumps and valves for the entire prescribed period of operation.

9.13.6. Steam generators

It is required to describe the assessment methods, applied for justifying the strength and SG performance, with due regard to the loads from the external influences. Provide the applied settlement schemes and to justify their conservatism. It is necessary to provide load combinations, applied in the assessments. It is necessary to describe the methods and results of calculations, obtained with respect of the influence of loads from the jet blow by breaking the pipe and reactive forces from external influences, accidental loads. Describe the applied criteria of strength. It is necessary to present the methodology applied for calculation and analysis of SG supports for the selected combinations of loads.

9.13.7 Diesel electric power generation sets

It is required to provide a description of the premises of diesel generators, including the general form of drawings, supplied with the necessary sections, allowing establishment of the relative position of the diesel generators and the surrounding structures. Design schemes of diesel generators and load combinations, applied in the assessment, shall be provided. To provide a description of the assessment methods based on man-made assumptions. To demonstrate the transfer mechanisms with regard to the loads from foundations on diesel generators under external influences. Applied computational programs shall be certified and describe diesel generators requirements towards testing and inspection in the course of operation, which would confirm the ability of diesel generators to maintain their performance under any external influences.

9.13.8 Control and measurement devices and equipment of automatic

process control system

It is necessary to define all CMI, APCS equipment and their supporting structures, related to the first seismic category. It is necessary to provide criteria for verification of seismic stability and resistance to external influences. Provide the parameters applied as input for validation of seismic stability and resistance to external influences. Describe the methods and procedures, applied to verify the resistance to external influences of CMI and the equipment. Thus, it is necessary to demonstrate that these instruments and equipment perform their safety functions in the course and after any external influences.

It is required to introduce methods and techniques for inspection of resistance towards external influences of support structures of the CMI and APCS equipment, as well as testing procedures, applied for considering possible increase in design loads under conditions of external influence.

9.13.9 Ventilation equipment and air ducts, filtration systems equipment

It is required to provide a description of the analysis of the resistance of ventilation equipment and air ducts, as well as of the equipment filtration systems to the loads, specified in 9.4. The following information shall be included:

– Criteria and duct modeling techniques;

– Methods for dynamic analysis of airway systems;

– Criteria and methods of selection of basic natural vibration frequencies of subsystems and equipment based on an analysis of the spectrum of frequencies of forced support structures fluctuations;

– Methods of analysis and criteria of stability of the equipment and subsystems, attached at different heights inside the buildings and between them, having different input signals.

9.13.10 Carrying and lifting equipment

It is necessary to provide the justification of strength, durability and stability of lifting and transporting equipment, with due consideration of the overall nomenclature of impacts, provided in 9.4. It is necessary to provide the justification of the acceptability of the methods, chosen for justification and the reliability of results.

9.13.11 Nuclear reactor control rods drive systems

The information, required for verification of the suitability of the functional elements of the control rod driveline under NOC, emergencies and external dynamic effects. For electromagnetic drive systems, this information shall include information on the mechanism driving the control rods and extension cords to the point of connection to the reactivity control elements.

For hydraulic systems they shall include information on the mechanism, driving the control rods, hydraulic control unit, condensate supply systems, rapid discharge volume and extension cords to the point of connection to the reactivity control elements.

A description of the drive system design with required drawings, a brief description of the operating conditions of drive control rods, and information on the design criteria and testing program shall be provided. Information on the assessment norms, standards, technological specifications, and on the general design criteria, applied in the assessment, manufacturing, installation and operation of the control rod driveline shall be provided.

It is required to specify the criteria that have been applied in the assessment of any element designs of the drive system.

Also the information, required to assess parts of the control rod driveline, located outside the reactor vessel, including the magnitude of the stresses, applied in the assessment, strains and allowed number of cycles or the allowed stress by fatigue assessment.

If instead of the assessment they apply experimental studies, they shall provide a description of the program of their implementation. Methods and techniques, applied for identification and verification of the stresses, deformations and number of cycles, occurring in the structural elements of automatic control systems of the drive rods.

The order of the quality assurance program shall be provided, as well as the references to the previously applied test programs or standard industrial techniques of checks with regard to the similar mechanisms.

In the present quality assurance program the following issues shall be considered:

– Check program efficiency;

– Operating conditions in the course of testing period;

– Checking mechanisms efficiency.

9.13.12 Nuclear reactor emergency protection elements

It is required to provide information in order to confirm the structural integrity and functional fitness of emergency protection elements of nuclear reactor by NOC, emergencies and external dynamic effects.

It is required to describe functional requirements for each emergency protection elements, as well as to demonstrate how the elements affect the vibration of emergency protection elements, caused by circulation of coolant, any significant changes to the design as compared with the designs of power plants of a similar type, for which the vibration test has been conducted.

Present the foundations of strength assessment of emergency protection elements of a nuclear reactor. There shall be included such characteristics as allowable stress, deflection and the permissible number of cycles, mechanical or thermal limits for the reactor core (adjusting and fixing).

Provide assessments demonstrating that the allowed offset would not interfere with the normal functioning of all inter–related mechanisms (e.g., control rods and cooling backup systems) and that the stress, associated with these shifts, would not exceed the allowable values.

9.13.13 Seismic control and measurement tools

9.13.13.1 This subsection shall include and justify a program of measurements of seismic effects parameters.

9.13.13.2 They shall provide a description of the control and measuring seismic instruments, such as the three-dimensional model accelerographs, three-dimensional time accelerographs and three-dimensional spectra recorders that would be installed on the selected systems joints in selected premises of the first seismic category. Furthermore, it is required to provide a justification of the choice of these structures, joints and CMI location and to determine operating procedure with regard to the values, obtained from these devices after earthquakes for checking the assessment of the seismic stability.

9.13.13.3 It is required to describe the measures that are to be taken in the shortest possible time after the earthquake for the notification of the operator of reactor remote control about the magnitude and type of acceleration of response spectra values. Furthermore, it is required to provide justification of the set specific values, from which shall start a reading of the values of seismic CMI for their displaying to the operator.

9.13.13.4 It is necessary to introduce criteria and methodology, applied for comparing the measured reactions of constructions of the first seismic category in the selected joints after the earthquake with the results of the design analysis of seismic resistance.

9.13.14 Software applied

A list of the software, applied by justification of the resistance of the equipment, pipelines, NPP systems and components towards external influences. The following information shall be provided for each program:

– A brief description of the purpose of the program;

– The assessment method, applied by the program;

– The main assumptions and limitations, imposed by the program on this class of problems;

– Information about certification of programs in supervisory bodies.

9.13.15. System and elements test methods

In this subsection it is required to provide the nomenclature of systems and components, for which the tests are conducted, as well as the description of all methods and test programs, applied by justification of the resistance of NPP systems and elements in the following sections (references to the relevant sections of NPP SAR are allowed):

– Methods of dynamic testing, where shall be submitted criteria, testing methods and dynamic analysis, applied for verification of the structural and functional integrity of pipeline systems, mechanical equipment and SI, suffering from the impact of vibration loads, including the loads, caused by coolant flow and seismic effects;

– Operational and pre-operational testing equipment, in particular, the nomenclature of the equipment, for which the operational and pre-operational test are required; the materials describing the program of operational tests of the equipment for the first, second and third classes of security; methods of measurement and control over the recommended operating parameters for each type of equipment; plan and schedule of operational tests conducting.

– Test of the equipment on working capacity under a combination of external conditions, including a description of tests and investigations that are performed or would be performed for each mechanism in order to verify its performance under the influence of external factors such as temperature, pressure, humidity, chemical composition and radiation (specific values of external influences shall be provided).

10 Reactor

In this section the information and analysis results, required for nuclear reactor operation safety justification in the course of installed life of the RI under normal operation conditions, violations of normal operation conditions, including accidents, as well as the information required for analysis of the violations, the results of which are provided in accordance with the requirements of the section 21 of the present technical code, shall be provided.

10.1 Purpose of reactor

10.1.1 Purpose and functions

The objective and functions of the reactor shall be stated.

The information on the regulatory framework of the RI design in the form of a list of technical normative legal acts, listed in the Supplement, shall be provided.

It shall be pointed out, that the reactor unit equipment and its systems are designed as the systems of normal operation, important to safety, the elements of which are belong to the first, second and third classes of security (a particular class is indicated in the description of the corresponding equipment).

Any equipment, located in the reactor vessel, shall refer to the first category of seismic activity and its seismicity shall be assessed pursuant to MCE.

10.1.2 Design fundamentals

In this section the following information shall be provided:

– Design characteristics of the thermal power generation;
– Applied nuclear fuel;
– The project design specifications;
– Nuclear fuel application mode;
– Nuclear fuel burnout;
– Duration of use of reactor unit equipment throughout the year;
– Design service life of the RI;
– Maintainability and recoverability.

The subsection shall not include any provisions of TCP 170, TCP 171 etc., as they formulate safety requirements for performance, instead of design bases.

10.2 Reactor project design

10.2.1 Reactor description

A description of the reactor with reference to the relevant design documents shall be provided.

It is required to provide information on the reactor and a summary with regard to the building, where the reactor is located, the protection of the reactor building from internal and external impacts of natural and technogenic origin (according to the requirements of the section 8) and from the events on NPP site, external as related to the reactor building.

The description shall provide explanation to the reactor orientation relative to the NPP building, the relative positions and interactions of the described equipment and systems, their impact on each other. In the description shall be included the list of components – systems (elements) of the reactor, performing distinct functions. The list shall include:

- Reactor core;
- Reactor shutdown system – operating parts of emergency protection (CPS)
- CPS (operating mechanism and driving);
- Reactor vessel, including internals;
- Equipment (system) of internal reactor treatment with core assemblies;
- Other elements of the system (e.g., special purpose channels).

10.2.1.1 It is required to provide a description of the purpose and the design basis for the reactor core and its assemblies, to indicate their groups in accordance with the classification of safety and seismic resistance, to provide a list of TNLA, determining design criteria and safety principles, basic requirements to the reactor core design and layout of its assembly.

Modernizing the reactor core, due to the use of new types of fuel, they shall submit the design materials of such modernization safety materials for additional safety foundation.

10.2.1.2 It is required to describe the layout of the core structure and its assemblies, drawings of their general views, demonstrating the relative position of the basic geometric dimensions, fastening methods and orientation as related to the axis of the reactor, coolant emission schemes for the reactor core assemblies.

Provide cartograms of the reactor core loading for the first charge, transitional charges and steady state operation of the reactor, the information on the amount of nuclear fuel. Each draft shall be provided with a reference to the relevant drawing of the record of reactor core technical design and its assemblies.

Description of the reactor core and its assemblies shall be accompanied with a list of the main technical characteristics.

10.2.1.3 By justifying the choice of materials of the reactor core assemblies, description of the nuclear fuel and coolant shall be provided information on structural materials, welding, nuclear fuel, absorbing materials, heat carrier.

According to the materials of construction the following information shall be presented:

- On mechanical and thermal properties, depending on the radiation dose and temperature (yield and endurance strength, the residual ductility, thermal conductivity, heat capacity, etc.);
- Period of irradiation of nuclear fuel;
- Corrosion interaction with the fission products and the coolant depending on the burnout of nuclear fuel, temperature and time of irradiation of nuclear fuel;
- The fatigue strength depending on the radiation dose, temperature, load and number of cycles.

For welding they shall provided the following information:

- Types of applied welding with the list of TNLA, regulatory requirements for welding;
- Experience of operation of welded joints or their testing under similar conditions;
- Differences of mechanical and corrosion properties of welded joints compared with the base metal in normal operation, by violation of normal operational mode and by accidents.

The following information on nuclear fuel shall be presented:

- Chemical composition, concentration, density, charge, uneven density emission of fissile isotopes, methods of their control, certification of testing methods;

– Creep and swelling of nuclear fuel depending on the temperature, the radiation dose and the load;

– Mechanical and thermal properties, depending on the burning temperature, the content of fissile isotopes (melting point, specific heat, thermal conductivity, thermal expansion, tensile strength);

– Compatibility with coating material, thermal expansion depending on burnout, temperature, time period;

– The behavior by accidents (depressurization of the fuel element, the contact with the coolant, the temperature increase);

– The possibility and feasibility of reprocessing of spent nuclear fuel (summary).

By upgrading reactor core, associated with the new type of fuel, including a burnable poison, shall additionally be presented research results on the classification of the fuel, for example, during irradiation in research reactors or irradiation in experienced assemblies with a new type of fuel in operating reactors etc., as well as forecasts of the allowable burn-up range.

With regard to the absorbing materials it is necessary to provide the following information:

– The chemical composition, the geometric dimensions, enrichment with nuclear fuel on absorbing materials, density, methods of control, certification of testing methods;

– Cover material compatibility;

– Behavior by accidents (decompression of fuel element, contact with the coolant, temperature rises);

– Behavior by irradiation and changing the properties.

By upgrading reactor core, associated with the new type of fuel, including a burnable poison, and by applying absorbing elements with an increased content of the nuclide-absorber shall be presented the research and development results, justifying behavior of the absorber under irradiation and forecasts of permissible burning nuclide-absorber in the absorber.

With regard to the coolant they shall providethe following information:

– On the thermal properties;

– On permissible impurities.

10.2.1.4. It is required to provide the description of the reactor pit.

10.2.2. Manipulation and control

The list of monitored parameters of the reactor core and its assemblies, control frequency, the range of measurement parameters, allowed measurement errors, the composition and location of the sensors shall be provided and justified.

The information on the control of the reactor core status and power control of the RI:

– On protection and block systems, regulators, diagnostic systems, automatic control programs;

– For controlling reactivity – on the rod absorbing system – operating parts of emergency protection (reactor control and safety system) and WEP, which are independent systems;

– For measuring neutron current – on neutron current monitoring system, which is the normal operation of the system, but because of its importance to safety implemented pursuant to the requirements of the CSS;

– For changing position of the operating parts – a drive control system (part of the reactor control and safety system), a description of the system in accordance with the requirements of 10.2.9 (it can be represented in the "Monitoring and Control" section);

– On IPM system;

– On system of diagnostics with regard to the state security barrier – fuel cell membranes (if such a system is provided);

– On system of controlling and limitation of the reactive unit equipment power;

– On a system of formation of brigades of preventive protection and blocking (in sections 13 or 18, in the subsection of the CSS, if these brigades are formed in the CSS of emergency protection);

– On formation of the system of commands for an emergency radioactive unit equipment shutdown – CSS of emergency protection (provided in the section 18 of this technical code).

By upgrading reactor core, associated with the new type of fuel, shall be submitted the applicability of existing metrological maintenance or otherwise, the description of the design-relevant updated metrological assurance, as well as a revised list and applicable values of monitored parameters and the requirements, applied by tests of the control and measurement equipment.

By increase in non-uniformity of the energy producing as compared to the original design shall be submitted justification for location of additional control points in order to increase the accuracy of measurement of in-core measurements and adjusted calculation of the energy recovery field procedures.

In case of a necessity, organizational and technical measures for modernization of IPM system shall be provided, including application software of IPM system.

Described shall be designed technical means and methods of control FE vessels hermeticity, including FE, produced from new type of fuel at a standstill, and (or) operating reactor, which shall provide reliable and timely detection of leaking FE. They shall also present and justify the techniques, applied for controlling the tightness of FE vessels at a standstill, and (or) working reactor.

10.2.3. Tests and checks

They shall describe the programs and methods of the testing core and its assemblies, methods of non-destructive inspection and testing in order to confirm the project design specifications of the core assemblies; submit a list of TNLA, defining requirements to the scope and methods of test and checks. Provide input control programs over the core assembly at NPP, acceptance certificate of the interdepartmental commission, a list of nuclear hazardous works with the core and its assemblies.

Modernizing the reactor core, associated with the new type of fuel, they shall present methods and techniques of reactor and post-reactor fuel assemblies testing program with due regard to the new type of fuel.

10.2.4. Project design analysis

10.2.4.1. It is required to include the description of the core and its assemblies operation in the course of normal operation of RI, including access to the MCL, the transitional modes under planned starts and stops. It is necessary to demonstrate the state of the reactor core under these conditions, the interaction with other systems of the reactor during the implementation of these functions.

10.2.4.2. The limits for safe operation of the core elements shall be provided. To provide reference to the RI design documentation and the sections of NPP SAR, which contain a justification of the safe operation limits.

The following information shall be provided:

– The limit of fuel (with regard to temperature or absence of melting);

– Limits of membranes of FE (with regard to temperature and density);

– Limits of the core (with regard to reactivity, if appointed by the RI design developing officer, and the period of change in capacity). With regard to the core – the limit of thermal power (power value that would encourage the achievement of limits of FE membranes temperature or fuel temperature in the course of transition process of design basis accident).

Upon reaching the limits of safe operation to provide EP alarm. There shall be provided values of installations and demonstrated that there is a sufficient supply from the input reference until the limit.

Provide the limits of safe operation with regard to the condition of the core: with regard to specific FE loads, coolant activity, the ratio of power consumption and other limits, specified in RI design.

Modernizing the reactor core, due to the use of a new type of fuel, they shall present corresponding limits and conditions of safe operation, including damages to FE. They shall state possible additional measures, provided for by the design, in order to maintain the adopted design ratio between the activity of fission products in the primary coolant and limits of FE damage.

10.2.4.3. Provide a list of nuclear hazardous works by handling reactor core assemblies and on condition of full discharge, if such operation is provided by design.

Modernizing the reactor core, due to the use of a new type of fuel, they shall confirm the applicability of the existing list of nuclear hazardous works or be provided an updated list.

10.2.4.4. Provide information on the works carried out in support of the design of the reactor core and its assemblies, which shall be divided into the following groups:

– Neutron-physical study;

– Justification of thermal-hydraulic performance;

– Substantiation of strength.

Provide information on the design carried out in support of the core research and development works in the following way:

– A list of experimental research and development activities, including those performed on the stands, research reactors and operating NPP;

– Description of the experimental procedures;

– Analysis of the experiments results.

Modernizing the reactor core, due to the use of a new type of fuel, they shall submit design-reasonable amount of additional design stands and reactor experiments in support of safety of new core loads using such fuel.

10.2.4.5. Describing the operation in case of failure, they shall provide a list of initiating events, including operator errors, and analysis of RI failures, and assess their impact on the operation of the reactor and its safety.

Considering the failures to analyze their common causes, they shall provide high-quality assessment (if necessary) and quantify their effects.

analyze the impacts of these failures on the reactor operation and other RI systems. A list of systems and equipment, required for control and (or) liquidation of the consequences of such failures.

The section shall also include a list of all design basis accidents (possible reference to the section NPP SAR "Analysis of accidents at NPP") and a list of beyond design basis accidents, provided for in the design, (also with reference to the relevant section of NPP SAR «Analysis of accidents at NPP").

Modernizing the reactor core, due to the use of a new type of fuel, they shall submit a revised list and a list of design basis accidents and a list of beyond design basis accidents, taken into account in the design, with due regard of the features of new types of fuel, which shall be considered under NPP SAR "Analysis of accidents at nuclear power plants".

10.2.5 Reactor shutdown system-control and protection system executive devices

10.2.5.1 Describing the system purpose and functions, they shall provide classification of CPS AE on a functional purpose (protective SS), elements of the security class and the seismic category, a classification designation.

Provide information on the regulatory framework of the reactor shutdown system-control.

10.2.5.2 Provide information on the design basis (efficiency, speed) for normal operation and emergencies.

10.2.5.3 Provide a description of the CPS AE construction, indicating the purpose and the basic elements of information about CPS AE groups.

Provide a description of the structure and purpose of CPS AE guide channels, CPS cartridges, including CPS AE figures with basic geometric dimensions and position of the rod as related to the core.

Provide a proof with regard to the CPS AE performance, based on experience in other reactors and the results of tests on the stands.

Provide basic project design specifications of the rods.

10.2.5.4 By description of the materials to apply information provided in 10.2.1.1.

To inform about the sources of the confirmation of CPS AE materials performance and CPS guiding channels.

10.2.5.5 By description of quality assurance to provide information at the NPP QAP by core molding.

10.2.5.6 Information on tests and checks shall be provided. To provide and justify the frequency control and the list of parameters of CPS AE that is to be checked, which define the criteria for loss of working capacity (reduction of physical efficiency below a certain level, the lack of movement of the rods).

provide a list of research, development, design and experimental works, carried out for support of the design and performance of the CPS AE, including production and physical weighing layout, fabrication and testing of hydraulic layouts.

10.2.5.7 Describing of the management and control apply the information, provided in 10.2.2.

10.2.5.8 Provide the limits and conditions for safe operation of the reactor as per CPS AE system (performance characteristics, efficiency, permissible axial deflections, durability, test period).

Modernizing the reactor core, due to the use of a new type of fuel, they shall present the corresponding limits and conditions for safe CPS operation. In addition, they shall confirm the applicability of the existing setting installments of warning and alarm protection system, or justify the application of new ones.

10.2.5.9 Analyzing the design of CPS AE, they shall provide information on the proper functioning, functioning in case of failure, design justification and evaluation.

a) Normal operation.

Provide description of the work of CPS AE in normal RI operation mode, violations of normal operation, including design basis accidents, demonstrate the state of CPS rods in these conditions, which determine and ensure their efficiency.

b) Operation in case of failures.

Analyze the potential failure modes of CPS AE with qualitative and (or) quantitative assessment of their impacts.

Provide information on measures to eliminate faults or to limit their consequences, taken in the course of AE design and CPS guide channels and their operation. Analysis of possible equipment failures when loading and unloading CPS AE, under overload conditions, uncovering from the cell, etc.

Inform the rationale for the safe operation of the reactor, with the results of operation of CPS AE of similar design and the results of bench tests and calculations.

c) Justification of the design.

Provide information on the works, carried out in support of the CPS AE design:

- Justification of thermal-hydraulic performance;
- Substantiation of workability (durability and reliability).

The information on each work group shall consist two parts – theoretical and experimental. In its turn, the design part shall include:

- The list of settlements;
- Applied procedures and programs with information on their certification;
- The results of calculations with their analysis. The experimental part shall consist of:
- A list of conducted research and development activities;
- Description of the methods applied;
- Analysis of the experimental results.

The following information shall be presented:

- The estimated value of the efficiency of CPS AE under appropriate absorber load, reducing efficiency, burning out, and DE fluence and CPS AE for a determined period of operation;
- Main thermohydraulic characteristics of the CPS AE, including the emission of

coolant flow, absorber temperature, DE vessels, rod details and CPS shroud tubes, core pressure overfall and buoyancy force, that influence them;

– Basic strength characteristics of CPS AE and CPS sleeves, determining their reliability, including DM membranes and CPS AE elements, changing DM size and shape due to swelling, creep, temperature, interaction of absorber with vessel, interaction of DE with shroud tube, interaction of CPS AE parts with CPS shroud tube;

– Assigned resource value, assigned operation period and assigned storage period of CPS rods;

– Criteria for loss of efficiency of CPS AE.

By modernization of the reactor core, due to the use of a new type of fuel, the efficiency of existing reactor shutdown systems shall be confirmed, including those performing function of EP, in terms of efficiency and speed, or design materials of modernized reactor shutdown systems shall be provided.

d) Design evaluation

To submit an assessment of TNLA requirements in the field of nuclear energy application.

10.2.6 Warning alarm protection system

Apply the information provided in 10.2.5.

In the subsection "Management and control” they shall provide information on the position of WEP assemblies.

In the subsection "Design evaluation" they shall demonstrate the compliance with technical code of common practice 170.

10.2.7 Neutron-physical valuation of the core

Provide the information and analysis, required for justification of operation safety of the reactor core in the course its design period of operation in normal operation, violations of normal operation, including pre-emergency situations, design and beyond design basis accidents, as well as information, necessary to analyze the causes of accidents, the results of which are included in the section NPP SAR "Analysis of accidents on NPP."

The information and analysis, presented in this subsection, shall be based on the materials of the reactor design, the core, the core assemblies and the results of scientific research.

10.2.7.1 By submitting a general description and basic neutron-physical characteristics of the reactor core it is necessary to provide the following information:

– Type of NF;

– Peculiarities of the core design (layout, FA fastening methods, the gaps between the FA, side and end reflectors, characteristic structures of the reflectors);

– Adopted in the design method of leveling power density field;

– Adopted in the design methods of power control;

– CPS AE (EP) (10.2.2);

– Presence in the core of other elements (experimental FA, neutron source, etc.);

– Accepted methods of FA overload of the core, CPS AE;

– The list of the principal physical characteristics of the core and their values, NF enrichment, maximum energy release, temperature margin to the melting of the NF under nominal conditions, the effectiveness of CPS AE, maximum margin of reactivity effects and coefficients of reactivity, subcriticality margin after a quick shutdown of the reactor, the length of the fuel campaign the maximum depth of burn-out, the maximum neutron flux, period between overloads, afterheat curves in the core, depending on the time after transferring the reactor into a subcritical state, etc.

10.2.7.2 Describing the operation modes in the core during the campaign provide:

– A common approach to replacement of the fuel in the reactor;

– Characteristics of steady state overload;

– The list of the principal settlement of the core states in the steady state;

– The main characteristics of FA overload programs of the core and CPS AE;

– A general description of the transitional regime;

– A general description of the starting core values and its basic physical parameters.

10.2.7.3 In order to characterize power density field it is required in the reactor core and surrounding structures provide information about the emission of the power density field in the reactor core and surrounding structures in different states of the core, characterizing the fuel campaign (prior to overload, after overload, in the average steady state and in other states, defined in the design, including the neutron flux emission in the core and surrounding structures.

10.2.7.4 For the characteristics of the power density field in the course of beyond design positions of CPS AE shall be considered the most unfavorable position of CPS AE and shall be provided emission of the power density fields and the neutron flux for the selected configuration.

10.2.7.5 Providing information about the effects and coefficients of reactivity, associated with changes in temperature and power, it is necessary to bring the values of temperature effects and reactivity coefficients, adopted in the design, and the structure of the components of these effects.

10.2.7.6 Represent the values of reactivity effects arising out of changes in the resonant interaction of neutrons by changing temperature (Doppler-Effect).

Provide values of Doppler-Effect with regard to different states of the core for the campaign, as well as component-wise – for the base materials of the core and for different isotopic compositions of fresh fuel.

10.2.7.7 Provide information on asymptomatic values of temperature and power effects of reactivity to different states of the core.

Provide values of the temperature reactivity effect and its components for different states on fuel burn: the temperature of the core elements at rated power, power effect of reactivity and its components and for different states on the active fuel burning zone.

10.2.7.8 With regard to balance reactivity and efficiency of regulation to present an analysis of the balance of reactivity and compliance characteristics of reactivity requirements with TCP 171. The balance of reactivity shall be determined with due regard to the possible errors in determining the effects of reactivity. Core reactivity balance shall be determined with regard to the beginning and end of the campaign and, if necessary, for the intermediate points burnout. Also shall be taken into account such factors affecting the reactivity and depending on different operating conditions, as:

– Regulatory group CPS DE, their prospective minimum allowable efficiency;

– The effectiveness of boric solution;

– The concentration and efficiency of boric solution;

– Disturbances in the moderator and fuel temperature, prospective vacuum disturbances;

– Burning (slag);

– Xenon and samarium poisoning;

– Permissible height of rods dipping into the core and their allowable misalignment.

The minimum required and designed shutdown reactivity margin for different moments of the campaign, with due consideration of the uncertainties of the stock and experimental checks on existing reactors, shall be presented and discussed.

The methods and limitations and regulations in normal operation, considering such aspects as:

– The concentration of the liquid absorber and its changes;

– The movement of the control rods, including the rods, acting on the axial profile of energy;

– Possible changes in flow rate or temperature of the coolant. There shall be included a description of:

– Launch from cold, hot, and the maximum xenon poisoned states;

– Load tracking mode and compensation of non-stationary xenon poisoning;

– The impacts on the volume of emission of energy (for reemission of xenon and xenon oscillations);

– The possible impact on the emission of burnout.

Modernizing of the reactor core, due to the use of a new type of fuel, they shall settle the applicability of existing boron supply system in the first circuit, or present the design materials of modernization of such systems.

10.2.7.9 Analysis of subcritical reactor state in the course of refueling. The neutron source, location and sensitivity of neutron detectors, control subcritical state. It is necessary to submit:

– A common approach to the control of subcritical reactor state;

– Neutron source, its structure, basic characteristics;

– Core neutron background depending on the isotopic composition of the fuel and its burnup degree;

– The location and characteristics of the sensitivity of neutron detectors;

– Control the refueling requirements and these requirements in the draft.

10.2.7.10 Power Monitoring.

It is necessary to describe briefly the applied neutron detectors for the measurement of reactor power and their characteristics. To provide the analysis of compliance of the selected measuring system power requirements with TCP 171 and the analysis of power measurement capabilities of the system in order to control the field and energy distortions, arising out of the beyond design position of regulatory and other causes.

10.2.7.11 Describing the methods, programs and constants for the physical settlement it is necessary to provide a brief description of programs and constants, applied for physical assessments. Specify the certified programs, as well as the degree of preparation for the certification of other applied programs; availability of verification reports, instructions for users, and other documents.

Modernizing the reactor core, due to the use of a new type of fuel, for the verification and validation of methods and codes, applied for determination of the neutron-physical characteristics of the core with a new type of fuel, with due consideration of the uncertainty analysis, shall be presented.

10.2.7.12 Provide the basic results of experimental studies on reactor physics on the critical stands, research and operating reactors.

Provide a description of modeling critical stands and a list of experiments performed on these stands, as well as on research and the existing reactors. Provide the basic results of the settlement analysis of these experiments and the possibility of applying the results of such analysis to evaluate the accuracy of the physical characteristics of the reactor design.

Modernizing the reactor core, due to the use of a new type of fuel, provide information about all the neutron-physical characteristics of the core with a new type of fuel, provided in 10.2.7.

10.2.8 Thermal-hydraulic valuation

10.2.8.1 Provide information on design constraints, affecting the thermal-hydraulic characteristics, RI design modes and selection of its parameters. These shall include:

– Maximum temperature of FE vessels;

– Maximum temperature of the coolant;

– Rate of temperature change of the coolant;

– Maximum linear FE loads;

– Maximum coolant flow rate in the core;

– MCP positive suction head.

10.2.8.2 In order to perform thermal-hydraulic assessment of the core it is necessary to provide:

a) The emission of the coolant flow and linear energy. There shall be described:

– Wiredrawing zone scheme of the core;

– Coolant flow emission to wiredrawing zones through inter-cassette clearances and cooling of the reactor vessel;

– Average and maximum values of the linear energy for different wiredrawing zones and enrichment zones at the beginning and end of the campaign;

– The coolant temperatures at the outlet of the reactor core and the reactor as a whole, with due consideration of the emission of the coolant flow at the beginning and end of the campaign;

– Fe vessels temperatures at the outlet of wiredrawing zones, subject to the possible temperature emission irregularities.

b) Pressure falls in the core and the hydraulic resistance. It is necessary to describe the scheme of coolant flow at the inlet of the reactor (e.g., high- and low-pressure collector), to provide the values of pressure falls in the core and the corresponding emission of the hydraulic resistance of the elements of the core.

Modernizing the reactor core, due to the use of a new type of fuel, in case of structural differences of FA with the new fuel from standard FA they shall confirm their thermal- hydraulic compatibility.

c) Techniques and calculation programs. It is necessary to provide information, applied in thermal-hydraulic calculations of the core techniques and computational programs, data on their verification or substantiation of reliability of the results.

Provide information on the experimental works carried out in support of the operation of the techniques and computational programs.

Provide the data on the accuracy of the results of thermal-hydraulic calculations based on uncertainty analysis.

10.2.8.3 With regard to RI thermal-hydraulic assessment it is necessary to describe the thermo- hydraulic assessment of the primary circuit and the heat line alarm system.

The description shall include the following information:

a) Information on the layout of equipment and pipelines of the RI primary coolant circuit.

To present thermo-hydraulic RI scheme, including:

– The number of coolant circulation circuits and functions (normal heat removal system, emergency heat removal system);

– Type of stimulus coolant flow (forced circulation, natural circulation);

– A list of equipment and pipelines in each of the circuits of circulation, the design value of coolant flow rates for each circuit element and the pressure fall by the corresponding consumption;

– Coolant circuit circulation in each of the coolant circuits, height layout circuit elements (equipment, pipelines) for the different contours, their geometric characteristics (including coolant circulation path length in the element), the values of the coolant volume in each of the elements;

– The values of the level of coolant in the primary RI contour elements and pressure of the gas environment in design modes.

b) RI design modes, which shall include:

– A list of design conditions (with reference to the subsection of the section "Reactor" of the NPP SAR);

– Thermal-hydraulic characteristics of each of the design conditions; coolant parameters and the rate of change in a variety of design conditions;

– Coolant temperature emission in the design conditions.

c) Techniques and calculation programs.

The information on the applied RI thermal-hydraulic assessment methods and analysis programs, the data on their verification and the rationale for the reliability of the results shall be provided, as well as the data on the accuracy of the results of thermal-hydraulic assessments, based on uncertainty analysis.

10.2.8.4 Provide a description of the program, testing procedures and inspections that shall be applied in order to validate the design of thermal-hydraulic characteristics of the reactor core and RI circulation coolant circuits.

10.2.9 Control and protection system actuating mechanisms

The content of the subsection shall be based on the developed design documentation for the CPS AM, applicable to CPS AM requirements of the Rules and Regulations for Nuclear Power Industry G-7-013-89 developed by QAP, operating experience of prototype products, testing of prototypes and the reports, issued during the execution of research and development activities and in accordance with the structure shown below.

10.2.9.1 Describing the purpose and design basis the following information shall be provided:

– Information on the composition, appointment and objective;

– Classification of AM security and earthquake resistance;

– AM criteria, guidelines and design limits for normal operation, violations of normal operation and design basis accidents;

– The maximum permissible values of the basic mechanical strength properties and valid values of AM reliability indicators.

10.2.9.2 Describing the structure the following information shall be presented:

– The description of the AM structure with the release of the individual performing independent function devices (elements), including the control device, fastening and sealing;

– Sufficiently detailed drawings and diagrams, illustrating the design, kinematic schemes of action and the location of the AM;

– The main technical characteristics of AM;

– A list of systems and equipment, affecting the operation of the AM.

10.2.9.3 With regard to the materials provide information on brands and properties, applied in the AM steels and materials and the rationale for their performance within the required time in an aqueous medium at design temperature and radiation effects, corresponding to RI normal operation, violations of normal operation, including design basis accidents.

10.2.9.4 Providing information on quality assurance give references to the development of the QAP (design), manufacture, installation and acceptance of AM and the list the main requirements under these programs and TNLA, regulatory requirements to ensure the quality of AM and their joints.

10.2.9.5 Describing the control, inspection and testing the following information shall be provided:

– Principles of AM management and monitoring of their condition;

– Characteristics of AM control signals;

– Analysis of possible control actions on AM by means of automation and employees;

– Methods, tools, scope and frequency of the condition monitoring and testing of AM to ensure their efficiency in the operation and regulatory compliance;

– Information about pre-commissioning works with AM, including a list of their testing programs, showing the adequacy of AM pre-commissioning tests, in order to substantiate the safety of RI operation, and a list of measures to prevent accidents in the course of testing.

10.2.9.6 Provide a design analysis by normal functioning of AM, operation in case of failure, provide justification for the design and its evaluation.

a) Provide the following information for normal operation:

– A description of AM functioning during normal operation of RI, including transients during planned start-ups, the power change and stop;

– A description of the state of AM, their interaction in the process of performing the required functions;

– Requirements for reliability and safety requirements for interacting with AM systems and equipment, important to safety;

– A description of operation in case of failure of AM systems and equipment, provided by the design and a description of measures to ensure their functioning in these failures.

b) With regard to functioning by failures provide:

– Analysis of the impact of AM failures, including failures due to personnel error;

– A description and justification of the adequacy of measures of prevention of possible failures of AM in a common cause, including external and internal exposure and failures of systems and equipment;

– Qualitative and quantitative (if necessary) assessment of the consequences of failure, including the characterization of changes of basic RI parameters that affect security;

– A list of AM failures that initiate violations of normal operation, including design basis accidents that require additional analysis in the relevant section of the report on analysis of RI safety.

c) By justifying design show that AM comply with safety rules, are tested during operation of VVER reactors or tested in conditions, similar to those required, substantiated by research and development works.

d) Provide an assessment to the corresponding TNLA requirements of the design.

10.2.10 Reactor vessel

10.2.10.1 By describing the purpose and design fundamentals the following information shall be provided:

– Information on the purpose and functions of the reactor vessel;

– Classification of the reactor vessel on the effect on the safety and seismic resistance;

– A regulatory framework of the design;

– Criteria, guidelines and design limits underlying the design of the reactor vessel for normal operation, violations of normal operation, including design basis accidents;

– A list of failures of the reactor vessel, considered in nuclear safety analysis.

10.2.10.2 Describing the design they shall provide the following information:

– Description of the construction of the reactor vessel with the release of the individual performing independent functions of the elements, including the control device, fastening, sealing;

– Drawings and diagrams illustrating the structure;

– The main technical characteristics of the reactor vessel.

10.2.10.3 A list of TNLA, regulatory requirements for the materials applied, information on brands and properties of the steel reactor vessel, the rationale for their ability to work within the operation period of RI in an aqueous medium at design temperature, temperature changes and radiation effects corresponding to normal operation of the RI, violations of normal operation, including design basis accidents, shall be provided.

10.2.10.4 Giving information on the management and control they shall provide the following data:

– Methods, tools, scope and frequency of monitoring the state of the reactor vessel metal for ensuring its performance in the course of operation and their compliance with the regulatory requirements of the definition of DM vessel material in the course of commissioning period – RI adjustment.

10.2.10.5 With regard to the tests, inspections and checks on the state of metal the following information shall be provided:

– Tests on reactor vessel blanks during manufacturing;

– Input control over the reactor vessel or its components before mounting;

– Control during mounting;

– Tests of strength, integrity, stability after mounting.

10.2.10.6 A design analysis shall include the following information.

a) For a normal operation mode it is necessary to provide the following data:

– A description of the functioning of the reactor vessel during normal operation in all modes of operation provided by the regulations for any possible combination of loads (thermal, cyclic, seismic, shock, vibration, radiation, corrosive, etc.);

– Analysis of possible failures of elements of the reactor vessel with the assessment of their impact on the basis of the PSA;

– Compliance with the requirements of mechanical, strength and reliability characteristics of the reactor vessel during all modes of operation.

b) Represent the following data on the operation in case of failure:

– Analysis of the consequences of failure of the reactor vessel or its components;

–A list of failures of the reactor vessel, an initiator of violations of normal operation, design and beyond design basis accidents, requiring further analysis in the relevant section, covering analysis of the RI safety.

c) By justifying the design demonstrate the compliance of the reactor vessel with TNLA requirements, the use of basic design solutions, manufacturing expertise, installation, testing and operation of vessels of similar existing facilities and the rationale for the design documentation or reports issued in the performance of R&D.

d) For the reactor vessel provide the limits of safe operation with regard to:

- Pressure;
- Temperature;
- Irradiation;
- Strength.

e) With regard to maintenance and maintainability to provide information on the maintenance and repair of the reactor vessel and a brief description of repair techniques.

f) Provide information on the analysis of the reliability and value of the estimated probability of failure of the reactor vessel.

The flux emission and neutron flux at the boundaries of the core and on the walls of the reactor vessel, depending on the lifetime of the reactor, shall be provided.

Modernizing the reactor core, due to the use of a new type of fuel, they shall additionally justify a radiation resistance of the reactor vessel and formulated restrictions on fast neutron fluency on the reactor pressure vessel internals and designs.

g) In order to represent the data on management and control it is necessary to apply information, provided in 10.2.2.

Provide a list of control points and information on diagnostic systems.

h) Provide a conformity assessment of the reactor vessel with regard to TNLA requirements and safety principles and justifying design decision-making.

11 Primary coolant circuit and its related systems

The scope of this section comprises the security aspects of the operation of the primary coolant circuit and the preservation of its integrity during normal operation, violations of normal operations, emergency situations and after the postulated initiating events not related to the depressurization of the primary coolant circuit. Sealed primary coolant circuit is the barrier, following the FE vessel, limiting the spread of radioactive substances in case of accidents.

The provided information shall ensure that included in the NPP SAR results of the safety analyzes are correct and sufficient, and that all the necessary safety tests are performed.

The references to the information included in other sections, if it is related to the primary coolant circuit, shall be included.

There shall also be submitted a list of existing technical design documents, on which this section was based.

In the section they shall provide information about the elements of the primary coolant circuit and its related systems.

The primary coolant circuit is a complex of equipment and pipelines connecting it with the pressure compensation system, through which coolant is circulated in the working zone under pressure.

In this section shall be considered the following elements and systems that make up the first circuit

a) primary circulation circuit that transfers heat from the reactor to the steam generator, and includes, as a rule:

- The reactor vessel with the upper unit and the seal;
- The main circulation pumps;
- Steam generators;

– MCC lines (lines connecting these elements);

b) the system (or part of the systems) associated with MCC, within the primary coolant circuit pressure boundary, consisting of systems that provide proper functioning of MCC, and ancillary systems.

Systems that ensure the normal MCC functioning:

– The pressure compensation system (pressure maintenance system);
– System(s) of emergency reactor cooling;
– Coolant purification system. Utilities:
– The system of feeding and purging the primary coolant circuit;
– Drainage and air–vent system, fill lines;
– Pulse lines and sampling lines;

c) reinforcement of the primary circuit;

d) attachment joints.

As for the different types of nuclear power plants the number of elements of the primary coolant circuit and related systems may differ, the applicant himself shall define a complete set of these elements and systems, depending on the project design specifications.

The boundary of the primary coolant circuit comprises a first passive barrier, such as wall pipes (including steam from the primary coolant) and the second shut-off valve from the core at any pipe associated with MCC, which comprises the coolant and may be pressurized by the primary coolant circuit.

Separative elements (bearings, dampers, displacement limiters, etc.) between the primary circuit elements and construction (base) structures are considered as part of each system.

11.1 Brief description of primary coolant circuit

This subsection of NPP SAR shall include a brief description of the complex systems for removing and transferring heat from the reactor core to the steam generator. Primary coolant circuit and its related systems

In this subsection of NPP SAR shall be summarized summary information on the design, the analysis of safety systems and components of the primary coolant circuit.

It is necessary to provide a description and designation of the primary coolant circuit, its main components and related systems. The description shall highlight the elements that perform separate functions, as well as the security features of each element and system. There shall be included a table of important theoretical and working (operational) characteristics.

It is required to set out the criteria adopted in the design and safety principles.

It shall be demonstrated how the basic safety function of the primary coolant circuit works – providing heat removal from the core through sufficient quantity of a coolant of a proper quality during normal operation, violations of normal operations, emergency situations and design basis accidents, in compliance with the operational limits and the limits of the security, provided by the design, including damage threshold (appendix A of technical code of common practice 171), and shall be provided a list of postulated initiating events.

They shall include references to other sections of the NPP SAR, which provide more detailed requirements for individual systems and elements of the primary coolant circuits.

It shall be demonstrated that the design, provided for temperature control, pressure and chemical composition of the coolant in the primary coolant circuit in normal operation, violations of normal operations, emergency situations and design basis accidents.

It is necessary to demonstrate that all the systems and components of the primary coolant circuit have been designed with due regard to the possibility of maintaining in the course of the entire operation life the environmental conditions (pressure, temperature, humidity, radiation) arising under normal operation, violations of normal operations, emergency situations, design basis accidents and after them.

They also shall provide a description of all the components, installed on pipelines and equipment, for sensing seismic loads, and it is required to demonstrate that the failure of systems and components that are not of the first seismic category, does not cause failure of systems and components of the first seismic category.

Provide information that the design allows operator to obtain information on:

- Violations of the conditions of normal operation of the primary coolant circuit;
- On the achievement of operational parameters and operational limits (or) the limits of safe operation.

It is necessary to demonstrate the possibility of radioactive coolant drain and the absence/ presence of dead zones, as well as the ability to fill with water and removal of air from the system according to Rules and Regulations for Nuclear Power Industry G–7–008–89. It shall be confirmed that the outer surface of the equipment and pipelines with temperatures exceeding 45°C is thermal insulated, according to Rules and Regulations for Nuclear Power Industry G–7–008–89.

It is necessary to demonstrate that the primary coolant circuit is designed in such a way as to provide an access to equipment for inspection, maintenance and repair, and as to maintaining the exposure dose towards the personnel, that shall be reasonable low, not exceeding the established design limits.

Also, they shall include references to the statements of design systems and components of the primary coolant circuits.

It is necessary to provide information on the accomplished assessments, the list of experimental works and the analysis of experimental results.

11.1.1 Principal flow diagram

It is required to introduce fundamental technological scheme of the primary coolant circuit, showing the boundaries of the primary coolant circuit and all the main elements, working pressure, temperature, flow and volume of coolant in the steady state operation of the plant at full power. The scheme shall specify all connected to the primary coolant circuit systems and the way of their disconnection from the primary coolant circuit. This is particularly important for systems with nonradioactive media, and systems with working pressure that is lower than in the primary coolant circuit.

Present piping layout within the reactor building in isometric representation.

11.1.2 Control and measurement tools diagram

It is necessary to submit a scheme of control and measurement tools of the primary coolant circuit and the associated non-disconnectable systems in the primary coolant circuit pressure zone. It is necessary to demonstrate the CMI equipment for measuring pressure, temperature, flow, level, chemical composition of water and gas, as well as the motion control and integrity indicating accuracy class of the instruments.

11.1.3 General drawings

It is necessary to introduce a common type drawings showing the marks of the equipment and the main dimensions of the primary coolant circuit with respect to the supporting and surrounding concrete structures of which is clear that there provided an opportunity to service and inspection, as well as fulfilled the requirements to ensure the conditions for the development of natural circulation, according to requirement 5.5.4 of TCP 171. If the design provides biological protection, it also shall be demonstrated.

11.2 Integrity (strength and density) of primary coolant circuit pressure boundaries

In this subsection of NPP SAR shall be provided a justification of measures, accepted in the design, to ensure the strength and density of equipment and pipelines of the primary coolant circuit in accordance with the requirement 7.3 of TCP 170 and requirements 5.5.2, 5.5.3 of TCP 171.

11.2.1 Compliance with the norms and rules of primary coolant circuit functioning

It is necessary to provide a table showing the compliance of the primary coolant circuit operating with the requirements of TNLA in the sphere of nuclear energy, which is controlled by MES. In case of presence of TNLA requirements, the implementation of which would lead to unnecessary complications and difficulties, which are not compensated by improving the quality and safety, to provide the foundations for performing alternative requirements. Describe how the acceptable level of safety and quality would be achieved in compliance with the proposed alternative requirements.

In cases where there is a possibility of choice of options to apply the rules provided by the developer (e.g., combinations of basic load with loads of the earthquake), indicate, which options are applied, and to provide corresponding justification.

11.2.2 Primary coolant circuit excessive pressure protection system

This subsection of NPP SAR shall provide a list of elements that perform the function of protection against excessive pressure in the primary coolant circuit. Provide a brief description of pulse-relief devices installed on the pipe of discharging steam into the steam bowler and performing the function of protection the equipment and pipelines of the primary coolant circuit from exceeding the limit of the primary coolant pressure in emergency and transitional modes, according to Rules and Regulations for Nuclear Power Industry T–7–008– 89.

In the subsection shall be listed all measures and ways to protect the primary coolant circuit from excessive pressure beyond design limits under normal operation conditions, violations of normal operations, emergency situations and design basis accidents.

The overall efficiency of devices and safety valves for pressure relief of the primary coolant circuit shall be provided, and measures to ensure minimizing the loss of coolant in the event of valve failure after opening.

The references to other sections of the NPP SAR, which specifically describes the individual systems and elements that protect the primary coolant circuit from destruction, shall be provided. Information on the individual systems shall be reported in accordance with Supplement A of this technical code.

11.2.2.1 In addition to the above listed information regarding the description of the design basis it is necessary to demonstrate how the probability of rupture of pipelines, equipment failure with a separation of parts, is minimized.

The following information shall be provided:

a) The criteria for the destruction of pipelines.

The information on evidence of potential places of pipelines rupture shall be provided (connecting points to the equipment, points with a maximum voltage) as well as areas where there is a potential risk of damage to adjacent equipment, important to safety.

With regard to low-temperature regime to provide the design data, confirming that the pressure in the primary coolant circuit elements at low temperatures (below operating one) are restricted to such values at which brittle fracture is eliminated, or the pressure corresponds to the level of stress, which is allowed for a given temperature level.

b) Analysis of the consequences of the destruction of pipelines.

They shall present the results of the analysis of the consequences of the destruction of pipelines, in which the following effects on adjacent equipment shall be considered:

– Temperature;
– Pressure effect;
– Load of jet streams on adjacent equipment and pipelines;
– The impact of humidity and radiation;
– Reactive load causing vibration and pipe whipping, where there is destruction;
– The damage of flying objects;
– Flooding of equipment important to safety.

In case of "Leak before Dismantlement" concept application, to demonstrate a set of pipelines it is applied to, and to provide a link to a document justifying its application.

c) Protection against the consequences of the destruction of pipelines.

It is necessary to present the methods, applied in the design for the physical separation of pipelines and movement restrictions, in order to prove that:

– Rupture of one of the primary coolant circuit of the pipeline does not lead to the rupture of another one, which is required to mitigate the consequences of the accident;

– Rupture of the pipeline, not related to the primary coolant circuit, so not cause the loss of coolant accident;

– Rupture of the primary coolant circuit would not cause destruction of the containment;

– Emissions of the coolant does not interfere with control stations and does not interfere with the systems applied to eliminate the consequences of the accident.

11.2.2.2 In addition to the above information, in the "System Design" subsection it is necessary to present the results of analyzes of transients, which may be accompanied with an increase of pressure in the primary and second coolant circuits. Describe the design modes, accompanied with an increase in the maximum pressure in order to determine the capacity of the SV.

It is necessary to provide a description of the equipment and systems of protection mechanisms of primary coolant circuit against overpressure, to present the drawings of general form of safety and relief valves, the description of the principle of their action.

Determine essential design parameters of each element, including design, flow area, the estimated bandwidth and the location of valves installation, as well as diameter, length and pipelines layout.

Identify the design parameters (e.g., pressure and temperature), to determine the quantity and type of duty cycles for each element, to specify the external conditions, on which systems and components are based. They shall include information about the drainage device according to Rules and Regulations for Nuclear Power Industry G–7–008–89.

Describe in detail the measures, taken for installation of pressure relief devices, located within the boundaries of the primary coolant circuit and on SG of the second coolant circuit, and the respective applications. Determine the source data for assessment of allowable loads of elements (axial force, bending and twisting). Provide a list of these loads and resulting stresses.

It is necessary to provide information on the setup inspection of the safety valve systems, hydraulic locks, if applicable, in accordance with requirements 6.2.28 – 6.2.30 of Rules and Regulations for Nuclear Power Industry G–7–008–89, as well as its location and service as required by 6.2.25 of Rules and Regulations for Nuclear Power Industry G–7–008–89.

Provide analysis of thermal-hydraulic assessment of the primary coolant circuit protection against overpressure and the system's ability to perform its functions.

Provide the results of the analysis demonstrating the impact on the characteristics of the operating conditions of the change system parameters and operating characteristics of the equipment. To provide a design justification of carrying capability and the number of valves, testing methods and monitoring their operation according to requirements 6.2 Rules and Regulations for Nuclear Power Industry G–7–008–89, as well as the analysis of system reliability.

11.2.2.3 In addition to the above listed information, as related to the management and control of the system, it is necessary to submit a scheme of pipelines and test equipment in accordance with requirements 6.3.5, 6.3.6, 6.3.9 of Rules and Regulations for Nuclear Power Industry T–7–008 – 89 of the protection systems of the primary coolant circuit against overpressure, demonstrating, in accordance with requirement 6.2.2 of Rules and Regulations for Nuclear Power Industry G–7– 008–89, the quantity and location of units and mechanisms, including valves, pipes, tanks, CMI and control devices. Demonstrate the boundaries with other systems.

It is required to provide information on verifying the functioning of safety equipment, including control circuits, prior to the first and subsequent launches, as required by 6.2.27 Rules and Regulations for Nuclear Power Industry G–7–008–89.

11.2.2.4 As related to the parts describing tests and inspections, it is required to specify the tests and inspections to be carried out before the operation start, in the course of installment start-up for the confirmation of the functional characteristics and in the course of operation for the check and confirmation of reliability.

11.2.3 Primary coolant circuit materials

This section shall provide the data demonstrating that the materials, manufacturing methods and elements controlling the primary circuit pressure zones meet the requirements of Rules and Regulations for Nuclear Power Industry G–7–008–89, Rules and Regulations for Nuclear Power Industry T–7–002 –87, Rules and

Regulations for Nuclear Power Industry G–7–009–89 and the Rules and Regulations for Nuclear Power Industry Y G–7–010–89.

11.2.3.1 TC for materials.

It is required to provide a list of TC with regard to the ferritic and austenitic stainless steels, non-ferrous metals (if applicable), which are produced from the primary coolant circuit elements, including fasteners, as well as welding and filler of the materials.

In the event when the selected material is not listed in Supplement 9 of Rules and Regulations for Nuclear Power Industry G–7–008–89 or is specified, but is used with disabilities in terms of nuclear energy, provided in Rules and Regulations for Nuclear Power Industry T –7–008–89, there shall be made a reference to the documents, justifying the possibility of applying the selected material.

It is necessary to demonstrate how by selecting the material of the primary coolant circuit are provided the following material properties, largely affecting the maintenance of the integrity of the pressure boundary:

- Chemical compatibility with the coolant;
- Compatibility with the material of pressure contact with the circuit elements (Insulation, supports, coating, sealing parts and assemblies, etc.);
- Cyclical and long-term strength and creep;
- Corrosion (including stress corrosion), corrosion-cyclic and erosion characteristics;
- Radiation damage (for steel exposed to neutron irradiation);
- Fracture toughness;
- Resistance to brittle fracture;
- Manufacturability in production;
- Activation by irradiation;
- Behavior in an emergency.

They shall provide data on the control element contents that adversely affect the performance of the materials as well as on measures to limit such impurities (e.g., cobalt content of the nickel-containing steels, copper, nickel and phosphorus in the body of steel, carbon, sulfur, phosphorus and silicon in the carbon steels, etc.).

11.2.3.2 Compatibility of construction materials with the primary coolant.

In this subsection they shall provide the following information relating to the primary coolant compatibility with structural materials and external insulation of pressure zones:

- The chemical composition of the primary coolant circuit with reference to the corresponding standard material.

Indicate changes in the chemical composition of different modes, if there are applied additives (e.g., sink); maximum limit of chlorides, fluorides, oxygen, hydrogen, and soluble corrosion products;

- Compatibility of construction materials with the primary coolant.

Provide a list of structural materials that are in contact with the primary coolant, and to describe the material compatibility with the coolant, impurities and products of radiolysis, that may be in contact with them. If the primary coolant circuit contacts with non-metallic materials, then it is required to provide a description of compatibility of these materials with the coolant;

- Compatibility of construction materials with the outer insulation of the primary coolant circuit.

Provide a list of the primary coolant circuit constructional materials, having thermal insulation, and a description of their compatibility with the external insulation, particularly in the event of leakage of coolant. Provide information on non-metal insulation austenitic stainless steel showing whether the concentration of chlorides, fluorides, and sodium silicates in the insulation is within the acceptable limits, and give the rationale for these limits.

11.2.3.3 In this subsection they shall provide information on the manufacture and processing carbon and low-alloyed steel, in particular:

- Technological features of the manufacturing process and semi-finished products;

– A description of the operation of non-destructive control of all elements of the primary coolant circuit pressure zone to confirm their compliance with the requirements of the rules of the device and the safe operation of equipment and pipelines of nuclear power plants in accordance with section 4 of Rules and Regulations for Nuclear Power Industry G-7-008-89 and control rules of Rules and Regulations for Nuclear Power Industry G-7-008-89. To provide reference to the quality control program.

11.2.3.4 This subsection shall provide the following information on the manufacturing and processing austenitic stainless steels, applied in the elements of the primary coolant circuit:

– The technological features of the manufacturing process (forging, welding, heat treatment), to prevent cracking due to stress corrosion, as well as limitations on the ferrite phase. To indicate the control methods, applied in the manufacturing and eliminating stress corrosion;

– Control over the technological processes in order to reduce the contact with the environment that can cause stress corrosion. Measures with regard to surface elements protection from dirt and damage, causing stress-corrosion cracking (from the production stage to the final installation);

– The characteristics of the mechanical properties of the deformed in the cold state austenitic stainless steels of the primary coolant circuit element and the allowable amount of deformation;

– Measures to prevent hot cracking during welding and assembly. Specify the requirements for welding consumables. Show matching welding technology, including repair of joints and control (including the certification of welders), the requirements of Rules and Regulations for Nuclear Power Industry G-7-009-89 and Rules and Regulations for Nuclear Power Industry G–7– 010–89;

– A description of the operation of non-destructive control of elements of the first circuit to verify their compliance with the requirements of the section 4 of Rules and Regulations for Nuclear Power Industry G-7-008-89, control regulations of Rules and Regulations for Nuclear Power Industry Y G-7-008–89; provide a reference to the quality control program.

11.2.4 Primary coolant circuit operation check and testing

This subsection shall provide a description of the test program and checks the first circuit elements of Groups A and B in accordance with the classification, set out in Rules and Regulations for Nuclear Power Industry G-7-008-89.

The description shall include:

– Border systems that are subject to control, including the supports and fixing elements; The location of the systems and components, with due consideration of the access to their control;

– Ways and methods of control to ensure the implementation of the requirements of section 7 of Rules and Regulations for Nuclear Power Industry G-7-008-89, including special ones, which can be applied to meet these requirements;

– The frequency of control;

– Operational control requirements of the program;

– Methods for evaluating test results;

–Frequency and order of hydraulic tests (strength and density).

Demonstrate the compliance with the requirements of section 5 of Rules and Regulations for Nuclear Power Industry G-7-008-89.

Specify the specifics of operational inspection and test individual elements of the primary coolant circuit, and to provide references to the relevant design documents.

11.2.5 Identifying leakage through primary coolant circuit pressure boundaries

A leak identifying system shall be described in accordance with the scheme described in 11.2.2 of this technical code.

Submit a description of applicable methods of leak detection, sensitivity and response time, as well as the reliability of the operation of instruments and equipment, to specify the minimum amount of leakage that can be detected by the methods applied.

In addition, to provide systems (methods), which are applied for signaling and serving as indirect indicators for leaks. To demonstrate a combination of public systems (methods), applied in the design, which determine the location of the leak.

Describe the signal processing program from the sensors, providing the operator with reliable information on the location and size of leaks.

Describe test procedures of the leak detection systems. It shall be confirmed that requirement 7.4.4.6 of TCP 170 and 5.5.13 of TCP 171 covering the means and methods of leak detection in the primary coolant circuit are observed.

11.2.6 Connections with secondary coolant circuit

It is necessary to provide the following information in the form of a table:

– The amount of coolant flowed into the second coolant circuit in the destruction of a steam generator tube;

– Time for pressure equalization between the emergency steam generator and the primary coolant circuit;

– The minimum volume of water and the maximum amount of steam in the steam generator during normal operation.

Provide the criteria for determining the allowable leakage of the primary coolant circuit into the second one during normal operation, and the criteria for determining the state of emergency barrier between the first and second coolant circuits. Provide justification for the selected diameter of the maximum possible rupture of the primary circuit piping.

Specify and justify the minimum setpoint pressure for SV of the second coolant circuit, their capacity for SV, installed on the steam line.

11.3 Reactor vessel and closure

11.3.1 Reactor vessel and closure materials

Provide evidence that the materials and methods of manufacture and control of the reactor pressure vessel meet the requirements of Rules and Regulations for Nuclear Power Industry G–7– 008–89, guidelines for welding and surfacing of equipment and pipelines of nuclear power plants and the rules of welded joints and surfacing equipment and pipelines of nuclear power plants.

11.3.1.1 TC for materials.

List the reactor vessel materials, and the equipment materials in contact with the reactor vessel. Specify the TC for the materials. In the event that the selected material is not listed in the Supplement 9 of Rules and Regulations for Nuclear Power Industry G–7–008–89 or specified, but is applied with deviations of application conditions set out in the requirement 3.4 of Rules and Regulations for Nuclear Power Industry G–7–008–89, the reference shall be made to the documents that justify the possibility of using the selected material.

Specify the selection criteria of materials and studying their performance.

11.3.1.2 Manufacturing process.

Describe fundamental technology of manufacturing composite parts of the housing assembly and specifying heat treatment conditions and welding type. When using non-standard or special procedures they shall be describe in detail and they shall demonstrate that their application does not affect the integrity of the reactor vessel.

11.3.1.3 Methods of non-destructive testing.

Describe in detail the methods for the detection of surface and internal defects, to provide references to methods, especially in cases where the methods differ from those recommended in Rules and Regulations for Nuclear Power Industry G–7–008–89. Provide references to a quality control program.

11.3.1.4 Specific methods of control of carbon and austenitic stainless steels.

Describe the welding methods of control, welding, heat treatment and other processing operations, provided for the production of vessel. To confirm the compliance with the requirements and recommendations of Rules and Regulations for Nuclear Power Industry G–7–009–89 and Rules and Regulations for Nuclear Power Industry G–7–010–89.

Provide references to the relevant quality control programs.

In the event that the method of standard documentation and the volume control is recommended to choose from several alternatives, validate the selected option.

11.3.1.5 Brittle fracture.

Describe tests to determine the characteristics of resistance towards brittle fractures, to indicate the acceptance criteria and to display their implementation for all components of the reactor vessel.

11.3.1.6 Control over the state of materials in the course of operation.

Describe in detail the program of monitoring the status of the vessel during operation. Demonstrate that the program meets the requirements of section 7 of Rules and Regulations for Nuclear Power Industry G–7–008–89. Provide a description of the control program according to witness samples, provide characteristics of the samples, their sets, the alleged extraction schedule. Demonstrate that the number of samples is consistent with the requirements of 7.7.5 of Rules and Regulations for Nuclear Power Industry G–7–008–89, or at least ensure that the requirements 7.7.6 Rules and Regulations for Nuclear Power Industry G–7–008–89 are met.

Provide a layout of the samples in the container and the reactor, a method of fixing the containers, to justify the representation of samples location (in terms of neutron fluence and irradiation temperature flow). Provide on the basis of certifying of the material the prospective influence of the radiation on the characteristics of the material (for example, the transition temperature shift).

11.3.1.7 Fasteners of the reactor vessel.

Describe the materials and design of the fasteners of the reactor vessel.

Confirm their compliance with the requirements of relevant sections of Rules and Regulations for Nuclear Power Industry G–7–008–89.

It is necessary to submit:

- Operations on non-destructive testing in the manufacturing process with reference to a quality control program;
- The type, amount and frequency control during operation.

Specify whether the design recommendation of TNLA are applied, or other alternative solutions for improving the resistance of the cyclic damage of fasteners.

11.3.2 Design limits for pressure and temperature

Provide justification of the design basis operating limits for pressure and temperature conditions for normal operation, violations of normal operation, emergencies, hydraulic testing, including the pre-operational ones. Present a detailed confirmation of compliance with the requirements of the 7.3 TCP 170 throughout the operation period of the installation and the requirements of the 5.5 TCP 171.

11.3.2.1 Limit values.

Present the extreme pressure and temperature values for the following conditions:

- Pre-hydraulic tests at the plant;
- Operational testing for leaks and strength as part of the primary coolant circuit;
- Normal operation, including warm-up and cool-down.

In case of applying techniques or criteria that differ from those recommended in Rules and Regulations for Nuclear Power Industry G–7–008–89, to demonstrate that the equivalent safety margin is provided.

Describe in the NPP SAR the design data limit values of temperature and pressure.

In the final NPP SAR include the results of tests of materials for strength and present limit values of temperature and pressure, based on the results obtained, as well as demonstrate the predicted effect of irradiation. Describe the source data, applied for forecasting.

11.3.3 Reactor vessel integrity

This subsection of NPP SAR shall contain the information on the integrity of the vessel that is not given in other sections. It shall be indicated (with reference to the analysis), the probability of destruction of the reactor vessel in accordance with the requirements of 4.16, 4.17 of TCP 170 and the factors contributing to the preservation of its integrity, as well as the reactor vessel designer and manufacturer, and their level of experience.

It is necessary to demonstrate that the reactor vessel withstand a static and dynamic loads in normal operation, violations of normal operations, emergency situations and design basis accidents for the entire operation period.

11.3.3.1 Design.

Provide the design principles and design criteria, adopted under section 2 of Rules and Regulations for Nuclear Power Industry G–7–008–89. Specify the safety class and the group in accordance with TCP 170 and Rules and Regulations for Nuclear Power Industry G–7–008–89; seismic category in accordance with the Rules and Regulations for Nuclear Power Industry–5.6.

Provide a brief description of the design, the design sketch labeling components, materials separately highlighting the design features and manufacturing techniques. Point out the construction regulations applied in the construction development, to indicate the justification for the implementation of the principles and design criteria.

If applicable, provide references to other sections of the NPP SAR.

11.3.3.2 Structural materials.

Include the materials, applied for vessel construction, the measures taken to improve their properties and quality (the impurity limitations of melting characteristics, etc.) into the description. Provide the criteria for selecting materials and provide justification for their implementation. If applicable, refer to other sections of the NPP SAR.

11.3.3.3 Manufacturing methods.

Specify the adopted manufacturing methods, to demonstrate the implementation of the requirements of section 4 of Rules and Regulations for Nuclear Power Industry G–7–008–89.

Describe the experience of operating vessels, manufactured by these methods. If applicable, provide links to other sections of the NPP SAR.

11.3.3.4 Control Requirements.

Specify design requirements for monitoring the integrity of the vessel (in accordance with the requirements for the quality control of basic materials and control of welding and surfacing rules) based on the requirements of 4.5 of Rules and Regulations for Nuclear Power Industry G–7–008–89 and Rules and Regulations for Nuclear Power Industry G–7–010–89; where the design requirements are appointed by the designer, give reasons for their appointment.

Describe any monitoring procedures adopted by the designer in addition to the prescribed regulations. Describe how the results of the checks are recorded with regard to the original vessel state. If necessary, provide references to other sections of the NPP SAR

11.3.3.5 Transportation and mounting.

Specify the means of vessel protection during transportation, protecting it from corrosion and damage, especially for the transportation via permitted modes of transport.

Provide the means of loading and unloading, assembly diagram, demonstrating the main operations, including installation of vessel on stakings.

11.3.3.6. Design limits.

Specify design limits, ensuring safety of the vessel, for normal operation (operating limits), emergencies and accidents. Provide justification for ensuring the integrity of the vessel under the most severe conditions, or refer to the relevant sections of the NPP SAR.

Perform the main stages of compression and decompression of the main casing joint of the vessel and other plug connections, working under pressure, indicating the measures to ensure the strength and density of connections (build order, tightening torques, control methods, etc.).

11.3.3.7. Control in the operation process.

Provide the description of order and the extent of vessel inspections, which shall comply with the requirement towards control over the equipment and pipelines metal state by operation and typical program of control, pursuant to Rules and Regulations for Nuclear Power Industry G-7-008- 89. Provide information on the applied control means, their characteristics and application experience with regard to similar facilities, justifying their applicability.

Stipulate the measures providing adequacy and compatibility of the control in different operation periods (including input and past-mounting control).

11.4 Primary coolant circuit elements

This subsection of the NPP safety report contains information concerning elements of the primary coolant circuit boundaries and its closely connected systems. The information hereunder shall be sufficient to estimate the degree to which the above elements affect the general safety of the NPP. It shall include the purpose of the elements and systems, design criteria, specification of the groups (according to Rules and Standards of Nuclear Power (PNAE) G-7-008-89), safety classes (according to TCP-170 (technical code of common practice), category of seismic stability (according to DS-031-01 (design standard) they belong to, technical specifications, structural design description and estimation of compliance with approved design criteria.

For every element (or system) an analogous one with established operating background is to be stated, as well as the differences between the element and its analogue and grounds for implementation of the former. In case of elements (or systems) fully adopted from other units and stock-produced items, full compliance of their technical specifications, operating modes and conditions with the requirements of the unit in question shall be shown.

In case of innovative elements (or systems), the grounds for their implementation shall be provided.

Quality assurance programs covering the element (or system) shall be described. It shall be shown to what degree and in what manner damages and failures of the elements affect the safety of the reactor unit (related references may be provided), with emphasis on the failures requiring separate analysis.

Since the quantity of main circulation circuit elements and systems closely connected to it may depend on the type of the reactor unit, the Applicant is to determine sets of elements and systems required for every single type of unit, as well as provide references to subsections describing every element or system depending on their nature. However, in any case, descriptions of every element or system closely related to the main circulation circuit shall be provided, besides the above stated information, as well as design-basis justification, a description, certificates of necessary tests and inspections and general estimation of the element or system; specific aspects of maintenance determined by radiation levels shall be taken into account. Detailed requirements to contents of subsections describing separate systems are listed in subsection 11.2.2 of this technical code.

11.4.1 Main circulation pumps (MCP)

Presented information shall include the description of MCP auxiliary systems, their specifications, design criteria and the grounds for their implementation. A short description of control and measuring equipment of the MCPs and their auxiliary systems with a list of internal blocking and protection mechanisms limiting the operating conditions of the MCPs shall be provided.

The information shall be provided to the extent specified by subsection 11.2.2 of this technical code.

Besides the information specified in subsection 11.4, a certificate of compliance with the requirements set forth by 5.5.7 of TCP 171, and a description of measures to ensure the integrity of the flywheel of MCP in cases of circulation speed rise caused by emergencies with large leaks of coolant or measures of preventing speed rise shall be provided, as well as references to related calculations

.

11.4.2 Steam generators (SG)

The information shall be provided to the extent specified by subsection 11.2.2 of this technical code. Besides, the list of SH technical specifications is to include calculated limits of radiations levels of the second SG coolant circuit during normal operating mode, as well as justification of these limits.

The radioactive consequences of breakages of heat exchange pipes of the SG collector and other emergencies leading to leakage from the primary coolant circuit into the secondary one shall be addressed, or references to the subsections of the safety report addressing these situations shall be provided.

Design criteria concerning prevention of critical damages to SG heat exchange tubes (caused by vibration, corrosion, etc.) and justification of their implementation shall be provided.

Calculation results justification is to include the following:

- Design conditions and allowances, a list of examined operating modes (of normal, abnormal and emergency operating modes) that are critical for determination of durability and reliability of heat exchange tubes and their seal areas in collectors;
- Results of tests and calculations affirming that the approved levels of stress intensity is sufficient for reliable operation of SG in accordance with the requirements set forth by sections 5.5.2 and 7.1.4 of TCP 170. References to corresponding subsections of the NPP safety report may be provided;
- Proof of retention of integrity of heat exchange tubes, tube plate, SG collectors in cases of accidents within the design basis with large amounts of leakage (serious breakage) in primary and second coolant circuits;
- The heat exchange surface allowance in accordance with 5.5.6 of TCP 171;
- Proof of compliance with the requirements of PNAE G-7-008-89 on surface metal temperature control and heat transfer medium level indicator.

11.4.2.1 Materials.

Information on SG materials shall be provided, with consideration of specific features of the SG and its manufacturing technology affecting requirements to materials (i.e. the presence of a separation of steam and water environment, temperature fluctuations, design and seal method of heat exchange tubes, etc.). The fact that the said specific features have been taken into consideration while choosing the type of material shall also be shown (i.e. the necessity to improve such features as crack or corrosion resistance).

Information on the peculiarities of the SG design that may affect the qualities of materials during operation (if such peculiarities are present) shall be provided.

The compatibility of SG materials with the heating medium of primary and second coolant circuit is to be stated and justified. A short review of the manufacturing technology behind major components of the SG shall be provided, with focus on the manufacturing technology behind collectors, welding of complex welded seams (i.e. dissimilar joints), as well as a detailed description of method of sealing the heat exchange tubes, justification and grounds for the choice of this particular technology and measures of prevention of cracks in perforated collector area. The degree of heat exchange tubes' expansion is to be stated. The means of cleaning the heat exchange surface during manufacture and cleanliness control methods shall be described.

The selection of the type of material for heat exchange tubes shall be justified. Requirements to surface condition, heat treatment and other parameters essential to maintaining operating capability of the tubes are to be stated.

A description of SG transportation method, of measures taken to prevent damages to SG elements during transport and installation, as well as the justification of necessity and a description of means of conservation of heat exchange surface, control over conservation and cleanliness of internal surface during storage, installation and final assembly at the NPP shall be provided. A short description of SG installation order shall be provided.

11.4.2.2 SG control and maintenance during operation.

A description of design solutions aimed at ensuring control of all elements of the steam generator during operation, including ensuring control of every heat exchange tube, SG elements' state control program, including the condition of metal shall be provided. The means of ensuring compatibility of control methods before and during operation shall be provided. Compliance of the control program with the requirements to methods of control over equipment and tube metal condition during NPP operation is to be stated.

A detailed description of means and methods of control of heat exchange tubes, their seal areas, perforated area of the tube sheet or the collector, phase interface area, welded seams, separable connections and internal units shall be provided. An estimation the manpower and labor effort and related dose intensity and the degree of work automation shall be provided.

The information provided shall include descriptions of equipment used in control of operations and precision of monitoring, registration methods, estimation criteria, control intervals, measures to be taken after defect detection, including measures of heat exchange tubes defects remedy.

A description of critical SG in-process maintenance operations, including means of heat exchange tubes cleaning in order to maintain their heat exchanging properties and pulp removal order shall be provided; the primary water chemistry guidelines of the second coolant circuit and design measures of their implementation are to be stated. The water chemistry guidelines limitations the violation of which provides grounds for suspension of SG operation are to be stated.

References to other sections or subsections of the NPP safety report or other related design materials shall be provided.

11.4.3 Pipelines containing the coolant of primary coolant circuit

This subsection of the NPP safety report contains design data on pipelines under primary coolant circuit pressure during operation (connected part of the primary circuit).

The connected part of the primary coolant circuit includes:

- The primary circulation pipeline;
- Adjacent systems' connection lines within boundaries of the primary coolant circuit(according to 11.1)

The information shall be provided in accordance with the requirements of subsection 11.2.2 of this technical code

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The pipeline description is to include corresponding references to detailed information on criteria, methods and materials stated in sections 9 and 11.2.3 of this technical code

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The general description shall contain proof of compliance with the requirements of5.5.4 and 5.5.5 of TCP 171, as well as control measures against crack formation in stainless steel due to stress related corrosion.

The use of "Leakage before break concept" in the design shall be supported by references to corresponding sections of the NPP safety report.

11.4.4 Limitation of steam consumption through steam main

This subsection shall contain the means of limiting the steam flow through the primary steam pipeline in cases of breakages in different areas of the steam circuit provided for by the design, if such means have been provided for (i.e. emergency flow limitations insertions).

11.4.5 Steam main cut-off system

This section shall contain means of isolating steam generators from the primary steam pipeline in order to prevent leakage of radiation into the environment in cases of steam pipeline breakages (outside the boundaries of the protective layer, if applicable) and rapid reactor shut-down cooling. If fast action pressure reducing valves are used for isolation, they are to be classified as protection security systems. In this regard, proof of their compliance with the requirements of sections 7.6 of TCP 170 and section 5.1.6 of TCP 171, as well as installation structural scheme, control scheme, triggering signals, methods and schedule of in- process maintenance.

The information shall be provided to the extent specified by subsection 11.2.2 of this technical code.

11.4.6. Reactor core cooling system

The information stated shall comply with the requirements of section 11.2.2 of this technical code

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11.4.7 Residual heat removal system

This section shall contain all measures taken (systems implemented) to provide appropriate residual heat removal with reference to their specific function.

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Detailed information on systems removing residual heat from the primary coolant circuit (i.e. heat exchange units integrated into the reactor) shall be provided. Other systems providing residual heat removal (i.e. from the second coolant circuit) shall be described in other sections of the NPP safety report. This section shall contain references to sections containing above descriptions.

The plan of information provision shall comply with the plan set forth by section 11.2.2 of this technical code.

11.4.8 Pressure compensator

The plan of information provision shall comply with the plan set forth by section 11.2.2 of this technical code.

11.4.9 Primary coolant circuit pressure maintenance system

When describing the primary coolant circuit pressure maintenance system, it is necessary to subdivide it into subsystems (pressure reducing subsystem, pressure increasing subsystem). The functions of every subsystem, the criteria imposed upon the performance of every subsystem and the characteristic state of elements of every subsystem during normal operation mode shall be provided.

The values of main parameters that turn every subsystem into operation, as well as characteristic of their efficiency (rate of pressure decrease or increase) during normal operation mode, abnormal operation mode, emergency operation mode shall be provided. The triggering and shut down signals shall be described. The redundancy level of subsystem elements and the state of subsystems in emergency situations are to be stated.

The plan of information provision shall comply with the plan set forth by section 11.2.2 of this technical code.

11.4.10 Valves

This section shall contain information on isolation and regulation valves.

The plan of information provision shall comply with the plan set forth by section 11.2.2 of this technical code.

The proof of compliance with the requirements to the design and safe operation of the equipment and pipelines of nuclear power units and pipeline valves for nuclear power plants set forth by PNAE G-8-008-89 and DS-068-05 shall be provided.

11.4.11 Safety and relief valves

This section shall contain description and properties of relief and safety valves. The plan of information provision shall comply with the plan set forth by section 11.2.2 of this technical code.

11.4.12 Support structures of main components

This section shall contain design sketches and short descriptions of supporting structures of the reactor, steam generator and the main circulation pump with specification of its design load.

12. Steam-turbine plant

The section shall contain the information on the steam-turbine plant within the second circuit systems' boundary.

All the steam-turbine plant and its systems shall be considered as normally functioning systems.

Concerning the turbo-unit, the information on all its systems, including the capacitor, vacuum system, regenerative heaters, oil system and gas supply shall be provided.

The information on power supply, ventilation, technical water, fire extinguishing shall be provided in section “Auxiliary systems”.

In necessary cases there shall be references to the respective sections of NPP safety report, e.g. section “Accidents analyses” or to section “Power supply”.

The information shall reflect the systems’ influence at the NPP’s safety.

Turbo-unit shall be considered as a unit that affects and ensures a reliable and safe NPP operation.

The information on the questions not affecting a reliable and safe NPP operation is not to be provided.

The information on the systems not affecting the safety s h a l l prove the capability of these systems to function without direct or indirect effect at the NPP’s safety.

The description of the systems shall comply with Supplement A.

12.1 Turboset

12.1.1 Project design fundamentals

12.1.1.1 Purpose and functions.

It is necessary to describe the turbo-unit designation with respect to the influence on the reactor unit from the point of view of reactor’s maneuver characteristics and power control. At the same time, it is necessary to show the turbo-unit’s functions at the normal operation mode, at abnormal mode, emergency situations and accidents connected with reactor unit operation.

Classification of turbo-unit equipment as per the requirements of TCP 170, seismic resistance category as per DS-031-01 and quality groups as per PNAE G-7-008-89.

The section shall contain a list of Technical Safety Regulations the turbo-unit shall comply with.

12.1.1.2 Design modes and initial data

It is necessary to describe the requirements to maneuverability stating the acceptable number of triggering during service life (from cold state, hot state, regular and irregular stops, load discharge to idle running, discharge to the lowest control range with successive loading), calculated triggering duration from different thermal states from the moment of feeding steam into the turbine till nominal load; control range of automatic power change; deviation of rotor’s rotation frequency in controlled range and emergency conditions.

It is necessary to describe characteristics of all turbine’s modes of operation including the conditions of triggering and stops as well as the parameters characterizing unacceptable increase in the number of turbine’s rounds.

12.1.1.3 Process layout and design implementation.

The primary design concepts and safety criteria of the turboset shall be specified.

The requirements to operational efficiency set forth by the technical design assignment, to safe operation of the turboset while exposed to flying objects and while accelerating, as well as in cases of short circuits with relevant Technological regulatory acts (TNLA) instruction shall be specified. The requirements to design embodiment, reliability and durability, including operational availability factor, mean error-free run time, inter- maintenance period, gross life, seismic resistance in cases of Operating base earthquake (OBE) according to the MSK-64 scale shall be specified.

This subsection shall contain lists of initiating events.

12.1.1.4 Requirements to the related systems:

The requirements to turboset cooling systems (circulation and service water), power and oil supply, ventilation, fire suppression, control, protection and sealing, alarm systems are to be stated.

12.1.1.5 The requirements to the turboset components arrangement:

This subsection shall contain the requirements to the turboset components arrangement (turbine operational flying objects, turbine orientation and placement of flammable and explosive materials).

The arrangement and orientation of the turbine are to be distinctly reflected on the power unit placement layout drawings.

The layout plan and elevation view of the turbine island are to show areas of potential ejection of flying objects ±25° wide relative to low pressure cylinders’ ring for every turbine within the boundaries of the turbine island.

The places of potential projectile hits (targets' area) shall be shown on the layout plan and the vertical view in regards to every safety-critical system (SCS).

12.1.2 System project

The section is to confirm the compliance with all primary design guidelines, requirements to related systems, criteria, requirements to construction and arrangement solutions.

12.1.2.1 Description of process layout and turboset construction

This subsection shall contain the description of process layout and turboset construction. A description of turbine rotation overspeeding control system, including a description of control and management systems' redundancy protection technology and the type of rotation rate control in place, shall be given.

A description of turbine cylinders' construction, control valves' type, vibration modes of turbine blading and the type of connection between the runner's components and the blading

shall be given.

A description of the construction of support bearings and turbine bearings, as well as their vibration properties shall be given.

The turboset arrangement layout plans and drawings (different views), heat balance diagrams, oil supply schematics, layouts of control, protection and alarm units networks with specification of their management technology and their connection to the power unit control station (PUCB) or an power unit control board (PUCB) or are to be supplemented to the subsection.

12.1.2.2 Description of components.

This subsection shall contain a short description of the components of the turboset and provide their classification. In particular, mechanical strength properties of the disc components of the turboset shall be listed (the description and construction of the turboset are to be stated in section 14 "Power supply").

A description of programs and methods used to evaluate the mechanical strength characteristics of the blading component and low-pressure rotor shaft shall be given. The data concerning calculations of the brittle fracture property of the rotating element of the turbine is to be listed.

This subsection shall contain justification of the fact that produced flying objects will not cause damage to SCSs or the oil tank if the unit.

This subsection shall contain calculated values of the parameters of the disc component of the turbine, as well as the data concerning the following properties:

- tangential stress caused by centrifugal force, interference and gradients in the area of stress raisers, in relation to normal and above-normal speed loads;
- peaks of tangential and radial stresses and specifications of the their concentration areas.

A description of calculation programs and methods shall also be provided.

12.1.2.3 Description of materials.

A description of materials used to manufacture the turbine components, containers (heating units), rotating units, disc components, blading, including the manufacturing technology, mechanical properties, chemical composition (including hazardous substances) shall be given.

This subsection shall contain the value rupture resistance parameters of the material of the rotating unit of the high-pressure cylinder, as well as the method of their calculation.

12.1.2.4 Protection from out-of-tolerance overpressure

This subsection shall contain data on justification and ground for the means of preventing out-of-tolerance overpressure from affecting the turboset and its components, as well as their description.

12.1.2.5 Protection from overspeeding

The system preventing the turbine from overspeeding is to be described, in particular - redundancy protection technology, evaluation of the reliability of units, the order of conducting tests and maintaining control (references to the requirements of sections 12.1.4 and 12.1.15 may be provided).

12.1.2.6 Disabling the system.

The description of the system disabling process shall contain means and conditions of disabling the turboset and its state after being disabled.

12.1.3 System management and operation control

12.1.3.1 A description of protection and sealing mechanisms affecting the scram pins (SP) of the reactor, power limiting unit, reactor unit (RU) alarm system, power control unit.

12.1.3.2 Control points

The description of control points shall include references to process layout plan containing all points. The review of control points shall be conducted in regards to their effect on systems and RUs listed in section 12.1.3.1 of this technical code.

12.1.3.3 Limits and conditions of safe operation.

This subsection shall contain all limits and condition of safe operation necessary for the correct function of all security and sealing systems. The above limits and conditions of safe operation shall primarily related to reactor SPs, power limiting unit and alarm systems, as well as the acceleration rate of the turboset.

12.1.3.4 Personnel activities.

The main activities of the personnel in cases of emergencies or abnormal operation shall be described.

12.1.4 Tests and inspections

This subsection shall contain a description of quality assurance measures taken during manufacturing, construction and the installation of the turboset and related equipment.

Scope and methods of acceptance control, pre-commissioning tests and their methodological support, as well as a description of control equipment shall be described.

The programs of pre-commissioning tests and in-process control of the whole turboset, as well as of its locking apparatus and automatic safety devices shall be described.

12.1.5. Project design analysis

12.1.5.1 Reliability targets.

This subsection of the NPP safety report shall contain the reliability targets of the turboset and related equipment, as well as the results of qualitative and quantitative analysis of its reliability.

The calculation of parameters shall be comprehensive and take into account the related systems.

If any tests were run in order to provide justification for reliability, a short description of every test shall be provided.

The information on equipment reliability parameters and calculation programs shall be sufficient to conduct alternative independent calculations.

12.1.5.2 Normal operating mode.

This subsection of the NPP safety report shall contain a short description of the normal operating modes of the turboset, including starting mode, power operation shutdown mode.

The factors affecting the operation of the RU related to normal operating modes shall be specified. In particular, the effect of the sudden loss of load and possible transition processes shall be described, and the operation of the turboset control system and overspeeding protection system shall be included as well.

12.1.5.3 Operation in cases of system failure

The description of operation in case of system failure shall include information on qualitative analysis of all possible failures of the components of the turboset and its subsystems.

The process of re-establishment of normal operation using the redundancy protection systems, or its temporary operation with disabled equipment shall be described.

12.1.5.4 Abnormal system operation

Transitioning process causing abnormal operation modes shall be described, as well as their effect on the power limiting system due to possible failures, on the alarm system and the SPs. The operation of the quick-acting pressure reducing air-discharge into the atmosphere system (BRU-A), quick-acting pressure reducing air-discharge into the turbine condenser system (BRU-K) and other related systems, in particular, the auxiliary steam- piping system and the turbine heat cogenerating system, shall be described.

System abnormal operation caused by the turboset specifically or by failures of related systems shall be described.

12.1.5.5 System emergency operation.

A list of initial events leading to emergency situations shall be provided.

This subsection is to detail system emergency operation with consideration of all its components.

The method of steam supply to the power unit in shutdown shall be described.

The full analysis of emergencies at the NPP caused by the abnormal operation of the turboset shall be provided in section titled “Emergency analysis” of the NPP safety report.

12.1.5.6 System operation in cases of external influence

This subsection is to detail system condition (operation or shutdown) in cases of external influence (i.e. earthquakes, explosions, plane crashes, tornadoes, etc.).

The extent of external influence presupposing shutdown of the turboset or the whole NPP shall be specified.

This subsection shall contain references to section titled “Auxiliary systems” of the NPP safety report, which describes fires at the NPP site and in the turbine island as initial

events.

12.1.5.7 Design evaluation

The design shall be evaluated based on qualitative analyses, quantitative parameters of system reliability and test data.

Besides, compliance with relevant safety TNLAs, special technical guidelines and industry-specific standards shall be shown.

12.1.5.8 Comparison of the design with similar ones

This subsection is to detail comparisons between the design and its analogues implemented at other NPPs, as well as advantages and drawbacks of design solutions affecting plant safety based on the comparisons.

12.2 Live steam lines system

12.3 Feed water system

12.4 Second coolant circuit steam dumping into turbine condensers system

12.5 Second coolant circuit overpressure prevention system

12.6 Second coolant circuit coolant make-up system

12.7 Second coolant circuit water chemistry guidelines

12.8 Turbine condensate removal system

12.9 Second coolant circuit process medium sampling system

The above listed systems (12.2-12.9) within the boundaries of the steam turbine unit shall be described as per the plan set forth by the beginning of the section, with specification of the influence of every system over the operation of the turboset and related failures affecting the RU.

The information shall not reiterate the contents of section “Primary coolant circuit and related systems”, or the contents of other sections of the NPP safety report. While detailing the data within sections 12.2.-12.10, the following concepts shall be emphasized: system reliability and their influence on the radiation levels at the NPP, since every system represents a hazard of potential radioactive substances (RS) leak and build-up.

The information on circulation water shall detail the matters of possible RS leak and build-up, as well as the hazard of flooding the NPP site in case of breakage of corresponding pipelines.

Information on possibility of flying objects in cases of high-pressure pipeline or vessel breakages and possible damage to security systems (SSs) shall be listed.

12.10 Substantiation of strength, steadiness and operability of pipelines, pumps, valves, main reinforcement, safety and relief valves against the impact of natural and technogenic origin

This subsection shall list the results of calculations confirming durability, resistance parameters and operational capacity of above elements in accordance with the classification, comprised for the elements of every system, and load combination (per PNAE G-7-008-89).

13 Control and management

This section shall describe systems and measures of control and management of the NPP unit during normal operation, abnormal operation or operation in cases of emergencies where protection of equipment, of NPP personnel, of the public and of the environment from possible radioactive releases may be required.

Requirements to the information contained in this section apply to systems and measures essential for the safety of the NPP unit, performing functions of control and

management in order to provide safety.

This sections reviews requirements to information concerning management aspects regarding safety matters related to reactor shutdown management during normal operation, safety control systems, emergency reactor protection system, system of transfer and display of safety-related data to the operator, control and management systems essential for safety assurance, as well as other normal operation mode systems, failures of which are not to affect the NPP unit safety.

The requirements to data concern safety aspects related to the special features of organization of control over the unit by operating personnel and safety-related functions of the personnel.

The requirements to data regarding control and management systems and measures unrelated to safety are classified as information showing that the said systems and measures are not essential for safety assurance.

Presented information shall be sufficient and detailed enough in order to justify technical and organizational safety solutions implemented in the technical design.

The requirements apply to systems and measures performing functions of control and management both via standard technical means of control and management and via automated control systems involving computers, informational systems and microprocessors.

13.1 Introduction

13.1.1 Defining safety-relevant control and management systems and measures.

This subsection shall list all safety-relevant control and management systems and measures, as well as their components and subsystems (control and measurement apparatus, indication and detection apparatus, sensors, transformers and converters, etc.), including alarms and communication, performing functions of control and management for the following purposes:

- Ensuring safety during normal operation of the NPP unit for efficient energy production;
- The prevention of violation of relevant limits and safe operation conditions;
- Accidents prevention;
- Minimization of the negative impact of accidents;
- Returning the NPP into operable state after accidents;
- Organization of personnel management and notification during normal operation mode, or alarm during emergencies.

The names and identifications of systems and measures of control and management shall be specified in accordance with design documentation and technical conditions.

The classification of said systems and measures according to their purpose and nature of their function shall be stated.

It shall be specified whether described systems represent an innovative technology or a standard certified one.

The differences between the existing systems and measures with well-known operational background and new ones shall be stated.

The systems and measures identical to those already implemented at other NPP units shall be specified.

13.1.2 Primary safety principles and criteria

All base data necessary for analysis, as well as documents, criteria, special regulations and specifications, standards, guidelines or other documents, which shall be taken into account while designing systems and measures, stated in subsection 13.1.1, shall be listed.

It shall be stated to what extent were special regulations and rules concerning safety (with specification of limits, subsections, paragraphs and specific requirements) fulfilled.

The extent of fulfillment of other related TNLAs shall also be stated. If any alternative approaches to ensuring safe control and management were implemented, it shall be demonstrated that the required level of safety has still been achieved

13.2 Control and management systems and measures ensuring normal operation of the NPP unit

13.2.1 System of control and management of the NPP unit

13.2.1.1 Designation and design basics

Information on conditions and limitations, as well as the grounds for said conditions and limitations, designation of systems and measures, safety principles and criteria at the basis of NPP unit's control and management system design and system classification data and its justification shall be provided.

The functions of the system (measures) and their fulfillment criteria are to be determined.

13.2.1.2 Description.

Information containing the description of unit control and management system (UCMS) and its components, as well as technical specifications, functioning mechanics during normal operation mode, abnormal operation mode and emergency operation mode taking into account its interaction with other systems and measures and related equipment, shall be given.

Information o n implemented technological solutions and UCMS structural components, including:

- Systems and measures ensuring remote, automated and (or) automatic control over normal NPP unit operation systems;

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- Measures ensuring control over and proper representation of information on

parameters characterizing the RU operation within the whole range of variations of operating modes, as well as information on variations in the normal operating mode;

- Operator informational support systems, including system ensuring dynamic presentation of general information on the RU and the NPP unit safety status to the personnel;
- Measures providing group communication between the PUCS, the PUCB and the operating personnel at the NPP performing on-site services;
- Measures providing individual communication between the PUCS, the PUCB and the personnel responsible for accumulation, processing, documenting and storing information;
- Status and operating mode diagnostics measures;
- Measures providing diagnostics of UCMS hardware and software, control systems and radioactivity status;

Information on UCMS components and implemented solutions shall also contain data on their composition, primary specifications, arrangement, layouts of systems and measures, description of their functioning mechanics during normal operation, abnormal operation or emergency operation, taking into account interactions between systems and measures and related equipment.

Initial calculations used for safety analysis, including methods of evaluation and control of reliability parameters at every stage of system design and operation, shall be provided.

Data on power supply and grounding, means of protection from external factors, systems ensuring the stability of the working environment of system equipment and personnel, shall be provided.

Justification of the use of materials, unique systems and measures, innovative technology and control and management methods, as well as of the implementation of imported and non-serially produced technologies and a comparison between them and their analogues implemented at other NPPs, shall be emphasized.

Drawings, layouts, diagrams and tables necessary for justification of implemented design and technological solutions concerning safety assurance, data flow charts and encoding system shall also be provided and described. The UCMS components irrelevant to ensuring safety shall be specified as such.

13.2.1.3 Pre-commissioning activities (PCA).

Information concerning justification of sufficiency of the required organizational and technical measures and of the list of potentially risk-associated activities and accident-preventing measures shall be provided.

Operational limits for the PCA stage of UCMS operation shall be specified. In cases where final requirements to operational limits and conditions, sequence and scope of PCAs are set during the “Operational documentation” stage, corresponding data shall be provided in the final safety report.

Methods of testing the operational capacity of control and management systems, methods of their complex adjustment and diagnostics, methods of documenting their properties, and acceptance criteria and its justification are to be emphasized.

Comparative data on similar organizational and technological solutions concerning UMCS and its components, accounting for testing and approbation of the analogues and their prototypes, shall be listed.

13.2.1.4 Maintenance.

Operational limits for the UCMS preventing violation of limits and conditions of safe operation of the unit shall be justified.

Justification of diagnostics solutions, methods of regular control of the status of UCMS and its components, of their regular inspection and operational testing, means of registering and documenting defects and failures, and personnel training is to be emphasized.

The provided information shall contain initial data for the analysis of the extent of impact of UCMS maintenance on safety.

A justification of measures and procedures aimed at remedying defects and failures during maintenance shall be provided.

13.2.1.5 Safety analysis.

The results of the analysis of the nature and impact of control and management system failures not representing an emergency initiating event, and of the analysis and nature of accidents reflecting the extent of compliance with design criteria, requirements of relevant regulations and with safety regulations, shall be provided.

The information provided in this subsection shall contain the results of the analysis of system response to external and internal influence (fires, flooding, electromagnetic interference, primary power supply network short circuit, etc.), system response to possible defects and failures (deterioration of insulation material, voltage loss and pickup, false triggering, loss of control, etc.), the results of quantitative reliability analysis, the results of the analysis of durability of control and regulation circuits and their impact on safety status.

In cases where initial calculation data and the analysis are related to personnel activities, the results of the analysis of the impact of personnel malpractice on safety status, as well as data on instrument and control equipment (ICE) and the machinery preventing and minimizing the effect of violation of normal operating conditions and accidents, shall be provided.

For systems and measures irrelevant to safety, results of the analysis of the impact of failures and accidents serving as evidence of the fact said systems and measures do not affect safety shall be provided. The same requirements apply to the analysis of the impact of maintenance on safety.

13.2.2 Power unit control station

The requirements to subsections 13.2.2.1-13.2.2.5 are the same as the requirements to subsections 13.2.1.1 - 13.2.1.5 of the technical code listed above .

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13.2.2.1 Designation and design basics

The requirements to designation and design basics are the same as the requirements to subsections 13.2.1.1 of the technical code.

13.2.2.2 Description.

This subsection shall contain a description of the PUCS, CMIs (including the subsystem displaying the status of the of the regulating components of CPS with relevant sensors communication channels and their back-up redundancy system, which makes the data available to the operator in order to conduct activities necessary to ensure safety), as well as:

- General description of the PUCS;
- The composition of PUCS control panels with control and management apparatus installed;
- General view of the PUCS boards and pads with control and management apparatus installed;
- Information on the arrangement of safety-relevant control and management apparatus, and information necessary to substantiate ergonomic requirements to their implementation and the arrangement of informational and body fields on the control board panels and on the control panel pad(s).

Emphasis shall be put on information concerning substantiation of technical solutions on:

- Registration of control personnel activities in emergency situations;
- Automatic delivery of data concerning the status of safety-relevant equipment to the operator;
- Independent in-process check of operability of safety-relevant equipment by the operator;
- A list of functions performed automatically with delivery of corresponding data to the operator;
- A list of functions performed by the operator;

Information substantiating back-up redundancy of automatically performed functions by functions performed by the operator;

The way the PUCS ensures control and management over the RI and other system components, including security systems, during normal operation or in emergency situations shall be reflected.

The functioning mechanics of the PUCS and its components in conjunction with other systems and related equipment during normal operation, abnormal and emergency operation shall be described.

A description of control and measurement instruments (including the system determining the position of regulating units) making the information received by the operator suitable for use in order to appropriately perform the safety-providing activities.

The extent of addressing the problems arising from the person-machine interactions shall be substantiated.

The sufficiency of the amount of workspace for all operating personnel both during normal operation and emergencies shall be substantiated.

The restriction of access to control stations to persons outside the working shift roster both during normal operation and emergencies provided for by the design of the PUCS, is to be shown.

Data on antropometrics and ergonomics of the operators' workspaces shall be stated.

The following aspects of the informational fields of the operators' workspaces shall be substantiated:

- The arrangement of means of displaying safety-relevant data on the PUCS panels and board pads.
- Colour-distinctive arrangement of the means of displaying safety-relevant data;
- The convenience of tracking displayed safety-relevant information by the operator (field of view, the size of diagrams, numbers and other symbols);
- The reliability of the backlighting of diagrams, numbers and other symbols implemented in the display apparatus.

The following aspects of the body fields of the operators' workspaces shall be substantiated:

- The arrangement of safety-relevant executive control means (buttons, keys, etc.) on the body field of the control station panels and board pads, with substantiation of convenience of tracking information displayed for the purpose of conducting control activities with said devices;
- Colour-distinctive arrangement of the means of conducting control over safety-relevant executive apparatus;
- Means of authorizing access to safety-relevant executive apparatus control devices, if access authorization is required;
- Distinctive configuration of safety-relevant informational devices. Substantiation of

the following aspects shall be provided:

- Lighting of the operator workspace, colour, sound and other distinctive properties of the alarm system that shall make it easily identifiable for the operator and shall have a single interpretation throughout all control centers at the NPP unit.
- Communication means implementation;
- Industrial television means implementation;
- Implementation of PUCS informational means intended to be used by all operators on the roster;
- Ergonomics of the technical solutions on manual and automatic registration of information by the operator at the workplace;
- Complex solutions on storage of operation-relevant documentation at the workplace of the operator;
- Technology and means of organization of food supply to the operator’s workplace during normal and abnormal operational activities, as well as in emergency situations.

13.2.2.3 Pre-commissioning activities.

The requirements to the description of pre-commissioning activities are the same as the requirements stated in subsection 13.2.1.3 of this technical code,

13.2.2.4 Maintenance

The requirements to the description of maintenance activities are the same as the requirements stated in subsection 13.2.1.3 of this technical code,

13.2.1.4 .

The extent and scope of measurement assurance of the PUCS equipment and its components shall be substantiated.

13.2.2.5 Safety analysis.

The requirements to safety analysis are the same as the requirements stated in subsection 13.2.1.5 of this technical code.

The results of the analysis of reliability of all components of PUCS, substantiation of all selected parameters displayed for the operator during normal operation, abnormal operation or emergencies are to be stated. It shall be shown that the selected parameters ensure provision of comprehensive data on compliance with the limits and conditions of safe

operation, as well as identification and triggering diagnostics and functioning of the SS.

The results of the analysis of the impact of systems ensuring the appropriate working environment of the PUCS on its reliability and operational capacity shall be provided.

The results of the analysis proving that failure of both PUCS and the EPUCS is impossible.

The analysis demonstrating that the operator possesses information sufficient to perform necessary from the safety standpoint manual operations (i.e. ensuring optimal arrangement of regulating apparatus, manual maintenance of safety apparatus, possible unforeseen post-accident operations and monitoring the status of the technical safety assurance means) and time sufficient to make necessary decisions and perform corresponding operations.

It shall be shown that the operator has access to data displayed by the reactor control apparatus, coolant circulation system, reactor containment vessel and safety assurance systems in all RI operation modes, including foreseeable operational modes and emergency modes.

The information presented shall include calculation criteria, types of read-out devices, number of read-out channels, measurement range in the said channels, accuracy and arrangement of equipment, as well as substantiation of the sufficiency of calculations.

13.2.3 Reactor installation control and management system (RICMS)

13.2.3.1 Designation and design basics

The requirements to this subsection are similar to the requirements of subsection 13.2.1.1 of this technical code.

13.2.3.2 Description.

This subsection shall contain the description of RICMS, its components, primary specifications and functioning mechanics during normal and abnormal operation modes and during emergencies, its interactions with other systems, UCMS, PUCS and related equipment.

This subsection shall list Initial calculation data on RICMS, including:

- concerning RI diagnostic means;
- concerning RICMS diagnostic means;
- concerning Registration system;
- concerning means of control over the quantity of neutron absorbing isotopes in the RI absorber;
- concerning means of control over the quantity of neutron absorbing isotopes in the in the absorber emergency vessels;
- concerning means of control and (or) measurement of absorber solution pressure in the absorbing unit emergency vessels;
- concerning operator informational support systems;
- Concerning industrial television systems;
- Concerning means of communication with PUCS, EPUCS and local control posts;
- Concerning means of signal transfer to (from) industrial accident control centers;
- Concerning accident, notification and emergency alarm devices;

The manner in which the RICMS and its components perform RI status monitoring and safe management during normal operation shall be reflected.

13.2.3.3 The requirements to the information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.1.3 of this technical code.

13.2.3.4 The requirements to the information on maintenance are similar to the requirements stated in subsection 13.2.1.4 of this technical code.

13.2.3.5 The requirements to the information on safety analysis are similar to the requirements stated in subsection 13.2.1.5 of this technical code.

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13.2.4 Reactor unit control and protection systems

The requirements to information to be presented in subsection 13.2.4 are similar to the requirements stated in subsection 13.2.1 of this technical code.

13.2.4.1 Function and design basics

The requirements to the description of the function and design basics are similar to the requirements stated in subsection 13.2.1.1 of this technical code.

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13.2.4.2 Description.

The requirements to description are similar to the requirements stated in subsection 13.2.1.1 of this technical code.

A description of RICMS components, reactor shutdown system, including the ones now performing EP functions during normal operation, abnormal operation and emergency situations, shall be given.

A description of every RI EP system shall contain:

- System’s structure;
- Automatically performed system functions;
- Functions performed by the operator;
- The description of the system’s functional mechanics;
- The description of safety-irrelevant system components; Materials to be presented are to contain:
- A list of reactor EP triggering signals;
- A description of every executive protection system signal programming on every parameter;
- A description of back-up means of protection system triggering;
- A description of access authorization procedure for protection system activation;
- A description of protection functions’ channels’ back-up redundancy procedure;
- Substantiation of compliance of the structure of every reactor EP system with the principle of variety;
- A description of auxiliary protection systems;

All means ensuring normal operation of reactor EP systems shall be specified and described in the materials.

Moreover, the following aspects of every system shall be stated:

- System functional algorithm;

- Composition, structure and properties of every system channel;
- Information of system equipment arrangement;

Information substantiating independence and sufficiency of EP systems' power supply during normal operation, abnormal operation, and in case of the occurrence of project and beyond design basis accidents shall be provided. Emphasis shall be put on the information about determination and remedy of the reasons of EP systems triggering, as well as the order of personnel activities during restoration of RI operation after the EP systems activation.

A description of neutron flux and reactivity control and management systems and their components:

- Control channels;
- Recording devices;
- Auxiliary control systems (if necessary);
- Reactimeters;
- Means of conducting automatic inspections of operational capacity of control channels and system failure alarm;
- Automatic RI power control system;
- Reactor core subcriticality control systems;
- Control of non-uniformity of power-density in the reactor core;
- Program for in-process calculation of critical power ratio, as well as neutron density fluctuation control and management means.

All related devices and system equipment components shall be specified and described as well.

Initial calculation data on all system properties and parameters, system layouts and its components, their allocation and arrangement layouts shall be provided,

13.2.4.3 Pre-commissioning activities.

The requirements to the information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.1.3 of this technical code.

13.2.4.4 Maintenance

The requirements to the information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.1.4 of this technical code.

13.2.4.5 Safety analysis.

The requirements to the safety analysis data are similar to the requirements stated in subsection 13.2.1.5 of this technical code.

The safety analysis shall emphasize the impact of failures that may cause systems and means of reactor shutdown to lose their operating capacity. The ability of RICMS to prevent the reactor from reaching out-of-control critical levels.

It shall be shown that it is possible to overlap the band of neutron flow density measurement system in the required range, and that failures of one of the channels or its shutdown do not cause fluctuations in reactor power level due to the automatic regulation system activation.

The results of the analysis are to show that failures of level control channels and (or) neutron flow density fluctuation rate trigger an alarm, alerting the operator, as well as a failure

registration system. The safety analysis shall substantiate measures to eliminate the introduction of positive reactivity.

Scope and sufficiency of measurement assurance apparatus shall be substantiated. The section materials are to contain the following analysis results:

- functional reliability of reactor shutdown EP system;
- Consequences of its failures;
- Consequences of supply systems (power supply, ventilation, etc.). Moreover, the analysis shall contain descriptions of the function of every system during design basis and beyond design basis accidents with consideration of such events as:
- Reactor EP systems air cooling failure;
- Reactor EP systems water cooling failure; RI unit load dump;

Turbine emergency shutdown;

The following aspect of every system shall be presented:

- System functional algorithm;
- Composition, structure and properties of every system channel;
- Information on system components' arrangement;

- Information display channels diagnostics.

This subsection shall substantiate the fact that the operator possesses sufficient amount of data to perform manual safety-relevant operations (such as the status of controlled rods in the reactor core, safety-relevant parameter control channels' operational capacity, power registration, etc.). It shall be shown that the ACS project implements the concept of 30- minute operator non-interference period in emergency situations. The manual control restriction mechanism (automated or on instructional basis) shall be specified.

This subsection shall contain the analysis showing that in all operational modes the operator is sufficiently supplied with data concerning the following parameters:

- Nuclear reactor status;
- Coolant and heat removal circulation systems;
- Safety systems, including automation and control means;
- Reactor vessel status

13.3 Systems and means of safety systems manipulation and control

13.3.1 Nuclear power plant power unit safety controlling systems

13.3.1.1 The requirements to information on the function and project fundamentals are similar to the requirements stated in subsection 13.2.1.1 of this technical code

13.3.1.2 The requirements to description are similar to the requirements stated in subsection 13.2.1.2 of this technical code

The description of every CSS shall contain:

- The system structure;
- Automatic system functions;
- The description of every safety-irrelevant system component;
- System function algorithm;
- Composition, structure and characteristics of system channels;
- The description of system functioning mechanics;
- Layouts and drawings of the arrangement of system components;

The multiplicity of system channels and its independence from the control and management system shall be substantiated. All system components shall be described.

13.3.1.3 Pre-commissioning activities.

The requirements to information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.1.3 of this technical code

13.3.1.4 Maintenance.

The requirements to information on maintenance are similar to the requirements stated in subsection 13.2.1.4 of this technical code

13.3.1.5 Safety analysis.

The requirements to safety analysis are similar to the requirements stated in subsection 13.2.1.5 of this technical code

The materials shall substantiate the compliance with safety requirements, as well as contain the results of tests on the following parameters:

- System function reliability;
- System failure consequences;
- Support systems (power supply, ventilation, etc.) failure consequences.

13.3.2 Emergency power unit control station

The requirements to subsections 13.3.2.1 - 13.3.2.5 are similar to the requirements to subsections 13.2.2.1 - 13.2.2.5.

13.3.2.1 Purpose and project fundamentals.

The requirements to information on the function and project fundamentals are similar to the requirements stated in subsection 13.2.1.1 of this technical code

13.3.2.2 Description.

The requirements to description are similar to the requirements stated in subsection 13.2.2.2 of this technical code

Emphasis shall be put on information showing that solutions concerning EPUCS provide a reliable switching of the reactor to a subcritical state and maintain this state for an indefinite period of time, as well as SS activation and regular reactor status updates.

The independence of the EPUCS from the PUCS shall be substantiated via a detailed description of corresponding technical solutions.

The following data shall be provided:

- EPUCS structure;
- General description of the EPUCS;
- EPUCS control and management panels structure;
- EPUCS board (if present);
- EPUCS board control and management pads structure (if present);

Information on safety-relevant control and management devices arrangement, as well as information substantiating ergonomic requirements to their operation (arrangement of informational and body fields on control station's panels and control board pads) shall be provided. Safety-relevant functions performed by the EPUCS shall be provided.

13.3.2.3 Pre-commissioning activities.

The requirements to information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.2.3 of this technical code

13.3.2.4 Maintenance.

The requirements to information on maintenance are similar to the requirements stated in subsection 13.2.2.4 of this technical code

Emphasis shall be put on substation of EPUCS in-process operational capability support procedure during normal operation.

13.3.2.5 Safety analysis.

The requirements to safety analysis are similar to the requirements stated in subsection 13.2.2.5 of this technical code

This subsection shall list safety-relevant functions performed via the EPUCS, as well as information necessary to substantiate the impossibility of simultaneous PUCS and EPUCS shutdown due to similar reasons and conditions of transfer of operating personnel from PUCS to EPUCS in case of PUCS shutdown.

The analysis of EPUCS reliability and durability in cases of design basis and beyond design basis accidents shall be provided.

13.4 Systems and means of defect diagnostics

The requirements to subsections 13.4.1 - 13.4.5 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.5 Barriers integrity and operability control systems and means

The requirements to subsections 13.5.1 - 13.5.5 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.6 Fire safety systems management and control systems and means

The requirements to subsections 13.6.1 - 13.6.5 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.7 Systems and means of explosion prevention and suppression control and management

13.7.1 Systems and means of explosion prevention and suppression control and management on unit level

The requirements to subsection 13.7.1 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.7.2 Systems and means of explosion prevention and suppression control and management on reactor installation level

The requirements to subsection 13.7.2 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.8 Systems and means of control and management over physical protection

The requirements to subsection 13.8 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.9 Organized radioactive products yield control systems and means

The requirements to subsection 13.9 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.10 Environmental control systems and means

13.10.1 Sanitary protection zone environmental control systems and means in control areas and nuclear plant premises

The requirements to subsection 13.10.1 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.10.2 Nuclear power plant power unit premises radiation situation control systems

The requirements to subsection 13.10.2 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.11 Systems and means of alert and communication

The requirements to subsection 13.11 are similar to the requirements to subsections 13.2.1.1 - 13.2.1.5.

13.11.1 Purpose and project fundamentals.

The requirements to information on the function and project fundamentals are similar to the requirements stated in subsection 13.2.1.1 of this technical code

13.11.2 Description.

The requirements to description are similar to the requirements stated in subsection 13.2.1.2 of this technical code

Moreover, the description of system and means of emergency personnel alert shall contain:

- A list of alert signals with specification of light, sound and other means of personnel alert;

- Technical properties of the means of personnel alert (rate of flashing, colour, tone pitch, etc.).

Information on the implemented warning and emergency personnel alert system shall contain the order of using the alert system in emergency situations.

Information on communication means, including the back-up means of communication, of organization of NPP management and alert systems for normal operation mode, during design basis and beyond design basis accidents shall be specified.

13.11.3 Pre-commissioning activities.

The requirements to information on pre-commissioning activities are similar to the requirements stated in subsection 13.2.1.3 of this technical code

13.11.4 Maintenance.

The requirements to information on maintenance are similar to the requirements stated in subsection 13.2.1.4 of this technical code

13.11.5 Safety analysis.

The requirements to safety analysis are similar to the requirements stated in subsection 13.2.1.5 of this technical code

13.12 Safety-irrelevant control and management systems

13.12.1 Description.

The description of safety-irrelevant control and management systems shall contain data on the following:

- A list of said systems and means;
- List and substantiation of design-based differences between systems and their analogues implemented at active units, if such differences are present.

13.12.2 Safety analysis.

The safety analysis shall contain an analysis the results of which show that the systems are safety-irrelevant. The analysis is to prove that safety-relevant control and management systems are capable of supplementing for failures of all types of safety-irrelevant systems.

14 Electricity supply

This section shall contain information confirming the operability and reliability of electricity supply systems, power output, multiplicity of channels, independence, resistance to external and internal influences, possibility of conducting maintenance activities, inspections and repairs, compliance with specifications and safety standards based on the analysis of their operability during normal operation, abnormal operation and power supply system failure, considering the possibility of personnel malpractice, as well as project and out-of- design basis accidents. Moreover, the section shall provide a qualitative and quantitative analysis of power supply system reliability

The basic principles of design and organization of the function of NPP power supply systems shall be provided in the section.

Deviations from the requirements of active regulation and other TNLAs, their justification and compensatory procedures concerning every system shall be described.

The technical data and calculation results presented in section 14 are to be sufficient

to conduct independent expert evaluation of the electricity provisions of the NPP power unit project.

14.1 External electric power supply system

14.1.1 Power output diagram

The following information shall be presented:

- The power system development;
- The designation and function of the NPP in the power system;
- Characteristics of power emission mechanics;
- The possibility of emission of power to regional substations without construction of additional switchboards at the NPP facility;
- The protection of grids and substations from influence of external factors;
- The presence of emergency automated systems, its structure, quantitative characteristics and reliability parameters;
- Voltage surge protection;
- Voltage fluctuation;
- The presence of automated dispatch control system;
- The organization of electric grid operation;
- Requirements to NPP flexibility.

14.1.2 Power system description

The following information shall be provided:

- Short circuit current in NPP systems;
- The reliability of the NPP auxiliary power supply systems in case of failure of its own power sources;
- For normal operation mode, the sufficiency of regulating power output in the system, the possibility of limiting the power output of the generators without compromising the NPP ones, etc., shall be presented. Moreover, it is necessary to present the energy system status justifying the NPP power output limitation (with specification of limit period and rate;
- The possibility of system frequency configuration in for manual and automatic operation in cases of system failures;
- The possibility of automatic or manual separation of the NPP from the energy system and switching it to auxiliary systems;
- Allowance for single power output for one NPP unit with consideration of energy system stability retention requirements in automatic and manual operation modes;
- The possibility of switching the NPP to a balanced load in cases of system failures;
- Types of energy system failures and their severity;
- The quantity of power transmission lines and the NPP full power output capacity in cases of grid failures;
- The sufficiency of energy system power output for ensuring automatic activation of auxiliary systems in case of NPP full load dump;
- Turbine generators activation system type according to the requirements to energy system stability retainment;
- The possibility of voltage reception from the system for power supply for NPP auxiliary systems in case of influence of natural phenomena (earthquake, tornado, frozen surfaces, atmosphere pollution, etc.)
- The influence of the energy system at the NPP operation. Calculations of the energy system and main scheme operation reliability parameters according to types, frequency and duration of failure persistence, including full de-energizing of electric switchgears, shall be provided. A comparison with the allowed number of failures and

defects of main NPP equipment (reactor, turbine, generator) shall be provided:

- The analysis of the impact of various failures and defects at the NPP operation. The following types of failures are to be considered:
- Full de-energizing in case of failure of connection to the external electric grid;
- Frequency deviations;
- Triple-, double- and single-phase short circuit;
- Voltage fluctuation;
- Synchronous and asynchronous oscillation in energy system, including asynchronous oscillations caused by failure of automatic asynchronous mode shutdown system.

14. 2 Main electric circuit diagram

14.2.1 General description

The general description shall provide confirmation of full compliance with TNLA requirements, substantiation of the scheme of connection of turbogenerators to the grid from the standpoint of ensuring maximal reliability of power supply to the NPP auxiliary systems, and the layout of primary communication.

Deviations from the current TNLA requirements shall be substantiated.

Layouts and protection setting points of power supply lines and other equipment shall be provided. Fire safety solutions shall be listed.

14.2.2 Turbine generator, lumped transformer and their auxiliary systems

This subsection shall provide a general description and specifications of primary and auxiliary equipment:

- Electric and technological schemes of primary switching;
- Provision of fire and explosion safety;
- Substantiation of deviations from TNLA requirements;
- Schemes of secondary commutation with protection set points.

14.2.3 Main circuit equipment fire safety

The analysis of the extent of influence impact of main circuit equipment fire safety of on the unit safety shall be provided. Fire extinguishing diagram with corresponding layouts and calculations shall be provided.

14.2.4 Main circuit control stations

This subsection shall provide the description of main circuit control units with measurement and alarm systems. Their durability is to be substantiated.

14.3 NPP own needs system

14.3.1 Nuclear power plant own needs electricity supply system in normal operating conditions

14.3.1.1 Auxiliary power supply to direct and alternating currents. This subsection shall provide operating and back-up power supply sources at the NPP site and outside of it, as well as a quantitative evaluation of their reliability. The self-sufficiency of load power supply support sources ensuring the safety of main equipment, as well as fire safety and unit activation and shutdown ensuring are to be stated.

Specifications of equipment, apparatus, cables, connections, insulation, etc., are to be given. Their compliance with TNLA requirements is to be confirmed, deviations form the requirements shall be substantiated. Primary switching layout shall be provided.

14.3.1.2 Calculations of short circuit current and single-phase line-to-earth faults parameters in grids with insulated neutrals. Results of calculations concerning selection of electric equipment, apparatus, connections, insulation and cables, calculations of protection parameters and automatic devices, possibility of automatic activation of unit auxiliary load, as well as diagrams of protection, automated equipment and other secondary switching circuits shall be provided.

14.3.1.3 The substantiation of the selection of activation settings for ASA and automatic systems of switching the reliable supply grid to the autonomous grid, substantiation of the possibility of turbogenerators reliably operation for their self-supply in heat and mechanic rundown modes with lower than allowed frequency and voltage parameters shall be provided.

14.3.1.4 Arrangement layouts for equipment, apparatus and cables shall be provided.

14.3.1.5 Possible power surges and measures of their prevention shall be shown,

14.3.1.6 Information on fire safety, including a description of systems of automatic fire detection and suppression with corresponding calculation results shall be provided.

The description and corresponding calculation are to substantiate the compliance of emergency power supply systems and selected electric safety system equipment with current corresponding TNLAs.

14.3.1.7 An analysis of possible fire sources in the electric Supplement of the NPP, the

paths and manner of fire spread and its impact on NPP safety shall be provided,

14.3.1.8 The protection of electric Supplement of the NPP from unintentional malpractice on behalf of the personnel (prevention of activation of equipment with protection and blocking systems off; automatic devices of programming alteration in protection and blocking systems in case of shutdown of single devices; automatic control over the correctness of electric and technological circuit assembly; prevention of deactivation of protection and blocking systems without corresponding automatic altering of operating modes of primary and auxiliary equipment).

14.3.1.9 Management and control.

The management and control information shall contain data on control stations, monitored parameters, alarm types, equipment class, sensors, instrument transformers, measurement control and protection from and external and internal interference.

14.3.1.10 The results of quantitative analysis of the reliability of the NPP auxiliary

power supply at all voltage values and substantiate its capability to provide design level unit safety, durability of control stations in cases of accidents and external influence shall be provided.

14.3.2 Emergency electric power supply system

A full description of system elements shall be provided. The extent of descriptions, technical data and calculations is to be sufficient for conducting an independent expert analysis of EPESS project for the NPP reactor and electric Supplement of the SS project.

14.3.2.1 Load characteristics.

The information on load characteristics is to be supplemented with a list of auxiliary current collectors requiring power supply from autonomous sources in case of primary power supply sources shutdown, with specification of allowance on:

- The duration of power supply interruption;
- Quantitative reliability data on power supply;
- Voltage increase (decrease) and current frequency with specification of allowed duration;
- Alteration of current curve shape and duration of its persistence;
- The required period of time before voltage re-supply to current collector is possible, and other requirements based on technological systems of CMS and CSS.

Specification data of every power-consuming device with specification of the period of operation without power supply from primary sources shall be provided.

A description of back-up procedure from technological systems connected to EPESS, CMS and CSS shall be provided.

The requirements to fire safety, fire and explosion protection of the equipment and EPESS and SS apparatus fire resistance.

Temperature, humidity, barometric pressure, radioactive containment and other external conditions of the operation of electrical equipment, apparatus and cables of the EPESS and SS during RI normal operation and emergency mode with specification of the duration of persistence of said conditions shall be described.

14.3.2.2 Technical characteristics of the EPESS:

The following EPESS technical characteristics shall be provided:

- System composition;
- Electric diagram of primary switching of the system with substantiation of its selection;
- System boundaries;
- Substantiation of the selected number of EPESS channels;
- Substantiation of the sufficiency of the period of non-stop functioning of power supply sources;

- Settings on voltage and current frequency for SDEEPGS activation. Substantiation of the values of settings and selected SDEEPGS stand-by period for reception of load since activation of a corresponding signal.
- Procedure for SDEEPGS load starting and increase and its substantiation;
- Prevention of operator interference and the period of prevention persistence with substantiation of the selected period;
- Activation of SDEEPGS with reactor technological parameters and substantiation of selected parameters;
- Technical characteristics of current sources, including their nominal and maximal rating power, allowable duration of non-stop activity, stability of voltage and current frequency, possible deviations of the current curve from a sine wave shape, technological SDEEPGS diagram;
- Specifications of system equipment, connections, insulation, cables, apparatus, sealed passages, etc.
- A description of the algorithm of switching to autonomous power sources;
- Results of calculations of short circuit current and single-phase line-to-earth short circuit current in the grid with an insulated neutral, selection of electrical equipment, apparatus, connections, insulation and cables, including the selection of drive gears of isolation valves and regulation valves and other SSs;
- Possible levels of voltage surges and measures of their prevention;
- Substantiation of the selection of neutral point connection (grounded, ungrounded) from the point of maximum reliability of power supply of corresponding consumers with compliance with the required level of personnel electrical safety;
- Evidence of sufficiency of system protection from unintended personnel malpractice during its commissioning (prevention of activation without prior activation of corresponding protection and automatic devices, automatic control over the correctness of electric and technological circuits, etc.);
- Emergency power supply systems and components safety class;
- Layouts of arrangement of EPESS equipment, apparatus, and cables, electric actuators, their switching apparatus and SS cables;
- Substantiation of fire safety with results of calculations of maximum temperatures of enclosing, supporting and confining structures in case of complete incineration of flammable substances in one of the cable compartments or detached equipment booth. Results of calculations confirming the sufficiency of durability of said constructs under given temperatures and impossibility of fire spreading, including during heat transmission via cable cores.

14.3.2.3 Protection from SCC and ground SC in grids with insulated neutrals shall be reflected. Automatic equipment and direct injection engines technological protection shall be described:

- Types of protection, its purpose and operation areas, technical characteristics;
- Protection redundancy rate, domination principle;
- Protection from internal and external interference;
- Protection from arc discharges;
- Calculations the selection of protection mechanics and their settings;
- Requirements to the reliability of operation of mechanisms of internal protection of electric equipment, cables and direct injection engines with specification of priority order of its activation relative to performance of safety functions by this power supply system;
- Selection of automatic devices settings (ASA, re-activation equipment, etc.) and its substantiation;
- Diagrams of protection devices, automatic devices and other secondary switching circuits.

14.3.2.4 The information on control, management and automatic devices is to include a description of:

- Control stations, their durability in cases of various emergency situations and external influences;
- Controlled parameters;
- Alarm types;
- Classes of equipment, sensors and instrument transformers;
- Metrological monitoring.

14.3.2.5 The possibility of conducting tests and maintenance. The following information shall be provided:

- Constant automatic diagnostic monitoring of systems and components;
- Frequency of tests, their methods and programs, controlled parameters;
- The possibility of conducting tests in-process or on deactivated equipment;
- Types and periods of maintenance of switching equipment, protection cables and automatic devices;
- Means of restoration of operational capacity;
- Terms of replacement of equipment after exhausting of its lifespan;
- Possibility of maintenance and testing activities in relation to radiation safety and environment.

14.3.2.6 Criteria for selection of power sources power rates. The following information shall be provided:

- Calculation of load parameters for transformers, diesel generators, power lines, inverters and accumulating batteries and charging devices.
- Coordination of source voltage with calculated loads;
- Coordination of load parameters (active load, capacitive load, induction load) with source parameters;
- Allowance on voltage fluctuation, frequency of curve deviation from the sine wave shape, inrush currents and asynchronous ASA currents;
- Characteristics of the accumulating battery with proof of its compliance with consumer requirements;
- Substantiation of accumulating batteries autonomous operation period without charging;
- Characteristics of charging devices;
- Electromagnetic compatibility of sources, current collectors, protection mechanisms and automatic devices;
- Substantiation of the duration of non-stop operation of sources with limited fuel supply;
- safety.

14.3.2.7 Arrangement, protective grounding, lightning discharge protection, fire Physical divides between premises housing distributing devices, sources and cables with multi-channel power supply, as well as its protection from external influence

(earthquakes, blast waves, airplane crash, dust storms, salt fogs, chemical and radioactive atmosphere contamination) shall be shown.

The following shall be provided:

- Protection from lightning surge and its secondary influence;
- Protective grounding;
- Fire alarm and fire suppression system;
- Provision of corresponding environmental conditions (temperature, humidity, atmosphere type);
- Protection of equipment, cables and sealed pathways from flying objects caused by destruction of equipment or pipelines, and from water sprays;
- Availability of access to equipment in relation to radioactive safety in order to conduct maintenance activities, and allowance on terms of maintenance personnel presence.

14.3.2.8 Criteria of selection of equipment, cables and sealed passages. The following data shall be presented:

- Environmental conditions;
- Seismic resistance;
- Power rating and load capacity;
- Equipment resistance to short circuits current, heat cable resistance, including resistance to thermal impact caused by deactivation of reserve protection mechanisms caused by SCC and after reapplication of voltage to non-remedied short circuit;
- Protection from dust and water;
- Ensuring of automatic and manual activation:
- Insulation class per heating parameter;
- Insulation class per contamination conditions;
- Life span (service life), possibility of repair or replacement;
- Resistance to internal and external influence;
- Fire safety.

14.3.2.9 Compliance with standards, specifications and requirements to technological component of the project and control systems.

Solutions ensuring compliance with current TNLAs and standards shall be described.

In particular, compliance with the following requirements and principles shall be shown:

- Single failure principle;
- Protection from external and internal influence;
- Independence of emission devices and cable lines;
- Independence of connections;
- Possibility of conducting testing and maintenance activities and resource utilization control;
- Distinctive marking of equipment and cables;
- Maintenance safety;
- Completion of protective procedure;
- Common failure analysis;
- Associated malfunction analysis;
- Multi-purpose function.

14.3.3 Cable systems fire protection

14.3.3.1 Cable fire hazard parameters.

Cable fire hazard parameters in accordance with STB 1951-2009 shall be provided.

14.3.3.2 Means of cable installation in areas of varying hazard level.

The areas of cable installation shall be classified in relation to their explosion, fire and mechanic damage hazard.

14.3.3.3 Passive protection means.

Complete information on passive protection means (fire barriers and their filling, application of fire-resistant coating and other solutions ensuring compliance with regulated fire safety requirements) shall be provided.

14.3.3.4 Active protection means. The following information shall be provided:

- Fire alarm;
- Automatic fire suppression systems;
- Means of ensuring compliance with operational temperature limits during normal and emergency operation modes, including blackout occurrences.

14.3.3.5 Solutions ensuring compliance with requirements to protection from external and internal influence, including the requirements of TCP 263, shall be described.

14.4 Operation

References to section “Nuclear power plant operation” may be provided.

14.4.1 Operation manuals

General guidelines of the operational manuals concerning systems of reliable power supply shall be provided, including the following matters:

- The order of performing activation of equipment and systems and their deactivation of repair purposes;
- The order of conducting equipment and system test runs;
- The rate of test runs;
- Control of quality of fuel and oils, terms, criteria and order of their replacement;
- The rate of equipment and system housing premises inspections.

14.4.2 Instructions on repair

General information concerning repair activities shall be provided:

- The scope and rate of repairs and inspections of protection mechanisms and automatic devices;
- Terms and order of replacement of equipment with exhausted lifespan;
- Rate and scope of measurement instruments inspections.

14.4.3 Commissioning

Information concerning commissioning procedure shall contain programs for adjustment, approbation and testing of equipment, apparatus and systems including the scope of inspection of protection mechanisms and automatic devices.

14.5 Communication

Internal and external communication mechanics shall be described. The information shall contain a general description, power supply diagram, arrangement layout for communication equipment, and an analysis of communication resistance in case of design basis or beyond design basis accidents.

The descriptions and data are to be sufficient for conducting independent expert analyses of electrical NPP Supplement.

14.6 Standards, norms

This section shall contain a list of norms and standards related to nuclear energy safety in the form of tables (see table 7), with specification of relevant systems (relevant systems are to be marked with a + sign in the tables).

Table 7 - A list of standards and norms

<table>
<tr><td rowspan="3">No of standard s and</td><td rowspan="3">Name of standards and norms</td><td colspan="4">Area of implementation</td><td rowspan="3">Installation and operation</td></tr>
<tr><td rowspan="2">Electrical system outside the site</td><td colspan="2">Electrical system within the site</td><td rowspan="2">Standard tests</td></tr>
<tr><td>C</td><td>C</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
</table>

14.7 Labeling

Labeling markings implemented in the project shall be provided.

15 Power unit auxiliary systems

15.1 Nuclear fuel storage and management systems complex

The introductory part of this subsection of the NPP safety report shall contain the structure of the complex, including the description of the following systems:

1) A system of handling and storage of new (non-irradiated) NF;
2) Reactor core overload system;
3) SNF handling system, containing:

- A system of at-reactor SNF storage;
- System for SNF storage in the premises located outside the reactor room in a dedicated CP;
- Protective chamber (if present).

The matters of SF transport at NPP site from the point of new fuel reception to the reception (transfer) of SNF shall be described.

The order of SF control and registration at the NPP unit shall be described.

15.1.1 A system of handling and storage of new (non-irradiated) nuclear fuel

15.1.1.1 Designation and classification.

Information on system designation with specification of all its functions shall be provided. Class, category and safety and seismic resistance group of the components of the system of storage of new NF in FFSF in accordance with classification set forth by the current TNLAs on safety and seismic resistance shall be provided. Relevant safety TNLAs shall be listed.

15.1.1.2 Project design fundamentals.

Project design fundamentals shall be provided. The following information concerning storage facilities is to be stated:

- Maximum storage capacity;
- Storage norms;
- The characteristics of potentially stored new fuel (enrichment level, size, activity degree, heat radiation, etc.);
- Distinctive markings identifying the fuel enrichment level in the RFA and means of its identification - visual and (or) via overload devices;
- Distinctive markings for the RFA with a burnable poison rod, mixed fuel, including U- Pu fuel, etc. (if present), and means of their identification.

Methods and programs used to substantiate the safety of storage and transport of NF with specification of their application area, as well as data on their set validation and certification procedures, shall be listed.

Project design parameters, subsystems and system components ensuring its safe operation shall be listed.

A list of project initiating events for the system shall be provided. Combinations of calculation loads shall be presented.

Special requirements to systems relevant to the main system operation shall be provided.

Main principles and criteria at the foundation of system arrangement solutions shall be provided.

The modernization of reactor core section with a new type of fuel, and, respectively, a new type of storage facilities, the substantiation of the possibility of utilization of the existing FFSFs for this purpose, or the materials of existing FFSF modernization project shall be provided. In particular, the possibility of storing new U-Pu fuel underwater and of modifying some areas of the transfer floors and transport equipment shall be considered.

15.1.1.3 Systems description

A description of system structure and (or) of the technological scheme of the whole system, its subsystems, constructs and components, if they perform independent functions, shall be given.

Drawings, layouts and diagrams reflecting the structure and operation of the system and its components, their arrangement and connection to other NPP unit systems shall be provided.

a) Description of system arrangement.

The internal arrangement of storage facilities with specification of the storage class and environmental parameters (temperature, humidity, etc.) as well as TNLA safety requirements, shall be described. In particular, it shall be shown that the premises arrangement and project solutions rule out the possibility of flooding and intake of other neutron flow retarding materials in the non-irradiated fuel storage area; that personnel evacuation in case of an accident is not hindered in any way (with specification of types of accidents, evacuation routes, calculations of evacuation period); that no routes to other operational facilities lie through the fuel storage facilities (with a description of access route and its control system).

The arrangement of the storage facilities with specification of its location relative to other NPP unit premises, stations and adjacent systems shall be described.

The following information shall be provided (if not stated in section “Description of the NPP site and region” of the NPP safety report):

- Classification of FFSF buildings and constructs (if present) according to their safety and seismic resistance;
- Means and methods of enforcing the prohibition on transferring any loads except for parts of the loading and overloading devices over the stored fuel during loading and overloading activities above the storage facility covered by any constructs, as well as proof of its capacity to withstand dynamic and static loads occurring during cargo allocation and transfer, shall be provided.
- Information on the classification of FFSF buildings and premises as either access- controlled or free-access areas.
- Information on classification of FFSF premises according to different categories of radioactive and fire safety and on FFSF premises where operation may sharply increase
radiation level.
- Information on compliance with the principle of separate ventilation of free-access and access-controlled FFSF areas and compliance with the requirement to ensuring that no air vents connect ventilation systems of premises with different maintenance categories.
- Information stating that all auxiliary fire (emergency) exits and entrances of the access-controlled areas are equipped with air-lock doors.
- Information confirming that storage facility construction allows for easy surface decontamination and that room surfaces of access-controlled areas are coated with highly susceptible to decontamination materials with low RS absorbing.

б) Description of new NF storage system equipment.

The description of new NF storage system equipment shall contain:

- The composition of system fuel storage and handling equipment, including equipment used for fuel storage, transport and canting operations, de-conservation, inspection (acceptance control) and repair of RFA (if present), and a short description of its structure;

- A description of shipping packages handling system, if they are present in the new fuel storage facility.

In case of modernization of reactor core area related to the implementation of a new type of fuel and the necessity of storing it in FFSF a IPTSC (TSC) the possibility of using the already implemented IPTSC (TSC) for these purposes is to be confirmed, or materials of a new IPTSC (TSC) project, providing for compliance with regulatory limits on the values of radiation burden on its surface, and information the measures of radiation level control and maintenance conditions of TSC with this type of fuel shall be provided.

В) Data on other equipment and materials stored in FFSF. The following shall be provided:

- Means and methods of ensuring compliance with the prohibition on storing flammable materials and materials not used for packaging with fire-hazard related properties;
- A list of non-NF reactor core components (in case of their storage in the FFSF), and the order of their arrangement according to the project;
- Means and methods of enforcing the prohibition on storing effective neutron retarding materials between jackets, racks and material packaging groups;

Г) This subsection shall contain information on systems related to the functions of the new fuel storing and handling systems complex, the arrangement of all systems, composition

of its equipment, its redundancy back-up mechanism, set lifespan, operational environment, parameters, etc.

The information is to specify parameters corresponding to functional designation of the system in question. Parameter values shall be specified with their possible spread (allowance).

Systems, subsystems, equipment, constructs and components performing separate functions shall be specified, in particular:

- The localization devices intended for prevention or limitation of the spread of RS or ionization radiation in case of accidents inside the storage facility and into the environment;
- The emergency alarm system alerting of the occurrence of a self-sustaining chain reaction;
- The fire alarm system;
- The system of operational and emergency lighting;
- Industrial television (if present);
- The ventilation system;
- The drainage system;
- The communication system;
- The complex decontamination system;
- The storage facility heating system.

The modernization of reactor core section with a new type of fuel and the use of the existing FSFF for its storage requires proof of sufficiency of systems relevant to the function of new NF storage systems, or project materials of corresponding modernization of said systems.

15.1.1.4 Materials.

The minimal volume of information on materials is to include:

- Data on project materials of primary components, including welding, mechanical and technological characteristics; references to relevant technical regulations, GOST, etc. may be provided. Information is to demonstrate compliance with the requirement to supply of equipment, devices, materials and items for nuclear energy related purposes. Information confirming the compliance of transport equipment for FFSF subject to the requirements of current TNLAs with above stated requirements shall be provided;
- Confirmation of authorization on the use of sated materials, including data on authorization of implementation of non-metallic materials (if present) if it is required by the safety TNLA; if such requirements are absent, a corresponding entry is to be registered;
- Special data concerning the resilience of materials, including absorbing additives which are part of FFSF construction materials (if present), to operational conditions, including decontamination or abnormal operation or accidents. The information is to reflect compliance with TNLA requirements;

- Special information, confirming, in particular:

1) Compliance with the requirements to non-flammability or fire-resistant of facing, fit-out, sound-absorbing, sound- and heat-proof materials used for internal storage facility fit- out;

2) That enveloping structures are built from non-flammable materials compliant with requirements to fire-resistance limits;

3) That the surfaces of FFSF premises and equipment are coated with easily decontaminated water-resistant materials with low RS absorption;

4) Data on hazardous properties of the implemented materials, including ones stored in FFSF (if present), and the probability of said properties affecting any operation modes.

15.1.1.5 System operation manipulation and control.

A list of controlled parameters for all operation modes and repairs with specification of their allowed values shall be provided. The arrangement of control points, control methods description, data on metrological certification of used methods and requirements to control and measurement instruments shall be provided.

System connections to unit control systems, sensor communication channels back-up redundancy mechanics (references to sections 13 and 14 may be provided) shall be described.

The description of control systems shall contain schemes points and means of measurement, controlled parameters, setting points for protection activation and the rate of tests, evaluation criteria and methods.

The information on FFSF shall contain data on devices and systems of control and alarm.

Information of all alarm and control types shall be provided.

15.1.1.6 Quality assurance.

Information on quality assurance program compliant with the requirements if the TNLAs shall be presented.

15.1.1.7 Commissioning.

Information shall be presented under the requirements of section 20 of this technical code.

15.1.1.8 Tests and checks.

Information on the order and procedure of regular FFSF system and equipment in process checks and tests shall be provided.

Information on methods, scope and terms of conducting control and testing activities of systems during operation of the NPP, the description of the measures provided for this purpose by the project, and their compliance with the requirements of safety TNLAs shall be provided.

15.1.1.9 Normal system operation.

System function during normal operation and its interaction with other systems shall be described.

Information on operational procedures of the storage and handling of new fuel systems to the extent compliant with the requirements of section 19 of this technical code.

15.1.1.10 System operation in case of equipment failure.

This subsection shall contain an analysis of possible system component failures, including personnel malpractice, as well as an evaluation of the impact of their consequences, including due to a general cause, on system operational capacity and the safety of the NPP unit as a whole.

The modernization of reactor core area related to the implementation of a new type of fuel requires provision of a modified list of possible design basis accidents with consideration of the new type of fuel, as well as a list of accounted for beyond design basis accidents related to fuel handling, which shall be considered in NPP SAR section “NPP accident analysis”.

15.1.1.11 System reliability analysis.

A description of calculation programs used to conduct the analysis of system reliability, as well as initial data for calculations, limitations and allowances used for algorithms and analytical models, with results of calculations and conclusions drawn from them, shall be provided. Data on validation and certification of calculation programs shall be presented.

The extent of presented information is to be sufficient for conducting independent calculations. In case any tests have been carried out in order to validate the reliability of system project, testing environment and conditions shall be described, and an analysis of their compliance with design conditions, measurement assurance of the tests, and interpretation of their results in relation to design conditions shall be provided.

Lists of initiating events, failures, external influences, operator malpractice which shall be taken into consideration in the analysis of potential system accidents and the analysis of NPP reliability on NPP SAR section “NPP accident analysis”, shall be provided.

The information shall contain quantitative parameters of FFSF equipment reliability in accordance with manufacturing technical conditions.

The information is to present a qualitative analysis of system reliability and determine quantitative values of system reliability parameters (transportation and technological diagrams for reception and emission of new fuel). Calculations of quantitative parameters of system reliability shall be supplemented with short descriptions of calculation programs, including values allowances, limitations and information concerning program validation.

Results of calculations of quantitative parameters of system reliability, the analysis of these results and conclusions on their acceptance or non-acceptance shall be provided,

The extent of information shall be sufficient for conducting independent expert evaluation if necessary.

15.1.1.12 Evaluation of new NF storage project.

This subsection shall be completed with the analysis of compliance with TNLA requirements concerning nuclear energy.

The conclusions shall be drawn with consideration of the criteria of compliance of new fuel storage and handling systems with the safety requirements and requirements if the TNLAs related to nuclear energy. The compliance with the principles of radioactive safety sated in the radiation safety TNLAs shall be evaluated.

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Means and methods of determination of the allowed quantity of packages and jackets in a group or in a stack shall be described.

15.1.2 Core refueling system

Requirements to core refueling system shall be presented.

15.1.2.1 Designation and classification.

Information concerning purpose and classification of the components of core refueling system shall be provided.

15.1.2.2 Project design fundamentals.

Information concerning project fundamentals shall be provided. The description shall be given to the required by section 15.1.1.2 of this technical code extent.

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15.1.2.3 Core refueling system description. A) Technical plan description.

The technical plan of performing refueling operations, with specification of equipment, devices and components performing independent functions, is to be described.

The composition of specific system equipment is to be described.

The technical plan of performing refueling operations in case of unloading the core and its components, with specification of variations from refueling plan and of special equipment in use, is to be described.

In particular, the following aspects shall be described (specified):

- Means and methods of identification of the extent of compliance of refueled RFA and (or) core components with the ones specified in the refueling plan;
- The selected method of carrying out refueling operations and its substantiation;
- The status of the refueling box during refueling;
- The system and structure of the loading equipment for loading reactor core elements to the reactor;
- The rate, volume and order of refueling and their substantiation;
- Technical means provided for by the project to prevent foreign objects from getting into the reactor during refueling and repairs;
- The structure of refueling system with substantiation of its sufficiency and specification of requirements ensuring safe use of RFA, including in cases of failures and damages;
- Technical means ensuring heat removal from refueled RFAs. Moreover, the

following aspects shall be described:

- Means of preventing damages, defects, destruction or falling of RFAs;
- Means of preventing application of excessive force to RFAs during their removal or installation;
- Technical means preventing RFAs from falling after discontinuation of power supply;
- limits;

- Protective means ensuring the displacement of devices is conducted within allowed

- Equipment provided for by the technical project for safe transfer of fuel to safe places in case of failure or violation of conditions of safe operation of refueling devices;
- Technical means preventing the removal of RFA with large amount of residual heat;
- Boards (panels) displaying information on the status (condition) and orientation of RFAs and gripping components provided for in refueling devices.

B) It shall be shown that all loads occurring during normal operation, including asymmetric loads and acceleration loads, have been accounted for in the NF refueling design; it shall be shown that the load stress does not exceed the limits set for different

equipment components.

C) The refueling system operational capacity is to be substantiated.

D) The information on systems relevant to the operation of reactor core refueling system shall be provided.

Brief information on the arrangement of every system, the composition of its equipment, back-up redundancy, supposed lifespan, working environment, parameters, etc., shall be provided.

Information on the following systems shall be presented:

- Industrial television for control over refueling with a list of refueling operation controlled via industrial television;
- Shell pressure-sealing control;
- Operational and emergency lighting;
- Fire suppression;
- Ventilation and air filtration;
- Communication and alert;
- Emergency alarm.

15.1.2.4 Materials.

The information on used materials shall be provided. The extent of given description shall comply with the requirements of subsection 15.1.1.4 of this technical code.

15.1.2.5 System operation manipulation and control.

A list of controlled parameters for all operation modes and repairs with specification of their allowed values shall be provided, as well as the arrangement of control points, control methods description, data on metrological certification of used methods and requirements to control and measurement instruments shall be provided.

System connections to unit control systems, sensor communication channels back-up redundancy mechanics

A description of protection and sealing mechanics shall be given.

The operational capacity of all control and manipulation systems is to be substantiated, and their function shall be specified. References to sections 13 and 14 of this technical code may be provided.

15.1.2.6 Quality assurance.

Information on quality assurance of NF refueling system shall comply with the requirements stated in section 23 of this technical code.

15.1.2.7 Commissioning. Information on commissioning of NF refueling system is to comply with the requirements stated in section 20 of this technical code.

15.1.2.8 Tests and checks.

This subsection shall contain information concerning the order of regular checks of equipment and systems of NF refueling during operation, on methods, scope and terms of controlling the status and testing the systems during NPP unit operation, the characteristic of measures provided for these purposes by the project and confirm their compliance with the requirements of safety TNLAs.

15.1.2.9 Safe operation conditions.

The safe conditions of reactor operation during refueling shall be provided.

15.1.2.10 System reliability analysis

The information stated hereunder shall comply with the requirements of stated in section 15.1.1.11 of this technical code with respect to NF refueling system

15.1.3 Spent (irradiated fuel management systems complex

15.1.3.1 System of SNF at-reactor storage

1) Designation and classification.

2) Project design fundamentals.

The information hereunder is to comply with the requirements stated in section 15.1.1.2 of this technical code with respect to the system of SNF at-reactor storage.

The modernization of reactor core area related to implementation of new type of fuel and, respectively, the necessity of storing the corresponding SNF requires confirmation of the possibility of utilization of existing SNF storing facilities, or materials of its their modification project, as well as potential modification of some components of transportation and technical equipment.

3) Systems description

A description of system structure and (or) of the technological scheme of the whole system, its subsystems, constructs and components, if they perform independent functions, shall be given.

Drawings, layouts and diagrams reflecting the structure and operation of the system and its components, their arrangement and connection to other NPP unit systems shall be provided.

The description shall be supplemented with parameters corresponding to their function.

4) Technical plan description.

The information on the at-reactor SNF storage shall contain maximum design basis heat removal capacity of the CP, environmental parameters (temperature, air pressure, etc.) and SNF storage guidelines. It is ti be shown that the CP capacity allows for decreasing of radiation level and heat emission, and for provision for conditions of unloading one full core at any moment during operation.

The properties of potentially stored NF (incineration, activity level, level of heat emission, etc.) shall be given.

The data on any other materials (in particular - on new fuel), being temporarily or long-term stored at the at-reactor storing facilities for SNF, with specification of grounds, terms and regulations of their storage, as well as the properties of said materials, shall be provided.

The arrangement of CP and transportation and technical equipment in the NPP unit premises with specification of their location relative to other NPP unit rooms and adjacent

systems is to be described.

A full description of CP structure, technical plan of SNF storage with specification of subsystems, equipment and components performing independent functions, shall be provided.

Support and structural components of CP to the extent of their impact on safety status shall be described.

It shall be shown that:

- The CP design provides for detection of leaks;
- The possibility of cooling irradiated NF in cases of project and out-pf-design basis accidents is provided for.

The description of the structure of equipment used for allocation and storage of SNF, including for non-airtight RFAs, as well as for equipment used for storage of other reactor core materials (if present) shall be provided.

In case of SNF storage in at-reactor facilities the organizational and technical measures ensuring safe storage of damaged and non-airtight RFAs shall be described.

The composition of specific equipment of SNF storage system and the compliance of this equipment with safety TNLAs shall be provided.

5) Data on systems relevant to the function of SNF storage and handling system.

The information on the arrangement of every system, the composition of its components, back-up redundancy, supposed lifespan, working environment, parameters, etc., shall be provided.

The parameters corresponding to the functional purpose of the system in question shall be provided. The parameter values shall be supplemented with their spread (allowance).

The information on the following systems shall be provided:

- LSS preventing or limiting RS or ionizing emission spreading inside the premises and into the environment in case of accident.
- Coolant;
- Filling and drainage of CP;
- Feeding;
- Cooling intermediate circuit;
- Ventilation and air filtration;
- Technical control and monitoring;
- Fire suppression;
- Communication and alert;
- Emergency alarm.

The function of the above listed systems and proof of their operational capacity shall be provided (references to sections containing such information may be provided).

The modernization of reactor core area related to implementation of new type of fuel and, respectively, the necessity of storing the corresponding SNF requires confirmation of the

possibility of utilization of existing SNF storing facilities, or materials of its their modification

project.

6) Materials.

The description of the requirements to materials shall be provided to the extent specified by the requirements stated in section 15.1.1.4 of this technical code.

7) System operation manipulation and control.

The description of the requirements to system operation management and control shall be provided to the extent specified by the requirements stated in section 15.1.2.5 of this technical code.

8) Tests and checks.

The scope and methods of acceptance control, interdepartmental pre-commissioning tests, their measurement assurance shall be substantiated; a list of controlled parameters and their allowed values, as well as their substantiation, and requirements to CMI and A used during for testing activities, shall be provided.

9) Quality assurance.

Systems, equipment and technical procedures within the storage facilities and system structures subject to NPP QAP shall be specified.

The NPP SAR shall contain confirmation of the fact that the manufacturing technology, supply and storage conditions, etc., comply with the requirements of project and regulatory documentation, as well as substantiate actual changes or deviations (if present), including deviations from specific project requirements and TNLAs; files documenting said deviations shall be specified.

General information at the NPP QAP shall be provided.

10) Commissioning.

The general information on NF at-reactor storage facilities shall comply with the requirements stated in section 20 of this technical code.

The results of CP testing shall confirm that CP facing material provide an appropriate level of leakage protection, resistance to force impact, etc.

11) Operation.

Information on the order of regular SF at-reactor storage facilities in-process equipment inspection shall be provided.

This subsection shall contain information concerning methods, scope and terms of controlling the status and testing the systems during NPP unit operation, the characteristic of measures provided for these purposes by the project and confirm their compliance with the requirements of safety TNLAs.

Information on operational procedures of at-reactor NF storage systems to the extent specified by the requirements stated in section 19 of this technical code.

12) System reliability analysis.

The contents of this subsection shall comply with the requirements stated in section 15.1.1.11 of this technical code.

13) Project design evaluation

The analysis of requirements, principles and criteria set forth by the current safety TNLAs shall be provided.

The conclusions are to be drawn based on the formulation of the criterion of compliance of the NPP with the safety requirements and its compliance with the TNLA requirements.

15.1.3.2 System of SNF storage underwater or in other cooling environment in the cooling pond located outside the reactor chamber in the dedicated SFSI.

1) System purpose and classification.

2) Project design fundamentals.

The description of project fundamentals shall be provided to the extent specified by th requirements stated in section 15.1.1.2 of this technical code with respect to CP located outside the reactor chamber in a dedicated SFSI.

3) Systems description

A description of system structure and (or) of the technological scheme of the whole system, its subsystems, constructs and components, if they perform independent functions, shall be given.

Drawings, layouts and diagrams reflecting the structure and operation of the system and its components, their arrangement and connection to other NPP unit systems shall be provided.

The description is to be supplemented with parameters corresponding to their function. Parameter values are to be supplemented with their potential spread (allowance).

4) A description of technical plan shall be given.

5) Data on systems relevant to the function of SFSI complex.

Information on the arrangement of all systems, composition of their equipment, back-up redundancy, potential lifespan, working environment, parameters, etc., shall be provided.

Parameters corresponding to the functional designation of the system in question shall be specified.

Information on the following systems shall be presented:

- LSS preventing or limiting RS or ionizing emission spreading inside the premises and into the environment in case of accident.
- Water cooling (except for cases where it is proven that water overheating is ruled out and without a dedicated water cooling system);
- Water filtering;
- CP filling and drainage system;
- Feeding;
- Water supply;
- Collectors for leaked radioactive water (collecting and returning leakages);
- Emergency feeding;
- Ventilation and air filtration;
- Underwater lighting;
- Fire suppression;
- Communication and alert;
- Emergency alarm;
- Power supply.

The modernization of reactor core area related to implementation of new type of fuel and, respectively, the necessity of storing the corresponding SNF in a CP located outside the reactor chamber in an existing SFSI requires confirmation of the possibility of such storage, or materials of the modification project of corresponding storage facilities, including transportation and technical equipment.

6) Materials.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.4 of this technical code.

7) Management and control information shall be provided to the extent specified by the requirements stated in section 15.1.1.5 of this technical code.

8) Quality assurance.

Systems, equipment (components) and technical procedures of storage facilities, as well as system structures, which are subject to NPP QAP, shall be specified as such, with specification of corresponding methods and levels of control and inspections.

The NPP QAC information complying with the requirements of TCP 101 and TCP xxx-20xx “Requirements to nuclear power plants quality assurance programs” shall be provided.

9) Tests and checks.

The scope and methods of acceptance control, interdepartmental pre-commissioning tests, their measurement assurance shall be substantiated; a list of controlled parameters and their allowed values, as well as their substantiation, and requirements to CMI and A used during for testing activities, shall be provided.

10) Commissioning

Information of the SFSI system commissioning shall generally comply with the requirements stated in section 20 of this technical code.

11) Operation.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.9 and 15.1.1.10 of this technical code

12) System reliability analysis.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.11 of this technical code

15.1.3.3 System of SNF “dry’ storage in a facility outside the reactor chamber in a dedicated building (SFSI) (if present).

1) Designation and classification.

2) Project design fundamentals.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.2 of this technical code

3) Systems description

A description of system structure and (or) of the technical plan of the whole system, its subsystems, constructs and components, if they perform independent functions, shall be given.

Drawings, layouts and diagrams reflecting the structure and operation of the system and its components, their arrangement and connection to other NPP unit systems shall be provided.

The description is to be supplemented with parameters corresponding to their function. Parameter values are to be supplemented with their potential spread (allowance).

4) A description of technical plan shall be given.

5) Data on systems relevant to the function of SNF “dry” storage complex. Information on the arrangement of all systems, composition of their equipment, back-up redundancy, potential lifespan, working environment, parameters, etc., shall be provided.

Parameters corresponding to the functional designation of the system in question shall be specified.

Information on the following systems shall be presented:

- LSS preventing or limiting RS or ionizing emission spreading inside the premises and into the environment in case of accident.
- Providing heat removal from the IPTSC with consideration of non-exceeding of project values of IPTSC external surface temperature;
- Temperature control;
- Control over water ingestion into the IPTSC;
- Ventilation;
- Radiation control;
- Fire suppression;
- Communication and alert;
- Emergency alarm;
- Power supply of systems and support devices.

6) Information shall be provided to the extent specified by the requirements stated in section 15.1.1.4 of this technical code

7) Management and control information shall be provided to the extent specified by the requirements stated in section 15.1.1.5 of this technical code

8) Quality assurance.

Systems, equipment (components) and technical procedures of “dry” storage facilities, as well as system structures, which are subject to NPP QAP, shall be specified as such, with specification of corresponding methods and levels of control and inspections.

The NPP QAC information complying with the requirements of TNLAs shall be provided.

9) Tests and checks.

The scope and methods of acceptance control, interdepartmental pre-commissioning tests, their measurement assurance shall be substantiated; a list of controlled parameters and their allowed values, as well as their substantiation, and requirements to CMI and A used during for testing activities, shall be provided.

10) Commissioning.

Information of the SNF “dry” storage system commissioning shall generally comply with the requirements stated in section 20 of this technical code.

11) Operation.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.9 and 15.1.1.10 of this technical code

12) System reliability analysis.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.11 of this technical code

15.1.3.4 Protective chamber system

1) Project design fundamentals.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.2 of this technical code with respect to protective chamber system.

2) Systems description

A description of system structure and (or) of the technical plan of the whole system, its subsystems, constructs and components, if they perform independent functions, shall be given.

Drawings, layouts and diagrams reflecting the structure and operation of the system and its components, their arrangement and connection to other NPP unit systems shall be provided.

The descriptions are to be supplemented with corresponding to functional designation parameters.

The use of protective chamber for a new type of SNF requires provision of materials of the dedicated protective chamber project, or materials on modernization of the existing equipment.

3) A description of technical plan shall be given. Moreover, the following shall be provided:

- Data on the organization of entrances and exits of the protective chamber;
- Proof of compliance with sanitary requirements;
- Data on areas of SNF handling within the protective chamber, where operation may cause the radioactive environment to alter.

4) Data on systems relevant to the operation of the protective chamber system. A short description of the arrangement of every system, their equipment composition, back-up redundancy, supposed lifespan, operational environment, parameters etc., shall be provided.

The information shall contain parameters corresponding to the functional system designation.

The information on the following systems shall be provided:

- LSS preventing or limiting RS or ionizing emission spreading inside the premises and into the environment in case of accident.
- Ventilation and air filtration;
- Lighting (operational and emergency);
- Autonomous active drain system;
- Complex decontamination;
- Gas supply;
- Vacuum pumping mechanics;
- Power supply to systems and support devices;
- Fire suppression;
- Communication and alert;

- Emergency alarm.

For all above-mentioned systems their compliance with safety TNLA requirements shall be shown.

5) Materials shall be described to the extent specified by the requirements stated in subsection 15.1.1.4 of this technical code.

6) Control and manipulation.

A list and substantiation of allowed values of controlled parameters during all operation modes and repairs shall be provided. The control points locations are to be stated, control methods shall be described, the data on measurement assurance certification of used methods shall be provided, the requirements to CMI equipment are to be stated. Systems of communication with control systems, sensor and communication channels back- up redundancy shall be described.

The description of control systems shall contain schemes, points and means of measurement of controlled parameters, setting points for protection activation and the rate of tests, evaluation criteria and methods.

The proof of provision of compliance with the requirements on defect detection and remedy to control and manipulation systems stated in TCP 170 shall be provided.

All control systems and devices for the protective chamber shall be specified.

7) Quality assurance.

The NPP QAP information compliant with TLRA requirements shall be provided.

8) Tests and checks.

A list of regular operational tests and checks shall be provided.

9) Commissioning.

Information of the protective chamber system commissioning shall generally comply with the requirements stated in section 20 of this technical code.

Compliance with current TLRA requirements is to be stated.

10) Operation.

Information shall be provided to the extent specified by the requirements stated in sections 15.1.1.9 and 15.1.1.10 of this technical code with respect to protective chamber system.

11) Project design evaluation

Proof of compliance with safety TLRA requirements shall be provided.

15.1.4 In-plant nuclear fuel transportation system

15.1.4.1 Designation and classification.

15.1.4.2 Project design fundamentals.

Information shall be provided to the extent specified by the requirements stated in section 15.1.1.2 of this technical code with respect to in-plant NF transportation system.

15.1.4.3 Systems description

The information on the parking of transport vehicles and the arrangement of in-plant railways intended for transportation of NF, means and scope of NF containers acceptance tests, means of transfer of NF to storage, the layout of transportation of NF on NPP site territory, means of delivery of NEF to units in in-plant transport containers via special transport vehicles shall be provided.

If new types of fuel are to be transporter in-plant, the possibility of using the existing IPTSC for these purposes, or materials of IPTSC corresponding modification and information on radiation level control and conditions of new fuel transport via special transport vehicles shall be provided.

Systems relevant to in-plant NF transport shall be described on the grounds of maintaining information completeness to the extent of them being a part of this system.

If necessary information is contained in another section of this document, this subsection shall provide a reference to it.

Information on the arrangement of all systems, composition of their equipment, back-up redundancy, potential lifespan, working environment, parameters, etc., shall be provided.

15.1.4.4 Control and manipulation.

Information on control and manipulation procedures for NF transportation shall be provided.

15.1.4.5 Tests and checks.

Information on operational control, checks and tests shall be provided.

15.1.4.6 Operation.

A short description of operational procedures shall be provided.

15.1.4.7 Project design evaluation

Information on compliance with safety TNLAs shall be provided.

15.1.5 Organization of recording and control of nuclear fuel at the nuclear power plant

The organization of recording and control of NF at the NPP, including matters of NF identification (RFA type, number, base composition, enrichment, etc.), places of installation, recording of time of transfer to storage facilities and delivery to the reactor core, keeping of cartograms and other recording documentation, as well as emission of liability for recording, shall be described.

Provided information shall show that the recording and control procedures for fissionable NM provide for valid data on quantity and placement of NF, timely detection of loss, unauthorized use or theft, including:

- A description of NM balance areas and key locations for measurement of inventory quantities and NM flows with respect to FFSF;
- Classification of fissionable NM;
- Description of procedures of registration of changes of inventory quantity if fissionable NM, including delivery to MBZ and transfer from it, with respect to FFSF;
- A description of keeping of material-balance recording and operational accounting documents on MBZ and key measurement points;
- A description of conducting physical inventory of NM;
- A description of procedures of reporting on MBZ status.

15.2 Systems with water operation medium

It is recommended to comply with the plan set forth by section 5 of this technical code while providing corresponding information.

15.2.1 Purge, makeup and boron control system

15.2.1.1 Project design fundamentals.

1) System purpose and function.

This subsection shall contain information on the boundaries of the system in question with a list of its support systems.

This subsection shall contain system purpose and function, as well as classification of its components, i.e. safety class, quality group and category.

The determination of a function shall list all system functions intended to fulfill its purpose (during normal and abnormal operation).

The section shall list main safety TNLAs at the basis of system design and requirements it shall adhere to.

2) Project design modes and initial data.

This subsection shall list NPP project modes providing for operation of purge, makeup and boron control systems with specification of the necessity of input-output of boron with concentration of boric acid in the coolant.

The initial project data of system in question shall be provided (system performance, pressure, temperature, design modes).

3) Design guidelines.

This subsection of the NPP SAR is to formulate system requirement based on the current TNLAs.

Safety criteria to which the system shall adhere, points of specific TNLAs, quantitative parameters and safety criteria shall be provided.

4) Requirements to related systems.

A list of systems relevant to the system efficient operation shall be provided, including:

- General requirements to related systems with accounting for a single failure and maintenance;
- Technical requirements to systems ensuring power supply, automatic control, component cooling, required environmental parameters, steam supply to auxiliary systems, processing of water containing boron, coolant filtering, preparation and delivery of chemical reagents, preparation and delivery of decontamination solutions, hydrogen incineration, sampling, delivery of deionized water, ensuring level compliance, leakage

collection, etc.

5) Arrangement requirements.

The requirements to the arrangement with accounting for the arrangement of components and systems in order to ensure efficient performance and access to equipment, with consideration of possible impacts caused by coolant leakage, and keeping the equipment operational capacity at a steady level, shall be provided. The requirements to the arrangement of components connected to different power supply systems shall be provided.

15.2.1.2 System project.

1) Technical plan description.

The section shall contain a description of the technical plan of the system in question. A layout with the arrangement of all CMI specified shall be provided.

Compliance with the requirements of TNLAs and of section 15.2.1.1 of this technical code is to be stated.

The following equipment characteristics shall be provided:

- Environmental category;
- Information on protective coating of every component;
- Labeling, number of operational and emergency components;
- The purpose of a component;
- Thermohydraulic and structural properties of a component. The following data shall be provided as a part of characteristics. Pumping assembly:
- Description;
- Type;
- Electric drive gear type;
- Delivery rate, m^3/h
- Delivery head, MPa (mm. w.g.);
- Intake pressure, MPa (kgf/cm^2);
- Maximum pressure, MPa (kgf/cm^2)
- Maximum power rate, kW;
- Pumped medium;
- Pumped medium temperature, K (°C);
- design temperature, K (°C);
- Rate of rotation, Rpm.;
- Pump seal, leakage, m^3/h (l/h);
- Pump material;
- Design pressure, MPa (kgf/cm^2);
- Positive suction head, Pa (mm.w.g.); Heat exchange unit:
- Type;
- Surface area, m^2;
- Tube side;
- Medium;
- Flow rate, t/h (max/nom.);
- Design pressure, abs., MPa (kgf/cm^2);
- Operational pressure, abs., MPa (kgf/cm^2);
- Operational temperature, K (°C):
- At input;
- At output;

Material; Tube side:

- Medium;
- Flow rate, t/h (max/nom.);
- Design pressure, g. MPa (kgf/cm^2);
- design temperature, K (°C);
- Operational pressure, MPa (kgf/cm^2);
- Operational temperature, K (°C):
- At input;
- At output;
- Material; Deaerator:
- Type;
- Medium;

- Shell;
- Heat exchange unit;
- Efficiency rate, t/h;
- Vaporization output, kg/h;
- Operational pressure, MPa (kgf/cm^2);
- Design pressure, MPa (kgf/cm^2);
- Operational temperature, K (°C):
- design temperature, K (°C);
- Battery container volume, m^3;
- Heating steam pressure, MPa (kgf/cm^2);
- Material; Valves.

General information on the valves, arrangement of protective coating inside and outside of them, structural features concerning ensuring its airtightness and types of connections to pipelines, shall be provided. Data and substantiation of the arrangement of isolation valves (references to the NPP SAR section "Safety systems" may be provided)

shall be provided.

2) Description of components.

A description of the main system equipment inside and outside of its protective coating, and of its features, shall be provided.

3) Description of materials.

This subsection shall provide criteria for material selection based on the following factors:

- Operational environment WCC and its impact on the rate of corrosion of structural materials;
- Operational environment parameters;
- General environmental parameters;
- The feasibility of equipment and pipeline manufacturing technology (no defects, compliance with technical requirements).

The primary material shall be specified, as well as means and (or) measures of equipment protection form the environmental impact, the type of climatic category of the item.

Information concerning materials shall provide references to relevant GOST or TS for the material with specification of its mechanical properties and chemical composition. The selection of material is to be substantiated for normal, abnormal and emergency operation modes.

In case of implementation of new materials data on their certification and experimental substantiation of their implementation shall be provided.

4) Overpressure protection.

Means of providing overpressure protection to systems and the design (or experimental) substantiation of the operational capacity of these means are to be stated.

5) Equipment arrangement.

The following data shall be provided:

- System equipment allocation to the corresponding buildings and premises and markings showing its arrangement;
- Conditions of arrangement of components connected to different power supply and control systems;
- Room fire resistance;
- Conditions of compliance with fire safety guidelines;
- Protection from flying objects;
- Data on systems maintaining the required environmental parameters;
- Seismic resistance category of corresponding buildings and constructs. References to arrangement layouts supplemented to this section (plans and views)

shall be provided.

6) System deactivation.

Information concerning system deactivation in case of RI shutdown shall be provided. The conditions of system deactivation providing for NPP safety shall be stated.

15.2.1.3 System operation manipulation and control.

1) Description of protection and sealing systems.

A list of controlled parameters (parameter values, relevancy groups, registration, alarm, extent of impact on protection and sealing mechanisms and automatic control) shall be provided.

The section is to present requirements to CMI apparatus and information of back-up redundancy of sensors, communication channels, connection to control systems (PUCS, EPUCS).

References to system technical plan supplemented to section 15.2.1.2 “System project”. shall be provided.

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2) Control points.

Parameter control points shall be specified.

3) Safe operation limits and conditions, operational limits.

The information shall contain parameter limit values based on project design data, and state system safe operation conditions.

Moreover, operational limits are to be stated.

4) Operator activities.

System control conducted by the operator in case of automatic control system failure or some deviations from normal operation parameters is to be described.

15.2.1.4 Tests and checks.

Information concerning system tests and checks, including testing methods with specification of controlled parameters and CMI equipment shall be provided. The rate of tests and checks is to be stated.

15.2.1.5 Tests and checks.

1) System reliability parameters.

System equipment components reliability parameters shall be listed as tables based on TS and technical documentation.

Qualitative analysis and calculation of reliability parameters of the system shall be conducted on the basis of stated parameters, and their results are to be stated.

Simultaneously, information on calculation programs shall be provided.

Conclusions on system reliability are to be drawn based on calculation results.

2) Normal operation.

This subsection shall contain information of the function of system and its components during different NPP operation modes and the carrying out of its respective functions:

- Unit activation from a cold state;
- Unit operation mode at capacity, including intake-exhaust of boric solution or pure condenser into the primary circuit;
- Unit shutdown with cooling.

3) System operation in case of equipment failure.

Information concerning operation of systems, alarm, automatic functions, operator activities, possibility of reactor shutdown and unit cooling for refueling shall be provided.

The following factors are to be accounted for:

- Possibility of localizing automatic devices failure points;
- Back-up redundancy of equipment, pipelines, valves, control points.

This subsection is to state information on the response of the reactor system and NPP as a whole to failure in case of operator non-interference in case of occurrence of the following initiating events:

- Loosening of regenerative heat exchange unit of the primary circuit;
- Failure of cooling water delivery to pre-cooling of primary circuit purging;
- Failure of the regulating valve of coolant removing component;
- Leakage of primary circuit feeding deaerator;
- Breakage of pipe still of the deaerator heating surface;
- Discontinuation of delivery of pure condenser;
- Failure of the regulating valve of the primary circuit feeding system;
- Uncontrolled delivery of pure condenser to the primary circuit;
- Leakage in pressure pipeline of feed line outside the containment and inside of it.

4) System function in case of deviation from normal operation parameters. The following data shall be provided:

- On system function and performance in case of failure of some components;
- on the possibility of identification of the corresponding system failure by the operator, the impact of these failures on system and reactor operation and NPP general

safety;

- On operator activities concerning localizing failure points, and on the means of returning the RI to a safe state;

- On system and RI response to normal operation conditions violation and emergencies, failure of separate system components with or without operator involvement.

Moreover, the following aspects are to be considered:

A) Coolant leakage compensated by a feeding system. The following information shall be provided:

- On the possibility and means of maximum primary circuit feeding with a boric acid solution with accounting for operator or automated devices involvement. The impact of the

possible cold water leak to the primary circuit on the resilience parameters of the MCC shall

be considered;

- On the means of prevention of uncontrolled pure condenser delivery;
- On the duration of the cycle of cold water delivery and procedures to be performed after localization of corresponding failures;
- on the stores of boric acid solution used to compensate coolant leaks;
- in the means of detection and determination of the size of coolant leak.

A more detailed information is to be presented in section “Nuclear power plant accidents analysis” of the NPP SAR.

B) NPP blackout.

Information on reliable power supply provision to system components via diesel generators, the description of system function and of the function of its components and the activities performed by automatic devices and by the operator in order to substantiate carrying out the corresponding functions by the system shall be provided. A more detailed information shall be presented in section “Nuclear power plant accidents analysis” of the NPP SAR.

5) System function in emergency mode, including external influence.

All available system emergency modes and emergency modes triggered by external or internal influence shall be described, with specification of primary emergency modes, in particular:

A) The system function in case of earthquake.

The function of system and its components in case of an earthquake shall be described, as well as its necessity. The measures ensuring system performance in case of an earthquake shall be described, as well as the procedure if cutting off the seismic resistant system from the non-seismic resistant. A description of system function with the possibility of reactor shutdown cooling with ensuring efficient refueling and fuel removal shall be described.

B) A plane crash.

The section shall provide information on NPP unit shutdown and cooldown in case of the occurrence of the corresponding initiating event.

6) Project design evaluation

Project design evaluation shall be conducted on the basis of a qualitative analysis and reliability parameters calculations; system compliance with TNLA requirements, criteria, project principles shall be shown, deviations from TNLA requirements, if present, shall be substantiated.

7) Comparison to similar projects.

A comparison to similar domestic and (or) foreign projects shall be provided. If operational data of such systems is available, it shall be provided.

15.2.2.-15.8.8. Systems to be described in section 15

The information concerning auxiliary systems in specified sections shall comply with the plan set forth by subsection “General requirements” if this technical code.

. The description shall be given similarly to the description of purge and feeding, and boron control system, provided in the section 15.2.1 of this technical code. Descriptions of every system shall contain information specific to this system. Relevant drawings and diagrams shall be provided.

The information contained herein is not to repeat the information stated in section

Primary coolant circuit and its related systems or in other section of the NPP SAR.

15.9 Substantiation of strength of pipeline systems, air ducts, ventilation, process and carrying and lifting equipment of a NPP power unit auxiliary systems with the account of impacts of natural and technogenic origin

Calculations shall be carried out to substantiate the strength of specified system components on the basis of classification of every system components and load combination compliant with the requirements of TNLAs.

Calculation results shall be provided for every system in subsection of NPP SAR "Project design evaluation".

16 Radioactive waste handling

The section shall contain information on handling of gaseous, liquid and solid NPP RAWs, show the possible points of RAW leak into the environment and describe the RAW handling technology.

The means of ensuring compliance of RAW handling technology principles with ALARA principle shall be described.

16.1 Sources of radioactive waste formation at a nuclear power plant

This subsection shall list RAW sources, characteristic parameters acting as initial data for systems of handling all types of RAW both during normal NPP operation and in cases of emergencies.

Parameters used to determine the activity of every radioactive nuclide in the coolant of primary and secondary circuits shall be specified, their allowances - substantiated.

Quantitative characteristics of RAW (radioactive nuclide) flowing into the coolant as a result of damage to NFE cartridge vessel, shall be substantiated with calculated values accounting for heat stress applied to fuel elements and other relevant parameters, as well as existing operational background of analogous fuel assemblies, including accident handling background, temperature modes and fuel burning out rate.

Data on concentration (activity) of radioactive nuclides of corrosion and fission products, used in calculations of energy spectra of radiation of equipment and waste, shall be provided. The manner in which activation degree of water and its impurities is accounted for shall be specified. The radionuclide composition of wastes, as well as a mechanism of their generation and data on waste radionuclide concentration, shall be described. The implementation of existing operational background is to be reflected.

Analytical models used to calculate initial data (consumption, concentration, energy spectra, etc.) at the foundation of the RAW handling system project with normal and transitional operation modes accounted for shall be presented.

Design values of organized and disorganized coolant leaks into the primary and secondary circuit, auxiliary equipment circuit, decontamination water, equipment, etc., which may constitute potential sources of RAW leak into the environment, shall be systematically arranged.

Data on sources of leaks and flows, their size and evaluative parameters of their share of the general radioactivity level shall be presented in the form of tables. Comparative data on the specified parameters shall be presented along with operational data of analogous acting units.

The evaluation of RAW liquid, gaseous and aerosol intake into the premises on every radionuclide with specification of the ways of their further spread and leak into the

environment shall be conducted and provided. Methods of leak measurement and design means of decreasing leak size shall be provided. References to prior experience of active NPP operation shall be provided.

Systems which may constitute sources of RS emission (dump), which are, however,

not classified as RAW (i.e. steam generator purge systems, air filtering under the containment, etc.) shall be specified. Evaluation of potential RS (radionuclide) emission from every specified source with a description of the mechanics of its possible transfer, spread and emission in to the environment during normal operation and during potential emergencies, shall be provided.

Data on leak consumption, radionuclide concentration and other parameters necessary to conduct evaluation calculations shall be provided. Project design solutions on localization of such sources, with specification of the manner in which prior experience with

active or designed NPPs has been utilized, shall be provided.

The analysis of project principal solutions on decreasing the RS (radionuclide) content in primary circuit coolant with comparisons with previous generation NPPs shall be provided. Comparison of calculation data and operational data of analogous active units shall be provided.

16.2 Gaseous radioactive waste management systems

This subsection shall contain description of all NPP systems constituting potential sources emission of RS into the environment in the form of gases or aerosols, including ventilation systems of access-controlled building areas, technical purge cleaning systems, turbine ejectors, turbine hall ventilation, etc. The NPP SAR shall contain a description of potential project solutions on handling gaseous waste during all operation modes, including emergencies, in all specified systems, as well as list design basis accidents at the plant.

16.2.1 Project design fundamentals

This subsection shall contain main principles and criteria of safety implemented in the project and (or) technical system plans, and provide references to specific paragraphs of safety TNLAs.

Class, category and groups of primary components shall be specified in accordance with classification set forth by the current nuclear energy TNLAs. Data on system and component classification shall be included in the subsection to comply with information completeness standard. References to other sections may be provided on condition that they contain relevant information.

The information shall be presented as tables, if possible.

Goals and criteria of system parameters calculations shall be supplemented with potential annual RS emission and potential irradiation exposure of the personnel and the civil population caused by the emission.

The descriptions are to include an evaluation showing that implemented principles and corresponding technology increase the efficiency (including economic efficiency) of waste processing. The evaluation shall show that the implemented systems use all available contemporary technological means of decreasing personnel and civil population irradiation exposure.

All used calculation data, methods and allowances shall be provided.

The way in which specific features of the site stated in section “Description of the area and the site of a nuclear power plant location” of the NPP SAR, with respect to meteorological and hydrological conditions, have been accounted for, shall be stated.

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An evaluation showing that systems perform at an appropriate level and possess a

necessary level of back-up redundancy in order to provide RS filtering during all operation modes in case of non-airtightness of NF cartridge required for safe operation depending on the RI type, shall be provided.

It shall be shown (on the basis of evaluative calculations of system performance) that the system provide compliance with emission limitation criteria during all operation modes: normal operation, abnormal operation or in case of emergencies.

The specific project features activating the means of decreasing the amount of necessary maintenance, equipment downtime, the potential of RS emission into the premises,

and the means of increasing efficiency of environment filtering methods, shall be described.

The design parameters of radionuclide activity in all system components implemented shall be provided with initial data for determination of said parameters.

Arrangement and geometric parameters of system equipment necessary for biologic protection calculations in accordance with the requirements stated in section 17.3 of this technical code shall be provided.

The project means of control over RS (radionuclide) emission in areas not covered by the gaseous RAW handling systems shall be provided. Potential operator malpractice and single failures which may lead to uncontrolled emission into the environment shall be described. The project means of control over emissions caused by operator malpractice or potential equipment failures shall be provided. The efficiency of preventive measures of radiation and contamination control and system manipulation, automatic emission amount limiting in case it exceeds set limits, shall be provided.

All system equipment where an explosive gas build-up is possible with design pressure and substantiation of equipment approved in the design, shall be described.

CMI equipment (including gas analyzers), measures of explosion prevention and prevention of loss of air-tightness in case of an explosion, shall be described.

Radiation control measures for technical procedures and emissions shall be described in accordance with the requirements stated in section 16.5 of this technical code.

16.2.2 Systems description

Systems shall be described in accordance with the plan provided by supplement A.

The description of all systems of handling gaseous RAW and gas flow layouts specifying technical equipment, gas flow paths, system and equipment performance, back-up equipment, shall be provided. For complex multi-function systems the subsystems with autonomous components shall be specified, and corresponding equipment shall be described. Maximum gas consumption and RS (radionuclide) concentration for all operation modes of every system shall be presented in the form of tables. The initial data used for determination of specified parameters shall be provided. The composition of gas flow with specification of hydrogen containing flows handling technology shall be provided.

The connections between systems and their boundaries according to equipment belonging to different classification groups shall be specified on technical plans.

The CMI equipment and system control means shall be described.

The bypass lines with conditions affecting their utilization, and predicted frequency of their utilization related to equipment downtime, shall be described.

The arrangement of hydraulic seal containers (hydraulic seals) and means of preventing their failure shall be provided. The arrangement of ventilation holes and secondary circulation paths for all systems shall be described.

All operation modes, including gas filtering under the vessel, shall be described. The ventilation systems of every building with potential of RS appearance shall be described. The descriptions are to include building volumes, potential consumption in ventilation systems of the buildings and corresponding premises, filter characteristics and evaluation criteria at the basis of these characteristics. The description of normal operation mode of every ventilation system and specific features of operation for different NPP operation modes, including design basis accidents, shall be provided.

A table with design concentrations of suspended in dispersed state RS (radionuclides) contained in the air in building premises and corridors for all operation modes, including design basis accidents, shall be provided.

Other NPP systems constituting potential RAW sources, such as turbine ejectors, etc., shall be described. RS concentration of these systems for all operation modes, including design basis accidents, shall be provided. The initial data used for determination of these concentrations is to be stated.

Data on potential rate and amount of emitted steam during its dumping into the atmosphere in case of activation of protective devices of the primary and secondary circuit with specification of data for these properties shall be presented in the form of tables. If necessary, references to other sections of the NPP SAR may be provided.

16.2.3 Radioactive substances emission

This subsection shall contain criteria to be used for emission of gaseous RAW, and accepted emission norms.

Parameters and allowances used for calculation of RS (radionuclides) in gaseous waste and substantiation of their selection shall be provided. The potential volumes of gaseous waste during all operation modes, including emergencies, shall be shown. The rate of gas emission of every subsystem and system in general shall be presented in the form of a table.

The potential radionuclide concentrations in gaseous waste during all operation modes, including design basis accidents, shall be provided (in Ci/year for every reactor) Concentrations of radionuclides for every subsystem and system in general shall be included in the table. The design data shall be provided for operational limits of NF cartridge damage in accordance with NPP engineering order with consideration of potential additional emission of fission products from the fuel into the coolant during transitional modes and unit shutdown, shall be provided.

A prognosis for potential short-term increase of RS content in gaseous waste in case of the non-airtightness parameter of NF cartridges reaching safe operation limit per TNLA shall be provided.

The accounted allowances, including dilution factors, and points of gaseous RS emission into the environment shall be specified on technical plans of gas flows and general NPP plan drawings.

The information shall, if possible, be presented in the form of tables and diagrams. The operational data on annual RS emission into the environment at units constituting

prototypes of the designed NPP shall be provided. Comparative analysis is to be conducted on the basis of the above mentioned data.

The foundation height, inner diameter, rate of gas flow and gas temperature of dump ventilation pipes shall be provided.

The general description, configuration, flow rate, gas temperature of ventilation holes of buildings and other dumping devices shall be provided.

16.3 Liquid radioactive waste management systems

This subsection shall contain description of all NPP systems of liquid RAW handling, their characteristics and for all operation modes, including project accidents. Project design fundamentals

16.3.1 Project design fundamentals

This subsection shall contain main principles and criteria of safety implemented in the project and (or) technical system plans, and provide references to specific paragraphs of safety TNLAs.

Class, category and groups of primary components shall be specified in accordance with classification set forth by the corresponding TNLAs on safety, seismic resistance, radiation danger level, etc. Data on system and component classification shall be included in the subsection to comply with information completeness standard. References to other sections may be provided on condition that they contain relevant information.

The information shall, if possible, be presented as tables.

Goals and criteria of system parameters calculations shall be supplemented with potential mean annual and overall liquid RS (radionuclides) production and potential irradiation exposure of the personnel and the civil population caused by the emission.

The descriptions are to include an evaluation showing that implemented principles and corresponding technology increase the efficiency (including economic efficiency) of waste processing. The evaluation shall show that the implemented systems use all available contemporary technological means of decreasing personnel and civil population irradiation exposure and liquid RAW solidification.

All used calculation data, methods and allowances shall be provided. The way in which specific features of the site stated in section 8 with respect to meteorological and hydrological conditions, have been accounted for, shall be stated.

An evaluation showing that systems perform at an appropriate level and possess a necessary level of back-up redundancy in order to provide RS filtering during all operation modes in case of non-airtightness of NF cartridge required for safe operation depending on the RI type, shall be provided. It shall be shown (on the basis of evaluative calculations of system performance) that the system provide compliance with emission limitation criteria during all operation modes: normal operation, abnormal operation or in case of emergencies.

The specific project features activating the means of decreasing the amount of

necessary maintenance, equipment downtime, the potential of RS emission into the premises, and the means of increasing efficiency of environment filtering methods, shall be described. The design parameters of radionuclide activity in all system components implemented shall be provided with initial data for determination of said parameters. Arrangement and geometric parameters of system equipment necessary for biologic protection calculations in accordance with the requirements stated in section 17.3 of this technical code shall be provided.

Potential operator malpractice and single failures which may lead to uncontrolled dump of RS into the environment shall be described. The efficiency of preventive measures, both technological and via protections, sealing, CMI, shall be shown. The project means of control over uncontrolled and unintended RS dump into the environment shall be provided.

Radiation control measures for technical procedures and emissions shall be described in accordance with the requirements stated in section 16.5 of this technical code.

16.3.2 Systems description

Systems shall be described in accordance with the plan provided by supplement A.

The description of all systems shall include technical plans with specification of equipment, normal liquid flow paths, system performance and corresponding equipment components, back-up equipment. For complex multi-function systems the subsystems with autonomous components shall be specified, and corresponding equipment shall be described. The technology of handling all types of liquid RAW shall be described.

Maximum and normal values of liquid consumption input (m^3/day for a reactor) and radioactivity value (as a percentage of primary circuit coolant activity) for all operation modes,

including design basis accidents, shall be provide in the form of tables or diagrams. The initial data used for determination of specified parameters shall be provided.

The division of liquid RAW flows, principles of their division according to their physical and chemical properties, radioactivity value, etc., shall be described. All possible bypass lines and conditions affecting their utilization, as well as potential rate of their utilization related to equipment downtime, shall be described.

The connections between systems and their boundaries according to equipment belonging to different classification groups shall be specified on technical plans. In order to provide information necessary for conducting evaluations under section “Radiation protection” of the NPP SAR, the components of equipment and pipes with an increased radionuclide concentration shall be specified.

All normal operation modes and deviations from their parameters during different NPP operation modes, including design basis accidents, shall be described.

16.3.3 Dumping radioactive substances

The parameters and allowances of calculations of radioactivity (radionuclides) dumping and initial data used the calculation of said parameters and allowances with consideration of the portion of filtered liquid waste that may be included into the closed cycle for reuse, shall be presented.

The potential amount of dumped RS (radionuclides) for all operation modes, including emergency modes and design basis accidents, shall be presented (in Ci/year for every reactor). The amount of dumped radionuclides for every system shall be presented in the form of tables with specification of their concentration. The dumping points of liquid RS and dilution factor accounted for during evaluation of activity per unit volume, shall be provided.

A prognosis for potential short-term maximum RS daily dump into the environment in case of the non-airtightness parameter of NF cartridges reaching safe operation limit per TNLA shall be provided.

Parameters and allowances used to calculate the residual water dump from the plant and initial data used to calculate said parameters and allowances shall be presented. The potential amount of residual water dump from the plant for all operation modes, including emergencies and design basis accidents, shall be provided.

The design data shall be provided for operational limits of NF cartridge damage in accordance with NPP engineering order with consideration of potential additional emission of fission products from the fuel into the coolant during transitional modes and unit shutdown, shall be provided.

A prognosis for potential short-term increase of RS content in residual water in case of the non-airtightness parameter of NF cartridges reaching safe operation limit per TNLA shall be provided.

A comparative analysis of maximum activity per unit of residual water with requirements to levels of surface water set forth by corresponding TNLAs shall be conducted.

16.4 Solid radioactive waste management systems

This subsection shall contain description of all NPP systems of solid RAW handling, their characteristics and for all operation modes, including design basis accidents.

16.4.1 Project design fundamentals

This subsection shall contain main principles and criteria of safety implemented in the project and (or) technical system plans, and provide references to specific paragraphs of safety TNLAs. Current TNLAs are to be used.

Class, category and groups of primary components shall be specified in accordance with classification set forth by the corresponding TNLAs on safety, seismic resistance, radiation danger level, etc. Data on system and component classification shall be included in the subsection to comply with information completeness standard. References to other sections of the NPP SAR may be provided on condition that they contain relevant information.

The information shall, if possible, be presented as tables. Goals and criteria of system parameters calculations shall be supplemented with waste characteristics, their

maximum and supposed quantity to be processed, radionuclide make-up and waste activity

level.

16.4.2 Systems description

Systems shall be described in accordance with the plan provided by supplement A.

The description of every system is to include descriptions of subsystems of solid waste handling implemented for processing of ion-exchange resins, pulp, concentrated substances, and of the system of liquid RAW solidification. All system components shall be listed. The design performance level and structural materials shall be presented.

The maximum and potential waste quantity, their physical shape, composition, source, radionuclide make-up and unit activity shall be presented in the form of tables. The initial data used for calculation of above mentioned parameters shall be listed. Methods of processing of every type of waste, container types for waste packaging, final form of conditioned waste shall be described.

Technical process diagrams reflecting normal operation order, system consumption, processing duration of every assembly, potential isotope composition of every flow and equipment performance shall be provided. Means of conducting control over technical processes and CMI equipment shall be described.

Technical plans with specification of system connections, CMI equipment and boundaries between equipment belonging to different classification groups shall be provided.

Layouts of area packing, storage, loading and transport of wastes of different categories shall be provided.

The design data shall be provided for operational limits of NF cartridge damage in accordance with NPP engineering order with consideration of potential additional emission of fission products from the fuel into the coolant during transitional modes and unit shutdown, shall be provided.

A prognosis for potential short-term increase of RS content in solid waste in case of the non-airtightness parameter of NF cartridges reaching safe operation limit per TNLA

shall be provided.

A description of means of prevention RS spill into the premises and the environment provided for by the project shall be given.

The efficiency of implemented means of preventing RS spill into the premises and the environment and related CMI (references to information stated in section “Management and control” of NPP SAR) shall be shown. Possible operator malpractice and single equipment failures which may lead to RS spill into the environment shall be listed and described.

The subsystem of solid waste handling intended for treatment of workwear, equipment, instruments, system filters, ventilation etc., and other compressible and non- compressible RAW.

Maximum and expected values of parameters of specified wastes stated as waste source names, quantity, radionuclide composition and activity (in Ci) shall be provided in the form of tables. Initial data used for calculation of stated parameters shall be provided.

The conditioning and packages methods used for treatment of wastes and related equipment

shall be described. The means of processing and packaging of large wastes, such as reactor core elements, etc., shall be described. Containers used for RAW packaging shall be described. The compliance with current regulations and norms shall be shown. Means of compression, decontamination and transport of waste containers to storage facilities shall be described along with an analysis of potential emergency situations, such as depressurization of containers caused by them falling, etc. Means of collecting and decontamination technology to be used in case of container depressurization shall be described.

Preventive measures implemented for waste storage before loading and transporting, the expected duration of RAW storage at the site, layouts of packing, storage, loading and transporting areas are to be given.

Maximum and expected annual quantities of every type of RAW to be disposed, their radionuclide composition and activity (in Ci) shall be stated.

Information on operational RAW and RAW produced after plant shutdown to be transported to regional depository shall be provided.

Conditions of temporary operational waste storage at plant site and potential location of their long-term storage shall be described. Information on processing and disposal of RAW of different categories produced after plant shutdown shall be provided (references to information stated in section “Nuclear power plant taking out of operation” of the NPP SAR may be provided).

16.5 Radiation survey and sampling system

This subsection shall contain description of system providing radiation control (references to information stated in section “Radiation protection” of NPP SAR may be provided), as well as sampling during RAW handling, RS dump and emission during all operation modes, including emergencies and design basis accidents (this information may be stated in sections “Gaseous RAW management system”, “Liquid RAW management system”, and “Solid RAW management system”, of the NPP SAR).

16.5.1 Project design fundamentals

This subsection shall contain main principles and criteria of safety implemented in the project and (or) technical system plans, and provide references to specific paragraphs of safety TNLAs.

Current TNLAs are to be used.

Class, category and groups of primary components shall be specified in accordance with classification set forth by the corresponding TNLAs on safety, seismic resistance, radiation danger level, etc. Data on system and component classification shall be included in the subsection to comply with information completeness standard. References to other sections of the NPP SAR may be provided on condition that they contain relevant information.

The information shall be presented as tables, if possible.

The NPP SAR is to include goals and criteria of calculations of dump radiation control, emission and sampling system. The information on dosimetry control of dump and emission shall also contain differences between design problems for normal operation and design basis accidents.

16.5.2 Systems description

Systems of radiation control sensors and means of sampling used for dosimeter measurements, RS emission and dump control for all operation modes, including normal operation, emergency operation and in case of occurrence of design basis accidents, along with means of analysis of mediums contained under containment (in the leak-tight enclosure system) in the period after an out-of-project accident.

For continuous dosimeter control of technical processes, emissions and dumps the following information shall be provided:

- Sensor arrangement;
- Sensor type, characteristics and type of measurements;
- CMI equipment, back-up redundancy, independence of measurements;
- The range of RS concentration measurement and initial data for determination

of provided range;

- Types and locations of alert devices (including emergency alarm), regulatory apparatus and their description;
- Back-up power supply;
- Settings of emergency alarm and protection, sealing and regulator triggering; initial data for determination of their values;
- Means of calibration, maintenance, inspection, decontamination and replacement of radiation control devices.

The following information on every sampling device shall be provided:

- Substantiation of the selection of their location;
- Expected consumption, composition and concentration of radionuclides in samples;
- Substance quantity necessary for measurements;
- Rate of sampling type of equipment and methods used for procurement of representative samples;
- Methods of laboratory analysis and instrument sensitivity.

16.5 Radiation survey and sampling system

In this subsection you have to describe a system that provides radiation monitoring (links to the information in PSD NPP "Radioactive shielding" subsection are allowed), as well as RAW sampling, RAS discharges under all conditions of operation including accidents and design basis accidents (describing the information is allowed in PSD NPP "Gas RAW system," "Solid RAW system" and "Solid RAW system" subsections).

16.5.1 Project design fundamentals

In the subsection, basic principles and safety criteria shall be indicated that are implemented in the project and (or) PF Diagram systems specifying certain TNLA security sections. TNLA shall be used during the time of system designing.

One shall indicate category, class, group, type, etc. for systems and when it's necessary for their basic elements in accordance with the classification reported in used TNLA concerning security, seismic resistance, the degree of radiation hazards, etc. Classification data of the system and its elements are indicated in this section for the reasons of information integrity about the system. A link to other sections could be provided, if there is any necessary information.

It is desirable to provide information in tabular form. NPP SAR shall contain the objectives and criteria for the calculation of radiation discharge monitoring system and sampling system. Differences between tasks calculations for normal operating conditions and design basis accidents shall be indicated for a radiation monitoring system of discharges and emissions.

16.5.2 Systems description

It's necessary to provide radiation monitoring sensor systems and sampling tools used for dosimetric measurements, emission monitoring and RAS discharges in all normal operation conditions including emergencies and design basis accidents, also for the analysis of environment under the protective sheath (in a sealed enclosure system) after DEC accident scenario period.

The following information shall be provided for continuous radiation monitoring of processes and emissions:

- The location of the sensors;
- Type of sensors, characteristics, type of measurements;
- Test equipment, redundancy and the independence from perform measurements
- RAW concentration range and the initial data for measuring the range.
- Types and location of signal devices, alarms (including emergency alarm), regulators and their description;
- Power backup;

- Emergency alarm installation and protection, block, regulator operation; initial data for measuring those values; measures provided for calibration, maintenance, inspection, decontamination and replacement of radiation monitoring devices;

The following information shall be provided for each sampling system:

- basis for the choice of the location of sampling points;
- Expected flow rate, composition and concentration of radionuclides in the samples;
- The amount of material required for the measurement;
- The frequency of sampling, type of equipment and procedures used to obtain representative samples;
- Methods of laboratory analysis and the sensitivity of instruments.

17 Radiation protection

This section shall contain information about radiation safety assurance and evaluation of personnel radiation exposure during normal operation, including repair and maintenance work (overload and storage of fuel, collection, processing and storage of RAW; repair works and preventive maintenance; metal control and inspection welded joints etc.) and during emergencies. Radiation monitoring, individual monitoring, radiation monitoring of the environment programs shall be provided. It is necessary to prove that during normal execution of work, personnel radiation exposure doses won't exceed the established limits, collective exposure is kept to a minimum and a RAW inflow (radionuclides) in the environment through emissions and discharges won't exceed designated exposure dose quotas per an individual member of the society.

One shall provide values of radiation criteria that help identify accident initiation or incident (links to the information in NPP SAR “Operation of NPP" and "The limits and conditions of safe operation. Operating limits” sections are allowed).

Each section and subsection shall have percentage of completion of functional TNLA concerning radiation safety, if necessary - specific alternative approaches that will be used. If necessary, special links to the information provided in other sections.

17.1 Assurance of the minimal attainable occupational exposure (the ALARA principle)

17.1.1 Radiation Safety Concept

One shall describe what technical and organizational measures helped ensure the protection of personnel, population and the environment against harmful effects of radiation. One shall prove the use of the proposed means and event management practices that do not lead to established exposure limit excess, excluding any unjustified exposure. Existing radiation exposure is kept at such low level that is reasonably obtained taking into account economic and social factors. One shall display how effective protective systems are and that they are enough to get a slight increase in health risk or other damage to the personnel, population and the environment in comparison with the existing values of the risks and damages caused by the other production activities.

The limits shall be indicated:

- An individual exposure dose of personnel;
- A collective annual exposure dose of personnel;
- Acceptable accidental emission limits;

17.1.2 Project design fundamentals

To provide a description of the radiation protection principles adopted in the design of facilities and equipment that provide the reduction of occupational radiation dose to such a low level that is reasonably achievable, taking into account economic and social factors (ALARA principle).

It shall demonstrate that the protection, from external and internal exposure of the personnel, is designed with a safety factor for the entire lifetime of NPP.

Describe how gathered experience in designing and operation of a power plant used in developing an improved project of reduced occupational radiation exposure to the lowest possible level, also to point out changes in the project (in comparison with similar projects) of reduced occupational exposure.

Evaluate additional costs arising because of these changes and compare them with the economic benefits that can be obtained by the proposed reduction of occupational exposure.

Describe provided means that are used to reduce dose rate in contamination control area and reduce the duration of stay of operational personnel as well as the number of RAS sources. Means that are used to improve the protection, contraction of volume and time consumption on servicing, give access to equipment, simplify operating procedures as well as reduction and simplification of other actions needed during the operation.

17.1.3 Organization of operation

Demonstrate that during maintenance, organization requirements are met and that they guarantee the reduction of occupational exposure doses to such a lower level that is reasonably achievable, taking into account economic and social factors (ALARA principle). Show how the requirements of operation and operating experience of other similar units are taken into account in the design of equipment, biological protection and the plant in accordance with the information provided in 17.1.2 and 17.3.1 of the technical code.

Specify radiological criteria used in the development of guidelines and technical means for radiation-hazardous work, including maintenance works, operational inspections, metal monitoring, the overload of the reactor core, work with RAW for reducing occupational exposure doses in accordance with the ALARA principle.

17.2 Radiation sources

17.2.1 Equipment containing radioactive substances

Give the data about RAS substance in equipment pieces (except RAW systems contained in the section “Radioactive waste management”) that are sources of radiation taken into account at the stage of calculations and design of biological protection.

Shall be described:

- the reactor core as a source of determining the levels of ionizing radiation during power reactor in operation at indoor biological protection where the presence of operational personnel may be required, also as a source of fission products entering primary circuit.
- the first circuit as a source of reactor coolant of a primary circuit and activation corrosion products and fission products which get to the coolant due to defective fuel rod cladding;
- The second circuit as a source of RAS when primary coolant leaks;
- other utilities and power plant equipment which may contain RAS;
- spent fuel handling, transportation and storing system that contain fission products in the irradiated fuel and activation products of structural materials;
- Other sources of radiation, including neutron launchers for the check of devices and apparatus, sources of gamma-radiography, by products of a nuclear reaction and any others requiring protection from a radiation.

Description of the radiation sources (except the reactor core) shall contain a radionuclide composition data, an activity data and geometric parameters of the source as well as an initial data to determine specific values. NPP SAR shall contain the information about radionuclide composition quantity and physicochemical forms of all sources whose activity exceeds 100 mC.

It shall be justified that during power operation, fission-products yield corresponds to the normative operational limit of a fuel failure. In case of emergencies and transients, positive fission- product yield effect into the coolant from the fuel shall be taken into account (for example, due to a spike-effect).

Information shall be presented to the extent that could be used as an initial data to perform calculations of biological protection.

Drawings and plans of general layout of a power plant shall show the location of all radiation sources as well as potential and actual transport routs of RAS.

17.2.2 Gasious radioactive substances sources

Provide a description of gas RAS sources that go to the atmosphere of contamination control area taken into consideration as protective means and occupational exposure assessment in accordance with the GSP-2002. Besides the sources that exist under normal operating conditions, other sources, that were caused by denials of basic equipment as well as maintenance, shall be described (the opening of a reactor, SNF movement and etc.).

The description shall contain the calculated concentration of radioactive gases and aerosols expected during normal operational transient conditions and under anticipated operational occurrences in a contamination control area.

Models, parameters and initial data shall be presented that are necessary for calculation of concentrated radioactive gases and aerosols. If an initial data is absent, a data from similar NPPs could be used.

17.3 Account of peculiarities of radiation protection designing

17.3.1 Buildings, structures and equipment location and layout

Present the plan (on a scale) of a complex of industrial buildings, structures and plant premises with an indication of process equipment layout that is a source of radiation and all sources of radiation indicated in the sections 17.2 and 16 of the technical code.

The plan shall show:

- contamination control area borders and zoning its premises by non-occupied area,

periodically served premises and served premises as well as normally occupied area including administration and on-site facilities;

- Location of sanitary inspection rooms, sanitary clean rooms, a special laundry, medical posts;
- personnel flow, transport flow, delivery of clean components and removal of contaminated components;
- Arrangement of places for the storage of contaminated components, decontamination areas, solid radioactive waste material places, equipment control room, RAW handling system mechanisms;
- The location of the sensors and radiation control panel;
- Laboratory facilities for the analysis of samples of radioactive environments (chemical, radiochemical, radiometric, spectrometric), personal dosimetry monitoring laboratory as well as metal control, engineering and calibration (workshop), storage of ionizing radiation sources.

Adopted classification in the design of areas and premises of NPP which is the basis for the design of biological protection from penetrating radiation and RAS pollution prevention of the air of served rooms in the controlled area.

17.3.2 Features of equipment systems and elements design

It shall be pointed out that design features of the equipment and systems which allow to ensure the reduction of occupational exposure doses in accordance with the ALARA principle, and exemplify how these features affect the basic requirements of operating regulations that are indicated in in the 17.1.3 requirements of the technical code.

The description shall include design features that reduce maintenance or other operations in radiation fields, reducing the intensity of sources and providing quick entry, easy access to the workplace, a remote-acting conduct of operations or decrease of occupancy time or any other measures that reduce personnel radiation exposure.

It's worth including a description of used project methods of decreasing, distributing and saving active corrosion products by reducing the rate of corrosion and the erosion of circuit materials using the minimum of the first material circuit with high cobalt content, primary water chemistry guideline conformance of the coolant, a coolant cleanup, a stagnant zone minimization (cavities, pockets), where activation products may accumulate, the max reduction of the concentration of activated nuclides in the make-up water. Provide illustrated examples that include drawings of equipment and element piping layout that require personnel access to the plant unit at power (special water-cleaning equipment, tankage (tanks), coolers, de-aerators, pumps, a tube bundle, systems (sampling). It's worth showing the location of sampling sites, control and measuring equipment and a control panel (stations).

17.3.3 Biological protection

This paragraph shall provide the information about the biological protection for each radiation source pointed out in the section "Radioactive waste management" and "Radiation Sources" including the characteristics of the protective materials, a coating layer thickness, a protection measuring method, a moment method, accumulation factor etc.), the geometric parameters of power and protection.

Special protection devices shall be displayed and equipment that include containers, covers, screens, loading equipment etc., which are used for RAW handling of any kind.

The solution programs shall be showed with man-made assumption and technical equipment that is used for hazards evaluation. The results of calculations shall be provided including the calculated level of emissions in attended rooms, periodically attended rooms of contamination control areas, also in normally occupied areas including the administrative building, in normal operation, during a transient condition and activity planned.

17.3.4 Ventilation, filtration and conditioning systems

The main design parameters of ventilation systems in contamination control area shall be provided including repair ventilation to protect personnel as well as any elements of personnel protection that are related to ventilation systems and not included to the NPP SAR sections - "Power units and Control Systems" and "Radioactive waste management." The Removal of gas fission product from the contamination control area, process vent as well as RAW management system are to describe in the NPP SAR section - "RAW management."

Provide illustrated examples of air filtration from radioactive gas and aerosol procedures including the plan of the premises where cleaning and clarifiers are located (filtration plants), the pipe layout, the filter tree.

Indicate Terms and Conditions and describe the means of verification, testing and insulation systems. Describe the means which determine the effectiveness of air purification, the replacement and transportation of used filters (filter elements). It's necessary to indicate decontamination factors that were adopted during radiation safety analysis. Because there is a strong dependence of these coefficients on the filtering conditions in the radiation situation assessment they shall be taken into account based on the hardest filter operation conditions (estimated sizes of aerosol particles set equal to sizes of the most penetrating particles for each filter, iodine-based filter and drying agent. Adopt the most adverse of all possible temperature-humidity characteristics).

17.3.5 Radiation survey system

Provide selection criteria of radiation monitoring, sampling point schemes, equipment location (devices). Describe the technical means of radiation control at NPP including the equipment:

- permanent monitoring based on automation stationary systems and fixed instruments;
- Operational control based on portable (carried), moving and (or) non-fixed equipment, installation;
- laboratory analysis based on laboratory devices, units, selection means and preparation of radioactive samples for analysis;
- individual personnel dose control

The description shall include the basic specifications (controlled parameters, sensor types and their quantity, measuring range, an intrinsic error), the information about the methods and means of metrological support, the information about the alarm system, recording devices and sensor location that show (read) and warning instruments (devices). Valve and flow booster sampling lines shall be provided.

One shall indicate the location of the point(s) of air selection for gas-aerosol activity monitoring, describe the air sampling system and present criteria and methods for gas and aerosol concentration sampling.

One shall describe possible technical means of radiation monitoring to measure the radiation parameters including high-power radiation and personnel radiation exposure in the event of a radiation accident, shall justify the need for additional test equipment to carry out such measurements.

One shall describe the software that processes and presents the information, programs that forecast radiological consequences of NPP events collection, storage and systematization of data about radioactive contamination of the environment, personnel and general public radiation exposure.

17.4 Operational and emergency dose assessment

Provide an assessment of the duration of stay of personnel (throughout the year) including the number of people and length of stay in contamination control areas (permanent stay areas of personnel) during normal operation, under transient conditions and during repair works. For contamination control areas where are expected to have gas and aerosol activity pointed out in the section 17.2.2 of the Technical Source Code, provide duration of stay assessment of personnel in man-hours and RW entry into a body assessment via inhaling.

Provide an assessment of the annual individual dose (total and separate internal and external irradiation) and personnel radiation exposure (collective dose) during the performance such basic functions as operation, maintenance, operation control and welded connection inspection, radioactive waste management, overload of the reactor core and during conduct repairs.

Show that radiation doses and dose consumption are estimated during the time depending on the lifetime of the power plant.

Specify the initial data, calculation methods, assumption models and access methods used in the determination of the above-mentioned values. If the estimated (predicted) doses and dose consumption will be unacceptably high, describe the activities provided by the project with the purpose of reducing them.

Information about radiation doses and personnel dose consumption received during the operation of similar power plants can be used for dose assessment and dose consumption during the execution of unpredictable actions (operations) based on certain conservative assumptions.

Provide an annual dose assessment at exclusion area boundary, normally occupied area (operating nuclear islands) and NPP control area and on the territory of NPP where main radiation sources are (power blocks, RW repository, radioactive effluent discharges and emissions, etc.). Assess annual dose for constructional workers from these sources at the existing NPP during the construction of another power blocks. Specify initial data, methods and model calculations, man- made assumptions.

17.5 Radiation protection assurance program

17.5.1 Organization

Present EE departmental unit structure including radiation security service at NPP that implements the radiation safety program. Specify qualifications and experience of the personnel that executes programs, also specify their powers and authority for the execution of each program item including radioactive material control (nuclear materials, radioactive sources, etc.).

Describe the technical and administrative control measures of personnel who work in contamination control area, the implementation of instructions on radiation hazardous works. Carry on a training program on the use of personal protective equipment.

Provide information about mobile units equipped with the technical means to receive information about radioactive contamination during both normal operation and accident situations and accidents.

Describe the organizational structure of the system and equipment storage conditions and their calibration and metrological certification.

Show how the government regulatory agencies are informed and control over results. During the section development, it's acceptable to indicate a reference to the information contained in the section "Operation of NPP" of NPP SAR.

17.5.2 Radiation survey programs

During the normal operation of NPP and accidents, listed below radiation control programs shall be executed with the indication of procedures and methods that provide personnel and general public exposure decrease. List of questions is given in Supplement G., each section of control programs shall have relevant information.

17.5.2.1 Radiation Control Program at the plant

Radiation Control Program at the plant shall contain integrity monitoring subprograms and barrier conditions on the way to RAS spreading and ionizing radiation; personnel exposure control; RAW management; non-proliferation of radioactive contamination.

The information shall be provided in integrity monitoring subprograms and barrier conditions on the way to RW spreading and ionizing radiation that is sufficient for:

- Received information about the integrity and status of the barriers;
- Signaling when regulated levels of intervention are reached (Operational limits and the limits of safe operation for barriers at NPP)
- Independent and immediate informing of bodies of state administration about integrity and status of the barriers.

It needs to justify and expound the contents of radiological environment in potential residential areas for personnel and individual dosimetric control over personnel in personnel exposure subprogram that is sufficient for:

- determining radiation dose rate served and semi-occupied areas of NPP;
- determination and evaluation of personnel radiation exposure in the entire range of possible levels of radiation exposure produced during normal operation, design basis accident and DEC accident scenario;
- calculation and prediction of personnel radiation exposure during both normal operation and accidents;
- obtaining information for emergency assessment of the radiation situation at personnel workplaces to make a well-judged choice and protection measures in normal operation and DEC accident scenario making.

RAW monitoring management subprogram is needed to justify and present the content of radiation monitoring over liquid, solid and gas RAW as well as discharges and emissions. At the same time it shall indicate that monitoring content is sufficient for:

- Obtaining information about the radiation environment caused by radioactive emissions and discharges into the environment, determining personnel radiation exposure at NPP in control area and general public radiation exposure in control area;

- Determining quantity and radionuclide composition created and stored RAW at NPP;
- Obtaining information about personnel radiation exposure during the work with RAW;
- Detecting and recording above-limit discharges and emissions values to the environment as well as unauthorized movement of radioactive waste and accumulation at NPP territory.

Non-proliferation of radioactive contamination RAW management subprogram shall justify and present radiation monitoring content of barrier effectiveness which prevent RAS spreading to the environment that is sufficient for:

- contamination level determination of working space surfaces and equipment, skin cover,

shoes, industrial overcoat, personnel individual protection equipment, used vehicles in the process of crossing contamination control area;

- contamination level determination of personnel individual clothing and footwear in the process

of crossing the territory of NPP;

- contamination level determination of vehicles and transported goods in the process of crossing the territory of NPP.

17.5.2.2 Radiation monitoring program of the environment in control and buffer areas.

The program shall justify and explain radiation monitoring content in NPP control and observation areas of environmental compartments, personnel and general public that is sufficient for:

- obtaining information about exposure level of critical population groups and personnel;
- obtaining information about trends and changes of RAS accumulation in environmental compartments and a human body;
- correlating the results of radiation monitoring of environmental compartments and radiation monitoring of RAS emissions and discharges.

17.5.2.3 Radiation monitoring programs in case of accident situations.

The program shall prove and explain NPP radiation monitoring content in case of accident situations, design basis accidents and DEC accident scenarios as well as radiological environment monitoring in a radiation accident area by manpower and resources of NPP taking into account the radiation monitoring data.

The content shall be sufficient for:

- detection of violations of barrier integrity;
- determination of RAS emission (discharge) intensity
- determination of environmental RAS emission efficiency, quantity of RAS dispersion (discharge) and their radionuclide composition;
- vapor-gas medium sampling from reactor compartment after an accident;
- Identifying, assessing and forecasting the radiation situation in NPP premises, operating nuclear island, control and observation areas;
- Identifying, assessing and predicting the values of equivalent external and internal exposure of personnel and all people who are within the territory of operating nuclear island, control area, and critical population group in the observation area;
- determination based on radiological environment forecast of emergency measure areas, preventive measure areas and restrictions within a radiation accident area;
- intervention level forecasting and emergency preparedness levels;
- guaranteed execution of radiation monitoring subsystem in the conditions created by a design basis accident with the most severe radiation situation at NPP;
- assuming and developing the best possible protective measures of personnel and general public;
- radiation situation forecasting at the spreading afield distance of a radioactive

emission to the atmosphere in the process of development of design basis accident to protect general public in accordance with regulated criteria of population protection in case of radiation accident at NPP;

- informing the government in a timely manner about the necessity of population protection measures.

17.5.3 In-plant personnel medical care and health protection

17.5.3.1 Medical care organization

NPP SAR shall have the organizational structure of health care and health monitoring of personnel required for radiation exposure control and prevention. Responsible health care personnel shall be instructed. It shall include the description of methods and inspection procedures (internal and external) of personnel including methods of recording, reporting and analysis. Describe the assessment program of personnel radiation exposure (the whole body and single organs) including personnel selection criteria which will be examined within the program, radionuclide level estimation in a whole body and single organs.

17.5.3.2 Equipment, protective equipment and facilities

Specify the location of health and sanitary premises (health centers, health posts, special laundry) and indicate types of equipment (tools, devices) for sanitary control.

Describe personal protective equipment, specify their characteristics, their use and maintenance.

Specify the location of the main equipment ensuring personnel radiation safety (including changing rooms, showers, meter men rooms, radiation exposure posts), laboratory facilities of radio and spectrometric analysis, storage places of protective clothes, respiratory protection equipment, decontamination of equipment and personnel and other equipment.

17.5.3.3 Radiation protection methods

Include radiation protection methods provided in instructions, during refueling, metal condition monitoring and welded seams, spent fuel management, RAW, normal operation and maintenance, sealed and unsealed waste product storage, sources, special NM.

Provide special air sampling methods as well as the selection and special equipment usage and respiratory protection devices. Describe criteria and methods of radioactive contamination monitoring of personnel, equipment and surface.

18 Safety Systems

This section shall contain information about safety systems provided by design of the reactor plant and NPP to operate in case of emergencies and accidents (reactivity, connected with heat sinking violation or the integrity of primary system and fuel handling), intended to secure the reactor shutdown, installation cooling (emergency and afterheat removal), safe radioactive emission containment or, if necessary, fused nuclear reactor core containment.

Reported systems shall come into operation in case of exceeding the trigger settings (up to exceeding the limits of safe operation) and the failure of normal operation systems.

This section shall provide detailed information about plant safety system (security, localizing and supporting) and their function performance to prevent accidents or limit consequences. Control safety systems are described in the NPP SAR section “Manipulation and Control.”

You shall provide a list of normal operation systems that perform safety functions in case of accidents and their working analysis.

Emergency situation analysis, design basis accidents, DEC accident scenarios and their consequences shall be presented in the NPP SAR section “Accident Analysis at NPP.”

Information shall ensure that the assessment included in NPP SAR is correct, complete and all the necessary tests are performed. Links to the other analyses included in other sections shall be indicated, if they are connected to SS.

SS development stage shall be indicated.

18.1 Protective safety systems

NPP SAR section shall contain information about the following SS:

- Protective SS for an emergency reactor shutdown (the information about the system or its part
can be also indicated in the section 13);
- High pressure AICS;
- Low pressure AICS;
- hydraulic accumulator system;
- Primary circuit overpressure protection system;
- Secondary circuit overpressure protection system;
- Primary circuit emergency gas removal system;
- Boration emergency injection system;
- SG emergency water supply system;

If there are any other protective SS in the block, they shall be described in Supplement A of the technical code.

18.1.1 Systems description

Each system of this section shall have the information based on the structure shown below.

18.1.1.1 Project design fundamentals.

The following information shall be provided:

- The purpose of the system by indicating its functions and safety class in accordance with the requirements of TCP 170;
- Basic design data that defines performance objectives and system parameters as well as
environmental conditions assuming that these characteristics are to be received. It is

necessary to assure safety concepts:

- Single failure concept. Provide evidence that the system is designed by taking into account a single failure concept.
- Redundancy concept. It's worth indicating single element redundancy in the project (performing the same function despite the requirements related to the appreciation of single-failure criterion) in order to increase system reliability. Show how exactly, during reliability and sufficiency system redundancy that perform secure function, standing period is taking into account related to maintenance, testing and repair;
- Diversity concept. You shall show how diversity concept is used during system and element dimensioning that except common-mode failures;
- Separation concept. One shall indicate physical barriers separating system trains or site
separation that except common-mode failure (fires, floods, etc.);
- Commissioning concept. One shall list signals that start the system, required energy sources and working environment.

18.1.1.2 System project.

One shall indicate the conditions where system elements will work. Limiting conditions shall be presented where each system element was designed and taken into account:

- Make a list of postulated initiating events that require particular system commissioning;

- Environmental parameters affecting controlling security systems under all conditions. Show that all controlling security systems were designed to withstand environment conditions (pressure, temperature, vibration, buff loads, humidity and radiation fields arising during the operation). Show that these conditions shall be maintained by elements during design basis accidents and after them and also during the whole age of component;
- Radiation protection and availability of elements. Show that protective SS are specially designed for providing an access to equipment for inspecting, maintenance works and personnel radiation exposure are supported as low as reasonably achievable below prescribed limits;
- Seismic resistance. Provide a description of all catch arrangements, supports and oscillation

absorbers installed on conduit pipes and equipment. Show how temperature sensing works according to 5.5.10 of TCP 171.

- Show how the following requirements are applied to catch arrangements, supports and oscillation absorbers (If the relevant information is missing in the NPP SAR section "Area characteristics and NPP locations"):
- Dead load, earthquake load, temperature expansion under design conditions during stationary operating conditions and transient states;
- Temperature non-exceedance of element construction specified in the project limits;
- Accounting requirements conducted during inspection operation. Show that system and element failures, not related to the 1st category of seismic resistance, do not cause system and element failures of the 1st category;
- Reliability requirements. It is necessary to bring the results of the analysis, which show that the functional reliability of systems that perform safety functions, satisfy the performance requirements in accordance with the assumptions used in the analysis of initial events. For the second safety class elements, it's necessary to provide information about reliability and provability (diagnostics) in accordance with the requirements of 7.1.10 and 7.1.11 of TCP 170;
- Human factor accounting.

It's necessary to list means of single personnel errors and their consequences mitigation in accordance with the requirement of 7.1.9 of TCP 170.

Furthermore, execution of technological regulations shall be shown, in particular

7.1.6 - 7.1.8 of TCP 170, 5.4.1, 5.4.2 and 5.4.24 PNAE G-7-008-89, TCP 171 and etc.

18.1.1.3 System operation manipulation and control.

It is necessary to explain the requirements to the operator, the following information:

- on any operational irregularities that appear during normal operation of the block;
- on operational characteristics that exceed established operational limits;
- on availability (non-availability) of protective SS to perform security functions (for example, if there is a sufficiency of boron solution of required concentration);
- on the need of implementation of safety functions;
- on implementation of safety functions by protective SS;
- on safety functions implementation or there was a rejection of function execution.

18.1.1.4 Tests and checks.

One shall provide the information on the methods, scope and terms of monitoring and system testing in the process NPP operation, their characteristics within a special project and TNLA requirement capability.

18.1.1.5 Tests and checks

The information on the calculation shall be grouped into the following groups: thermal and hydraulic calculations, stress calculation of system elements, radiation situation calculations. It shall consist of:

- A list of all of the calculations;
- A list of methods and programs used for safety justification, indicating the scope, assumptions, information on programs of certification;
- analytical model;
- Analysis of the calculation results;
- Conclusions.

Additional information:

- A list of all carried experimental studies;
- Description of experimental procedures;
- Information about the experimental design, the assumptions;
- Analysis of the experimental results with the findings;
- List of studies to be carried out during the development of working documentation.

18.1.2 Systems of core emergency cooling, boron emergency injection, feed water supply into steam generator, primary and secondary coolant circuits excessive pressure protection systems

18.1.2.1 It is necessary to formulate the purpose of the system with an indication of its functions and point out system safety class in accordance with the requirements of the TCP 170.

The initial data shall be presented for calculation of the system, algorithms, methods, and results of calculations. Initial data shall be presented as complete as possible to carry out independent calculations in other programs based on calculations.

18.1.2.2 The following system requirements shall be presented:

- Consumption;
- Pressure;
- Temperature;
- The volume of containers;
- The concentration of boric acid;
- Hydraulic resistance paths;
- The main characteristics of the reinforcement steel (speed work, mode of operation);
- Reservation of energy sources and active elements of SS;
- EIP reservation.

The following information about overpressure safety systems shall be provided:

- The number of safety devices (valves);
- Resettable environment and its total mass;
- Changes in the environment flow through each valve in time;
- The opening pressure of the valve;
- The opening of the valve;
- The need for power supply, power supply category;
- Operating reliability for the opening and closing;
- The number of bubbler systems for steam receiving;
- Steam consumption time change and the total amount of steam received by bubbler system;
- The initial and final temperature of the water in the bubbler system.

18.1.2.3 Provide a description of protection systems against fire and flooding.

18.1.2.4 Show how the system is protected against unauthorized intervention.

18.1.2.5 Present regulations and periodic maintenance tests in systems and (or) their separate elements.

18.1.2.6 Provide information on the required storage of consumable materials and spare parts.

18.1.2.7 Present characteristics and system control:

- A list and protection justification and blocks;

- Work algorithms, security, reliable performance;
- Control system description, the accuracy of the parameters;
- A list of hand operation management;
- Delay time during which the wrong actions of the operator in emergency situations will not cause harmful effects;
- Means of support availability for the operator in the systems and components management;
- Control panel habitability.

18.1.2.8 Present characteristics of power supply systems:

- System and power category emission requirements;
- Connection of consumer schedule during system start-up;
- allowable time variation, frequency and voltage.

18.1.2.9 Provide information on compressed air supply system of SS:

- Rate, parameters and air quality;
- System description including its failure functioning.

18.1.2.10 Present the following characteristics of the oil supply system:

- Rate, volume, parameters and quality of oil;
- Oil change and deoiling regulations.

18.1.2.11 Present characterization of water supply system by distillate oil:

- Rate;
- Parameters;
- Allowable water supply breaks.

18.1.2.12 Provide information on air-vent and drainage system performance.

18.1.2.13 The following information shall be presented on SS ventilation:

- Fans and ventilation system characteristics;
- Heat emission amount;
- Incoming gases and aerosols amount;
- Air exchange rate.

18.1.2.14 Provide information on metal conditions, pipelines and the equipment:

- Methods;
- Means and control regulations.

18.1.2.15 Vibration, noise and leak monitoring and diagnosing

18.1.2.16 Provide the following information on system heat extraction:

- Heat extraction characteristics;
- Heat-eliminating mediums;
- Feeding;
- Mechanical impurity characteristics.

18.1.2.17 Provide information on mechanical impurities and RW water purification:

- Cleaning agents;
- Water exchange rate;

- Clogging, heat-transfer and throughput measures (clogging of the heat exchangers, filters, meshes, etc...).

18.1.2.18 Provide hydro-testing scheme and its requirements

18.1.2.19 Provide information on gas extraction and gas purge of the system and the means of fire safety.

18.1.2.20 Provide makeup flow and environment storage on SS completing and charging.

18.1.2.21 Show the use of SS in beyond-design-basis accident management.

18.1.2.22 Provide data on indoor environment conditions where the normal operation of the elements is guaranteed.

18.1.2.23 Provide information on the registered design elements and conditions of their working requirements for decommissioning nuclear power plant unit.

18.1.2.24 Provide information on operating systems:

- Method, volume, timing monitoring, system and component testing;
- Maintenance schedules, periodic inspections of systems and components;
- Data on the required number and qualifications of operational personnel and maintenance personnel who are entrusted to work on the systems;
- Data on the performance of the systems, on the failure of systems and components;
- Data on loading cycles, start-up and cool-down the stand-by mode during operation;
- Data on consumable materials, spare parts and assemblies.

18.1.2.25 Provide additional information on system elements taking into account the specifics of these elements:

a) Pipelines and their elements:

- Pipeline list;
- TCP 170-2009 classification and seismic resistance;
- Manufacturer;
- Design, location, layout, tracing conditions, slope;
- Support design, structure, construction, track design, compensators;
- Drains, vents;
- Welding data;
- Data on the structural and welding materials as well as their compatibility with the technological environment;
- Permissible heating and cooling rates;
- Data on the safety devices;
- The basic data of input control, manufacture control, assemble control (quality of the metal, welding, hydraulic test results);
- A list of monitored parameters and volume during diagnostic operation (state of the base metal and weld displacement and vibration, corrosive and erosive wear, the chemical composition of fluids, the state of insulation);
- Design and calculation of thermal insulation;
- Marking, painting, corrosion protection;
- Hydro-testing program during commissioning and operation.

b) Reinforcement:

- A list of the valve;
- TCP 170 classification and seismic resistance;
- Normative base;
- Manufacturer;
- Design;

- Data on structural materials and welding; Data on the compatibility of structural and welding materials with technological environments;
- Characteristics (tightness, flow resistance, the opening pressure of the check valves, for
driving - the drive parameters, response time, allowable pressure drop);
- The conditions on the layout, the location, the external environment;
- Support and structure design;
- Permissible heating and cooling rates;
- List of controlled parameters of the operation and scope of diagnostics (displacement, vibration, wear, leaks, driving parameters);
- Marking, painting, corrosion protection;
- Maintainability.

c) Heat exchangers:

- A list of heat exchangers;
- TCP 170 classification and seismic resistance;
- Normative base;
- Manufacturer;
- Design;
- Data on the structural and welding materials and their compatibility with the technological environment;
- Thermal design;
- Features: costs and speed media, media parameters (pressure, temperature), the heat transfer coefficient of hydraulic resistance circuit, protection and blocking;
- Linking conditions, location of the media;
- Requirements to the quality of the cooling water;
- Instrumentation data;
- Support and structure design;
- Permissible heating and cooling rates;
- List of monitored parameters during the operation and volume diagnostics (displacement, vibration, leaking, media parameters, characteristic of solids in media, the heat transfer coefficient changes);
- Insulation construction;
- Marking, painting, corrosion protection;
- Maintainability;
- Overpressure protection (circuit design and characteristics of the safety devices, the design and experimental validation of their performance);
- Search technology leaks pipes, elimination of defects;
- The technology of heat exchange surfaces clean of impurities.

d) Pump units:

- A list of pumps;
- TCP 170 classification and seismic resistance;
- Normative base;
- Manufacturer;
- Design;
- Data on the structural and welding materials and their compatibility with the technological environment;
- Features: performance, pressure, power, time reversal, surge marin, the starting power of the motor, suction height, vortex formation absorption data, requirements for clean water from mechanical impurities, vibration characteristics, the temperature of the pumped water; the number of permitted starts per hour;
- EIA data;
- Protect methods and blocks;

- layout, location conditions;
- Support and structure design;
- Environmental conditions (temperature, humidity);
- The parameters of the lubrication system;
- List of controlled parameters of the operation and diagnostic scope (displacement, vibration, leaking seals, the parameters of the water and oil pump performance);
- Marking, painting, corrosion protection;
- Maintainability.

e) Tanks:

- A list of the tanks;
- TCP 170 classification and seismic resistance;
- Normative base;
- Manufacturer;
- Design;
- Data on construction materials, compatibility with technological environments;
- Characteristics: volume, frequency sharing environment;
- Drainage and air-vent design;
- the concentration of the absorber uniformity;
- Sludge removal technology;
- Providing project-level process environment and the absence of overflow;
- layout and location conditions;
- Designed mounting supports;
- A List of controlled parameters during operation (levels, value of allowable leak, media parameters, the concentration of the absorber);
- Marking, painting, corrosion protection;
- Maintainability.

f) Bubbler systems:

- A list of bubbler systems;
- TCP 170 classification and seismic resistance;
- Normative base;
- Manufacturer;
- Design;
- Data on the structural and welding materials and their compatibility with the technological environment;
- Thermal calculations, justification of water bubbler vapor condensation;
- Characteristics: environment flow variation in time and speed, environmental parameters (pressure, temperature, volume parameters, water consumption and the amount of steam received during the time that the bubbler is capable of condensing steam, blocks and protection);
- Characteristics of the built-in heat exchanger: changes in environment consumption over time, speed environment, water coolant parameters, heat transfer coefficient, flow resistance, the pressure drop;
- EIA data;
- layout, location, environment conditions;
- Support and structure design;
- Quality requirements for condensing and cooling water;
- List of monitored parameters during the operation and diagnosing the volume (displacement, vibration, leaking, the parameters of the condensing and cooling water, mechanical characteristics and chemical contaminants; variation coefficient of heat transfer);
- Overpressure protection (circuit design and characteristics of the safety devices, the design and experimental study of their performance);
- Technical measures to prevent the formation of vacuum in the steam line supplying

steam to a water level in the bubbler;

- Insulation construction;
- Marking, painting, corrosion protection;
- Maintainability;
- Defect detection and elimination technology of embedded condenser tubes;
- Technology of cleaning the heat transfer surfaces from contamination.

g) Provide the following information on RASDF and SV:

- A list of RASDF and SV;
- TCP 170 classification, earthquake resistance and PNAE G-7-008-89;
- Normative base;
- Manufacturer;
- Design, operation;
- Data on the structural and welding materials and their compatibility with the technological environment;
- Characteristics (throughput capacity, metering characteristic, operating pressure, opening time, hermetic state data, specifications and drive parameters);
- EIA data;
- Layout conditions, outdoor environment data;
- Support and structure design;
- List of controlled operating parameters and volume diagnosis of (displacement, vibration, wear, leaks, drive parameters);
- Need for energy supply;
- Marking, painting, corrosion protection;
- Maintainability;
- Design and experimental study of efficiency.

You shall provide information about the tests specified in the project during PC automation systems, the withdrawal of the necessary characteristics of RASDF and SV, defining the range of control and the opening time.

18.2 Localizing safety systems

18.2.1 General description and project fundamentals

18.2.1.1 Purpose and project fundamentals.

Name all localization safety systems and their components that are presented in this unit.

In this and in other sections (a link shall be provided), one shall make a list of TNLA which apply to the system or component.

Specify each system functions, groups in accordance with the security classification, seismic and PNAE G-7-008-89.

The principles and criteria shall be presented which are taken as the basis for system design, including RI requirements.

Provide LSS element load limits created by postulated design basis accidents and external effects that are typical for operating nuclear island; reliability allowable values.

Show how and to what extent it is possible to control the state, maintenance, testing, repair, deactivation of LSS and their elements.

Present experimental study design performance of LSS and their elements. One shall describe the experimental setup, how to conduct experiments and to present the main results in the form of diagrams or table parameters changing in the experiments. It is necessary to introduce an experimental study of LSS modes of operation.

Present calculations showing that LSS elements can take nondestructive and abnormal operation loads from the postulated design basis accidents and external influences in the range mentioned above or in combination defined by current TNLA. You shall submit the original data to perform these calculations as well as the main assumptions used in the development of computational algorithms and the algorithms to the extent that these calculations could be repeated by an independent expert; information on testing, verification and validation of used calculation tools.

Show that all LSS and their elements will stand provided in the project the number of their own tests as well as the required number of overpressure and de-electrifying leak-tight enclosure for mechanical strength operational test and PC hermetic state and operation without loss of performance.

Justify the time from the start of design basis accident with the loss of reactor coolant until the moment when it becomes possible to access personnel in accident confinement area. The same time shall be justified for DEC accident scenarios.

Show how LSS active elements are managed and controlled; provide an analysis of the need and scope of monitoring and control of LSS active elements with RCB; passive components with mechanical moving parts - PUCB with RCB and one need to show that the requirements for the implementation of RW limit emissions into the environment by these elements during accidents are taken into account.

Indicate the measures to prevent the harmful effects of microorganisms on LSS elements that are in contact with solutions during normal operation.

18.2.1.2 Description of the construction and (or) technological scheme.

Provide description of the construction and (or) technological scheme of the system underlying performing independent system functions, equipment, facilities, devices, elements, including mounting hardware, supports, substructures, etc. Descriptions of the individual elements can be divided into independent subsections with the same structure as in the general description of the system.

One shall provide sufficiently detailed drawings and diagrams illustrating the design or the technological scheme of the system, as well as the main technical characteristics of the system and its elements.

One shall provide sufficiently detailed drawings and diagrams illustrating the design or the technological scheme of the system as well as the main technical characteristics of the system and its elements.

18.2.1.3 Management and Control.

It is necessary to give a description of the management and control of each system, as well as the characteristics of the parameters (settings), which triggered the technological protection and blocking.

18.2.1.4 Materials.

One shall justify the choice of materials based on normal operating conditions, field troubles and accidents.

18.2.1.5 Manufacture, installation and construction quality assurance**.**

One shall indicate manufacture, installation and construction quality assurance programs for all LSS elements.

18.2.1.6 Pre-commissioning**.**

Provide information on PC including its testing. Indicate the objectives and basic stages of PC, provide description of these stages indicating the test methods and parameters. Highlight operations during which the security can be compromised and define measures to prevent accident initiation. It is necessary to prove the adequacy of pre-launch testing for the safe operation of NPP.

18.2.1.7 Operational and control testing.

In this section, you shall provide information about the methods, scope and timing of condition monitoring and system testing in the process of NPP operation, program activities are taken into account for these purposes by the project and show their compliance with TNLA.

18.2.1.8 System operation.

Describe system operation including the information of possible failures in other units (within a single failure principle), and provide a description of the measures to project the system from the effects of these failures.

For each mode of the system including failures of other systems, it is necessary to present basic characteristics (mechanical, thermal hydraulic, physical and chemical, structural, etc.), reliability measures and show that they do not exceed the permissible values specified in 18.2.1.1.

18.2.1.9 System operation in case of failure.

Provide failure analysis of system elements including operators' errors (within a single failure principle) and assess the impact of the consequences of a failure on the system performance and the safety of NPP in general.

It is necessary to analyze the failures of passive components with mechanical moving parts (e.g. back-pressure valves), active elements (valves, pumps, etc.), control and measurement instrumentation of the system and associated control and supporting systems. Particular attention shall be paid to the analysis of common cause failures including possible fires.

It is necessary to present qualitative and quantitative failure characteristics at hand and their consequences including the characteristics of basic parameter changes affecting the safety of NPP.

It is necessary to show the impact of these failures on other system performance.

18.2.1.10 System reliability analysis.

It is necessary to present qualitative and quantitative system reliability analysis based on the information in 18.2.1.9 in accordance with the requirement of 7.1, 7.6 of TCP 170.

It is necessary to show that the ratio of LSS operational unavailability is less than or equal to

$1.0 \cdot 10^{-3}$.

18.2.1.11 Project design evaluation.

Based on performed analysis, one shall indicate that the system design meets accepted requirements, principles and safety criteria.

18.2.2 Sealed enclosure system

In addition to 18.2.1.1 and 18.2.1.11 of the technical code, it is necessary to list the basic elements of SES.

It is necessary to show that the SES constructions provide inherent function performance in accordance with LSS requirements and comply with PIN AE 5.6, NP-031-01, PNAE G-7-008-89.

Show that the steel vessel comply with PIN AE G-10-012-89.

Show that the degree of SES hermetic state as well as the multiplicity of the attenuation elements of this system of ionizing radiation comply with current TNLA.

Provide information provided means for recording the stress-strain state and the temperature of the concrete enclosing structure of SES.

Provide information on the means that perform SES excess pressure and vacuum test as well as dip survey.

Show how exactly hermetic state of sealed concrete part of SES is controlled and if necessary, make a repair.

18.2.2.1 Hermetic steel cladding.

Show how connections of parts of hermetic steel cladding are made between each other and with other SES elements, how the periodic inspection of the hermetic connections is conducted. Show how to ensure control of the sealing assembly of welded joints of steel lining in the process of acceptance and operation, as well as the rapid detection of defects (a link to the «General provisions and approaches to the design of buildings, structures, systems and components" section of NPP SAR is allowed).

Indicate whether hermetic steel cladding is allowed to use as external reinforcement and (or) the formwork.

Point out:

- What TNLA was used for hermetic steel cladding strength calculations;
- What criteria was used during anchoring type and array selection;
- Steel type and grade of hermetic steel cladding, what TNLA was the basis for this;
- How hermetic steel cladding thickness was chosen, what assumptions were made in calculating the strength, show the algorithm of calculation and its basic data;

- If there are premises in a unit, in which there are containers with radioactive environments and

excess pressure above 4.9 kPa is not possible, describe, how hermetic state issue of these premises is settled.

Show how is settled the issue with hermetically sealed premises that are part of a sealed enclosure and at the same time serve as a container for any environment, the level of which shall be maintained at the level of the project..

Provide basic data and the results of calculations justifying the preservation of cladding and its hermeticity considering the strength characteristics of concrete walling and thermal stresses encountered during design basis accidents.

18.2.2.2 Concrete structure. One shall indicate:

- What TNLA was used to select load and impact on reinforced concrete structure, and their combinations during calculation of the sealed enclosure system strength (links to information in the section 9 are allowed)
- What TNLA was used to design LSS engineering structures performing the function of biological protection against ionizing radiation environment, ranging SES;
- What processes and factors were considered when a metal reinforcement and stretched

reinforced concrete structure were chosen;

- That the reinforced concrete structure was designed to be tested in accordance with the requirements of TNLA;
- The number of allowable SES load cycles for the entire service life, taking into account the

acceptance and performance tests;

- How reinforced concrete structure made of pre-stressed concrete is meant for the possibility of periodic tightening tendons;
- The possibility of in-service inspection and replacement of tendons.

For reinforced concrete structure made of pre-stressed concrete, one shall indicate NPP unit operation criteria in case of individual tendon failure.

It is necessary to present basic data, methodology, judgements and assumptions as well as the results of strength calculations confirming the functional performance of concrete structure.

18.2.2.3 Embedded parts (a link to the section "Terms and approaches to the design of buildings, structures, systems and components" of NPP SAR)

Specify, what current TNLA was used to design SES Embedded parts.

Provide materials of embedded parts (strips, plates) affecting the degree of SES hermeticity, and specify TNLA.

Provide materials for embedded parts (anchors, strips, plates and other profiles) as well as anchoring elements for sealing the steel lining that will not influence the degree of tightness of the SES, and specify TNLA.

Identify ways and attaching points of steel clubbing to steel concrete structures, and specify devices or attaching points of steel clubbing to the steel landing stages, cradles and other tools.

18.2.2.4 Hatches, locks, doors and their embedded parts.

One shall indicate:

- On what basis and for what purpose certain SES elements are selected, what conditions are taken into account when choosing the number of sluices, hatches or doors;
- Purpose of each hatch or door lock and their hermetical requirements and provide appropriate

drawings;

- Method of joining embedded parts (frame openings hatches, doors, frames, sluice embedded parts) with cladding and gateway housing compound with an embedded part;
- The method and frequency of leak testing of these compounds in the process of operation, as

well as their availability;

- Possibility to control the tightness of hatches, doors and locks on the outside in relation to the area of the accident location, doors and hatches - after each cycle of opening and closing;
- That the design of locks, doors and hatches with their embedded parts provide a set of design

(engineering) documentation on hermeticity and frequency attenuation of ionizing radiation during normal operation and design basis accidents, beyond design basis accidents;

- Value of allowable leakage through the locks, hatches and doors at the design pressure;
- Which way to open the door (inside ALA or vice versa), whether there is an position indicator alarm at the trapdoors and leafs (hermetically sealed - unsealed) in PUCB and ECR and mechanical or electrical interlock prevents the simultaneous opening of the two gateway doors; If the door locks are provided with valves for pressure equalization with pointers of their situation;
- The possibility of activating the mechanisms by one person manually opening and closing leafs and hatches both outside and inside ALA or gateway;
- How gateway design allows emergency evacuation of personnel from ALA in emergency situations;
- Information on the emergency lighting system and two-way communication sluices with PUCB and RCB;
- what standards are used to calculate design integrity of trapdoors, sluices, doors and their embedded parts;
- what TNLA is responsible for anchoring embedded parts, hatches and doors;
- what elevation points related to the floors in the rooms are set trapdoors, hatches and doors used during the evacuation. Specify the possible the level of the water on the floor in case of an accident.

18.2.2.5 Penetrations. One shall indicate:

- All types of penetrations and present the scheme and (or) the drawings of these penetrations;
- How penetrations connect to embedded parts and embedded parts to sealed steel liner;
- how weather tightness of welded joints is controlled in the period of manufacturing, installation and operation;
- Value of allowable leakage through each tunneling at design pressure environment in SES;
- How group electrical penetration is performed with regard to safety train separation principle.

18.2.2.6 Isolation devices.

One shall list all the crossing guard tight pipeline communications, submit them to the respective schemes. One shall show on these schemes how the environment in the accident localization zone and outside the pipes are connected, the number of isolation devices and their place of installation; formulate and bring the principles of installing isolation devices on intersecting tight enclosure communications.

Bring a list of communications, where the isolation devices may not be installed and the necessary justification is required.

It shall be shown what calculations are made to select the type of isolation devices and take into account their performance. It is necessary to submit basic data for the calculation methods and calculation programs.

One shall specify:

- A list of initiating events which require tight overlap of crossing guard highways. For each line shall be activated dependent time release in case of isolation device failures;

- The requirements which shall comply with TNLA used as isolation device pipe fittings;
- Allowable leak value at the design pressure for all the types of isolation devices and the total number of units for each type separately;
- Frequency of testing pneumatic and (or) of electrically insulating devices;
- What fittings can be used as isolation devices;
- What tools and measures are provided in isolation device system management to prevent unauthorized opening or closing leading to RW or important component damage and NPP systems both at the time of the accident and in the post-accident period;
- That isolation devices during reactor operation at power testing, individually or as part of SS channel (if it's considered by the project) the level of safety unit is not reduced.

18.2.2.7 Bypass and safety devices. One shall show:

18.2.2.8

- Where and for what purpose bypass and safety devices are used and how they function;
- In what cases the accident localization zone is not equipped with regular safety devices, but equipped with such devices (for example, for the period of SES testing for durability and tightness);
- Safety devices that provide a sealed room with the parameters of design basis accidents;
- How to choose (in terms of what conditions) the number of safety devices and their capacity;
- the design of the safety and bypass devices provides carrying out individual tests on operation and tightness as well as the replacement of the sealing elements, inspection and repair of a shut-down reactor;
- That provides tools and techniques to carry out periodic tests of safety and bypass devices operation and performance;
- if NPP unit operation and SES tests for strength and tightness with defective safety devices

are allowed.

18.2.3 Systems of decompression, heat removal, hydrogen removal and gas spray cleanup

18.2.3.1 Passive steam condensers.

It is necessary to specify the basic elements of passive steam condensers and show the drawings.

It is necessary to show that the passive steam condensers created in accidents with the depressurization of the primary circuit have an ample supply of coolant, providing reliable steam condensation just formed. Otherwise, it is necessary to show that the passive capacitor tanks (pools) are equipped with pumping and heat exchange units of required performance with the necessary redundancy.

Indicate what requirements shall be guided in the design of passive steam condenser walls when they are part of the sealed enclosure and in the case of placement in the tanks condensing devices.

Show that in steam-supply lane, inputs and outputs are free from various pipelines and equipment, otherwise, it is necessary to show that these elements and their mountings are designed to impact the flow of vapor and other possible dynamic effects and the cross-sectional area, equipment free area, pipelines and auxiliary structures (staircases, catwalks, walkways) sufficient to ensure non- exceeding design parameters within ALA in accidents with loss of coolant.

It is necessary to describe the system of filling and emptying the tanks (pools), water treatment tanks (pools), level and temperature control in them.

Show that the passive steam condensers are able to operate at the project bank of the reactor compartment. At the same time, specify the maximum permissible deviation from the vertical steam- supply devices for the entire service life of NPP. In case of the permissible deviation excess from the vertical, specify the method for correcting the position of steam-supply devices of passive steam condensers.

It is necessary to specify what environment parameters (pressure, differential pressure, temperature and humidity) in view of its dynamic action are designed for tanks (pools) passive steam condensers.

It is necessary to show why it's not possible to damage the walls and ceilings of passive capacitor tanks (pools) in steam from water hammering that is possible with bubbling gas mixture as well as the possible evacuation from an accident localization zone in case of accidents or false positives of sprinkler system.

Show what requirements are determined by the chemical composition of the solution in the passive steam condenser tanks. It is necessary to specify measures to avoid non-uniformity on the volume of the solution tank (pool), cleaning agents and adjusting the chemical composition of the solution.

One shall provide information about the availability of surface tanks (pools) for repairs and inspections.

It is necessary to justify an experimental study of design performance of passive steam condensers, at the same time cover all possible modes of operation. The information shall be presented in the form of schemes and (or) drawings of the experimental setup, as well as graphs or tables parameters change in experiments.

18.2.3.2 Passive sprinkler devices.

It is necessary to specify the PSD basic elements and provide accompanying drawings, information about the availability of PSD tank surfaces for inspection and repairs as well as designed devices for internal inspections of closed tanks (hatches, manholes, ladders, etc.).

It is necessary to describe the system of filling and draining of PSD tank and devices for monitoring and measuring the water level in the tank and its temperature.

It is necessary to introduce requirements for sealing siphon pipe of PSD and their tightness monitoring as well as experimental validation performance of PSD design, it is necessary to cover all possible modes of operation.

It is necessary to show, based on the requirements defined by any part of the solution, spray

PSD, specify measures to avoid non-uniformity of the solution for the volume of tanks and cleaning means and adjusting the chemical composition.

18.2.3.3 Active sprinkler system.

It is necessary to specify the basic elements of active sprinkler devices and present accompanying drawings.

It is necessary to show, how the chemical composition of the solution is determined sprayed by sprinkler system. Indicate measures to prevent non-uniformity of the solution by volume in the tanks sprinkler system and means of cleaning and adjusting the chemical composition of the solution.

It is necessary to show that the active sprinkler system was designed and constructed in a way that it can be tested in close-to-real emergency conditions and get in practice the entire sequence of operations actuating system including the transition to a source of emergency power supply.

It shall be presented an experimental study of efficiency of all elements of the sprinkler system for all possible modes of operation.

Show that the harmful effects on the equipment associated with the operation of the sprinkler system during the tests are minimized; during power operation of NPP, one can check the performance of the active elements of the sprinkler system, including the sprinkler pump.

It is necessary to show how the active sprinkler system with PUCB and RCB for various accidents are controlled.

Provide information on whether any locking devices on pipelines sprinkler system have position indicators regardless of the type of drive in the PUCB and RCB.

It shall be showed how impossible the depressurization of SES through the sprinkler system piping in the case of not starting the sprinkler pump for alarm.

It is necessary to describe the thermal control system parameters of active sprinkler system (pressure, temperature, flow rate) with the type of instruments and sensors as well as the monitoring of chemical parameters of sprayed water inside the zone of the accident localization (concentration of chemical additives for reactors boric regulation).

18.2.3.4 Water tank pumps of the sprinkler system. One shall indicate:

- what factors were taken into account when choosing the design and the number of water tanks pumps of sprinkler system;
- water tank structure is protected from contamination, for example, filter elements (multi-row labyrinth mesh grille), and prevents the loss of water in any mode of operation of NPP unit;
- water tank supply, the design of its filter elements and intake devices provide simultaneous operation of all devices connected to the tank pump sprinklers and other security systems without the disruption of supply taking into account the delay of water return to the water tank from ALA premises during the disaster period.

It is necessary to introduce the experimental confirmation of the tank performance (tanks) - Pit (pits) or pools in case of failure with thermal insulation of pipelines in the accident. Number of torn insulation needs to be justified. Show how to ensure a uniform composition of the solution in the water tanks.

18.2.3.5 Ventilation and cooling equipment.

- It is necessary to determine the use of ventilation and cooling systems in case of accidents with loss of coolant.
- Show that by using the ventilation and cooling systems for NPP during normal operation it’s not possible to condensate or moisture ingress from these plants to other equipment deployed in an accident localization zones.
- Provide a description of the parameters of the control system and management of ventilation and cooling systems, performing LSS functions, their connection to PUCB and RCB.
- Bring experimental study design performance of ventilation-cooling systems for all modes of operation.

18.2.3.6 Concentration control system and emergency hydrogen removal. One shall indicate:

- Where in premises, the accident localization zone is provided control of hydrogen concentration and where information is transmitted on its concentration, provide study arrangement of hydrogen concentration control points;
- How and where the emergency hydrogen removal system is managed; One shall specify the alarm means are triggered in the event of exceeding the project value of hydrogen concentration in the areas of accident localization.

It is necessary to provide:

- Information about the materials inside the ALA (thermal insulation, chemical coatings, etc.), which can participate in chemical reactions with the media in case of accidents with loss of coolant to produce hydrogen;
- design-basis justification of hydrogen storage with all the processes that take place inside ALA, moreover, show that the system of emergency hydrogen removal performs its functions during design basis accidents;
- Experimental justification of emergency hydrogen removal systems taking into account all the possible modes of operation.

18.2.3.7 Emergency installation of gas-aerosol cleaning. It’s necessary to indicate:

- Filter elements of emergency gas cleaning installations are available during normal operation and in the post-accident period for their replacement ensuring the required level of tightness and biological protection of these elements;

- With the "dry" cleaning method provides the possibility of replacing filters and transportation of a waste in a protective container, while "wet" method of treatment in the post-accident period is provided for water purification from radioactive contamination;
- Plant operation is effective and experimental study results of their design taken into account all possible modes of operation.

18.2.3.8 Passive heat removal system from the accident confinement area.

It is necessary to bring the drawings of CPS construction and its related notes, results of an experimental study design of CPS or appropriate design-basis justification for all possible modes of operation.

18.2.3.9 There could be other LSS in a unit; their description shall also be given in accordance with Supplement A of the technical code.

18.2.4 Testing localizing safety systems and their elements

It is necessary to show how the LSS and their elements will be checked for compliance with design specifications after manufacture, during commissioning, after repair and periodically
throughout the service life of NPP unit.

It shall be mentioned:

- How a check shall be carried out on seismic stability of LSS and their elements;
- LSS types of tests and their elements for compliance with design specifications and certified test methods;
- what documents and who carried out LSS element testing after their manufacture, installation
and during operation;
- When and what methods are used for SES testing and its elements of strength and tightness after installation and during operation.

List the device and (or) systems necessary for the SES testing of strength and tightness.

Specify when, how and for what purpose functional LSS tests and their elements are carried out; what exactly is tested during the functional tests; How the personnel is assigned to carry out the tests; how structure inspection access is permitted during the increase of the pressure or the load; where, during the raising and lowering of loads involved personnel shall be conducting tests and using monitoring devices; prohibited personnel actions during tests as well as
personnel actions after detecting defects.

18.2.4.1 SES strength tests.

One shall list the events where SES strength tests are conducted and the criteria on which the decision to hold a re-test of strength is made.

Show:

- By whom the decision to re-test of strength is made;
- How to choose the test medium pressure and specify the environment;
- Which parameters need to be registered during the strength testing.

It is necessary to introduce the methodology of these testing.

Specify the criteria for evaluating the strength according to the visual inspection (for reinforced concrete structures), as well as criteria for evaluating the stress-strain state on the basis of the measured parameters.

It is necessary to provide information on the design of sensors for measuring parameters of the stress-strain state and specify their errors.

18.2.4.2 SES tightness testing.

It is necessary to show how isolation devices (what signals) get blocking state on the crossing SES communications during leak testing.

One shall show a description of the method used to determine the degree of tightness of the SES. Show that it satisfies the accuracy of determining the value of the leak, it requires a minimum amount of time to conduct testing for a given value of tightness and certified in the prescribed manner.

It is necessary to specify in which cases SES testing for tightness design pressure and vacuum are conducted as well as the frequency of the SES performance testing for tightness and low pressure vacuum.

Present the testing methodology and specify the security measures taken during the testing. The method of calculation is required to specify the value of overpressure and vacuum pressure and pre-dilution value.

The testing methodology shall be specified:

- When and what sources of energy in ALA and in the course of any testing (pre-commissioning

or operational) shall be switched off during testing;

- When and how closed position of isolated valve will be provided;
- When and how isolating valves with pneumatic and electric drives will be brought into the closed position;
- What technical devices will create excess air pressure and vacuum inside the ALA;
- The criterion for determination of the stabilization parameters within ALA;
- The frequency of setting recording;
- Holding time of pressure or vacuum in ALA;
- Where and how to register SES detected defects;
- The number of testing pressure and vacuum levels during SES tightness testing in the process of commissioning;
- SES testing results criterion for leaks both during proposed pressure and low pressure and vacuum, and under low pressure and vacuum during operation;
- The rate of pressure increase and decrease or vacuum inside ALA during tightness testing.

One shall indicate whether there is air dump from ALA through the filters under SES tightness testing during operation.

One shall indicate calculation algorithm of a tightness value during SES tightness testing.

18.2.4.3 SES element tightness testing.

- One shall list all the elements of SES that shall be tested for tightness.
- Provide drawings that allow understand the design of each element of SES to be tested; method of testing; criteria for successful completion of testing both during construction and commissioning as well as operation.

One shall specify:

- When testing shall be carried out;
- SES element requirements according to their availability to carry out testing;
- what SES element testing include during commissioning;
- The amount of incoming control, post-construction testing and element acceptance criteria;
- Frequency of SES element testing during the operation and the extraordinary criteria testing.

18.2.4.4 Premise and tank hydraulic testing.

One shall specify premises and tanks forming elements of LSS that shall be subjected to a hydraulic testing and when testing is held.

Present methodology of hydraulic testing.

Specify the early termination of testing criteria as well as their successful implementation.

18.2.4.5 Functional testing of the active sprinkler system and water tank pumps of a sprinkler system.

One shall specify:

- When you need to carry out functional testing of the active sprinkler system and its water tank pumps;
- what shall be checked during testing, provide testing methodology;
- criteria of successful carrying out of tests;
- Frequency;
- What documents shall be the basis of element testing of the active sprinkler system and its water tank pumps.

18.2.4.6 Concrete cladding structure testing as a biological shield.

It is necessary to specify the time of concrete walling testing as biological protection; SES areas of concrete cladding structure which shall be tested; design dose rate of ionizing radiation.

Lead testing methodology and provide information about its certification, eligibility criteria for concrete cladding structure operation as a biological shield.

18.2.5 Maintenance and technical service of localizing safety systems in the process of operation

One shall provide information on the requirements and documents that will contain LSS, the security services of LSS, good condition of their operation, the contents of production schedules of NPP regarding LSS.

Present basic requirements for LSS operating instructions, information on the volume and frequency of maintenance and inspection LSS performance, specify the criteria of the inspection success.

One shall specify:

- The frequency and types of inspections of active and passive elements of LSS in the process of operation;
- How results of inspections are made;
- Who is responsible for developing the operating instructions of LSS who they prepare, negotiate and approve them;
- The condition of LSS at any level of power, including MCL;
- Under what LSS conditions reactor start-up is prohibited;
- Checks before starting the reactor after the repair operations at LSS;
- reactor start testing before entering the MCL and what documentation is issued by LSS before reactor start;
- Which LSS elements denied personnel access during reactor operation at power;
- Which LSS elements and at what time personnel is allowed to get access during reactor operation at power;
- Which parameters shall be controlled in systems and LSS elements during NPP unit operation;
- Time (with justification), LSS needed to restore maintainability, after which, if their performance is not restored, the reactor is transferred to the subcritical state;
- What documentation is issued at the end of maintenance and operation inspection of the

repaired LSS component (if necessary, the entire LSS);
- What information is written in LSS certificate.

18.3 Safety supporting systems

This subsection shall have information about the following supporting systems:

- Emergency power supply;
- Nitrogen and compressed air, used as an energy source for the safety systems;
- Technical safety system water supply;
- Fire-fighting;
- Supporting ventilation systems.

If there are other SSS units, their description shall be in accordance with Supplement A of the technical code.

You shall list all SSS and their elements provided in the project, and provide links to other section of the report which contain information about these systems.

Each system shall have the following description of its structure.

18.3.1 Project design fundamentals

Initial data for design given in the section shall define the required characteristics and parameters of the system as well as external conditions in which these characteristics are to be achieved.

Show the principles and safety criteria laid down in the system design:

- The concept of a single failure. Prove that the system is designed in accordance with the principle of a single failure;
- The concept of reservation. Show accepted in the project reservation systems of the individual

elements (performing the same function, regardless of the requirements associated with the principle of a single failure) in order to increase system reliability. Show how the analysis of the reliability and adequacy of backup systems performing safety functions have been taken into account the expected periods of downtime associated with the maintenance, testing and repair;

- The concept of diversity. Show how the concept of diversity during system and component design to avoid common cause failures;
- Separation concept. Identify physical barriers separating the system channels, or separation

in space to avoid common cause failures (fires, floods, etc.);

- Commissioning concept. List signals that launch the system, the required energy sources and working environment.

Show concepts and safety criteria compliance laid down in the system design.

18.3.2 System project

This paragraph shall have the following information:

- Description of the construction and (or) system process design performing highlighted independent functions of subsystems, equipment, structures, devices, elements, including fasteners, supports, foundations, etc. Descriptions of the individual elements can be separated into independent divisions with the same structure as the description of the system taken as a whole;
- Sufficiently detailed drawings and diagrams that illustrate the design or the technological scheme of the system as well as the main technical characteristics of the system and its components;
- Justify the choice of materials taking into account NOC, their violations, accidents and emergencies;
- Limits loads on SSS elements created by postulated design basis accidents and external effects that are typical for industrial areas. Provide valid values of reliability indexes;
- How and to what extent it is possible to control the state, maintenance, testing, repair,

deactivation of SSS and their elements;

- Experimental study design performance SSS and their elements. It shall describe the experimental setup, how to conduct experiments, and the main results;
- Calculations proving that SSS elements are able to take loads without destroying or abnormal performance from the postulated design basis accidents and external influences mentioned above and within the combinations defined by TNLA. Provide input data to perform these calculations as well as the basic assumptions in the development of algorithms for calculating the algorithms to such an extent that could be repeated by an independent expert. Provide information on the verification of used computer codes;

- Prove that all SSS and their elements pass planned number of tests in the project during SES tightness testing parameters without loss of performance;
- Justification of time from the start of a design basis accident with loss of coolant to the moment when it becomes possible to access the personnel to ALA;
- How active SSS elements are managed and controlled. Provide analysis of the need and

scope of monitoring and control of active SSS elements and RCB; analysis of the need and the amount of control to the PUCB and RCB passive components with mechanical moving parts. Show that the requirements are taken into account for the implementation of these elements in case of accidents of their functions to limit RAS emissions into the environment;
- Measures to prevent the harmful effects of microorganisms that are in contact with solutions, on SSS elements during normal operation.

18.3.3 System operation manipulation and control

It is a description of the management and control of operation of each system as well as the characteristics of the parameters (settings), which triggered the technological protection and blocking.

18.3.4 Tests and checks

It shall provide information on the PC of the system including its testing, said the goal of basic stages of PC and a description of these steps, indicating the test methods and parameters.

Be sure to highlight the work during which the security can be compromised and define measures to prevent the occurrence of accidents.

Justify the adequacy of pre-launch testing for the safe operation of NPP. Describe the inspection and testing during operation.

Provide information on the methods, scope and terms of the condition monitoring and system testing in the process of NPP operation, the characteristic activities regarding these purposes by the project and show their compliance with TNLA.

18.3.5 Project design analysis

18.3.5.1 It is necessary to present a qualitative and quantitative analysis of the reliability of the system in accordance with the requirement of TCP 170-2009. Based on the review show that the system design meets accepted requirements, principles and safety criteria.

18.3.5.2 It is necessary to describe the system during normal operation, including possible failures in other systems available on a NPP power unit (within the limits of the concept of a single failure) and to submit a description of measures provided by the system to protect it from the effects of these failures.

For each mode of operation of the system including the failures of other systems, one shall indicate performance and reliability of the main characteristics (mechanical, thermal- hydraulic, physicochemical, strength, etc.), and show that they are within the allowable values.

18.3.5.3 During description of the operation of the system in case of failure, it is necessary to present an analysis of failures of system elements, including operators' errors (within the concept of a single failure) and assess the impact of the consequences of a failure on the performance of the system and the safety of NPP in general.

It is necessary to consider the failures of passive components with mechanical moving parts (e.g., check valves), active elements (valves, pumps, etc.), the instrumentation of both the system and the associated control and support systems. Particular attention shall be paid to the analysis of common cause failures, including possible fires.

For these failures shall result in qualitative and quantitative characteristics of their consequences, including the characterization of changes in the main parameters affecting the safety of nuclear power plants.

Be sure to show the impact of these failures on the performance of other systems.

18.3.5.4 Lead Quality Assurance program for all system components in the manufacture, installation and construction.

18.3.6 Additional information

Besides above-mentioned data, in addition you shall provide the following information on SSS

18.3.6.1 Concept is laid in the design of the system:

- The ability to perform any functions in an emergency including de-energizing;
- The ability to control and testing all modes of normal operation without loss of functional properties;
- The ability of channel by channel release for maintenance in any mode of normal operation;
- Duration of (limited or unlimited) work in an emergency period;
- combination of SS functions and normal operating systems without impairing the level of safety;
- design solution testing;
- the system enables exceeding design limits;
- Comparison with similar solutions that exist in the world, deviation from the norms and safety regulations.

18.3.6.2 It is necessary to give information about SSS protection (except the automatic fire extinguishing system) from fire, flood, physical damage, as well as from mechanical damage arising from accidents with pipeline rupture.

18.3.6.3 It is necessary to provide information on the possibilities of the system operation under design basis accidents.

18.3.6.4 One shall provide regulation of maintenance of the system and its periodic audits.

18.3.6.5 It is necessary to include information about the required stocks of consumables: spare parts, lubricants, refrigerants (freon, carbon dioxide, etc.), etc.

18.3.6.6 It's required to submit the following information on the management system:

- Lock on and off;
- turn-on delays;
- Bans on and off, etc.

18.3.6.7 One shall specify the functions of the management system performed manually:

- Having a time-limited ban on the intervention of the operator;
- Having no time limit.

18.3.6.8 One specify allowed time to power supply the system.

18.3.6.9 It is necessary to bring the procedure of switching on the system and its components in the blackout mode in accordance with a program start step.

18.3.6.10 Provide information on means of operator support during system operation.

18.3.6.11 One shall provide information about the places to which the system and its individual elements can be put into action, and their characteristics.

18.3.6.12 It is necessary to justify the choice of the location and performance of drainage and air- vent.

18.3.6.13 One shall provide information about the state of the control system equipment, as well as the methods and means of control (control of metal piping, equipment, state assemblies, electrical resistance).

18.3.6.14 One shall provide information about the diagnosis of systems, methods and means of vibration control, leakage and noise.

18.3.6.15 Provide information about the removal of heat from the system:

- Emitted during equipment operation;
- Recorded by the system.

18.3.6.16 It is necessary to provide the following information on the hydraulic system testing (not including ventilation)

- Hydro testing scheme;
- The parameters of hydro testing.

18.3.6.17 One shall provide information on system filling and charging (volumes, costs for filling and charging).

18.3.6.18 Describe system element breakout (limit stops, supports, expansion joints).

18.3.6.19 One shall provide data on the durability of used materials and their covers applied to the conditions of normal operation and under accident conditions. Particular attention is paid to the formation of secondary degradation products that pose a threat in terms of toxicity and explosion in conditions different from the project ones. For example, it is necessary to consider the process of decomposition of freon in refrigeration machines in the event of a fire.

18.3.6.20 One shall provide information on the accounting requirements for the decommissioning of NPP unit.

18.3.6.21 One shall provide a description of interrelation with other systems, and requirements for other systems.

18.3.6.22 Emergency power systems are described in NPP SAR section “Electricity supply.”

18.3.6.23 If there are other support systems at a unit, they shall be described by the scheme set out in Supplement A.

19 Nuclear power plant operation

This section shall provide information relating to the preparation and organization of plant operation.

The information provided shall comply with the requirements of 4, 8.1, 8.3 and 8.5 of the TCP 170 and give confidence that the organizational structure of the OO and provided her a set of measures will ensure that the licensing requirements and conditions imposed on the applicant in the implementation of works and (or) services with regard to operation NPP.

19.1 Organizational structure of the operating organization

19.1.1 Management and technical support structure

This subsection is necessary to bring an organizational chart of the part of OO, which seeks to ensure plant operation support (information relating to the organization of operational NPP management, are specified in 19.1.2).

Information shall include a list of departments or organizations involved in OO on a contract base shall provide specific activities to their name, indicating the leading administrative posts, the structure of departments, job responsibilities of personnel, his qualifications and responsibilities, the division of responsibilities and authority data between departments.

19.1.1.1 List of divisions.

the block diagram is a list of OO units, responsible for providing the following activities:

a) the design and construction of NPP.

List of OO units (or organizations involved in the OO on a contract basis), providing the following activities (issues related to quality assurance, shall be considered under NPP SAR «Quality assurance»):

- Site selection, taking into account natural and technogenic impacts;
- Development projects of buildings, structures, PN, SS and ancillary systems;
- Evaluation of the level of development;
- Preparation of PSD NPP;
- materials and equipment supply;
- Carrying out construction and installation operations;
- Study the issues of NPP decommissioning; b) pre-operational training.

One shall make a list of departments responsible for carrying out the activities planned before the NPP commissioning and presentation of complete nuclear PSD NPP. These activities include:

- Development of technical means to ensure the implementation of the program input NPP in operation, taking into account possibilities of PUCB and RCB;
- Development and implementation of the program of recruitment and training;
- Development of the program and instructions for the NPP commissioning;
- Development of annual maintenance plans and maintenance of equipment; c) technical support service.
- Shall a list of technical support services, responsible for addressing issues of:
- Engineering and technical support operation in solving the problems of nuclear and radiation safety and radiological protection;
- Maintenance, repair and modification of thermal mechanical, electrical equipment and machinery, instrumentation and controls;
- Inspections and audits, including control of metal and welded joints;
- Handling operations with the NF;
- Maintenance of WCC – NPP, radioactive waste management.

19.1.1.2 Departmental unit structure.

In accordance with the check list 19.1.1.1 of this technical code, each unit (or organization involved), shall indicate its structure, from heads of unit to the technical personnel, including number of personnel with backup by position and job description lists.

19.1.1.3 Personnel proficiency.

Each position shall be followed by the data that provides complete information on the educational level of the personnel, including basic education information, background, special qualifications and working experience on other positions and / or organizations. The employment of persons who do not have higher education as an engineer shall be proved (if available).

19.1.2 Nuclear power plant operational management

This paragraph shall contain the organizational plan of the operational management of the NPP.

The information provided shall contain:

- List of NPP divisions with their title and leading administrative positions indication;
- Units structure;

- Job descriptions of the personnel, its qualifications and responsibilities, as well as data on the coordination between plant units and OO supporting unit.

The organizational chart for many-unit NPP shall clearly reflect future changes and additions, which are entered in the organizational structure of the entire station as a result of addition of new capacities. A graph shall be created that allows defining the terms of employment of each post as result to the addition of new capacities.

19.1.2.1 The organizational structure of the NPP operational management scheme.

The following departments and services shall be reflected on the block diagram:

- NPP administrational management;
- Production department;
- Technical departments, laboratories and service.

19.1.2.2 Departmental unit structure.

In accordance with the check list 19.1.2.1 of this technical code, each unit shall indicate its structure, from heads of unit to the technical personnel (shift supervisor, replacement operators, maintenance stuff, etc) number of shifts, number of personnel with backup by position.

NPP structural unit data shall be submitted with the following information:

- Unit functions;
- Unit and OO supporting units coordination procedures, defined in paragraph 19.1.1.1 of this technical code, between themselves and public authorities regarding safety regulation when using nuclear energy.

19.1.2.3 In-plant personnel rights and responsibilities.

Rights and responsibilities of the in-plant personnel are determined by the job descriptions, which list shall be presented in accordance with the requirements of the paragraph19.3.2. of this technical code. In particular, it shall result in the order of succession of powers (including the transfer of the right to issue permanent or temporary orders and instructions), and responsibility for the operation of the entire NPP, of at least three functionaries (in case of temporary circumstances).

19.1.3 Personnel proficiency

An analysis shall be taken of the TNLA execution regarding selection of persons to the job, mentioned in block diagrams 19.1.1 and 19.1.2 of this technical code, in accordance with the required qualifications (education, work experience, training) and requirements to the license from the Ministry Of Emergency Situations needed.

In the case of deviations from the requirements, the possibility of the recommendation to the appropriate position of the person not having the required qualifications need to be proved in detail. Personnel training

19.2.1 Organization of personnel training

Information shall be given demonstrating the implementation of the requirements of 4.12 and 8.3 of TCP 170, sections 5 and 6 of TCP 171, 1.3, 1.4, 8.2, 8.3 and 9.1 of Nuclear Power Rules and Standards G-7-008-89 during personnel training and implementation level of the requirements regarding organization of work with personnel, of selection, training, access to work and control during NPP personnel operation for the selection of persons to the positions.

It is necessary to bring the results of training facilities analysis and simulators for personnel training, as well as compensative measures in case of absence of the full-scale simulator of nuclear power unit or a specific unit mismatch.

19.2.2 Coordination (correlation of the stages) of personnel training with the stages of nuclear power plant precommissioning and nuclear fuel loading. Personnel employment schedule.

Paragraph shall include graph (network graph - if possible) of each stage of operational personnel training accomplishment for each function group regarding implementation of each NPP launch step (or provide links to a NPP SAR section “Commissioning of NPP”) and the expected date of the fuel load.

In addition to the above mentioned, the graph shall show the necessary deadlines for employment admission to the operational personnel workspaces relative to the time of

RI physical start- up, presence of the authorized personnel and commissioning personnel of other organizations directly involved in the commissioning, start-up and physical power tests.

19.2.3 Maintaining the personnel proficiency level

It is required to show the monitoring system of personnel level and activities to maintain the required qualifications, including repeating trainings and training on simulators to stimulate actions in normal operation conditions and emergency situations and also show how the requirement 8.3 of TCP 170 to account of analysis of the errors in operation previously occurred during the personnel preparation.

19.3 Instructions

19.3.1 Preparation of instructions

Specify at what stages of operational activities will be prepared and put in place appropriate instructions.

19.3.2 Duty regulations

Information about the job descriptions of administrative, managerial and operational personnel shall include a list of them in accordance with the structural arrangement and the OO organization, including the nuclear power plant operation.

19.3.3 Operation manuals

19.3.3.1 Manufacturing instructions.

Technological regulations of the NPP shall be provided.

19.3.3.2 Operation manuals of equipment and systems.

List of instructions regarding systems and equipment operation of the station shall be introduced, the order of searching appropriate instructions for actions during alarms by operational personnel and identification of initiating events of arising emergencies specified, as well as instructions to the operating personnel that shall be known in their entirety.

19.3.3.3 Instructions to maintenance and repair.

Lists of station, manufacturer, standard instructions and other technical regulations to be followed shall be introduced when carrying out maintenance and repair of main and auxiliary equipment systems, security, automatic devices and other systems mentioned in the relevant sections of the NPP SAR.

19.3.3.4 Safety instructions.

List on safety instructions that shall be situated on every workplace shall be introduced, along with operating instructions according to the technical documentation approved by the chief engineer (director) list of technical documentation for each workplace.

19.3.3.5 Instructions for conducting online documentation.

The information relating to the instructions for the maintenance and management of operational documentation, shall be specified by its prescribed procedure for keeping online documentation by operational personnel, the place of its permanent residence, documentation requirements for its preservation and storage period, depending on its category.

The actions of the administrative and technical personnel of the station to monitor the conduct of the operational documentation shall be described.

19.3.4 Anti-accident instructions

19.3.4.1 Introduce a list of emergency regulations in accordance with the following classification of emergencies:

- Accidents related to the automatic shutdown of the reactor (activation of different groups of ES);
- Emergency situations that require immediate shutdown of the reactor;
- Emergency situations that require the translation of the reactor to a lower power level;
- Emergency situation arising in the fuel.

19.3.4.2 The information given in the instructions shall include:

- Personnel actions for unique identification of an emergency;

- Corrective action, required number of operational personnel (with particular reference to what it is) for the implementation of corrective actions, the degree of independence of the operator's actions;
- Typical signs of success (failure) in the performance of the equipment operations;
- Criteria for the transition to action on the instructions of the Guide to accident management.

If this information is contained in other sections of the SAR, the reference may be to the relevant sections.

19.3.5 Accidents management manual

The paragraph shall introduce Accidents management manual. It allowed him to bring in a separate Supplement.

19.4 Technical maintenance and repair

19.4.1 Annual plans of equipment technical maintenance and repair

In this paragraph the annual maintenance outage and SPP of equipment plans shall be introduced, showing the main types and volumes of activity (general maintenance, overhaul, repair and replacement of components, testing, system modifications, etc.).

It shall be shown how to ensure effective and timely assistance to the project company in case of failure and the need of modifications to individual nodes, and possibly upgrading systems

and stations as a whole.

It is necessary to submit a graph of preventive maintenance.

It shall be shown, how to take into account the experience outage of the equipment and plant systems while graphing the maintenance schedule and SPM.

19.4.2 Technical maintenance conditions

The paragraph shall introduce maintenance support tools:

- Workshops for the repair of mechanical, electrical and measuring equipment;
- maintenance and decontamination of radioactive components support tools;
- Lifting equipment;
- Special equipment and tools.

It is necessary to specify the availability of funds, materials, spare parts, etc.

19.5 Organization of survey and providing information on a nuclear power plant operation safety level

This subsection shall contain information on the adopted system of control over operational (current) state of the NPP, data collection and analysis process, as well as providing information about the current level of nuclear safety.

19.5.1 Survey by the operating organization representatives

Give information about the organizational and technical activities planned by OO, for the cross-exchange checks for compliance with the requirements of the basic aspects of operational technical regulations.

19.5.1.1 Checkout program.

It is planned to present the checkout program with the following information.

a) Type of checkout.
b) Scope review on the following main questions:

- Verification of compliance with the requirements of the operating instructions and the status of operational documentation;
- Assessment of the quality of maintenance of WCC and monitoring metal condition of the equipment;
- Checking the status of systems and equipment;
- Checking the status of nuclear and radiation safety;
- проверка выполнения корректирующих мер, предписанных регулирующим органом.
- Checking the condition of the system of selection, training, access to individual work and maintaining the NPP personnel qualification, verification of compliance with the order of

the emergency response training;

- Verification of compliance of fire protection and other emergency measures;
- Carrying out repair and maintenance work;
- Verification of compliance of the corrective measures ordered by the regulator.

c) The frequency of inspections.

d) Criteria for assessing the results of inspections and surveys that can help determine whether the plant operation is carried out in accordance with regulatory requirements and the operation of the QAP (the requirements of section 23 of this technical code).

d) The procedure for registration of the results of audits, corrective actions and performance of their registration. Requirements for storage and access to accounting documentation.

19.5.1.2 Organizational Structure.

It provides information about divisions of the OO and the officials who are carrying out a program of in-checks, including their qualifications.

19.5.2 Preparing and providing information on the current safety level

Information represented in the section shall comply with the requirements for annual reports on the assessment of the current level of operational safety units and the requirements to the investigation procedure and accounting irregularities in the operation of the NPP.

19.6 Nuclear power plant physical protection (security) assurance

This section shall show the basic organizational and technical measures to prevent unauthorized actions of personnel or other persons in relation to nuclear materials or systems, equipment and devices of NPP, so important to safety, which may directly or indirectly lead to emergency situations and be dangerous health and safety of plant personnel and the public as a result of exposure to radiation. The information provided shall confirm the fulfillment of the requirements of technical regulations on physical protection.

19.6.1 Physical protection composition and requirements to it

This subsection shall identify clearly:

a) Engineering and technical subsystem description:

- Alarm system;
- An access control system;
- Video surveillance system;
- Rapid communication system;
- Engineering means of protection;
- Supporting systems and tools providing physical protection functioning.

b) Arrangements (as a subsystem), specifically:

- NPP security organization, including training of security personnel;
- Preparation of plant personnel to act in extreme situations;
- Access organization for permanent and temporary personnel into the protected area and vital area;
- Organization of the accounting system, storage, use, transportation of nuclear materials and control;
- Organization of personal and special examinations of NPP personnel, seconded persons, visitors and vehicles, and others.
- Show that FA refers to the SCS and while projecting met the following requirements:
- Independence;
- Multi-channel;
- Fire protection;
- Performance and reliability under extreme impacts of both external and internal.

19.6.2 Physical protection diagrams and structural imaging

Introduce basic schematics of engineering and technical tools of control and alarm by FA. In addition, it is necessary to introduce essential structural construction of FA on the organization of NPP protection, without revealing the location of the controls of places, post alarm and surveillance.

The section on FA NPP shall be stamped, which gives access to a limited number of people.

19.7 Emergency planning

This subsection shall contain information on the planned and practical implementation of measures to protect personnel and population in case of an accident in accordance with the requirements of 8.5 TCP 170, the standard contents of the action plan for protection of personnel in case of a radiation accident at the plant, the model content to protect the public plan activities general case of radiation accident at the plant, the TCP 112 and other technical regulations for the protection of personnel and population.

19.7.1 Personnel protection

The information provided shall give a clear picture of planned and practical implementation of measures to protect personnel in the event of accident at the plant in accordance with the requirements of the TCP 170, the standard contents of the personnel protection plan in case of a radiation accident at the plant and other technical regulations to protect workers and to mention the following questions:

a) Levels of emergency preparedness and intervention..

b) Arrangements in case of an emergency, including:

- The allocation of responsibilities and the development of an coordination action plan with

external organizations within the site and the NPP SPZ (fire brigade, civil defense, hospitals, local authorities);

- Determination of the officials carrying out the notification of accidents and the start of implementation of the personnel protection Plan in case of radiation accidents at nuclear power plants;
- conditions and means of communication alerting.

c) Types of emergencies that may arise at the station or in the plan of action in an emergency, and how to alert personnel.

d) Types and amount of RAS that can be thrown into the premises of NPP, the path of radiation exposure and safety equipment.

d) The access time and people occupancy in a specific zone station (in particular, it concerns power control and accident-prevention control unit).

e) Emergency procedures, sequence of events and the time required to carry them out (one shall show how the development of an action plan and its implementation take into account probability that sequence of events and a scale of the consequences, initiated by the initial event may vary considerably. In this approach of an actual emergency, a need for significant deviations from a pre-existing plan of action would be minimal).

f) instrumentation required in emergency situations (their suitability for rapid detection and continuous assessment in an emergency; their operability, including measurement and response time range, the location of the sensors and the recording equipment, and the availability of spare and duplicate devices; alarm).

g) The number of personnel and resources required for assessing a situation, taking corrective and protective measures, the organization of communication and record keeping as well as assisting victims.

h) The criteria for personnel evacuation start, marking evacuation routes, assembly allocation places of exchange personnel, first aid and calculation of the necessary medicines.

I) The availability of emergency hardened command points at NPP and in the towns (townships) of NPP that are equipped with computers and data processing, means of communication, public announcement means, information gathering means on radiation and meteorological conditions at NPP territory, in SPZ and NPP control area.

j) The availability of shelters that meet the requirements of the TCP 112, full cover of

NPP

personnel, workers and employees (including personnel of the military and fire departments) who operate and perform vital functions at NPP.

k) The availability of RPS that meet the requirements of TCP 112 and equipped with means of protection against the destruction of radioactive products of NPP units for full cover of NPP personnel and their families in the towns (townships) of NPP.

l) Local system readiness to alert NPP personnel and warn general public within the 5-km zone in accordance with the requirements of TNLA.

m) Terms of ARASMS creation at NPP territory, in SPZ and control area.

c) Operational status of industrial and residential buildings and structures at NPP territory, in the town (township) of NPP for initial cover NPP personnel and their families (in deficiency of shelters and RPS).

n) State event planning for the preparation of primary and alternative evacuation areas to receive NPP personnel and their families in the event of accident at NPP.

o) Progress of equipping shelters at NPP territory and accident-prevention control points (at NPP, in the town / township of NPP) means of air regeneration and iodine radionuclides absorbent filters.

p) The availability of a sufficient number of special vehicles, vans and buses with a pressurized cabins at NPP equipped with removable filter system and designed to deliver food and personnel transportation to NPP in case of dangerous radiation accidents.

q) The availability of developed protection measures and water resources use within SPZ and NPP control area.

r) Record and report preparation and maintenance.

19.7.2 Population and environment protection

Presented in this section information shall provide a clear picture of planned and practical implementation of measures to protect the population of the 30 km zone, in accordance with the requirements of a typical content of an action plan to protect the population in case of a radiation accident at NPP, building regulations and rules, other TNLA on general public protection and consider the following issues:

- Organizational arrangements in the event of an emergency including the procedure for coordination of NPP personnel with the object and the territorial forces of civil defense, civil defense services, local authorities, ministries and agencies involved in the protection of the general public and the elimination of consequences of the accident;
- Population warning procedure;
- The types and amount of RAS that could be disposed into the environment, indicating the paths of radiation exposure (e.g., a radioactive cloud and RAS swallowing);
- Temporal characteristics of the possible emissions and radiation exposure;
- Areas which will require the use of protective measures and means of specifying the allowable residence time;
- Actions to be taken by various organizations to monitor an accident situation development and

  order of evacuation;
- Evacuation route marking (taking into account the information given in the "Area characteristics and NPP placement area" section of NPP SAR);
- Allocation of general public checkpoints;
- Estimate the data on possible number of victims, the necessary number of medicines and other medical supplies (including means of exposure prevention), vehicles for the evacuation and transportation of victims, protective equipment to fight possible fires and protection of airways, etc.;
- Maintenance of general public readiness in case of emergencies through training exercises, civil defense training programs as well as status monitoring of individual protective equipment required in an emergency;
- The state of development of a hard-surfaced road network at NPP area providing three-four areas to the plant;

- The availability of specific surveillance network facilities and laboratory control intended to

conduct the control of environmental pollution, food and agricultural products of RAS within the radiation accident zone, and equip them with the necessary equipment and appliances;

- The availability of developed guidelines for people who live in RAS contaminated areas as well as the prevention of radiation injuries of people in the NPP area;
- The availability of general public health maintenance for those who had radiation exposure during an accident at NPP;
- The availability of the developed measures for effective law enforcement agencies involvement to block the territory within the zone of potential danger of radioactive contamination, peacekeeping, safety of public and state assets, personal property of evacuated population in case of dangerous radiation accidents at NPP;
- The availability of the developed activities for the admission and the passport regime, the personal account of the evacuated population and monitoring its movement and the movement of vehicles within the zone of possible hazardous contamination;
- The availability of the developed measures for protection and use of water resources in the area of possible hazardous contamination;
- Conduct a search and exploration of ground waters for water supply in the NPP area at the

territory of possible radioactive contamination danger zone as well as in evacuation areas (main and reserve);

- The availability of agrochemical and veterinary laboratories, Hydrometeorology network units at the regional sanitary and epidemiological stations within the possible hazardous contamination zone, radiology departments, and an individual dosimetry center (laboratory) at a regional sanitary and epidemiological station;
- The availability of the regional (stationary and portable) radiometric laboratories for irrigation (land reclamation) facility monitoring located within the zone of possible dangerous contamination.

19.7.3 Anti-accident actions control points at a nuclear power plant and in the town (township) of the nuclear power plant location

Provide information on accident-prevention control points at NPP, located in the area as well

as a place where they are not likely to be affected by an accident as the main center.

Information shall show compliance with the solutions proposed to accommodate accident- prevention control points at NPP and in the town (township) of NPP, the requirements and the recommendations contained in paragraph 5.3 of the IAEA Safety Guide 50-SG-06. It is necessary to indicate:

- The location of a point shall be selected so as not to have serious difficulties in movement to it or from it in case of an emergency situation;
- Control center personnel and their qualifications;
- A list of equipment in the section and conditions of its storage and maintenance in a state of readiness (one shall indicate that accident-prevention control points are equipped with the technical means: instrumentation pool, means of communications, spare parts, safety equipment etc. - operational and properly fulfill their function in case of any emergency).

19.7.4 Accidents consequences elimination

This subsection shall indicate possible consequences of accidents and appropriate measures for their complete elimination or partial extenuation. Specify what criteria shall be used

during an accident management and elimination of its consequences, and describe the methods and

means of deactivation of the main and auxiliary equipment, facilities, location; methods and means of assisting the exposed personnel, the population, including data on the sanitary processing and medical care; list of medicines, bandages and other tools with an indication of their storage places; methods and means of decontamination of contaminated areas; criteria for the complete elimination of consequences of an accident and transition conditions to the normal operation.

19.7.5 Anti-accident training

The section shall have programs, methodology, and on the final NPP SAR stages - training and emergency exercises drawings with an indication of the categories of administrative and

operational personnel who is involved in appropriate action developing in emergency conditions and

the aftermath of an accident as well as used techniques (including simulators) for training and monitoring temporary regulations of action implementation (a link to the information contained in the section «Personnel training» of NPP SAR is allowed).

20 Nuclear power plant commissioning

In this section of NPP SAR, one shall provide information on how to put NPP into operation, describing the structure system component testing and during commissioning and giving the

confidence that the OO is fully complied with the requirements of TCP 170 8.2.

The information shall cover all phases of commissioning from the acceptance of the installation of equipment and systems to comprehensive unit testing at rated power and putting it into commercial operation (including such types of work as the post-construction equipment and circuit system washing; individual adjustment testing of equipment and systems in general, comprehensive testing of RI equipment, an initial fuel charge of the reactor core, achieving first criticality and the minimum controlled power level, the gradual development of the power to the nominal value and put into commercial operation).

The NPP SAR shall have the commissioning program with the criteria of success of the implementation of all its products for assessing the successful implementation of the whole complex of works on commissioning. The NPP SAR volume shall show further extent to which addressed issues such as the availability of a sufficient number of qualified personnel to perform testing; supervision of their implementation; the use of the practical experience gained by personnel in familiarization with the equipment and testing it; the adequacy of operating instructions.

Final Safety Evaluation Report shall definitively confirm the specific performance of NPP SAR requirements taking into account the results of the installation, commissioning and testing equipment, and NPP systems, organization and maintenance work. During information presentation on how to put NPP into operation it is necessary to show that the following main conditions are provided:

- Operation on inspections, commissioning and testing during commissioning facility operation, systems and components are carried out in sequence that at any time security won't depend on unpracticed systems and (or) equipment;
- Verification and validation of the documentation of the project design specifications of the structures, systems and components, including SS;
- Verification, confirmation or clarification of the procedures for maintenance, technological

constraints, limits and conditions of safe operation of structures, systems and components;
- Operational consistency, the optimal conditions for manufacturability, and damaging , structure, system and component forming;
- Compliance with the guarantee conditions of the manufacturers and suppliers;
- Required volume of the robustness of operational and emergency instructions as well as their correction, where necessary;
- Timely organization of accounting modes of equipment load cycles are justified under the

terms of the cyclic strength and durability of its operational life;
- Operating personnel skill gain in the operation and maintenance of structures,

systems and components.

20.1 Requirements to the information in a preliminary nuclear safety analysis report

20.1.1 Scope of work, its organization and personnel

Indicate the program that perform basic input stages in NPP operation indicating issues, acceptance criteria and the necessary organizational and technical measures for the implementation at each stage. The program shall include testing related to the commissioning of NPP as a nuclear (nuclear steam generating plant), and auxiliary systems and SS.

The program shall describe the organization of work and interaction structure as in the preparation of, and in the process of putting NPP in operation between NM personnel and representatives of design, engineering, installation, construction, commissioning organizations, organizations, suppliers and inspectors of the regulatory (supervisory) body.

One shall show the emission of leadership and executive roles and responsibilities between personnel of different levels aimed at the implementation of the objectives and tasks of putting into operation.

Organization of operation and personnel shall meet the requirements of industry leadership, technical and regulatory documents or have an alternative approach to the justification of the possibility of its use.

In the presentation of information, it is necessary to indicate the following issues:

- The organizational structure of NM including industrial personnel of NPP, their rights and responsibilities, qualification requirements. One shall provide Information, if there are differences in the organizational structure shown in the section 19 of the technical code during commissioning;
- Organizational activities carried out by the NM, the project developers, suppliers, and others involved in the implementation of the organization's work as well as the regulatory and supervisory agencies (the formation and organizational structure of the management start-up group, working committees and state acceptance commission, etc.);
- Description of the general responsibilities of various institutions, their interaction and subordination, allocation of duties and responsibilities as well as to personnel requirements (to give a brief description of the composition, functions and principles of operation of these bodies with reference to the existing provisions and documents);
- The master plans for additional personnel to the existing personnel at NPP for each of the input stages in the operation, details of the qualification and the indicative schedule of sending a reference to the date of fuel loading;
- Description of organizational security measures including radiation protection, fire safety, appropriate medical care and activities of commissions to investigate accidents and violations at NPP.

20.1.2 Work stages

The information shall contain the main stages of NPP commissioning, taking into account the specific characteristics of each NPP and problems to be solved at each stage. It is necessary to show

the division of work in separate stages, to ensure optimal performance of the sequence and (or) tests

of combining, the quality control of their implementation and acceptance criteria.

Information shall be driven by the following main stages:

- Pre-commissioning tests;
- Pre-operational acceptance testing;
- The physical and power start-ups.

Give a brief description and the amount of work for each stage and sub-stage testing as well as leading the specificity and purpose of steps (substeps), indicate how the work is done in terms of RCB and auxiliary systems including SS, show the relation to the work of other under construction or operating power units, if there any at the area.

It is necessary to show that the amount of work on the stage and in power unit commissioning are sufficient and met the conditions set out in the introducing part of the chapter "NPP Commissioning" of NPP SAR.

Specify the criteria to be achieved on completion or beginning of each of the available stages including the availability of premises and equipment.

When writing a paragraph, you can follow the standard documentation for the operational power units with VVER as well as take into account the requirements of TCP 170, ISCS AC- 90 and others.

20.1.3 Test programs

Provide a brief description of the programs at every stage of power unit commissioning and information about programs for individual equipment, systems and components at each stage.

One shall show the information on the experience of commissioning of similar NPPs or NPPs with a different type of reactor and how this information proves appropriate steps, methods and acceptance criteria for newly developed programs. It is necessary to provide quantitative and qualitative indicators of the commissioning program of a unit in comparison with others in terms of volume, tools, techniques and methods of organization of operation and testing and give convincing evidence of their reliability because of repeated practical use.

a) It is necessary to reflect:

- Purpose of work and testing, acceptance criteria;
- The sequence where testing shall be performed and readiness requirements of facilities, systems and equipment to the conditions of their implementation;
- Technological limitations and guidelines, limits, conditions and measures for the safe

operating and testing;

- Composition, consistency, correlation and duration of testing;
- Methodology of work and more detailed description of the preparation of testing and methods of testing a unique, unparalleled equipment, indicating its acceptance criteria;
- Requirements for the reporting documentation including design, presentation and storage, access procedure;
- Requirements on the number and qualifications of participating in the works and testing personnel, emission of duties and responsibilities including the administrative authorities.

It is necessary to show how and to what extent the project will be carried out normal, transient and emergency condition sampling (give a list with reference to specific programs and the planned operations), show design modes that cannot be checked and the failure to justify the admissibility of such tests. It is necessary to provide specific and detailed information as well as strong evidence to confirm that the planned work and testing will run each of the conditions displayed in the initial section “NPP commissioning“ of NPP SAR.

- Describe in details: Procedures and methods of analysis used to reach the initial criticality and measurement of neutron-physical characteristics of the reactor core, including the effectiveness of EP; security control of nuclear reactor core and methodology for assessing the most important characteristics of RCB equipment, SS and the main characteristics of NPP and give lists of potentially hazardous operations and measures to prevent accidents;
- Individual system commissioning and testing of NPP equipment that are safety-relevant (e.g.,

SPZ, FA of the reactor, active and passive SS and others).

One shall take into account the order of development and approval of work programs based on project documentation (including public authority safety regulations during the use of nuclear energy).

During preparation of operational programs, you can use a set of standard programs and testing procedures used during power unit commissioning with VVER and commissioning methods.

20.1.4 Work and testing schedule

One shall show comprehensive schedules of read-in program of NPP unit to put in commission with reference to the term of the fuel loading and put a unit in commission after the entire scope of work, including the rated load.

The complex chart shall indicate the milestone in accordance with the requirements of this standard 20.2.2, calendar time of their duration. One shall give a list of all types of works and tests

for each of the stages separately. This information for RI and its auxiliary systems and SS for the steam-power and electrical equipment of NPP shall be presented separately.

It is necessary to present the planned sequential schedules for each testing stage and separate structures, systems or nuclear elements. On these graphs, one shall indicate the calendar dates, list of works, with the positions and numbers of existing instruments and programs, as well as a schematic reflect their mutual linkages in time and technology (network graphics)

It is necessary to specify the relationship of the work at the power unit that is put in commission with other under construction or operating power units, if there are any. One shall reflect the issues of connection and use of common technological schemes, equipment and personnel taking into account given conditions for ensuring security of existing and put in commission units.

Graphs shall be taken into account during operational works, processing and presentation of results and their approval at prescribed manner with concerned organizations. You shall also take into account the time needed to develop a more detailed and refined manufacturing operations or work at the NPP working area and their approval before their acceptance.

One shall demonstrate how these terms take into account the time to develop detailed instructions for testing, recruitment and training of managerial and operational personnel and emergency response training and operation instructions (or share the link to the corresponding section of NPP SAR «Operation of NPP").

In the process of writing a section, one shall follow a standard schedule that used in practice when starting with VVER reactors.

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20.1.5 Additional requirements to a nuclear power plant power unit commissioning

It is necessary to set out in details the additional requirements that shall be taken into account in the process of preparing to work at the NPP territory, including:

- The preparation to the conditions and approval of working documentation for NPP: the set of instructions including actions in emergency situations; technological rules of safe operation; NPP SAR and etc.;
- participation of additional operational personnel involved in carrying out works and tests and

issuance of documentation including reporting (reporting requirements in the form of documentation for concerned parties);

- organizational and technical measures and actions in case of non-project characteristics or deviations from the project, including the need to adjust the project and operational documentation;
- violation and accident investigations at NPP;
- the organization of scheduled maintenance and document archiving at the NPP;
- the organization of the restricted areas and protection areas at NPP facilities depending on the stages and phases of the power unit commissioning program according to PRB AS-89, NRB 2000, the OSP-2002; Fire security service organization and monitoring at NPP;

- Buffer zone organization, radiochemical and radiometric control services in their own areas and near NPP according PRB AS-89, NRB 2000, the OSP-2002;
- development and registration of a passport for industrial (commercial) power unit operation;
- development and implementation of emergency prevention activities and personnel and general public protection in the case of an accident at NPP according to the TCP 171, TCP 170 in the section where these issues are not reflected in the section NPP SAR “Operation of NPP";
- Ecological conclusion development (EIA).

20.2 Requirements to the information in a final nuclear safety analysis report

A unit is developed on the basis of NPP SAR requirements and the concrete experience of work and testing, as well as on the results of editing, setting and testing at various stages of power unit starting including comprehensive testing at rated power before completion to the industrial (commercial) use.

Based on reporting materials of conducted operations and tests, it is necessary to confirm by documents the implementation of the planned requirements in NPP SAR and conform the compliance of structures, systems and components of the project with current TNLA.

In the case of deviations from the project and TNLA in the field of nuclear energy through appropriate adjustments to the project documentation, possible deviations from required level of security and reliability shall be justified and appear in the final NPP SAR.

20.2.1 Organization and personnel

It is necessary to provide the organizational structure of the OO, which was formed as a result of work on power unit commissioning (including industrial personnel of NPP, its rights and responsibilities, qualification requirements). It is necessary to show that personnel requirements for operational commissioning work was completely satisfied.

20.2.2 Work stages

It is necessary to provide information on scheduled work sufficiency for each stage taking into account the specific features of each power unit of NPP input and the problems to be solved at each stage. It is necessary to show the fullness of works on each stage, ensuring optimal performance of the sequence and (or) combined testing, monitoring results of their implementation and the achievement of the acceptance criteria.

20.2.3 Test programs

It is necessary to show that the tests meet the program’s requirements completely at each stage of power unit operational commissioning and programs for the individual tests of the equipment, systems and components at each stage, i.e., tests conducted in the amount of assigned programs and reached criteria established in them. One shall provide test results of programs and coordinate them with concerned organizations.

It is necessary to provide specific and detailed information, as well as strong results that confirm that the planned works and testing have allowed to perform every condition that was described in the introducing part of the section NPP SAR «NPP commissioning."

It is necessary to present the extent of information on commissioning experience of similar NPP or NPPs with a different type of reactor and how this information proves appropriate stages, methods and acceptance criteria for newly developed programs.

20.2.4 Work and testing schedule

It is necessary to show that the work and testing schedule of NPP commissioning are completed fully and in time, any deviations are justified. It is necessary to reflect the relation issues of power unit commissioning operations and other under construction units or operating power units, if there are any.

20.2.5 Additional requirements to a nuclear power plant power unit commissioning

It is necessary to present in every details, what and what degree of adequacy additional commissioning requirements are met including adjustments to the operational documentation based on past experience.

21 Nuclear power plant accidents analysis

NPP safety assessment shall include an analysis of the system reactions and NPP facilities to identify possible initiating events to be conducted in order to determine the sequence of events (scenarios) and the conditions of their run taking into account dependent and independent failures,
system and element destruction or personnel errors that compound matters.

Such an analysis shall be an integral part of the justification of NPP safety.

The section shall identify the projected scenarios, their consequences and evaluate the possibility of intervention in the system operation in order to control running processes.

This analysis shall be in the basis of NPP management system control in various situations. The analysis of each projected initial event superimposed:

- Independent failures;
- Undetected failures;
- Common cause failures;
- Personnel errors.

Safety analysis shall be carried out according to the lists of initial events for which the lists of design and beyond design basis accidents are formed.

21.1 Within design basis accidents list

21.1.1 Initiating events classification

Each initiating event shall be analyzed in a conjunction with various failures and other factors in order to select the most significant for analysis scenarios, as it was noted above.

The initiating events shall be combined into classes according to their functional effects on RI:

a) Internal:

- Increasing the heat removal from the primary circuit;
- Reduction of heat removal from the primary circuit;
- Reduction of coolant flow;
- The reactivity and power emission changes;
- An increase of primary coolant mass;
- Reduction including the loss of mass of the primary coolant;
- The release of radioactive materials from systems and equipment;
- The loss of the second coolant;
- The loss of power supply;
- transportation and installation violations;
- False system operation;
- Etc.;

b) External:

- Seismic actions;
- Shock waves;
- Floods;
- plane crash;
- The loss of cooling water;
- A tornado;

- etc.

21.1.2 Initiating events causes and identification

Each initiating event range shall be identified by specified initiating events, causes of occurrence shall be analyzed.

It is necessary to provide detailed information on the events that lead to consequences that are more serious; analyze all possible sequences of emergency events based on quantitative indicators of the probability of their occurrence.

If, according to expert analysis, an event does not lead to dangerous consequences, it is sufficient to provide qualitative description of possible consequences.

It is necessary to make an expert assessment of qualitative changes in basic parameters during initiating events that can be used to identify an initiating event.

21.1.3 Analysis of possible development of situations relating to initiating events

Each event shall register:

The sequence of machinery and system operation, issuing signals, achieving critical (estimated) parameters, values, personnel necessary actions, etc.;

- Onset and offset boundaries of SS actions;
- The impact of the existing normal system operation on the process flow;
- Estimation of the necessary information, which is necessary for operating personnel, on the situation, including test indications.

It shall be possible to make qualitative assessments of the severity of the consequences of an initiating event during the independent and dependent failure imposing or personnel errors. On the basis of these assessments for the considered initiating events, one shall distinguish such sequences (chains) of events and failures that could have the most serious consequences (the greatest increase in pressure in the first circuit, the smallest margin of boiling crisis, the highest dose, etc.).

Such a preliminary examination of possible accident sequences is a necessary element on its basis a list of design-basis accidents is created to have a quantified analysis.

It necessary to list all functions of SS which are used in safety assessment, estimated uncertainty that are associated with each of these functions as well as with expected and maximum delay time.

21.1.4 Within design basis accidents list

The recommended approximate minimal list of initiating events is given in Supplement D.

21.2 Beyond design basis accidents list

21.2.1 Scenarios of beyond design basis accidents causing excessive emission of radionuclides into the environment. Nuclear power plant vulnerable areas

Based on the results of the analysis, one shall highlight all scenarios beyond design basis accidents leading to personnel and general public radiation exposure excess and emission guidelines and RAS content in the environment established for design-basis accidents. One shall identify vulnerable NPP places through minimal tree cut set of events (failures). Hereinafter they referred to the combination of design features of NPP, its circuit design, layout, operational procedures and organizational structure of personnel activities. They are the most possible causes of reactor core damage output that goes beyond the scope of damages allowed for design-basis accidents.

21.2.2 Specific groups of beyond design basis accident scenarios

From the scenarios highlighted in the previous paragraph, one shall form groups where a response from operational systems, is required to prevent development accidents, is the same (the

same system-functional event trees).

21.2.3 Representative scenarios of beyond design basis accidents

Within each group of the previous paragraph to allocate one or more representative scenarios that satisfy all of the following four criteria:

- The maximum in-plant personnel and (or) population radiation exposure;
- The highest intensity of radionuclides emission;
- The largest integrated release of radionuclides;
- The greatest extent of system and equipment damage.

21.2.4 Beyond design basis accidents list

Scenarios highlighted in the preceding paragraph, put in the list of beyond design basis accidents for further analysis.

21.3 Methods of analysis

21.3.1 List of applied methods

This subsection of NPP SAR shall have presented list of quantitative applied methods providing details of their certification. If this method hasn't been certified, scheduled date of certification shall be specified.

21.3.2 Description of mathematical methods

This subsection shall have a provided description of the physical model of the analyzed processes, one shall enumerate the basic physical phenomena that determine behavior.

Describe used mathematical methods. Present basic equation system in the same form as it was converted from the canonical record form for direct usage in the calculation model. Provide constitutive relationships. Provide a description of the used nodalization scheme and a numerical technique.

Mathematical methods, describing the transport of fission products in the active area, circuits and NPP systems, shall consider the physical and chemical processes that influence the change in the concentration of radionuclides in the circuits and technological areas where radionuclides appear during a scenario accident. The minimum set of these processes shall be as follows:

- Natural deposition on the internal surfaces;
- Desorption with internal surfaces in vapor-gas medium;
- Radioactive decay;
- Drain with vapor-gas medium through leakiness in the adjoining rooms and environment due to the pressure falls;
- Leakiness into the environment after the pressure equalization due to free convection that is determined by the temperature differences between the environment, composition of medium and the atmosphere;
- Steam air medium cleaning as it goes through the condensation of passive devices (bubblers);
- Steam air medium cleaning driven by working sprinkler system;
- Steam air medium cleaning during the special ventilation system operation;
- Chemical reactions in water leading to a change in the physicochemical properties of fission products;
- Chemical reaction in the vapor-gas phase and on surfaces leading to a change in the physicochemical properties of fission products;
- Purification of water from radioactive products.

Mathematical methods shall take into account the behavior of aerosol particles and fission products grouped according to their physical and chemical properties. Among the groups ones that shall be analyzed:

- Inert radioactive gases;
- Volatile (organic and inorganic) forms of iodine.

Mathematical methods shall have only validated values of factors which characterize the simulated physical processes (diffusion, desorption, removal, etc.). During new (newly introduced) factors, one shall justify the need for their use and prove the accuracy of the used values.

Used mathematical methods shall contain valid values taken into account the weight ratio of the radioactive iodine that is in molecular form, in the form of organic compounds in aerosol form.

Information shall be illustrated by necessary graphic materials (schemes, flow charts, diagrams) which explain the interaction of programs and the transmission of information from a program to a program including the process of adjusting calculations due to changes in the basic data, if necessary.

In cases where separate processes are not taken into account, it is necessary to show that the ongoing estimates are conservative.

21.3.3 Assumptions and errors of calculation methods

Conduct all assumptions and simplifications used in the mathematical method. Justify the implementation of such simplifications. Evaluate the conservatism that was brought by admitted assumptions, procedure errors.

21.3.4 Calculation methods application area

Define the scope of a used calculation method declared or submitted in the attestation certificate. The fields of application shall be based on the results of the appropriate verification. Justify the usage of the calculation method for performing analyses

21.3.5 Information on calculation programs verification

Mathematical methods of emergency modes used for safety analysis, the development of accident management programs and mathematical support of simulators shall be verified, i.e. be compared with experimental data. Verification Matrix shall include all experimental setups used to verify software tools. Their composition shall include at least one special test bench, structurally similar to NPP, i.e., containing physical models of the main equipment of NPP that reflect the most important features of each prototype: the reactor core, SG , steam drums, MCP, hermetic enclosure, passive heat removal system, etc.

These installations reproduce emergency modes because of internal events listed in 1-3, 5, 6, 8, 9 of Supplement D. The experiments at this special stand, in addition to verification of mathematical methods, are used to justify design decisions of modes and technologies, playback and demonstration of potentially dangerous emergency modes and their recovery from consequences.

The complete verification data is determined by the presence or absence of qualifying certificate. If the certificate is at hand, references shall be given to the relevant registration number and the verification report, If certificate is not at hand, provide information about experimental facilities, the standard issues and processes which were carried out verification calculations on the program; the status of these settlements (post- or pre-test and etc.); a description of the results. This information may be presented in a separate verification report attached to NPP SAR.

21.4 Initial data for calculations

One shall indicate a list of input and initial data that allow, if necessary, to carry out a recalculation.

21.4.1 Geometrical initial data

- Bring the main structural characteristics (volume, length, flow areas, elevation, heat exchange surfaces, mass, wall thickness, hydraulic diameters, local resistance, etc.) for:
- Reactor (lower and upper chambers, standpipe annular channel);
- Core (fuel rod, tape, intercluster space);
- The main circulation of a pipeline (hot and cold skin, hydraulic locks, places of inlet and outlet pipes);
- SG (carcass, sewer, pipe heater, pipes);
- Pressure compensator;
- Steam lines;
- AICS accumulator tank;

- Low leakage containment building of reactor containment dome.

21.4.2 Physical initial data

It is necessary to submit:

- Neutron-physical characteristics (non-uniformity and reactivity coefficients, the integral efficiency of AI, the lifetime of the prompt neutrons, the proportion of delayed neutrons, etc.);
- Thermal characteristics (thermal conductivity, heat capacity and density of used materials, the temperature and enthalpy of various feed sources and storage tanks, the position of the phase level of the masses in a phase separation vessels);
- Physical and chemical properties of the reagents and solutions produced during the accident, their radiation resistance, the constant emission and chemical reactions with basic iodine compounds.

21.4.3 Process initial data

It is necessary to present project design specifications (algorithms, settings, specific parameters, characteristics of the main equipment - pumps, waste devices, heaters, etc.) of the following technical systems.

a) EP: nomenclature, properties and settings on the operation.

b) Pressure maintenance systems in the primary circuit:

- Specifications and opening / closing pressure of SV pressure compensator;
- Specifications and the opening / closing pressure of fuel injection control;
- Specifications and the on / off pressure of pressurizer heater.

c) Pressure maintenance systems in the second circuit:

- Specifications and the opening / closing pressure of RASDF-C;
- Specifications and the opening / closing pressure of RASDF-A;
- Specifications and the opening / closing SV SG pressure.

d) the feed water system.

e) Steam removal systems.

f) AICS:

- Setting to run diesel generators;
- Characteristics of high- and low-pressure systems. g) CPS.

g) Features:

- MCP;
- Main and emergency feed water pumps;
- AICS pumps;
- Sprinkler pump.

k) Specifications valves (shut-off valve, shut-off valves, check valves, etc.).

l) General protection and blocking (blocking of the first circuit, MCP, SG, steam header).

m) The sprinkler system.

n) System of hydrogen suppression.

o) Ventilation systems.

p) filtered discharge systems environment from the containment.

q) Containment systems (traps) molten fuel, if any in the project.

r) SES (reactor containment dome).

21.4.4 Topological initial data

In the case of design model (nodalization schemes) one shall illustrate the relationship of calculated elements and compounds indicating elevations and critical points (places of leaks, additional feeding, valves, etc.).

21.4.5 Initial conditions

Show a list of initial conditions. They shall be conservative for the analyzed process. The degree of conservatism shall be properly assessed.

The recommended minimum and suggested initial condition list are provided in Supplements E and G.

21.5 Analysis of design basis accidents

21.5.1 Description of the sequence of events and systems operation

Based on the analysis results provide a description of the sequence of events and systems operation in a table, which shall include characteristic points of the process with the appropriate points in time.

21.5.2 Safety assessment criteria

Based on the fact that the safety parameters in a simulated emergency mode may exceed permissible limits, give the relevant criteria, the comparison of the results obtained with which allows to assess the object safety in such an emergency mode.

21.5.3 Analysis of calculation results

Information shall be provided for all stages of a transition process or an accident. Process discontinuation may be signaled by either at least one safety system channel starting to function with parameters of dampened equipment with steady operation conditions per design scheme for normal operation or at a stable operation.

21.5.3.1 Change in the reactor installation (RI) circuit parameters.

The following information shall be provided:

- changes in power;
- heat flux values;
- change in circuit pressure;
- temperature change in the coolant, cladding and fuel;
- critical heat flux ratios;
- coolant flow in the reactor and loops;
- primary coolant parameters at the inlet and outlet and in the most stressed channels;
- thermotechnical characteristics of fuel;
- coolant balance in specific volumes and areas taking into account the reserve and make-up opportunities at different points in time;
- secondary coolant parameters;
- coolant flow in various systems and channels;
- weight (quantity) of reacted zirconium;
- hydrogen output from the primary circuit;
- flow and the enthalpy of the coolant flowing out of the circuit;
- amount of hydrogen in the primary circuit.

It is necessary to compare the calculated values with admissible ones.

21.5.3.2 Change in the parameters in the containment building.

It is necessary to describe in detail the processes occurring in the containment building. At least the following shall be reflected:

- pressure in low leakage containment building;
- characteristics of the existing leaks from the system into the containment building (leakage flow, leakage flow through relief valves and PRVs, temperature);
- characteristics of release into the environment (flow, total mass ejected);
- characteristics of hydrogen sources;
- performance characteristics of the spray system;
- performance characteristics of containment area heat removal system;
- temperature of environment in the atmosphere of containment building and on the floor;
- weight of water and steam in the atmosphere of containment building and weight of

water on the floor;

- temperature of walls and structural elements;
- relative proportions of the components in the atmosphere of containment building, including hydrogen.

21.5.3.3 Release and dispersion of radioactive products.

In the sub-paragraph the assumptions, parameters and methods of calculation used to determine the radiation doses resulting from accidents shall be outlined.

The processes of fission products transfer in the containment building shall be described in detail.

At least the following shall be reflected:

- accumulation of fission products in the fuel and under cladding at the time of the accident;
- thermo-physical characteristics of the atmosphere and internal surfaces of process facilities along the path of fission products;
- time-dependent leakage of fission products out of the fuel element cladding and primary circuit;
- characteristics of basic processes behavior of transfer and deposition of fission products in the RI process compartments taking into account the transition from one phase to another, from one physical-chemical form into another and leakage of fission products into the environment.

The paragraph shall contain all the necessary input data to conduct an independent analysis as follows:

- design parameters;
- places and areas where the dose is counted, including the nuclear power plant premises (alternate control center (RCC), power unit control station (PUCS), safety system (SS) that require inspection and maintenance of equipment located in them), boundaries of estimated areas.

Generalized or certified programs used in the project may be invoked.

In the absence of radioactive products outside the borders of any of the barriers, the quantity (or value) of available margins, reserve, etc. that provide maintaining the marked boundaries shall be characterized.

The analysis results shall be presented in the form of tables.

If it is unfeasible to present the results of the analysis in the form of a table due to the vastness of the material, it may be presented in a separate section or presented in the form of references to relevant materials containing the required information in sufficient detail. This section shall contain a detailed diagram of the dose rate calculation in case of damage of protective barriers, including leaks from the containment (sealing circuit), with the corresponding explanation of the adopted model. The scheme shall examine all possible ways of release and transfer of radioactivity from room to room and to the environment. The scheme shall specify safety equipment (filters, sprayers, membranes, partitions, etc.), the direction of flow movement. Several schemes for various periods or events may be provided.

When considering the used assumptions and the radiological consequences assessment methods attention shall be drawn to the fact that they shall be well supported by sufficient accumulated data by describing the relevant information with reference to other sections within the NPP safety analysis report (SAR) or reference to the relevant documents. Such information shall include the following:

- a description of mathematical or physical models, including simplification and approximation;
- identification and description used in the analysis of computer codes or analog systems. Description of used mathematical models and programs shall be carried out with reference to the literary source and a summary of its content in the text of NPP SAR;
- determining the time-dependent characteristics, activity and the rate of leakage of fission products or other transferred radioactive material in the containment system, which can escape into the environment through leakage of the containment boundaries and the vent pipe;
- considering the uncertainty of calculation methods, equipment performance, sensitivity of instruments or other uncertainties that are taken into account when evaluating the results;
- description of the degree of interconnectedness of systems that affect, directly or

indirectly, control and limitation of leakage from the containment system or other sources (e.g., from the spent-fuel storage). For example, the contribution of the following systems: spray, air cooling, distillation and purification, emergency reactor cooling, filtration, dampening, control and others.

The section shall present the results on the dose absorbed by the thyroid gland of a child, and external doses on the controlled access area (CAA) boundary, the value of the absorbed dose in process compartments at different times with singling out specific phases (excess pressure period, destruction period, response, duration of shifts).

The data for operational personnel shall be singled out separately. It is necessary to characterize accident progression phases and, on the basis of design data, to describe a zone of possible radioactive contamination (pollution) according to equivalent dose, equivalent dose of external exposure and internal exposure of population due to inhaling radioactive aerosols at different distances from the point of accident.

Depending on the type of accident and its consequences, the level and the volume of detail of information provided shall increase with the severity of the accident.

21.5.4 Conclusion

In summary, draw conclusions about the main results of the analysis, including the identification of the most heavy-duty operation modes and the basis for conclusions about the unit safe operation in terms of design basis accidents.

21.6 Beyond design basis accidents analysis. Elaboration of actions for controlling beyond design basis accidents

21.6.1 Description of the sequences of events and systems operation (failure) during beyond design basis accidents

Give a description of the sequence of events, response, failure of systems and equipment for beyond design basis accident scenarios. It is advisable to present the development of accident events in a form of a table containing the main stages and corresponding points in time.

21.6.2 Calculation results analysis

21.6.2.1 Change of the thermohydraulic parameters in RI circuits.

For all beyond design basis accidents of the list drawn up a description of hydraulic processes occurring in the primary and secondary RI circuits shall be given. Volume of information provided shall include the parameters and initial conditions, a minimum and indicative list of which is given in Supplements F and G:

- reactor power;
- characteristics of heat flows;
- change in circuit pressure during emergency transition process;
- changes in the coolant temperature, fuel cladding and fuel in the core elements;
- coolant flow in the reactor and loops;
- primary coolant parameters of the core most high-heat channels inlet and outlet;
- thermal performance of fuel;
- secondary coolant parameters;
- coolant flow in various systems that affect the development of an emergency transition process;
- weight (quantity) of zirconium reacted with steam in the core;
- release of hydrogen from the reactor core and the primary circuit;
- flow and the enthalpy of the coolant flowing out of the circuit.

21.6.2.2 Change of the parameters in the containment building.

For beyond design basis accidents involving the release of coolant and (or) materials of the core from the primary circuit into the containment area, describe the thermohydraulic processes in the containment, an indicative list of which is given in Supplement G. The amount of information provided shall include at least the following parameters:

- pressure in the compartments;
- characteristics of heat flows.

21.6.2.3 Interaction of fuel-containing mass with concrete. Thermohydraulic processes in the fuel trap.

For beyond design basis accidents involving melting and dropping out of core materials from the reactor vessel into the containment, describe the thermohydraulic processes occurring in the reactor cavity or fuel trap, if any is specified in the project. Volume of information provided shall include at least the following parameters:

- change of state of fuel-containing mass components;

- change in the temperature of fuel-containing mass and concrete of the cavity or structural elements of the traps;

- characteristics of heat flows;

- performance characteristics of the trap cooling systems;

- change of the cavity configuration due to concrete disintegration;

- changes in the thickness of the reactor compartment underframe in the location of fuel-containing mass;

- weight (share) of zirconium and other metals reacted with water vapor:

- characteristics of vapor explosions (the energy released, the parameters of shock waves acting upon the reactor vessel and other structures of RI and the containment).

21.6.2.4 Release and dispersion of radioactive products.

The processes of transportation of fission products in the containment building shall be described in detail with reporting on the conditions and parameters set out in Supplements J and K, as well as the following information on:

- fission-product build-up under the fuel cladding and in the fuel at the time of the accident;

- thermophysical characteristics of the atmosphere and internal surfaces of process compartments along the path of fission products;

- fission-products leakage from heated and melting fuel and the primary circuit with time;

- fission-products leakage during interaction of molten fuel with reactor cavity concrete with time;

- characteristics of progression of basic processes of fission-product transfer and deposition in circuits and RI process compartments taking into consideration the transition from one phase to another, from one physical-chemical form into another and fission products leakage into the environment.

21.6.3 Beyond design basis accidents control actions

21.6.3.1 Operational safety objectives.

For each level of beyond design basis accident severity operative safety objectives shall be formulated, i.e. objectives which operational nuclear power plant personnel shall seek to achieve in these conditions, in order to prevent or stop the further development of equipment damage and (or) safety-critical systems (SCS) or restrict the release of radioactive materials into the environment.

21.6.3.2 Condition characteristics of the plant, accident initiation and progression criteria

On the basis of the executed design analysis of beyond design basis accidents condition characteristics shall be formulated and criteria shall be established by which, using the condition characteristic, the fact of occurrence of beyond design basis accident can be determined, and its progression can be traced by relevant levels of severity.

21.6.3.3 Systems and equipment that can be deployed to achieve safety objectives and restrict accident consequences.

Identify all NPP systems technical (including non-safety-related systems) that may be involved not for the design purpose and not in design modes to achieve the operative safety objectives and restriction of accident consequences at every level of severity. Elaborate issues of duplicating systems that perform the same function. Describe the possibility of using materials and equipment located in adjacent power units, as well as outside the NPP industrial site, outline means of their delivery.

21.6.3.4 Criteria for the success of correction actions.

Formulate criteria for the success of the personnel to achieve the operative safety objectives at each level of accident severity. Determine how to express these criteria through the condition characteristic.

21.6.3.5 Analysis of information volume on the condition characteristic available to operational personnel during accident progression.

Determine the amount of information required to monitor the condition characteristic, to determine levels of accident severity, to control the required technical systems, to assess the success of action for beyond design basis accident management. Determine the technical means and ways to get this information in the projected conditions. If there is need for indirect assessment of the required parameters, methods of such assessment shall be presented.

21.6.3.6 Strategy for correction action.

Describe the strategy for personnel correction action during beyond design basis accident conditions to achieve the safety objectives at all possible levels of accident severity.

21.6.4 Assessment of the proposed beyond design basis accidents control actions effectiveness

Show, by calculation, that the implementation of the planned strategy for corrective action during a beyond design basis accident that is due to manifestation of any of the identified vulnerabilities at all possible levels of accident severity, provides either termination of the accident scenario, or substantially mitigates the accident consequences.

21.6.5 Conclusion

On the basis of the material above, draw conclusions about possibilities and efficiency of the developed measures for beyond design basis accident management.

22 Safe operation limits and conditions. Operating limits.

This section shall provide information on the limits and conditions for safe operations and operating limits specified by the design for systems (components), safety and safety-critical systems, as well as the whole NPP.

Information shall cover SCS, and what is more, provide information about the systems in Classes 1 and 2 in accordance with the requirements of 5.5.1 and 5.5.2 of The technical code of Common Practice (TCP) 170 and Class 3 - for systems containing radioactive substances (RS) and performing control functions of radiation protection, as well as buildings, structures and building constructions classified in accordance with the requirements of PiNAE-5.6 for categories I and II.

The operating limits, limits and conditions for safe operations shall be based on the safety analysis of the entire nuclear power plant in accordance with the provisions of its design.

Justification of limits and conditions for safe operations can be accompanied by a description of design-basis programs with information on their certification and (or) relevant experimental studies (references to NPP SAR sections with the required information are permissible).

At any stage of NPP SAR the information in this section and the information in the technical specifications shall be equivalent.

At the stage of final NPP SAR the section may be amended in the event that amendments are required according to the results of tests carried out during the start-up work, or on the basis of experience and technological development subject to (for RI) requirements of section 6, TCP 171.

References to NPP SAR sections that contain the necessary details and explanations of the selected parameters and the set conditions are permissible.

In the text there shall be used standard definitions of the existing technical regulatory legal acts (TNLA) and additional definitions characterizing permitted normal operating conditions, which include, for example, “hot and cold shutdowns”, “fast shutdown of the reactor," "power operation", etc.

22.1 Safe operation limits

22.1.1 List of controlled parameters and their safe operation limits

There shall be given all monitored parameters, the method and the exact location of their measurement, the rationale of the accepted value and accuracy of its measurement, ranges of change and measurement of the parameter, accuracy of calculation made and (or) experimental validation of the parameter (references to the NPP SAR sections “Reactor” and “Commissioning of the nuclear power plant into operation” are possible), the allowable data loss time, measurement channels reservation (reference to TNLA and (or) NPP SAR section “Steam turbine plant” is possible).

It is necessary to specify limiting values of monitored parameters, deviation from which leads to disruption of limits for safe operation and (or) accident progression.

22.1.2 Safety systems pickup settings

It is necessary to provide all the safety system trip points. It is compulsory to justify the accepted trip level values, indicate modes (processes), determining their achievement, as well as the accuracy of their measurement, location, measurement channels reservation and the principle of compiling instructions for SS operation. It is necessary to give the values of pre-alarm and alarm set points with justification of the interval response to the SS trip point values (there may be a reference to the NPP SAR section “Monitoring and control”).

22.2 Operating limits

22.2.1 Process parameters limit values

There shall be given boundary values of process parameters corresponding to the area of the boundary values of normal operating conditions. For each system limit values of parameters for all the equipment, which is part of the system shall be given. Give the rationale for the selected parameters values in the permissible modes, the accuracy of their measurement, location, measurement channels reservation, the allowable data loss time (there may be a reference to the NPP SAR section “Monitoring and control”).

22.2.2 Process safety devices, power unit systems and automatic regulators with their pickup settings

Give the values of process parameters under which basic process protections, interlocks and automatic control rods shall operate.

Accepted values of process parameters shall be grounded for permissible modes. Location of sensors, their reservations, power supply shall be specified (reference to the NPP SAR section “Monitoring and control”). Values of pre-alarm set points shall be given, the range between alarm triggering, tripping and locking, as well as the value of SS trip points.

22.3 Safe operation conditions

22.3.1 Power levels and permissible normal operating modes

Permitted modes of normal operation shall be presented, for example, work at partial power level, work on the incomplete number of loops, modes of heating up and cooling down, refueling, etc., and the corresponding acceptable power levels. These modes shall be defined.

For permitted modes of normal operation and for each level of power necessary give performance limits of the basic parameters such as power, power distribution, pressure of the primary coolant, the rate of change in pressure, coolant temperature, rate of temperature change, chemical composition, leakage through the pressure boundaries of the primary coolant, radioactivity of the primary coolant, reactivity and radioactivity of the working medium of the secondary circuit (there may be a reference to the NPP SAR section “Operating limits”).

These limits shall be expressed through the parameters monitored by the operator; otherwise, it is necessary to show the connection of the limiting parameter directly with monitored parameters using appropriate tables, charts or methods of calculating them.

It is necessary to indicate the justification for the restrictions imposed on the allowable power levels and permitted modes of normal operation with reference to the relevant NPP SAR sections.

22.3.2 Safe operation conditions and list of operable systems and equipment necessary for start and operation in permissible modes

Provide information on the composition and state of systems, whose performance or state of readiness are required for startup and work at the allowed modes.

The following system requirements shall be given: primary coolant system and SG; reactivity effects system; ECCS; excess pressure protection system; the main and emergency feed water system and main steam lines; core control system; CSS; cooling and ventilation system (ultimate heat sink); Instrumentation and controls; LSS and storage and refueling equipment.

For each of the systems it is necessary to present the composition and quantity of equipment, which is necessary for start-up and operation in the allowed normal operating conditions; requirements for tightness; the quantity and quality of working environments; triggering of equipment, including the sequence of actions, the logic of the automation and inherent protection; the system performance (power, flow, time, etc.); support systems (power supply, cooling system, ventilation, etc.) and operator intervention conditions.

It is also necessary to present conditions relating to the permissible loading cycles of the main equipment taking into account design resource.

It is necessary to provide justification of the established requirements and conditions.

22.3.3 Permissible power levels and permissible reactor operation duration at deviations from permissible safe operation conditions

This subsection shall provide information on the permissible time of the reactor operation at power and the power level or the state of the unit in the presence of deviations from the conditions for safe operation.

The method of unit transition to the desired state shall be indicated. It is necessary to indicate the justification for selected conditions.

22.3.4 Conditions for technical maintenance, testing and repair of safety critical systems

In the subsection, it is necessary to specify the testing conditions, inspections and maintenance and repair of systems identified in 22.3.2.

It is necessary to provide information about the timing, scope, methods and means of carrying out this work and operating restrictions, if required.

It is required to provide information on the state of the RI metal state control.

22.4 Administrative conditions and documenting of information on keeping the limits and conditions of safe operation

It is necessary to list the requirements for the administration and the personnel of the nuclear power plant to ensure compliance with the established limits and conditions for safe operation.

It is required to provide a list of standard documentation and describe the procedures according to which all deviations from the limits and conditions for safe operation are recorded and compliance with them is monitored.

23 Quality assurance

23.1 General provisions

23.1.1 This section sets out the information requirements for ensuring the quality of all works and services that affect the safety of the nuclear power plant, which the Applicant shall give in the NPP SAR. It is necessary to describe the rules of compiling this section NPP SAR provided by the Applicant as part of the supporting documents on safety.

23.1.2 The information shall provide assurance that the design, construction and operation of the nuclear power plant under consideration are carried out properly and meet all of the requirements for quality assurance.

23.1.3 In view of the fact that safety technical regulations, international guidelines and standards use different terms and definitions, it is advisable when presenting information in the NPP SAR to have regard to a single definition of terms, for this reason it is recommended to list the used terms and their definitions in the appendix to the NPP SAR section “Quality Assurance”.

23.1.4 In the appendix to this NPP SAR section it is advisable to give a list of TNLA on quality assurance used in the development and implementation of quality assurance measures.

23.1.5 Objectives, basic principles, the requirements for the structure and content, procedure of development, agreement on and approval of NPP QAP, supervision and responsibility for their development and implementation are determined by the requirements for quality assurance program for nuclear power plants set out in the TST 099.

23.1.6 In order to assess the acceptability of activities to ensure the quality the Applicant shall provide information on the following areas:

- organization;
- quality assurance program;
- design supervision;
- control of delivery documents;
- instructions, methods and drawings;
- control of documents;
- control of supplied materials, equipment, devices and services;
- identification and control of materials, equipment and components;
- control of technological processes;
-inspection control;
- test control;
- check of instrumentation and test equipment;
- quality assurance of design work, software and calculation methods;
- handling the equipment, its storage and transportation;
- quality assurance;
- checking, testing and operational condition of the equipment;
- mismatch control (derogations);
- corrective action;
- documentation (recording) quality assurance;
- audit.

23.1.7 The structure of NPP SAR section “Quality assurance” shall be developed in accordance with the following requirements.

23.1.7.1 Section “Quality assurance” shall be split into subsections by names, relevant areas of quality assurance activities specified in 23.1.6 of this technical code.

23.1.7.2 Information provided in each section for respective quality assurance activities shall be prepared according to the analysis of developed quality assurance programs (general and special) and their implementation at the time of the NPP SAR development.

Basic requirements for information about the directions of quality assurance activities are outlined in Tables 8 and 9.

Table 8 - Areas of quality assurance activities

Areas of quality assurance activities	Quality assurance program*									
			D)	RI)			C)	CM)		DC)
1 Organization										
2 Quality assurance program										
3 Design supervision										
4 Control of delivery documents										
5 Instructions, methods and drawings										
6 Control of documents										
7 Control of supplied materials, equipment, devices and services										
8 Identification and control of materials, equipment and components										
9 Control of technological processes										
10 Inspection control										
11 Test control										
12 Check of instrumentation and test equipment										
13 Quality assurance of design work, software and calculation methods										
14 Handling the equipment, its storage and transportation										
15 Quality assurance										

16 Checking, testing and operational condition of the equipment										
17 Mismatch control (derogations)										
18 Corrective action										
19 Quality assurance documentation (recording)										
20 Audit										

*G – general, SS – when selecting the site, D – during design, RI – of reactor installation, R – when repairing the equipment, M – when manufacturing the equipment, C – during construction, CM – when commissioning, O – during operation, DC – during removal from service

Table 9 – Areas of quality assurance activities licensed works and (or) services

Areas of quality assurance activities	Licensed work and (or) services		
	regarding NPP location	regarding NPP construction	regarding NPP operation
1	2	3	4
1 Organization	+	+	+
2 Quality assurance program	+	+	+
3 Design supervision	+	+	+
4 Control of delivery documents		+	+
5 Instructions, methods and drawings		+	+
6 Control of documents	+	+	+
7 Control of supplied materials, equipment, devices and services		+	+
8 Identification and control of materials, equipment and components		+	+
9 Control of technological processes		+	+
10 Inspection control	+	+	+
11 Test control	+	+	+
12 Check of instrumentation and test equipment		+	+
13 Quality assurance of	+	+	+

design work, software and calculation methods			
14 Handling the equipment, its storage and transportation			
15 Quality assurance		+	+
16 Checking, testing and operational condition of the equipment		+	+
17 Mismatch control (derogations)	+	+	+
18 Corrective action	+	+	+
19 Quality assurance documentation (recording)	+	+	+
20 Audit	+	+	+

23.2 Requirements to the information on the directions of activities aimed at quality assurance

23.2.1 Organization

23.2.1.1 Quality assurance policy.

Provide operation organization (OO) general policy in the field of quality assurance. It is necessary to show that quality assurance policy is consistent with other areas of OO activities.

OO at the highest management level shall give a written definition of the policy binding to implement and continuously carry out into practice the QAP. It is necessary to show how the OO policy in quality assurance determines the principles and objectives that are being taken to ensure safety as a priority in relation to other objectives.

23.2.1.2 Quality system.

There shall be a description of the OO quality system. When describing the following shall be depicted:

- structure of the quality system;
- description of the main documents of the quality system (quality management - general and specific areas of activity, and others.);
- regulatory, organizational and methodological basis of the quality system;
- responsibility of the parties for quality assurance;
- structure of quality units;
- verification of the quality system with the requirements of international standards.

It is necessary to show that the applied quality system ensures confidence, while functioning, in the fact that:

- the system is effective and properly understood by all the quality-related services;
- quality problems are prevented rather than detected after their occurrence. It is also necessary to draw attention to and reflect the following issues:
- OO structure as the organization of the highest level in the total quality management system;
- authority, responsibility, direct functional responsibilities that OO directly executes;
- OO infrastructure formed by specialized enterprises and organizations, to which OO transfers part of its duties, authority and responsibility preserving full shared responsibility on its own behalf, without prejudice to the obligations and legal responsibilities of contractors;
- organization of works for creating OO infrastructure (selection, qualification and creation of a data bank of suppliers and companies that provide services, assessment of their quality system);
- measures which ensure adequate theoretical and practical training and certification of personnel performing quality-related activities; accumulation and maintaining suitable experience, formation of safety culture.

Reporting documentation shall include proof of the effectiveness of the quality system elements, related, including the periodicity of effectiveness checks of the OO quality system, the results of audits (reports), analysis and corrective action.

23.2.1.3 Organization of construction of a nuclear power plant.

This paragraph shall provide the organizational structure and job descriptions that indicate the levels of authority and lines of internal and external communications.

The diagrams and description shall also show:

- structure of the organization and quality assurance services, as well as other functional organizations that perform actions that affect the design quality, manufacture, construction, installation, start-up and commissioning operations (SCO), testing, checks and auditing of accounting records;

- general design organization scheme showing the interaction of the OO, the head organization for the development of nuclear power plant design and their contracting parties, as well as the procedure for approving projects;

- information about the organization, the procedure of conducting and planning of auditing OO QAP by head organizations and the Ministry of Emergency Situations;

- the list of documents that form the legal basis for the OO activities and head organizations involved in the QAP implementation;

- procedure for the development and execution of NPP SAR to be submitted as part of the supporting documents on safety.

It is necessary to provide a list of executive positions, for which the authority and responsibility for implementation and effectiveness of general and specific QAPs shall be established.

It is necessary to provide proof that the OO check out system and lines of communication for all the quality assurance work between OO and its contractors are effective for implementation of QAP.

It is necessary to provide information on compliance of responsibilities for development and implementation of QAP with the TNLA requirements.

23.2.2 Quality assurance programs

23.2.2.1 It is necessary to provide information on the development, design and results of QAP audit (general and specific ones) in accordance with the NPP QAP requirements.

23.2.2.2 Along with NPP SAR it is required to provide:

- at the stage of the preliminary approval of the site - NPP QAP (G), NPP QAP (SS);

- upon receipt of the license in terms of NPP construction - NPP QAP (D), NPP QAP (RI) NPP QAP (R) of head organizations, NPP QAP (C), NPP QAP (M) of head organizations of equipment manufacturing are submitted by OO to the Ministry of Emergency Situations before its manufacture, NPP QAP (CM) – submitted by OO before start up and commissioning at the NPP;

- upon receipt of the license in terms of NPP operation - NPP QAP (O).

23.2.2.3 It is necessary to provide information on implementation of the general and specific QAPs at the time of the Applicant's presenting NPP SAR.

23.2.2.4 It is necessary to provide information on the degree of QAP compliance with the requirements for NPP QAP.

23.2.2.5 It is required to indicate what components, systems, equipment and nuclear elements are covered by the QAP. It is necessary to give information proving that any activity that affects the safety-critical systems and equipment is suitably controlled within the QAP.

23.2.2.6 Describe the quality-relevant measures that were taken before being included in NPP SAR, including the terms of reference for a feasibility study, for the RI development, the design for the NPP construction and others.

The NPP SAR shall describe how these activities shall be controlled within the QAP.

23.2.2.7 Measures to be taken by the OO to ensure the current QAP performance shall be described.

23.2.2.8 The paragraph shall provide information on the analysis of the regulatory technical support at all stages of NPP construction and operation carried out by OO with the assistance of head organizations.

It is required to present the action taken by OO to ensure working out of the missing TNLA identified by the analysis.

23.2.3 Monitoring of project engineering

23.2.3.1 This subsection shall describe the measures (procedures) planned and implemented by the OO within NPP QAP (G) and its counterparts within specific programs NPP QAP (SS), NPP QAP (D), NPP QAP (RI) and NPP QAP (R) for design supervision, which shall include the validation of the decisions taken, as well as their compliance with the design requirements.

23.2.3.2 Information on design supervision shall contain the following points:

- the analysis of feasibility and subsequent implementation of the basic design requirements as part of technical specifications for the NPP design, development of RI and equipment, it is necessary to pay attention to the safety and reliability requirements;
- the description of the applied test methods, such as the design screening with the use of alternative calculations or tests with justification of the test method;
- the analysis of the requirements for organizations or officials responsible for verification and confirmation of the design data;
- the analysis of the requirements for documentation of test results in order to be able to inspect or audit the testing method after its completion;
- the analysis of the requirements for the timing of inspections which shall end after the qualifying tests of pilot or production prototype prior to issuing the documentation for manufacturing or construction;
- the information on implementation of the mandatory criteria for carrying out tests prescribed for verifying the design, the need to ensure the representativeness of tests and simulation of the most unfavorable conditions defined on the basis of the safety analysis.

23.2.3.3 This subsection shall describe the measures to identify and control the delineation of jobs during the design (internal and external).

The forms of documentation that establishes the delineation of jobs can be timeline of activities, job delineation protocols and other documents that are essential for planning and reporting on progress.

23.2.3.4 This subsection shall describe the measures taken to ensure the design-change control, resulting in the process of designing, manufacturing and at the NPP construction site, and during operation.

23.2.4 Monitoring of shipping documents

23.2.4.1 This subsection describes the procedures for consideration of documents for the supply of goods or services that are imposed and controlled by the OO in order to:

- determine that the conditions of preparation, review and approval are met;
- receive guarantee that they contain all the necessary technical requirements, the basic design criteria, requirements of inspections and tests and other quality assurance requirements;
- determine that the quality requirements are properly imposed and can be checked.

23.2.4.2 It is necessary to include the description of responsibilities between the OO and its contracting parties for:

- preparation, review, approval and control of documents for the supply of goods and services;
- selection of suppliers;
- review and approval of the suppliers QAP before carrying out the work covered by this program.

The information under this subsection shall be given with taking into account the development and implementation of NPP QAP (G) and appropriate specific programs from both of the OO and head organizations.

23.2.5 Instructions, methods and drawings

This subsection shall give the information on the distribution of administrative responsibility and availability of the system based on the results of the development and implementation at the time of presenting NPP QAP (O) and specific programs, which shall ensure that the instructions, procedures and drawings include both quantitative and qualitative acceptance criteria of the fact that safety-critical work have been carried out taking into account the provisionally adopted requirements.

23.2.6 Monitoring of documents

23.2.6.1 This subsection shall provide the information about the program of documentation control, developed by the OO, including:

- the area of control program distribution, i.e., types of controlled documents: design documents, instructions and methods, safety analysis reports, topical reports, quality assurance guidelines, reports non-compliance (deviation), report, etc.;
- procedures of review, coordination and issue of documents and amendments to them for supervision by the quality control units of organizations and enterprises of sufficiency of the quality requirements;
- procedures to ensure that amendments to documents shall be reviewed and agreed

upon by the same organizations that have agreed to the original documents;

- procedures to ensure that the necessary documents will be available at the site before the work starts;
- procedures to ensure the timely removal of the substituted documents;
- procedures determining the timely preparation of the applied drawings and related documentation to accurately reflect the actual state of the nuclear power plant design.

23.2.6.2 The information under this subsection shall be presented on the basis of the implementation of NPP QAP (G) and specific quality assurance programs taking into account the planned audit of document state.

23.2.7 Inspection of shipped materials, equipment and services

23.2.7.1 This NPP QAP subsection shall provide the following information on the results of NPP QAP (G) and specific quality assurance programs implementation.

The description of supplier assessment shall provide the following procedures, including:

- the availability of the MES design and manufacture certificates;
- the availability of the positive experience in the development and manufacture of similar products;
- the assessment of technical possibilities and quality system of the contracting party;
- the description of procedures or reference to the method of input control of supplied materials, equipment and instruments provided at all stages, including incoming inspection at nuclear power plants.

23.2.7.2 This subsection shall describe measures that ensure compliance with following requirements set forth by the initial data and statement of works:

- An indication of the need for private QAP;
- technical requirements;
- Requirements to tests, inspections and acceptance control;
- System of authorizing access to items and documentation;
- An indication of the requirements to quality assurance and customer QAP sections;
- An indication of the necessary documentation (manual, procedures, protocols, inspection and testing, etc.) on quality metrics registration;
- Requirements to the preparation of reports;
- Regulations on specification of deadlines for submission;
- Guidelines on control over delivery, preservation, custody, seizure of quality history records;
- Requirements to safety assurance, security assurance and other policies related to the OO quality assurance.

23.2.8 Identification and inspection of materials, equipment and components

As a result of the development and implementation NPP QAP (G) and private programs at the time of the NPP SAR presentation this section shall contain information on measures of the identification and control of materials, equipment and components, including purchased for complete elimination of the use of non-compliant with requirements or defective materials and products.

The information shall include the distribution of administrative liability.

23.2.9 Monitoring of engineering processes

23.2.9.1 This subsection shall list engineering processes covered by the QAP. The list shall contain, in particular, the following engineering processes essential to NPP safety:

- Mechanical processing and assembly of safety-relevant equipment and system components affecting the quality of finished items;
- Maintaining clean operating conditions during manufacturing;
- Innovative technologies of installation of safety-relevant equipment and system components;
- Non-destructive inspection techniques;
- Welding, facing and heat treatment;
- Installation and de-installation of safety-relevant equipment and system components;
- Refueling;
- Monitoring the air-tightness of fuel cartridges;
- Monitoring of the air-tightness of the protective cover;
- In-process repairs and maintenance;

23.2.9.2 This subsection of the NPP SAR shall contain information on monitoring and control procedures for engineering processes, implementation of specific QAPs, including:

- A description of administrative liability, including the liability of quality assurance agencies operating at the plant;
- An analysis of qualification trials, results of the review of performance of personnel and equipment performance relevant to engineering processes with embedded quality assurance procedures;
- Logging information certifying the quality of performance of engineering processes.

Results of reviews and OO inspections of engineering processes shall be listed.

23.2.9.3 This NPP SAR subsection shall contain measures taken in order to guarantee compliance with the following requirements to quality of engineering processes:

- Implementation of measures of providing adaptability of all stages of items lifespans;
- Reflection of essential (from the point of view of providing safety-relevant qualitative parameters of constructional design) technical requirements and control methods in design documentation;
- Results of development and testing of new engineering processes, implementation and assimilation of new equipment, control methods and means implemented mainly during development stage;
- A list of management solutions and technical measures aimed at provision of the credibility of control results, results of measurement assurance of control procedures during the whole cycle of NPP construction;
- A list of human resources management activities aimed at acquisition of qualified measurement assurance and technology experts.

23.2.10 Monitoring by inspections

This NPP SAR subsection shall contain information on the results of the implementation of NPP QAP guidelines and specific programs by means of conducting inspections, including:

- A list of inspections;
- The presence of inspective programs;
- The schedule of inspections and its implementation;
- The description of an administrative liability;
- The presence of training programs and educational measures for personnel involved in corresponding activities;
- The confirmation of independence of personnel involved in inspections from subject matter of corresponding inspections;
- The presence and implementation of QAP;
- The specification of the order of inspections of engineering processes control points, working stages halting the working process pending an inspection and certificate approval based on the results of monitoring and inspections;
- The provision of inspections of every operation requiring quality assurance.

23.2.11 Monitoring of testing

23.2.11.1 This subsection shall contain a list of tests of equipment and systems necessary in order to certify its operating capacity in operation.

23.2.11.2 It shall be shown how the following conditions and requirements are met in test programs:

- Item operation model;
- Requirements to measurement assurance;
- Acceptance conditions of test results;
- Test representativity.

23.2.11.3 The methods of documenting the results of tests and evaluation of acceptability of their results shall be described.

23.2.11.4 References to test reports shall be provided, as well as a description of their results with consideration of implementation of NPP QAP and specific QAPs.

23.2.12 Control, measuring and testing equipment and instruments inspection

This subsection shall provide information on development and implementation of a program of inspection of control, measuring and testing equipment and instruments on all stages of NPP construction with consideration of implementation of NPP QAP and specific QAPs at the moment of NPP SAR presentation, including:

- The extent and scope of inspection programs, the presence of lists of equipment and instrument to be subjected to inspections;
- A description and distribution of administrative liability and the liability of quality services;
- The presence of regulations concerning identification of control, measuring and testing equipment and instruments;
- The compliance with the requirements of equipment calibration and the rate of re-calibration;
- The compliance with the requirements of reference instruments and equipment used for calibration;
- Check of compliance with approved national or international calibration standards;
- The results of OO review.

23.2.13 Quality assurance of calculation work, software and calculation methods

23.2.13.1 This subsection of the NPP SAR shall provide information on quality assurance of calculations, software and calculation methods, including:

- Organizational structure, work distribution (internal and external), functional responsibilities, authority and administrative liability (of agents, inspectors, experts, managers, etc.);
- A list of programs used for engineering calculations (physics, thermohydraulics, durability, etc.) of design (CADS) and research (ASRAS, etc.) activities (the form of representation provided in table 10).

Table 10 - Engineering calculations programs

Program name	Description (capabilities)	Registration	Validation status (report)	Certification (document)

The description of the organization and quality assurance of calculation works shall show:

- Improvement of technology of calculations concerning design-basis justification of construction at all project stages;
- Improvement of software;
- Improvement of agents qualification;
- The use of certified databases for programming purposes;
- Implementation of service programs for automation of release of report documentation;
- Assimilation and implementation of alternative national and international programs;
- Training responsible personnel to solve thermo-physical and other problems using modern calculation methods.

Quality assurance of software and calculation methods (second level particular program - “Quality assurance of ECM software”) includes the following:

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- Software validation;
- Substantiation of calculation methods;
- Software certification;
- Software conditioning;
- Report on validation of software undergoing certification;
- Formation of software database;

23.2.13.2 This NPP SAR subsection shall provide:

- Directive and regulating documents on software certification;
- Organizations responsible for preparation and conducting software certification;
- Software certification procedure;
- Procedure of certificate document preparation;
- Data contained in the document;
- Contents of the report on validation of software undergoing certification;
- Procedure of software preparation and registration;

Information may be presented in the form of references to procedure documents and reports.

23.2.14 Equipment handling, storage and transportation

This subsection of the NPP SAR shall provide information on the results of implementation of NPP QAP (O) and specific QAPs and confirmation of compliance with specific requirements to handling, conservation, storage, cleaning, packaging and transporting equipment, including:

- Control over adherence to suppliers instructions and TCs of handling, storage and transportation of equipment;
- Presence of procedures of handling, storage and transportation of equipment;
- Presence of control over handling, storage and transportation of equipment;
- Equipment control before unloading;
- Results of inspection and OO reviews.

23.2.15 Reliability assurance

The general purpose of this subsection shall provide proof efficiency of measure taken to assure reliability of equipment and systems.

A list of NPP equipment with requirements to reliability assurance shall be provided.

Head organization and sub-contractor organizations carrying out reliability assurance services within the boundaries of corresponding QAPs shall be provided.

The order of interactions and the organizational structure diagram of agents ensuring reliability shall be provided.

If QAPs concerning repairs RAP (R), bulk manufacturing RAP (m) and operation RAP (O) are present, they shall be provided in a supplement to NPP SAR.

23.2.16 Equipment check, testing and serviceability

This subsection of the NPP SAR shall contain information on development and implementation of procedures establishing the status of inspections, tests and operation of equipment at the stages of manufacturing, installation and testing, with description of means if their identification (labels, tags, process charts, stamps, etc.) and methods of their implementation.

A description of means of control over the change of sequence of required equipment testing, inspections and other safety-relevant activities, shall be provided

Means of prevention of unauthorized activation accounting for equipment and mechanisms operational status (valves, switches) shall be described.

Means of documenting non-conformances (deviations) shall be provided.

23.2.17 Monitoring of unconformities

23.2.17.1 This subsection shall contain information concerning the order of registration of cases of non-compliance with the requirements to quality of items, services and procedures (design oversights, manufacturing flaws, defects and equipment failures, violations of operational schedules, etc.)

Information on the system of collecting and processing data on non-conformances and their causes, documentation concerning the order of exchange of information on non-conformances and the rules of conducting the analysis of their causes, shall be provided.

It is also necessary to describe the manner of transferring information on non-conformances and corrective measures to corresponding authorities and the services of the MES (as per the requirements of TCP 254).

23.2.17.2 Procedures of determination, documenting and notifying the corresponding organizations of detected non-conformances of materials, equipment and components shall be described (corresponding references shall be provided). A description of administrative liability of quality assurance services and other organizations related to non-conformances (deviations) monitoring shall be provided.

23.2.17.3 Information on documented cases of solutions concerning non-conformances and the results of monitoring conducted by quality assurance services shall be provided.

23.2.17.4 Information on the analysis of non-conformances from the point of view of the OO shall be provided.

23.2.18 Corrective measures

This subsection of the NPP SAR shall provide description of means of documenting corrective measures taken upon detection of such negative factors as damages, malfunctions, defects, deviations and other non-conformances.

A program of corrective measures and its efficiency, with specification of the role of quality assurance services, shall be described. Special attention shall be paid to determination of causes of non-conformances.

Information confirming that the primary causes and corrective measures preventing reoccurrence of non-conformances are documented and reported to the managerial personnel of the plant and the OO for consideration and evaluation shall be provided. The NPP SAR shall contain primary corrective measures based on the results of the implementation of NPP QAP and specific QAPs upon NPP SAR presentation.

23.2.19 Quality assurance documents (records)

23.2.19.1 This NPP SAR subsection shall describe documents on the implementation of QAPs, which are to reflect objective quality data, including the results of inspections, reviews, tests and checks of engineering processes and operational parameters, material analysis and related data, such as personnel qualification, procedural and regulative documents. The order of conducting monitoring over all information circulating between organizations, companies and departments shall be described.

23.2.19.2 This subsection shall contain a description of the order of documentation provision, including:

- A list of persons or organizations responsible for preparation, certification and release of documents;
- A list of corresponding documents to be used at different stages;
- The order of coordination and monitoring of documents determining the distribution of works (external and internal);
- Certification of validity of the use of documents, reception of the most recent copies, return of outdated versions and their corresponding marking in order to prevent accidental use.

The NPP SAR shall describe the conditions of assurance of collecting, storage and release of documents to be conducted in accordance with written procedure (company standards, instructions). They are to reflect the requirements to the sufficiency of documentation, to presence of quality-relevant data and primary operational conditions. Information on the aspects of documenting system related to collecting, identification, allocation, storage, handling and disposing of documents shall be provided.

23.2.19.3 This NPP SAR subsection shall contain a description of assurance system providing compliance with QAP, including:

- Comprising reports on the results of inspections of the use of documents, quality of designed items, quality related expenses, evaluation of credibility, etc.;
- Comprising annual reports on the quality of items manufactured over specified terms;
- Comprising annual reports on the results of designer supervision during manufacturing, installation, trials and operation.

23.2.20 Inspections (audit)

This NPP SAR subsection shall describe measures ensuring successful audits of the actual status of QAP and its efficiency.

This NPP SAR subsection shall contain the order of conducting QAP audits, including:

- Primary guidelines, methods, the order of carrying out works and instructions ensuring quality at the design stage, manufacturing stage, construction and commissioning activities.
- Determination of corresponding information (initial project data and documents);
- Inclusion of quality requirements into project and construction documents;
- Efficient control over documentation design and its modifications;
- Connection to design, engineering, manufacturing, construction, installation and trial procedures.

A system of external audits conducted by OO and internal QAP organizational audits shall be described.

Audits conducted by OO are provided for by plans and diagrams of “General quality assurance program”.

24 Nuclear power plant decommissioning

24.1 The concept of decommissioning

This subsection shall describe the proposed concept of decommissioning and corresponding order of activities in order to decommission the NPP unit and provide radioactivity protection in the process.

The manner in which radioactivity safety is provided to personnel, civil population and to the environment (upon removal of NF) at the stage of conservation (storage under surveillance), disposal (limited area use), and at the stage of unit decommissioning (unlimited are use). The following measures shall be taken: development of decommissioning program no later than five years prior to NPP unit design lifespan expiration; complex inspection, including inspection of radiation safety of NPP unit; preparation of a safety assurance report upon NPP unit decommissioning.

The measures taken to minimize the amount (volume) of RAW and radiation exposure to personnel and civil population in accordance with ALARA principle shall be described, as well as measures taken to minimize the radioactive products emission into the environment.

24.2 Radiation sources

In order to provide radioactivity safety during de-commissioning and decrease the volume of RAW, the content of chemical elements (main, additional and at a residual level from 10^{-2} to 10^{-5} weight %) in the SI materials, reactor shell materials (carbon steel and special), concrete (common and special) of protection and other construction objects, shall be provided. The fact that the primary amount of RAW produced during de-installation of equipment and protection and construction objects and decontamination of equipment and premises, as well as the dose of ionizing radiation received by the personnel during de-installation of said components and during storage and disposal of RAW is determined primarily by long-lived radionuclides contained at a residual level, shall be accounted for. The half-life of said radionuclides may comprise several to hundreds of thousands of years. They include tritium; carbon-14; ferrum-55,59; chrome-51; manganese-54, 56; cobalt-58, 60; nickel-59,63; zinc-65; molybdenum-93; niobium-94; technetium-99; argentum-108; europium-152, 154, etc. Besides the above stated radionuclides, chlorine-36, calcium-41, barium-41, samarium-151 and some other elements affect concretes (common and special).

The results of the analysis of two possible means of decreasing the amounts of radionuclides in steel constructions caused by neutron absorption in RI materials shall be provided:

- Implementation of alloys with low cobalt content or alloys containing no cobalt instead of alloys with high cobalt content;
- Decrease of content of cobalt, argentum, niobium and nickel in construction materials.

The matter of limiting the use of or complete exclusion of serpentinites, chrome iron ores, and magnetic irons due to their high cobalt and ferrum content shall be analyzed, their use is to be substantiated.

In order to decrease the activity caused by neutrons in concrete their consumption of artificial concrete is to be minimized as much as possible. Its decrease is to be achieved via the use of special additives in concrete mix for protective and constructional objects. Data certifying that the damage to radioactivity safety caused by the use artificial concrete has been minimized shall be provided.

The matter of lithium content in materials of protective and constructional at-reactor objects shall be analyzed because lithium becomes a source of tritium after neutron absorption. Tritium on average is present in materials of said constructions in larger quantities relative to other radionuclides. Introduction of additives containing elements with large different various energy levels neutron absorption cross section, low half-life of produced radionuclides or with low quantities of ionizing radiation produced by them, or with low-energy radiation, decreases radioactive consequences of neutron activation.

Results of calculation (evaluation) of activity of materials, equipment and protective and constructional objects, as well as of the radiation field of these components, evaluation of the general quantity of RAW and their isotopic composition, shall be presented, and the volumes of unlimited use (re-use) materials to be recycled are to be determined. The calculations are to be carried out for energy of activating neutrons within the boundaries of the whole reactor spectrum, as well as their classification into groups corresponding to the groups determined in the course of determination of the density of neutron flows. Calculation data on neutron activation of the equipment and protective and constructional objects and the dosage of their radiation shall include their temporal variation after shutdown of NPP unit reactor. Certified calculation programs are to be used for calculations.

Approximate evaluations of contamination of equipment, protective and constructional objects and NPP unit premises with radionuclides of sodium-22, potassium-40, manganese-54, cobalt-57,58,60, zinc-65, strontium-90, zirconium-95, niobium-95, ruthenium-106+rhodium-106, argentum-110m, caesium-134,137, cerium-144, etc., based on experience of decommissioning similar units and their radioactivity analysis, shall be provided.

Evaluations of the quantity and distribution of size particles in aerosols produced during the deinstallation of equipment and constructs based on the technology of cutting and fracture of metals, materials and data on specific equipment used for these purposes shall be provided.

24.3 Radiation survey

Requirements to the scope of radiometric (spectrometric) and dosimetric control shall be based on the analysis of ionizing radiation sources and aerosols characteristics.

This subsection shall show that the proposed system of radioactivity control complies with the requirements below and will be operational after NPP unit shutdown in the course of the whole de-commissioning period.

A) It is to be certified that the control system is capable of measuring the following parameters:

- Material activity (low, average or high activity) and the quantity of gamma-radiation dose rate in premises in the range between 0 to 1 Sv/h;
- Gamma-radiation dosage rate in specific SI components, reactor shell, etc., and their fragments during de-installation, sorting and transporting up to 10 Sv/h (inside SI - Gy/h);
- Surface beta-contamination of equipment and premises from 0 to 100000 beta-particles/cm^2□□min;
- Unit-volume activity of aerosols in the air in concentration range between 3,7 □10^{-3} to 3,7 Bq/l;
- Unit-volume activity of aerosols in the ventilation pipes in the range between 3,7 □10^{-3} to 3,7 Bq/l;

The range of gamma-quanta (photons) energies shall be between 0,015 to 3 MeV.

B) It is to be certified that external dosimetry provides control over emission of the following groups of radionuclides produced during de-commissioning activities into the environment:

- The group with a half-life lower than 10 years: calcium-45, chrome-51, manganese-54, ferrum-55,59, cobalt-60, zinc-65, argentum-110m, caesium-134, europium-154;
- The group with a half-life between 10-100 years: tritium, nickel-63, caesium-137, europium-152, plutonium-241, samarium-244, americium-241, stroncium-90;
- The group with a half-life higher than 100 years: carbon-14, chlorine-36, calcium-41, nickel-59, niobium-94, iodine-129, plutonium-239, carbon-14;

c) Information on the system of monitoring environment radioactivity in areas of RAW storage shall be provided.

24.4 Unlimited use (re-use) materials

This subsection shall list unlimited use materials, such as materials with the radionuclide content below a specific standard. According to IAEA (at present, standards in Belarus have not been established), such content is 100-1000 Bq/kg ($3.0 \cdot 10^{-9}$ - $3.0 \cdot 10^{-8}$ Ci/kg), and the natural background radioactivity rises only 1-10% during their use.

The NPP SAR shall contain calculation and evaluation data on the quantity of unlimited use material potentially produced in the course of decommissioning activities. In some cases, this parameter may be determined based on the data acquired during radiation survey.

The compliance with the requirements to radioactivity release control for materials to be recycled for further use without limitations shall be presented.

24.5 Activities, systems and equipment for decommissioning

This subsection is to present how the requirements to protective and constructional objects have been accounted for in the project. The requirements include:

- Adherence to the geometrics of the components of protective and constructional objects allowing for clear division between areas with different levels of neutron-induced activity (high, average and low), as well as between limited and unlimited use parts;
- Provision of radiation protection to technical radioactive equipment (primary circuit, etc.) in a module version, while maintaining all durability properties of protective constructs;
- Organization of a module version of protective construct providing for the possibility of its division into contaminated and non-contaminated areas;
- The use of special air-tight one-, two- and three-layer coating in order to decrease the level of radionuclide contamination of concrete constructs, as well as selection of

concrete components based on their ability to lower the depth of penetration by radionuclides with accounting for the minimal sorption capacity of said radionuclides;

- Organization of implementation of movable panels in floors and walls in order to create installation openings providing access to radioactive equipment and its de-installation. The possibility of installation of protective portable screens (shade shielding) in order to decrease radiation burden if the personnel during decommissioning activities.

The matter of organization of special rooms for decontamination of radioactive equipment, its processing, waste conditioning and unlimited use material handling (grouting, re-melting, etc.,) shall be considered.

The possibility of using robots and manipulators for activities involving highly radioactive equipment and RAW, as well as the organization of its transportation (paths, openings, etc.) shall be provided for.

It is to be determined whether the on-site energy unit ventilation systems performance is sufficient for full-scale decommissioning activities, or additional ventilation systems are required. The correlation between the particle size of aerosols and decommissioning techniques shall be considered, since the selection of filters and other protective barriers is based upon particle size.

Measures of providing radioactivity safety during reclamation of NPP site (soil decontamination methods or immobilization of contaminants, removal of higher layers, scraping of soil and heaping, etc.) shall be considered.

Supplement A
(mandatory)
Standard structure of systems description in a nuclear power plant safety analysis report

A.1 For each power plant system it is necessary to state its designation, category in accordance with the security, seismicity classification as well as the classes as per TCP 170-2009. It is necessary to provide a list of TNLA on safety, requirements to which the described system shall comply with, state the principles, criteria on which the design system is based.

It is necessary to provide lists of initial events, faults, external impacts, operator's errors and their combinations that are taken into consideration in the analysis of system functionality and NPP safety.

The information shall be presented in the following way:
- Designation and functions of the system;
- Design modes and initial data;
- Design principles;
- Requirements to the connected systems;
- Requirements to integrating.

A.2 To study the project of each power plant system it is necessary to present the description of a complete construction or a technological diagram of a complete system or its subsystems, a list of equipment, buildings, elements if they perform independent functions. It is necessary to present sufficiently detailed drawings, pictures and schemes illustrating the construction and the operation of the system and its elements, its location and connections with other NPP systems. The main technical characteristics of the system and its elements shall be specified.

It is necessary to justify the choice of materials taking into account the normal operating conditions, abnormal operating conditions, emergency and accident situations, the information on materials' certification and their experimental justification.

The information shall be presented in the following succession:
- Description of the technological scheme;
- Description of elements;
- Description of utilized materials;
- Location of the equipment;
- Description of protection and blockings;
- System shutdown.

A.3 For each NPP system it is necessary to present a list of grounded admissible controlled parameters at all operation modes and in case of maintenance stop, to indicate the location of check-up points, to describe the method of checking, to present the information on metrological certification of the methods to be applied, the requirements to the measuring equipment. It is necessary to describe the connections of a system with control systems, backing-up sensors, communication channels.

The information shall be presented in the following succession:
- Description of protection and blocking;
- Check-up points;
- Range and conditions of safe operation;
- Operator's actions.

A.4 Present the main requirements to the quality of a system and its elements during its manufacturing, building and mounting.

Present a list of nuclear hazardous work during mounting, experiments, operation, repair and withdrawal of system or its elements from operation.

The scope and methods of entrance check-ups, interdepartmental check-ups, commissioning testing, tests and check-ups during operation, their metrological provision shall be specified. Present and justify the list and admissible values of the parameters to be controlled and requirements to the measuring equipment.

A.5 To analyze the compliance of the safety of each NPP system's design with the approved safety requirements, principles and criteria it is necessary to present the description and algorithms of solver programs applied for analysis of system's safety, initial data for calculations, admissions and limitations of design diagrams, the results of calculations and conclusions. The information on certification of solver programs and their verification shall be provided. The amount of the information is to be sufficient for performing, in case of necessity, independent alternative calculations. If any experiments have been carried out to justify the safety of a system's design, describe the conditions of experiments, give the analysis of their compliance with the design conditions, describe the experimental base, metrological equipment of the experiment and give the interpretation of the results with respect to the design conditions.

Present the description of system operation at normal and abnormal operating conditions including accident situations and design accidents, interaction with other systems taking into account probable fails and measures to protect the system from these fails. Operation admissible allowances and conditions, safety limits, values of safety systems automatic activation and a specification of a system's reliability as well as its elements shall be presented for envisaged operating conditions.

Analyze system elements fails, including personnel's errors; analyze fails consequences (including those that happened because of general cause) and effects on the functionality of the system under analysis and those connected with it, and effects on the NPP in general. The information shall be presented in the following succession:

- System's safety characteristics;
- Normal operation mode;
- Functioning of the system at failures;
- Functioning of the system at design accidents;
- Functioning of the system at external effects;
- Analysis of design safety;
- Comparison with other designs.

It is necessary to analyze the fulfillment of the requirements, principles and criteria of the respective TNLA on safety.

Supplement B
(recommended)

Form of documenting the principal information on a nuclear power plant location conditions

1. General information

1.1 Name of NPP/ block number ____________________/_____________________

1.2 Year of putting into operation / withdrawal of the block from operation
______________/_____________________

1.3 Location
Region _________________ the nearest town ____________
Distance from the site ___________________ km.
Azimuth

1.4 Geographic coordinates of the site
Latitude ______________
Longitude _____________

1.5 Absolute marks of the site in Baltic System of heights
Natural: the highest / medium / the lowest __________/__________/
_________________________________m BS
Lay outs

1.6 Landscape within 20-30 km
Short description
Plain ____
Hilly area ____
Location in a valley____
Location of rivers ____
Lake shore ____
Other (indicate)

2. **Meteorological conditions**

2.1 Whirlwind zone as per the zoning map
____

2.2 Whirlwind intensity category as per Fujita's scale __________________________

2.3 Maximum horizontal rotation speed of the whirlwind wall ________________ m/s.

2.4 Length of the whirlwind path _______________________________________ km.

2.5 Width of the whirlwind path ____ km.

2.6 Pressure difference between the periphery and vortex cavity centre _______gPa.

2.7 Probability of whirlwinds in the area of the NPP ___________________________

2.8 Probability of hurricanes (typhoons) within the area of the NPP ______________

2.9 Estimated characteristics of the maximum probable hurricane (typhoon)
____

2.10 Estimated maximum wind speed , including 1,0.1 and 0.01% ___________

3. Hydrological conditions

3.1 Type of water body influencing the NPP's safety (river, lake, water storage basin, sea ____

3.2 Factors of maximum probable flood (MPF) laid in the design
____
For rivers: spring flood, rain floods, dam and mole breakthrough, blockages, ice jams, jams because of volcanic or seismic activity, falls, slides, mud flows (underline the necessary factor or indicate others)__________________________
____
For water bodies: onset, storm roughness, maximum wave splash on the cast, seiches and other (underline the necessary factor or indicate others)
____

3.3 The highest registered water level of the water body
____

3.4 MPF parameters at design values of formation factors.
Maximum levels of various origin, including 1, 0.1 and 0.01% _______________,
________________/ _______________________________ m/s.
Maximum wave height of various origin, including 1, 0.1 and 0.01% ___________,
___________________, _______________________,_______________ m/s.

For rivers: maximum water discharge of various origin, including 0.1 and 0.01% ___________, ____________, ______________,______________ m/s.
For water bodies: the MPF level, taking into account the maximum point of flooded coast at combined estimated forming factors' contribution (seiches, onset, wind waves) ____
The highest water level at seiche wave ______________________________ m;
Estimated values of wave onsets at maximum wind speed of various origin, including 0.1 and 0.01%____m;
The highest wave height on deep water at maximum wind speed of various origin, including 0.1 and 0.01% ____m.

4. Hydro-geological and engineering-geological conditions

4.1 Characteristics of the first from the surface water-bearing horizon:
Free-flow / confined water (underline the necessary);
Area of spreading ____;
Lower / higher aquifer mark, abs.m ______________/ __________________m;
Subterranean water level mark max./ medium / min. abs. m _____m/ ______m/ ______ m;
Lithologic characteristics ____;
Filtration coefficient _____________ m/24 hours; act. porosity ______________%;
Existing water extraction____
Subterranean water marks in RO' area max./ medium/min. abs. m _____m/ _____m/_________m/;

4.2 Characteristics of the second from surface water bearing horizon:
Area of spreading ____;
Absolute mark of the lower / upper aquifuge __________m/_____________m BS;
Lithologic characteristics ____;
Filtration coefficient _____________ m/24 hours; act. porosity ______________%;
Existing water extraction____
Subterranean water marks in RO' area max./ medium/min. abs. m _____m/ _____m/_________m/;

4.3 Aquifuge layers characteristics:
Area of spreading ____;
Lower / upper boundary mark abs.m _____________m / _______________ m;
Lithologic characteristics ____;
Filtration coefficient ____m/24 h;
Presence of hydro-geological windows _________________________________;

4.4 Characteristics of engineering-geological conditions:
Development of specific soil (weak, with a deformation module < 20 MPa, liquefiable, subsidence, swelling, salted, frozen for many years)
____
____
____
____
Dangerous modern geological processes and phenomena_____________________
Presence of karstic, erosive leakage processes______________________________

5. Seismicity

5.1 Seismo-tectonic model of the district.
5.2 A Diagram of detailed seismic zoning of the region.
5.3 A diagram of structure-tectonic conditions of the neighbor region.
5.4 Diagram of seismic microzoning of the site for natural and anthropogenically changed conditions.
5.5 Characteristics of spectral composition and fluctuations duration for various types of seismic affects: remote, intermediate, local.
5.6 Parameters of a maximum estimated earthquake (MEE) and estimated earthquake (EE) from the nearest seismogenic zones: magnitude, depth, earthquake center h, distance to the seismogenic zone r, seismicity J as per MKS-64 scale at the reference soil of the site.

Table B.1

Seismogenic zone №	Magnitude		Depth of the center, km		r, km		J, points	
	MEE	EE	MEE	EE	MEE	EE	MEE	EE

5.7 Seismicity of area of regulatory organ in case of MEE / EE ___________/ _________ points;

5.8 Maximum amplitude of horizontal vibrations on the free surface of the RO' area in case of MEE / EE:

Acceleration _____________/ _______________ m/s; speed _____________/ __________ cm/s;

5.9 Maximum amplitude of horizontal vibrations of roofing stones at MEE / EE

Acceleration _____________/ _______________ m/s; speed _____________/ __________ cm/s;

5.10 Period of maximum amplitude acceleration / speed on the planification level at MEE.

5.11 Ratio of vertical to horizontal acceleration ________________________.

6 Airborne vehicle fall

6.1 Minimum distance of the site from flight routes, airport approaches ______________rm.

6.2 Distance to a big airport ______________________ km.

6.3 Probability of airborne vehicle fall on the site.

Table B.2

Category of AV	Probability of falling onto the site, 1/year		
	Acc. to the statistics	Prediction for 10 years	Prediction for 50 years

7 Accident related explosions (ARE) within the range of 10-20 km

7.1 Potential sources of accident related explosions (ARE) outside : components of chemical, oil refineries, fuel stores, explosives stores; transport – land, water; pipelines for transferring liquid, gaseous energy resources; defense objects (underline the necessary).

7.2 Land transport potential sources of AREs. Their routes, ports, harbours, channels, railway stations, characteristics of cargo traffic.

Supplement: Situational plan (Scale 1:25000).

8 Fires outside the site

Potential sources of fire: forest, peat land, gas/oil/fuel pipes, base/ store/ fuel store, shipping canal (underline the necessary).

Supplement: Topographic-landscape map of the region reflecting fixed potential sources of fire.

9 Toxic and corrosion discharges into atmosphere

The sources of toxic vapor / gas / aerosols / corrosion sediments outside the site (underline the necessary).

Supplement: Scheme of discharge sources location.

Supplement C
(recommended)

Logical diagram of a facility safety analysis under external impacts

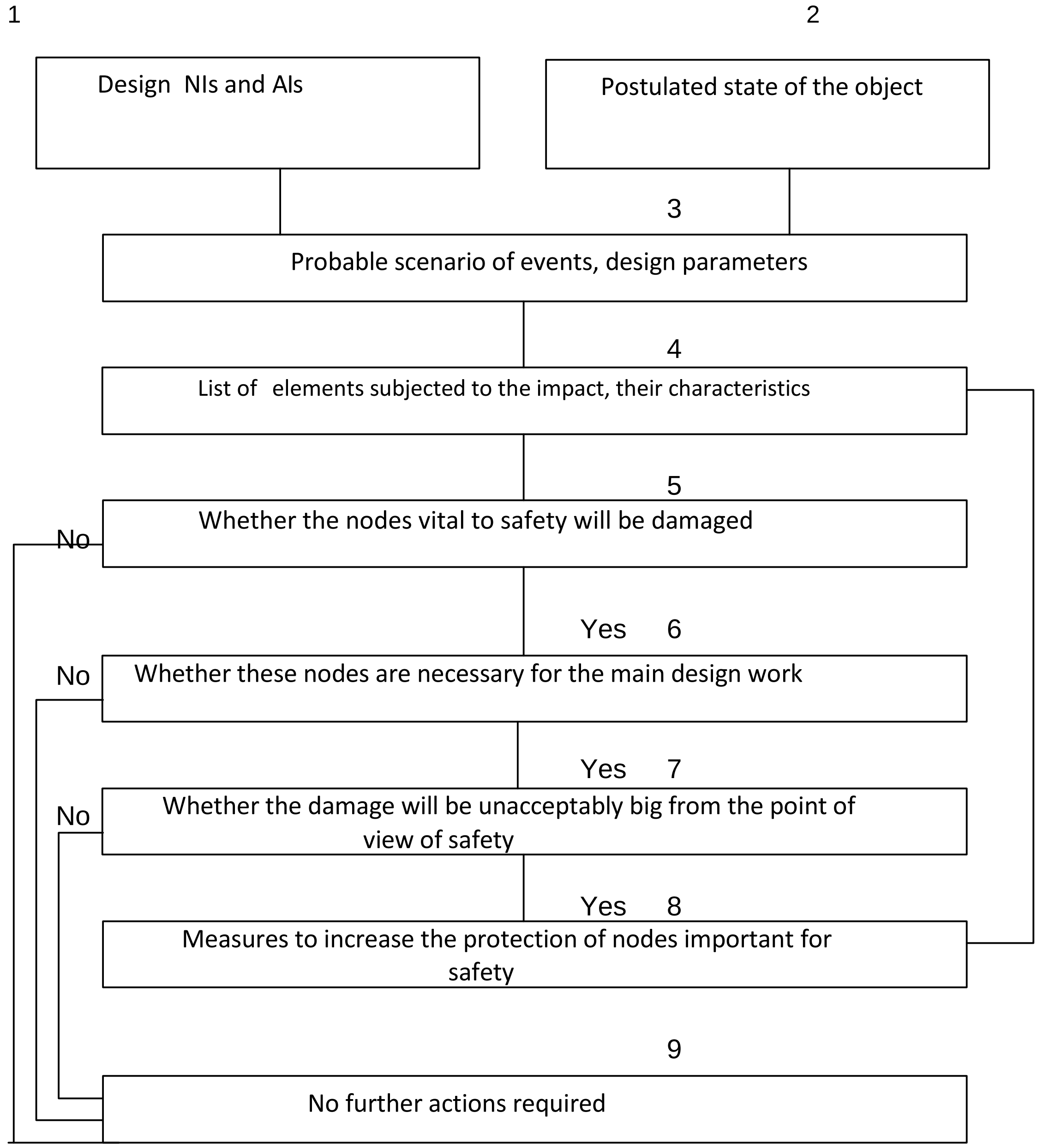

Figure C.1- Logical scheme of the object safety analysis at external impacts

A short description of the nuclear and radiation hazardous facilities' safety analysis procedure at external impacts of natural and anthropogenic origin presented in the scheme in Figure C.1:

1 Specify the postulated states for the object (Block 2).

2 Specify types of impacts taken into account in the basic design (block 1) and their input parameters (block 3).

3 On the base of studied probable consequence scenarios a list of elements subjected to the impact is defined, their characteristics and durability limits are set (Block 4).

4 Retroaction of buildings, facilities, systems and elements to the natural and anthropogenic impacts is defined deterministically using (or without using) the elements of probabilistic analysis (Block 5).

5 Safety analysis is performed with the purpose to estimate the risk (Block 6 and 7). If unacceptable risk characteristics are obtained for specified levels of impacts, the protection from NIs and AIs is performed.

6 The protective measures being performed, it is necessary to repeat the analysis starting from Block 4, 5, 6, 7 to prove the sufficiency and compatibility of protection means.

Note: In some cases, the events that cause the loads which are exceeded by other events' loads can be excluded from a detailed study (e.g. in most cases it is not necessary to take into account the equipment vibrations caused by outside explosions, if it has been designed taking into account the loads appearing at earthquakes and an airplane fall.

Supplement D

(mandatory)

Requirements to radiation survey programs content

The following information is to be contained in each chapter of the radiation control program (the programs may refer to the information given in art. 17.2, 17.3):

1 Objects to control

2 Means of control, including metrological means. The following shall be provided:

- Types of nonportable, portable and laboratory equipment and devices used for controlling: dosimetric and radiometric surface contamination levels, contents of volatile and gaseous radioactive substances in the atmosphere of buildings; for collecting samples, for individual dosimetric control of the personnel at normal operation, maintenance and accidents;
- Information on the way of providing the possibility of backing up (in quantity and places of keeping in case of an accident) of measuring channels, means of presenting and documenting the information on the radiation situation within the facilities and NPP site with the information outlet to the center of controlling anti-emergency measures outside SPZ.

It shall include mobile radiation control laboratory equipped with the equipment for controlling and radio-prospecting.

3 Software. Special attention shall be paid to the possibility of forecasting of the radioactive substances propagation and radiation situation in the NPP facilities, at its site and in the environment on the base of modern methods of mathematic and physical modeling at normal conditions as well as forecasting of radiation situation in all zone of radiation accident in accordance with the list of accidents taken into account in the design basis accidents.

It is necessary to show how the geographical conditions, meteorological factors and the development of the adjacent territories are taken into account in the design.

It shall be shown how the prediction mathematical models are implemented with the help of radiation control computer software (the contents of software packs shall be justified in the NPP project and shall be an integral part of the NPP radiation control system).

4 Means of computing equipment and methods of information processing, analysis, presentation and transfer. Capability of a computer or a computer system used in the radiation control system shall be specified. It shall be shown that they are sufficient enough for forecasting the propagation of radioactive substances and radiation situation in the scale of the entire radiation accident zone in a minimum time necessary for solving the problem.

5 The scope and periodicity of controlling radiation and meteorological parameters.

Supplement E
(recommended)
List of initiating events

INTERNAL EVENTS

1 Increase of the heat sink from the primary coolant circuit.
1.1 Abnormalities in the feed water system with the decrease of feed water temperature.
1.2 Abnormalities in the feed water system with the increase of feed water consumption.
1.3 Faults in the regulation system leading to the increase of vapor consumption.
1.4 Actuation of discharge and/or safety devices because of various reasons including probable unfitting.
1.5 Steam pipe and feeding pipelines break in different places and buildings:
- at non-intercept sections;
- at intercept sections;
- in sealed space;
- in non-sealed premises;
- in the turbine room.

2 Heat sink decrease from the primary coolant circuit.
2.1 Faults in the regulation system with the decrease in vapor consumption.
2.2 Loss of external electrical load.
2.3 Shutting of shutoff valve of the turbine plant.
2.4 Closing of cutoff gates on steam pipes.
2.5 Loss of vacuum in the condenser.
2.6 Disabling of feeding pumps.
2.7 Water feeding pipes breaks.

3 Decrease of heat-transfer agent consumption of the primary coolant circuit.
3.1 Shutoff of a number of central circulation pumps.
3.2 Jamming of the central circulation pump.
3.3 Central circulation pump shaft break.

4 Change in reactivity and of energy release distribution.
4.1 Uncontrolled removal of regulating organ with the operating speed in various conditions at;
- minimum controlled level;
- nominal power level;
- maximum power level, taking into account plus inaccuracy (of devices and mechanisms).

4.2 Ejection of regulation organ.
4.3 Incorrect actions with regulation organ.
4.4 The connection of non-functioning main circulation coolant circuit loop.
4.5 Fault in the system of dissolved absorber concentration regulation (fault of boric regulation).
4.6 Errors in fuel loading into the reactor.

5 Increase in the mass of the heat transfer agent of the primary coolant circuit.
5.1 Abnormal functioning of emergency cooling system.
5.2 Abnormal functioning of fueling system.
5.3 Fault in the regulation system of pressure compensator level.
5.4 Error made by personnel

6. Decrease, including the loss, in the mass of the heat transfer agent of the primary coolant circuit.
6.1 Activation of safety devices of the primary coolant circuit with successive unfit.
6.2 Break of pipelines carrying the primary coolant circuit medium.
- break of pulse pipes;
- break of steam generator pipes;
- break of pipelines transporting the primary coolant circuit medium out of pressure capacity.
- break of pipelines connecting the primary coolant circuit equipment;
- break of the main pipelines;
- break of steam generator’s collectors;
- small leakage in the reactor’s body at the mark lower the active zone boundary.

7 Ejection of radioactive media from the system and equipment.
7.1 Leakage through seals.
7.2 Leakage in pipelines of transport, storing and radioactive wastes processing systems.
7.3 Leakage and ejections from tanks containing radioactive substances.

7.4 Ejection of radioactive substances in case of accidents with fuel at:
- overloads;
- drop of fuel containers.
7.5 Leakage from the cooling pond or a pipeline break leading to the water level drop.
8 Loss of heat transfer agent of the second coolant circuit.
8.1 Activation and unfit of safety and discharge devices of the second coolant circuit.
8.2 Break of second coolant circuit pipelines.
9 Loss of power supply sources.
9.1 Partial de-energization of the own needs:
- while working at power;
9.2 Complete de-energization of the own needs:
- while working at power;
- at overloads;
- when storing and handling nuclear fuel systems.
10 Violations in nuclear fuel handling.
10.1 Choking up of the spent nuclear fuel in the central hall, cooling pond hall and other rooms at overloads.
10.2 Drop of some fuel assemblies, boxes, covers with fuel assemblies, packages during technological transport operations.
10.3 Drop of objects that can change the position and disturb the integrity of fuel assemblies and fuel elements' covers.
10.4 Failure of the equipment of storage and nuclear fuel handling systems.
10.5 Decrease in the homogeneous absorbers concentration in cooling pond water.
10.6 Breaking of packages fastening during the nuclear fuel transportation.
10.7 Formation of explosive mixture in spent fuel storage.
11 False operation of systems.
11.1 Partial activation of safety system in accordance with the emergency programs for various operation modes.
11.2 Complete activation of safety system in accordance with emergency programs for various operation modes.
11.3 Partial systems activation for normal operation in various operation modes.
11.4 Partial system activation for normal operation in various emergency modes.
12 Fires
- in cable tunnels, rooms, trays;
- in a power unit control board;
- in turbine room;
- at a standby diesel engine electric power generation set
- in rooms containing oil equipment;
- in nuclear fuel store rooms.

EXTERNAL EVENTS

1 Seismic impacts:
- of design basis earthquake magnitude;
- of maximum credible earthquake;
- caused by anthropogenic impacts (explosions, airplanes falls).
2 Shock waves:
- from explosions at NPP site;
- caused by human activity.
3 Floods
- seasonal;
- caused by disasters (dam breakthrough);
- flooding of nuclear fuel stores (except stores of class 1).
4 Airplane fall
- on the reactor department;
- on the turbine room;
- on the cooling systems;
- on the power supply systems;
- on the auxiliary premises containing high potential equipment (the equipment working at pressure, filled with hydrogen, oxygen);
- on the nuclear fuel stores.
5 Loss of cooling water

5.1 Drought
5.2 Breaks and damages of pipelines.
6 Whirlwind.

Supplement F

(recommended)

List of parameters and initiating events for calculating beyond design basis accidents in a nuclear power plant coolant circuits (minimum and exemplary)

1 Reactor’s heat power.
2 Average heat stream.
3 Maximum heat stream.
4 Axial power discharge distribution.
5 Radial power discharge distribution.
6 Heat transfer agent consumption through the active zone.
7 Leakage past the active zone.
8 Heat transfer agent consumption at loops.
9 Heat transfer agent temperature at the input of the active zone.
10 Average heat transfer agent temperature in the active zone.
11 Heat transfer agent temperature at the output of the active zone.
12 Maximum temperature of the fuel element.
13 Heat transfer agent stock (volume in barrels and levels in sinks).
14 Heat transfer agent level (in pressure compensator and steam generator and reactor).
15 Heat transfer agent pressure in the top reactor’s chamber.
16 Pressure jumps (at the loop, in the reactor, in the active zone, in the steam generator).
17 Steam capacity of one steam generator.
18 Steam pressure in the steam generator.
19 Temperature and consumption of feed water from the zone of emergency cooling system
20 Heat transfer agent’s activity.

Supplement G

(recommended)

List of initiating events for calculating beyond design basis accidents

(minimum and exemplary)

1 Environment pressure in the pressure zone.
2 Temperature in the pressure zone.
3 Humidity in the pressure zone.
4 Total heat transfer agent activity.
5 Ejection activity from the block (ventilation tube).
6 Activity in the pressure rooms.
7 Heat dissipation into the environment.
8 Cooling water temperature at the input.
9 Cooling water temperature at the input.
10 Cooling water activity.
11 Cooling water consumption.
12 Accumulated quantity of fission products under fuel elements blankets at the moment of the accident.
13 Accumulated quantity of fission products in the fuel at the moment of the accident.
14 Characteristics of leakage into the environment (consumption, total ejected quantity).
15 Characteristics of hydrogen sources and other combustible gases.
16 Characteristics of sprinkle system operation.
17 Characteristics heat removal system operation from the protective blanket.
18 Characteristics of ventilation system operation, including the system of organized medium discharge from the protective blanket to filters.
19 Characteristics of hydrogen suppression system operation.
20 Temperature of media in the atmosphere and on the floor of the protective blanket.
21 Mass of water and vapor in the atmosphere of rooms and the mass of water on the floor.
22 Temperature of protective blanket walls, their internal partitions and closures.
23 Concentration of medium components in the atmosphere of rooms, protective blanket, including hydrogen and other combustible gases.
24 Characteristics of the available leaks from the system in the premises (leakage amount including that through the discharge and safety valves, temperature or effusing medium enthalpy).

Supplement H
(recommended)

List of conditions and parameters for radioactive discharge analysis

The information shall be presented in the form of the table given below.

Table H.1

Name	admissions		
	initial	estimated	realistic

The column "Name" serves for indicating;

1 Admissions and conditions used for estimation of radioactivity escape in case of accidents:

- load diagram (power in time);
- burning out;
- quantity of nonhermetic fuel elements;
- activity as per isotopic composition;
- relative iodine content;
- organic fraction;
- elementary fraction;
- aerosol fraction;
- reactor's heat transfer agent activity before the accident;
- activity of the heat transfer agent of the second coolant circuit before the accident.

2 Initial data for estimation of a radioactive emission:

- capacity of hermetic premises (including primary and secondary blankets);
- dependence of leakage from pressure, temperature, season (weather conditions) in time;
- diagram of parameters' growth;
- diagram of safety organs and safety devices' activation;
- efficiency of precipitation, filtration, absorption of radioactive substances;
- parameters of circulation (consumption in time, coefficients, mixing, capacity of stagnant zones
- diagrams of heat removal for alternative cases (minimum the "worst" and the "best");

Diagrams of emergency and post-emergency behavior of parameters (before starting the post-emergency program in hermetic pressure zone, but not less than 30 days from the moment of the accident's beginning).

3 Data on dissipation

- location and characteristics of emission places;
- distance to the characteristic places (SPZ boundary, production site boundaries, the places and region of NPP location; distance to the human settlements, towns and cities;
- ration x/qs for characteristic places at definite time intervals;

4 Data on dose

- method of estimation;
- admissions in dose translation;
- extremum concentrations in protection blanket [function in time – fi(t)];
- radiation dose for characteristic places according to the kind and type – total, thyroid gland; beta, gamma.

Supplement I
(recommended)
List of conditions and parameters for accidents analysis by specific types of accidents
(minimum and exemplary)

I.1 Accident with the loss of heat transfer agent

I.1.1 Analysis of hydrogen expulsion process;

- time before the beginning of hydrogen expulsion with the assumption that recombiners are inactive;

- translation coefficient for iodine;

- x/Q in time with the mark of characteristic moments of emissions;
- rate of expulsion (burn off) in time after the beginning of the process;
- total radiation dose in the result of the accident.

I.1.2 The influence of equipment's nonhermeticity on the dose from an accident with the loss of the heat transfer agent:

- iodine concentration in the sink water;
- maximum leaks (rate of leaks and integral values in various time periods) and emissions of the primary coolant circuit medium through the equipment working during the accident: pumps' seals, flanges, safety valves, organized leaks, blow-offs etc;
- maximum leaks (rate of leaks and integral values in various time periods) and emissions of the primary coolant circuit medium through the equipment that does not work during the accident: pumps' seals, flanges, safety valves, organized leaks, blow-offs etc;
- total amount of leaked primary coolant circuit medium (in the form of tables according to the kind and type);
- change of temperature;
- time intervals for activating automatic systems and operator's actions;
- leak paths into the environment (ventilation systems, purification systems);
- coefficient of iodine discharge depending on the temperature;
- efficiency of iodine absorption in NPP systems and equipment, including cooling processes.

I.2 Accidents in the system of radioactive wastes:

- time of active media transporting;

- number of storage containers;
- containers capacity;
- time of Xe and Kr activity decrease caused by detention or to admissible values in filtering materials;
- characteristics of equipment's seismic stability;
- time of halting gas blowers and ventilators;
- duration of detention in the pipe lines and equipment;
- initial estimated activity in purification systems depending taking into account the fluctuations depending on the current activity of the primary coolant circuit heat transfer agent (the most unfavorable variant taking into account a conservative approach).

I.3 Accidents with a break of steam pipe lines and steam generator pipe heaters

- first and second coolant circuit parameters (temperature, pressure, capacity, consumption) before the accident, after the accident and after the accident;
- change in iodine activity because of the power and pressure change;
- time intervals for activating automatic systems and operator's actions;
- estimation of water and vapor discharge; state the approved models and admissions.;
- coefficients of iodine isotopes emissions and their justification;
- estimation of fuel damage and approved admissions.

I.4 Accidents during fuel loading:

- quantitative values (number of fuel assemblies, fuel elements, fuel quantity, construction materials);
- distribution of burn off;
- quantitative characteristics and the character of fuel damage;
- spread of damaged fuel in the zone;
- defining the moment of the accident with respect to loading;
- escape of iodine isotopes and noble gases;
- purification coefficients (purification degree), precipitation, removal etc;
- maximum pressure in fuel elements;

- water levels during loading and storing;
- maximum heat loads at the highest power of unloaded zone;
- maximum temperature in the center of the fuel element;
- average burn off value for the fuel assembly.

I.5 Accidents with the regulation organs:

- distribution of damaged fuel elements distribution of loads according to the radius and height;
- quantitative values of loads distribution (up to limit 1, up to limit 2, higher than limit 2, with exceeded melting temperature);
- quantitative characteristics of the radioactive substance discharge into the heat transfer agent;
- a list of first and second coolant circuit parameters used for defining radioactive emission from steam pipe lines;
- a list of pressure zone’s parameters used for estimating radio substances emission.

I.6 Drop of a container with spent fuel

- quantitative characteristics of the fuel contained in the container;
- burn-off and detention characteristics;
- damage characteristics of fuel contained in the container;
- loads distribution according to the radius and height;
- qualitative and quantitative composition of the emitted radioactive products;
- probable damage to the construction structures and equipment.

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