TECHNICAL CODE OF
COMMON PRACTICE

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GENERAL PROVISIONS FOR NUCLEAR POWER PLANTS SAFETY GUARANTEEING (GPSG NPP)

Official Edition

Ministry of the Emergency Situations of the Republic of Belarus

Minsk

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Key words: nuclear plant, nuclear and radiation safety, safety provision criteria, safety functions, technical and organizational measures of security guaranteeing, safety systems and elements, nuclear plant commissioning, normal operation of power plant, nuclear plant design basis accident, nuclear plant beyond design basis accident, nuclear plant decommissioning, operational documentation, nuclear plant personnel, safety culture.

Foreword

The aims, basic principles and regulations of the governmental control of the technical rate setting and standardization are set by the Law of Belarus *On the Technical Rate Setting and Standardization.*

1 DEVELOPED BY State Scientific Institution "The Joint Institute for Power and Nuclear Research - Sosny" of the National Academy of Sciences of Belarus

INTRODUCED BY the Ministry of Energy of the Republic of Belarus

2 APPROVED AND MADE EFFECTIVE BY order of the Ministry of the Emergency Situations of the Republic of Belarus of February 17, 2009 No 14

3 FIRST EDITION (canceling nuclear power engineering regulations 1-011-89 *General provision for nuclear power plants safety guaranteeing* (OPB-88), approved by *Gosatomenergonadzor* (USSR nuclear and radiation safety authority) in 1990 and valid from July 1, 1990)

Content

Introduction

This technical code of common practice was developed in compliance with:

– regulation of the Council of Ministers of the Republic of Belarus *On the Approval of the List of the State Scientific and Technical Programs for 2006 – 2010* of January 4, 2006 No 5;

– state scientific and technical program *Nuclear Physics Technologies for the Economy of Belarus*, approved by order of the Chairperson of the State Committee on Science and Technology of July 6, 2006 No 180;

– the plan of main preparation work to be finished before the beginning of the construction of the Nuclear Plant of the Republic of Belarus, approved by regulation of the Council of Ministers of the Republic of Belarus of July 18, 2006 No 905-9.

When working out this technical code of common practice they took into account the vast experience of the USSR and the Russian Federation in siting of nuclear plants summarized in:

– nuclear power engineering regulations 1-011-89 *General provision for nuclear power plants safety guaranteeing* (OPB-88), approved by *Gosatomenergonadzor* in 1990;

– Norms-001-97 *General provision for nuclear power plants safety guaranteeing* (OPB-88/97), approved by order of *Gosatomnadzor* (federal nuclear and radiation safety authority of Russia) of November 14, 1997 No 9.

This technical code of common practice was developed with due account for the technical and legal safety regulations of Belarus and IAEA recommendations.

TECHNICAL CODE OF COMMON PRACTICE

ОБЩИЕ ПОЛОЖЕНИЯ ОБЕСПЕЧЕНИЯ БЕЗОПАСНОСТИ АТОМНЫХ СТАНЦИЙ (ОПБ АС)

АГУЛЬНЫЯ ПАЛАЖЭННІ ЗАБЕСПЯЧЭННЯ БЯСПЕКІ АТАМНЫХ СТАНЦЫЙ (АПЗ АС)

General provision for nuclear power plants safety guaranteeing (GPSG NPP)

Effective from 2009-05-01

1 Scope of Application

This technical code of common practice (hereinafter – technical code) specifies the main criteria and demands for the safety issues peculiar for a nuclear plant (hereinafter – NP) as a source of a possible radiation impact of the personnel, population and environment, sets safety goals, main criteria and the principles as well as the nature of technical and organizational measures to guarantee the safety of nuclear plants.

The requirements of this technical code of common practice are mandatory for the legal bodies and private individuals taking part in siting, designing, building, commissioning and decommissioning of nuclear plant blocks in the whole territory of Belarus.

2 Terms and Definitions

This technical code includes the following terms with their appropriate definitions:

2.1 accident: A nuclear plant operation failure that caused an emission of radioactive substances or ionizing radiation beyond the design safety operation limits. An accident has an initial event, behaviors and consequences.

2.2 administration: Executives with some rights and liabilities responsible for the NP operation.

2.3 active system (element): A system (element), which functioning depends on the normal operation of another system (element), for example, the safety management system, the energy source management system etc.

2.4 nuclear plant: A nuclear installation to produce electric power and heat energy as specified by the regime or the work conditions, located in a certain area, having for its purpose a nuclear reactor or reactors and a set of necessary systems, devices, equipment or structures.

2.5 nuclear power plant: A nuclear installation to produce electric power.

2.6 radiation and nuclear safety of nuclear plant (hereinafter – nuclear plant safety): The ability of a nuclear plant to restrict its radiation impact on the personnel, population and environment within the design limits under normal operation and in case of its failures including accidents.

2.7 safe failure: A system or element failure that puts a nuclear plant into safe condition without any need to take an action via safety management systems.

2.8 biological shielding: A set of structures and materials around a nuclear reactor, its assembly units to reduce the radiation emission to a biologically safe level. A biological shielding is a barrier preventing or limiting the radiation impact on the personnel, under normal operation and in case of its failures including design basis accidents.

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2.9 nuclear plant block: A part of a nuclear plant consisting of a nuclear reactor with generating and other equipment to provide for the nuclear plant performance as specified.

2.10 block control unit: A part of a nuclear plant located in specialized rooms for the purpose of the centralized process control by the control personnel and automation means.

2.11 commissioning: The process of making nuclear plant systems and components able to work and estimation of their compliance with the nuclear plant project.

2.12 inherent safety: The ability to guarantee safety due to natural feedback couplings and processes.

2.13 decommissioning: The course of actions to stop the use of a nuclear plant with the provision for the safety of the operating personnel, other people and the environment.

2.14 achieved level of scientific and technical development: An amount of scientific and technical knowledge, certain technical developments confirmed by scientific research and practical experience shown in certain research works.

2.15 beyond design basis accident: An accident caused by events unaccounted for design basis accidents or accompanied by additional safety systems failures apart from a single failure or personnel wrong decision implementations.

2.16 protective safety systems (elements): Systems (elements) to prevent or limit nuclear fuel, fuel element jacket, equipment and radiant matter containing pipes damage.

2.17 initial event: A single failure in nuclear plant systems (elements), an external event or the personnel error that cause a disruption of normal operation and may lead to a violation of the safety operation limits and (or) conditions. An initial event includes all dependent failures that are its consequences.

2.18 system channel: A system part performing the specified system function.

2.19 end state: Settled and controlled state of nuclear plant systems and elements after an accident.

2.20 conservative approach: An approach to designing and building when the accident analysis uses parameters and characteristics with limits and values of more unfavorable results than can be expected.

2.21 reactor coolant contour (first contour): A contour with the pressure compensation system designed to circulate the coolant through the active zone within the framework of the specified regimes and operation conditions.

2.22 safety criteria: an NP safety parameters and (or) characteristics set by laws and regulations and (or) safety regulation authorities to justify the NP safety.

2.23 localization safety systems (elements): Systems (elements) to prevent or limit an accident-triggered emission of radioactive substances or ionizing radiation beyond the specified limits and their release to the environment.

2.24 NP abnormal operation: an NP operation disruption accompanied by a deviation from design operational limits and conditions. Other specified limits and conditions may be violated too including safe operation limits.

2.25 independent systems (elements): Systems (elements) that do not depend on a failure of another system (element).

2.26 undetectable failure: A system (element) failure that shows no signs under normal operation and cannot be detected by the provided control means according to the maintenance and check protocol.

2.27 nuclear plant normal operation: A nuclear plant work within the specified limits and conditions.

2.28 quality assurance: Planned and regularly carried out activities to ensure that every work related to the construction or operation of an NP shall be done as required and their results shall meet certain requirements.

2.29 support safety systems (elements): Systems (elements) to support safety systems supplying them with energy working environment and conditions.

2.30 pilot operation: An NP commissioning stage from the power start-up to the NP acceptance.

2.31 common cause failures: Systems (elements) failures caused by one failure or a personnel error, or an external or internal factor, or another internal source.

2.32 personnel error: A single unintentional incorrect action on control units or a single omission of a correct action, or a single unintentional incorrect action in the course of safety-important equipment and systems maintenance.

2.33 wrong decision: An unintentional incorrect set of successive actions done or a failure to do certain successive actions due to a wrong estimation of occurring processes.

2.34 passive safety system (element): A system (element) functioning due to a trigger event and irrelevant to the work of another active system (element) e.g. management system, energy source etc.

2.35 fuel element damage: A violation of one of the set failure limit for fuel elements.

2.36 fire safety: Individual(s), assets and nation fire security.

2.37 accident consequences: The radiation contamination caused by an accident that makes damages due to the radiation impact limits violation for the personnel, population and environment.

2.38 pre-emergency: The violation of NP safety operation limits and conditions that did not lead to an accident.

2.39 nuclear plant normal operation limits: Specified process parameters that may cause an accident, if violated.

2.40 precommissioning: An NP commissioning stage when constructed and mounted systems and elements are checked for their compliance with the specified criteria and characteristics; this stage is finished when the NP reactor is ready to be physically launched.

2.41 single failure principle: The principle according to which the system shall perform as required independently from the initial event that needs its performance and from a failure of an active or passive element with a mechanical movable parts, the failure being independent from the initial event.

2.42 independence principle: The principle of system reliability enhancement through functional and (or) physical separation of the channels (elements) that do not depend on a failure of another channel (element)

2.43 diversity principle: The principle of system reliability enhancement through the application of different and (or) analogue, but based on different principles means in different systems (or in different channels of the same system) to perform a function.

2.44 redundancy principle: The principle of system reliability enhancement through structural, functional, informational and time redundancy respecting the minimal sufficient amount for a system functioning.

2.45 check: The operational control of a system (element) to determine its health and troubleshoot.

2.46 design basis accident: An accident with specified initial events, end states and safety systems to restrict its consequences to design limits with the account for a single failure of a safety system or a single personnel error independent from the initial event.

2.47 design limits: Parameter, characteristic values the state of systems, elements and the whole plant as designed for the normal operation including pre-emergencies and accidents.

2.48 industrial safety of hazardous production facilities: The protection of an individual and the society from accidents at hazardous production facilities and their consequences.

2.49 commercial operation: A nuclear plant operation after commissioning that confirmed its compliance with safety and other design specifications.

2.50 accident propagation path: The sequence of NP systems and elements in the process of accident propagation.

2.51 radiation safety: Protection of present and future human generations from the harmful impact of ionizing radiation.

2.52 nuclear plant (reactor installation) designers: The bodies developing a nuclear plant (reactor installation) project and scientifically supporting it (chief designer, general design engineer, research manager).

2.53 reactor installation: A set of NP systems and elements to transform the nuclear energy into the heat one including the reactor and the systems directly supporting its smooth operation, emergency cooling, emergency protection and safety maintenance supposing every auxiliary and supporting function is carried out by every other system of the plant. The borders of the reactor installation are specified for each nuclear plant in its project.

2.54 reserve control room (unit): A part of a nuclear plant block located in a room specified for that purpose that shall secure the nuclear plant block into the undercritical cool state and keep it in it as long as necessary as well as activate safety systems and monitor the reactor state; it works if block control unit fails to react.

2.55 repair: A set of operations to restore the working ability of an object (systems and elements) and (or) its resource.

2.56 system: A set of elements to perform the design functions.

2.57 safety systems (elements): Systems (elements) functioning to maintain safety. Safety systems and elements can be divided up functionally to protection, localization, support and management ones.

2.58 safety-important systems (elements): Safety systems and elements and normal operation systems and elements which failures can lead to a nuclear plant abnormal operation or prevent the recovery measures to be taken, which may cause design basis and beyond design basis accidents.

2.59 normal operation systems and elements: The systems and elements for the normal operation.

2.60 maintenance: A set of operations to maintain the working ability of an object (systems and elements) in operation, in the stand-by mode, when stored or transported.

2.61 technical safety: A state of a nuclear object achieved with technical and organizational measures that provide for a sufficient safety level for humans and the environment from any adverse impact (radiation, explosions, pressure, temperature, toxic environments, electric tension etc.) related to the nuclear power.

2.62 beyond design basis accident: A beyond design basis accident with fuel element damage over maximum design limit that may lead to the limit of allowable release of radioactive substances to the environment.

2.63 accident management: Actions taken to stop the development of a design basis accident into a beyond design basis one and to limit the consequences of a beyond design basis accident.

2.64 safety management systems (elements): Systems (elements) to activate safety systems and control their functioning.

2.65 normal operation safety management systems (elements): Systems (elements) controlling the nuclear plant block normal operation system equipment according to design goals, criteria and restrictions.

2.66 emergency preparedness level: The determined degree of the preparedness of the personnel civil defense and emergency situations authorities and others involved as well as the equipment to protect humans from an NP accident.

2.67 interference level: A set of parameters and characteristics of the radiation environment that require taking measures to protect the personnel and population.

2.68 safe operation conditions: Design minimum conditions for the amounts, characteristics, working ability and maintenance conditions of safety-important systems and elements that provide for the compliance with safety operation limits and (or) criteria.

2.69 nuclear plant physical protection: The technical and organizational security measures to protect nuclear materials and radioactive substances, to prevent an unauthorized access to the nuclear plant, nuclear materials and radioactive substances and timely prevent acts of sabotage and terrorism against the NP.

2.70 physical launch: An NP commissioning stage when the reactor is loaded with nuclear fuel, the reactor is in the critical state and proper power measurement are made so that the heat removal can be carried out due to natural heat losses.

2.71 safety function: A specific purpose and its appropriate actions to prevent accidents or limit their consequences.

2.72 elements: Equipment, devices, pipelines, cables, building structures and other things that help perform a design function independently or in a system and are considered as structure units in reliability and safety analyses.

2.73 ecological safety: Environmental and human protection from possible harmful impact of any activity or natural and man-induced emergencies.

2.74 operation: Every activity to reach the goal of a nuclear plant safely including any power, launch, stop, test, maintenance, repair, reset, reload, inspection and other relevant activities.

2.75 operational limits: Parameter and characteristic values for individual systems and elements as well as the whole plant as designed for the normal operation.

2.76 operation conditions: Specified conditions respecting amounts, characteristics, working ability and maintenance of systems and elements necessary for the work with no deviation of operational limits.

2.77 operation with abnormalities: A nuclear plant operation with deviations from operational limits and conditions, but without safe operation conditions.

2.78 nuclear plant operator: The organization that sites, builds, commissions, operates, limits operational characteristics, prolongs the service life of and decommissions a nuclear installation and (or) storage premises, handles nuclear materials and (or) radioactive wastes on its own or with the help of other organizations.

2.79 nuclear plant power start-up: An NP commissioning stage from the end of the physical launch to the beginning of the electric power production.

2.80 nuclear accident: An accident related to fuel element damages exceeding the design limits of the safe operation and (or) to the personnel exposure to radiation beyond the allowable limits due to:

– loss of control of the nuclear chain reaction in the active zone of the reactor;
– criticality occurrence during fuel element reload, transportation and storage;
– fuel element cooling disruption;
– other factors causing FE damages.

2.81 nuclear safety: Protection of people and the environment from a harmful impact of ionizing radiation of a nuclear unit and (or) storage facility due to proper operation conditions, proper handling of nuclear materials and radioactive wastes.

3 Abbreviations

This technical code has the following abbreviations:
BCU – block control unit;
FE – fuel element;
NLA – normative legal act;
NOMS – normal operation management systems;
NP – nuclear plant;
NPO – nuclear plant operator;
NP SAR – nuclear plant safety analysis report;
RCU – reserve control unit;
RI – reactor installation;
SMS – safety management systems;
SPZ – sanitary protection zone;
TNLA – technical normative legal act.

4 Main Criteria and Principles of Safety Guaranteeing

4.1 An NP meets the safety requirements, if its radiation impact on the personnel, population and the environment under normal or abnormal operations including design basis accidents does not lead to the violation of design radiation doses limits for human exposure, radiation emission norms, radioactive substance content in the environment and also if all these are restricted after a beyond design basis accident.

This is partly achieved by following NLA including TNLA requirements for nuclear power and other NLA acting in Belarus.

4.2 Acceptable exposure limits for the personnel and population, radiation emission norms and radioactive substance content in the environment are set in compliance with NLA including TNLA of Belarus for normal operations and accidents.

4.3 The exposure levels for the NP personnel and population due to any emission of any radioactive substances from the NP shall be as lower than the design limits as reasonable possible.

4.4 The NP safety shall be secured due to the following the defense-in-depth concept based on a system of physical barriers against ionizing radiation and radioactive substances way to the environment and the system of technical and organizational measures to keep the barriers safe and effective and to protect the personnel, population and the environment.

4.5 The system of physical barriers of an NP block includes the fuel matrix, fuel-element jacket, reactor coolant contour edge, reactor installation leak-tight enclosure and biological shielding.

4.6 The system of technical and organizational measures shall consist of five defense-in-depth levels and include the following levels.

4.6.1 Level 1 (NP siting conditions and abnormal operation prevention) includes:

– NP siting estimation and choice;

– establishing the sanitary protection zone and the monitoring zone for protection measures planning around the NP;

– conservative-approach-based designing of a reactor installation with a well-developed inherent safety;

– providing proper NP systems and elements as well as work quality;

– operating NP in compliance with NLA including TNLA, technology regulations and operational manuals;

– maintaining safety-important systems and elements in good health by timely troubleshooting, preventive measures, replacing worn-out equipment, documenting work and control results;

– recruiting properly-qualified NP personnel and training them to work in normal and abnormal operation conditions including pre-emergencies and accidents, forming safety culture.

4.6.2 Level 2 (the prevention of design basis accidents with normal operation systems) includes:

– abnormalities detection and elimination;

– abnormal operation control.

4.6.3 Level 3 (the prevention of beyond design basis accidents with safety systems) includes:

– preventing the development of initial events to design basis accidents and design basis accidents to beyond design basis ones using safety systems;

– minimizing the consequences of accidents that could not be prevented by the localization of released radioactive substances.

4.6.4 Level 4 (the control of beyond design basis accidents) includes:

– preventing the development of beyond design basis accidents and minimizing their consequences

– protecting leak-tight enclosure form destruction in case of a beyond design basis accident and maintaining its working ability;

– restoring control under the NP when the chain reaction stops, the nuclear fuel is kept cooled constantly and radioactive substances as restricted to their limits.

4.6.5 Level 5 (emergency planning) includes making and using internal and external emergency plans at the NP site and outside it.

4.7 The defense-in-depth concept is followed at every stage of an NP safety provision to the extent that covers the appropriate activity. The strategy of undesired event prevention is a priority, especially for levels 1 and 2.

4.8 Under normal operation every physical barrier shall be healthy and its protection measures shall be ready to use. If they detect the unserviceability of any existing physical barrier or unavailability of its protection measures the reactor installation shall be stopped and measures shall be taken to make the NP block safe.

4.9 The technical and organizational measures taken to guarantee the NP safety shall be verified by previous experience or tests studies, prototyping and they shall comply with NLA including TNLA. This approach shall not be made in an NP and its equipment designing only, but also in the construction, operation and modernization of the NP, its equipment, systems and elements.

4.10 The structure and reliability of safety-important systems and elements and different safety-related work shall be subject to quality control.

4.11 The operator provides for the development and implementation of quality provision programs for every stage of the NP service life; to reach the goal it works out the general quality provision program and controls the activities of the contractors working for the NP (exploration, design, research, installation organizations, suppliers of systems and elements, factories producing NP equipment etc.).

The contractor companies that provide their services for NPO develop their own quality provision programs within the framework of the general quality provision program according to their activities.

4.12 Every people and company related to the siting of, construction, operation and decommissioning of the NP, designing, and making its systems and elements shall follow certain safety culture; this is achieved by recruiting and training personnel for every safety-related activity and strict discipline accompanied with clear distribution of personal responsibilities of the managers and workers, the development of and strict compliance with job instructions followed by their periodical upgrading according to the accumulated experience. Every employee shall know how his/her job is related to the safety and be aware of the consequences of his/her failure to follow the requirements of acting NLA including TNLA in full or in part.

4.13 The operator provides for the NP safety including measures to prevent accidents and limit its consequences, to account, control and protect nuclear materials, radioactive substances and wastes to control the radiation in the environment of the SPZ and monitoring zone; also, it is responsible for operating the NP within the design purposes limits only.

The operator is solely responsible for the NP safety. It is not excused from its responsibility in any relation to the contractor organizations' and safety control authorities' activities.

4.14 The operator creates structural units to build the NP being authorized, provided with finance, material and human resources from the operator and then controls their work.

4.15 The erection of the NP main buildings and structures can begin when the NP design project is ready and the license for the NP construction is obtained from a nuclear and radiation safety state regulation authority.

4.16 An NP project shall provide for technical means and organizational measures of the design basis accidents prevention, limitation of their consequences and safety guaranteeing in case of any accounted initial event with an event-independent single failure of any passive (with moving mechanical part) or active safety element or an event-independent single failure of the personnel according to the principle of a single failure independent from the initial event.

4.17 In addition to a single failure of an above-mentioned element independent from the initial event they shall account for the element failures that are undetectable in the course of the NP operation but may lead to the safe operation limits deviations and an accident development.

4.18 An NP project shall provide for technical means and organizational measures to prevent the violations of safe operation limits and conditions.

4.19 The project of RI and NP shall contain measures to control beyond design basis accidents according to the list per 4.21 and 4.22, unless they are excluded by the reactor inner structure or inherent safety.

4.20 For beyond design basis accidents they shall provide the reduction of the risk of radiation impact on the personnel, population and environment through measures to protect humans from an accident.

4.21 Preliminary lists of initial events, beyond design basis and design basis accidents, including initial events, their propagation paths and consequences shall include the severe-consequence scenarios for counteraction planning.

The analysis of beyond design basis accidents shown in NP design is the basis to plan human protection measures against an accident and to work out a beyond design basis accident manual.

4.22 Final lists of beyond design basis accidents, their realistic (non-conservative) analysis, with the estimations of possible propagation paths of beyond design basis accidents including core melting accidents, beyond design basis accident consequences, safety systems work are specified in an NP project; also they shall be shown in NP SAR being an integral part of an NP project.

4.23 To exclude the need to evacuate the population outside the protective measure planning zone set according to the normative requirements to an NP location they shall try to avoid any exceeding of the maximum emergency emission of 10^{-7} for a reactor a year.

4.24 If the beyond design basis accident consequences analysis does not confirm the execution of 4.23, additional technical solutions for accident control to limit accident consequences shall be provided for in the project.

4.25 NP safety technical and organizational measures system shall be reflected by

NP SAR. No discrepancies between the information in an NP SAR and an NP project and its implementation are allowed. The correspondence of an NP SAR and the real situation is supported by the NPO throughout the life of the NP.

4.26 This NP analysis and feasibility materials shall contain probable analysis of safety.

4.27 The NP project shall have the necessary organizational management structure and the personnel qualification requirements.

4.28 The NP project shall have a training center with a psychological examination laboratory with every training material and workers to train the personnel on a high-quality level.

For same-type NP blocks they shall develop a full-task simulator to be activated before the physical launch.

4.29 The NP project shall include technical and organizational measures of the NP physical protection and fire safety.

4.30 The NP project shall provide for communication means including backup ones to organize the control of an NP and alarms and notifications for normal operations, beyond design basis and design basis accidents.

4.31 At an NP they shall organize the accounting and control of all nuclear materials, radioactive substances and wastes.

5 Nuclear Plant Systems and Elements Classification

5.1 NP systems and elements are different in:

– their destination;
– their impact on safety;
– the nature of their safety functions.

5.2 NP systems and elements can be divided according to their destination to:

– normal operation systems and elements;
– safety systems and elements.

5.3 NP systems and elements can be divided according to their impact on safety to:

– safety-important ones;
– others that do not influence on the safety.

5.4 Safety systems and elements can be divided according to the nature of their safety functions:

– protection;
– localization;
– support;
– management.

5.5 Based the elements impact on the NP safety, four safety classes can be established.

5.5.1 Safety class 1 includes fuel elements and NP elements which failures can be initial events of beyond design basis accidents that can lead under design functioning of safety systems to fuel elements damages with the violation of design basis accident limits.

5.5.2 Safety class 2 includes the following NP elements:

– elements which failures can lead to FE damages within design basis accident limits under design functioning of safety systems with the account for specified number of failures for design basis accidents;

– safety system elements, which single failures can lead to non-functioning of systems.

5.5.3 Safety class 3 includes the following NP elements [2]:

– safety-important ones, not described by safety classes 1 and 2;

– containing radioactive substances which emission to the environment (including NP work premises) in case of failures exceed the limits set by radiation safety norms;

– the ones controlling the human protection functions.

5.5.4 Safety class 4 includes NP safe operation elements not described by safety classes 1, 2, 3.

5.5.5 Accident control elements not described by safety classes 1, 2, 3, also make a part of safety class 4.

5.6 If any element has at the same time the signs of different safety classes, it shall be considered as belonging to a higher class.

5.7 Sections having elements of different safety classes shall be considered as belonging to a higher class.

5.8 A safety class is vital sign of the formation of other classifications of NP elements set in NLA including TNLA. Other signs of these classifications are specified by normative legal acts according to a set of NP.

5.9 NP element safety classes are determined by RI project developers according to the requirements of this technical code.

5.10 The quality requirements to the NP element belonging to safety classes 1, 2, 3 and its provision are set by NLA including TNLA specifying its structure and operation. At that time, the higher safety class shall comply with higher quality requirements.

5.11 The elements of safety class 4, are subject to the requirements of general purpose industrial NLA including TNLA.

5.12 The belonging of elements to safety classes 1, 2, 3 and their being subject to the requirements of NLA including TNLA shall be indicated in the documents of the development, production and supply of NP systems and elements.

5.13 Classified designations shall show the belonging of an element to classes 1, 2, 3.

5.14 Classified designations are accompanied by a symbol indicating the element destination:

N – normal operation element;
P – protection element;
L – localization element;
S – support element;
M – SMS element.

5.15 If an element has several destinations, all of them are shown by symbols.

Examples

1 2N.

2 2NP.

6 State Management and Control of Nuclear Power Engineering

6.1 The state management and control of nuclear power engineering is performed in compliance with [1], by special governmental authorities according to their competences.

6.2 Nuclear power issues related to the NP are controlled by the Ministry of Energy of the Republic of Belarus (hereinafter – Minenergo) that works in compliance with its Charter [4] observing the Constitution of Belarus, presidential edicts, laws and regulations, governmental regulations and acts, norms and rules for nuclear power issues and other normative legal acts.

6.3 Minenergo, according to its competence, specifies the order of interaction of organizations i.e. NP and RI designers and the nuclear plant operator, and regulates the relations between all the participants of the NP (RI) project development, scientific support and operation at every stage of the NP service life (designing, siting, building, operating and decommissioning).

6.4 If the NP operator is unable to secure the NP safety, Minenergo is responsible for the NP safety and the proper handling of nuclear materials, radioactive substances and wastes. Minenergo must be responsible for the NP safety and the proper handling of nuclear materials, radioactive substances and waste until a new operator of the NP is established.

6.5 The state regulation of nuclear power issues is performed in compliance with article 7 [1].

The state regulation of the nuclear safety and the NP radiation safety organizational and technical arrangements is in the competence of the nuclear and radiation safety state regulation body.

Other NP safety issues are in the competence of other bodies of the state control of the safety according to the laws of Belarus.

6.6 The nuclear and radiation safety state regulation body acts in compliance with the regulation about it, following the Constitution of Belarus, presidential edicts, laws and regulations, governmental regulations and acts, national norms, rules and other NLA including TNLA for nuclear power issues, and nuclear and radiation safety guarantee.

6.7 The nuclear and radiation safety state regulation body gets acquainted with NP radiation and nuclear safety feasibility materials and issues appropriate licenses for organizations and individuals working for the NP operator as well as for the NP workers to perform certain work in compliance with the lists approved by the Government of Belarus.

7 Main Safety Principles to Be Followed in Designing Nuclear Plant and Its Systems

7.1 General Requirements

7.1.1 Safety-important systems and elements shall be designed according to this technical code and other NLA including TNLA for nuclear power issues as well as considered by the nuclear and radiation safety state regulation member necessary for lisensing.

7.1.2 According to the defense-in-depth concept an NP shall have safety systems to carry out the following safety functions:

– the emergency stop of the reactor and its maintenance in the undercritical state;

– the emergency heat removal from the reactor;

– the maintenance of radioactive substance within design limits.

7.1.3 The necessary amount of safety functions and their performance ways are designed and justified for every NP in its project and reflected in the NP SAR.

7.1.4 They shall provide for the technical means of an NP to reduce the consequences of beyond design basis accidents according to 4.21 and 4.22.

7.1.5 The NP project, safety-important systems and elements work papers shall determine (and as regards safety-important systems and elements of safety classes 1 and 2 they shall check the readiness of) equipment, devices, programs and techniques to:

– check the working ability of systems and elements (including the devices inside the reactor), replace worn-out equipment;

– check the compliance of the systems with their design parameters;

– check the sequence of signal transmission and equipment switching (including the switch to emergency power supply sources);

– control the health of metal and weld joints of equipment and pipes;

– check the compliance of the control channels metrological characteristics with their design parameters.

7.1.6 The safety-important systems and elements shall be able to function as designed with the account for natural phenomena impacts (earthquakes, hurricanes, floods that can happen in an NP site location area), any external man-induced events which are not uncommon for an NP site location area and (or) possible mechanical, thermal, chemical and other impacts caused by a design basis accident.

7.1.7 NP designing shall include justified measures to prevent common cause failures and to protect systems and elements from them.

7.1.8 NP and RI system and element designing shall have systems and elements based on the passive working principle and inherent safety (self-regulation, heat retention and other natural processes) as a priority.

7.1.9 The NP project shall provide for the technical means to prevent the personnel single failures or to minimize their consequences including those related to the maintenance.

7.1.10 A multipurpose use of safety systems and their elements shall be justified. The combination of safety functions and normal operation functions shall not lead to a violation of NP safety requirement and less reliable work of safety systems and elements.

7.1.11 Safety-important systems and elements shall be directly or completely checked for the compliance with their design values during the commissioning, after a repair and during the whole life of the NP.

7.1.12 If direct and (or) complete inspections are impossible, which shall be justified in the NP project, they shall carry out indirect and (or) partial inspections. The sufficiency of indirect and (or) partial inspections shall be justified in the NP project.

7.1.13 The shall be a possibility to check the health of safety systems and safety-important elements of normal operation belonging to safety classes 1 and 2 as well as a possibility to test them before work. Maintenance and inspection work shall be based on safe operation and maintenance technical regulations following the design safe operation conditions and limits for the plant shown in the NP SAR. The regularity and the time for the maintenance and inspections shall be either according to the current NLA including TNLA or according the project feasibility.

7.1.14 Safety systems shall function so that they perform their actions completely. The system return to its initial state shall require successive actions from its operator.

7.1.15 An NP SAR shall include the data on the reliability parameters of safety-important systems of normal operation (and their elements of safety classes 1 and 2) as well as the parameters of safety systems and elements. The reliability analysis shall account for common cause failures and personnel errors.

7.2 Active Zone Construction and Characteristics

7.2.1 The NP project shall determine the fuel element damage limits (damage number and degree) and the relevant reactor coolant radiation levels by reference isotopes in compliance with current norms and regulations for nuclear power engineering.

7.2.2 The active zone and the other systems determining its work conditions shall be designed in a way excluding FE damage above the safety limits throughout its work in the reactor. The limits cannot be violated in the following situations (with respect to the safety systems action):

– any single failures in the reactor installation control systems;

– power supply loss for main circulation pumps;

– turbogenerators and heat consumers switch off;

– total loss of any power supply of normal operation;

– reactor coolant contour leakages compensated by normal operation charge systems;

– a protective valve failure.

7.2.3 The active zone shall be designed to keep mechanically stable and to avoid deformations that disturb the work of the elements of the influence on the reactivity and emergency stop of the reactor or prevent FE from cooling; no matter, normal or abnormal operation including design basis accidents.

7.2.4 They shall try to avoid any exceeding of the total analyzed probability of severe beyond design basis accidents of 10^{-5} for a reactor a year.

7.2.5 The active zone and its every element influencing its reactivity shall be designed to avoid uncontrolled increase of the energy release in the active zone that may damage FE to a greater extend than allowed, if the reactivity is changed with regulating devices or reactivity effect under normal operations or in case of design basis and beyond design basis accidents.

7.2.6 The characteristics of nuclear fuel, the reactor structure and those of the other equipment of the first contour (including coolant purification system) accounting for the work of other systems shall not allow forming secondary critical masses in case of severe beyond design basis accidents including those with fuel meltdown.

If it is technically possible, the non-violation of the accidental release limit per 4.24 shall be provided for.

7.3 Reactor Coolant Contour

All reactor coolant contour equipment and pipelines shall be resistant to static and dynamic loads and temperature impacts on any assembly or component with no destruction (with the account for the safety systems actions and their possible failures according to 4.16) at any accounted initial event including unpurposed releases of energy to the coolant caused by:

– a sudden occurrence of the positive reactivity at a release with the maximum speed of the member impact on the maximum effective reactivity, if this release is not prevented by the construction;

– a “cold” coolant entering to the active zone (at a negative temperature reactivity factor of the coolant) or any other positive effect of reactivity related to the coolant.

7.4 Processing Control

7.4.1 General Requirements

7.4.1.1 Every NP block shall have the following to control the equipment of the normal operation and safety systems:

– BCU;

– RCU;

– NOMS;

– SMS;

– autonomous means of data registration and storage.

7.4.1.2 NP and NP SAR shall contain:

– the analysis of the control systems reaction to possible failures of management systems;

– the analysis of the control systems functioning reliability;

– the analysis of control contour stability.

7.4.2 Block Control Unit

7.4.2.1 An NP block shall have a BCU, which operative management personnel controls the equipment of the normal operation and safety systems under normal and abnormal operations including accidents.

7.4.2.2 The project shall justify the sufficiency of the measures to be taken to make a BCU function properly, to control the in any mode including design basis and beyond design basis accidents.

7.4.2.3 The design of a BCU shall include the most optimal solution for human-machine interaction system. The BCU parameters to be controlled shall be selected and reflected to be provided promptly to the personnel so that they could be sure about the compliance with the NP safe operation limits and conditions and for the purpose of the identification and diagnostics of the automatic reaction and work of the safety systems.

7.4.2.4 The design of a BCU shall include:

– control means for the process of nuclear fuel disintegration in any mode and under any condition in normal operation (including the undercritical mode during the refueling process);

– the reactivity members position indications, the automatic control of the soluble poison concentration and the indications of the status of other means of influence on reactivity;

– operator information support systems including the system of the prompt provision of the generalized information on the current status of the RI and NP safety to the personnel.

7.4.2.5 The BCU panel commands of the remote control of the technological mechanisms formed by the automatic control system or by remote control keys shall be registered automatically.

7.4.3 Reserve Control Unit

7.4.3.1 An NP block shall have an RCU.

7.4.3.2 The RCU shall perform the following functions:

– safety systems management;

– the reactor transfer to the undercritical state;

– keeping the reactor in the undercritical state;

– reactor plant heat removal;

– RI state control.

7.4.3.3 An RCU shall be independent from a BCU and provided with sufficient liveness.

Measures shall be taken to exclude common cause failures of BCU and RCU.

7.4.4 Normal Operation Management Systems

7.4.4.1 An NP block NOMS shall control technological processes in any NP block work mode with the design parameters of quality, reliability and metrological characteristics.

7.4.4.2 A NOMS shall include:

– the means of reliable of group and individual relation between BCU, RCU and operational personnel of an NP working at the place;

– the means to collect, process, document and store enough information for the timely identification of initial events, abnormal operations, accidents and their propagation, the establishment of the actual working algorithm of safety-important systems and elements belonging to safety classes 1 and 2 including deviation control systems for standard algorithms and personnel actions.

7.4.4.3 An NP block NOMS shall provide for the automatic and (or) automated diagnostics of operation states and modes including technical and software control means.

7.4.4.4 An NP block NOMS shall be constructed in a way of most favorable conditions helping the operative personnel make right solutions to control the NP and minimize the risk of wrong decisions.

7.4.4.5 An NOMS project shall contain:

– the analysis of the RI and NP block control systems to any possible failures in the systems;

– the analysis of the reliability technical and software control means functioning reliability;

– the analysis of control and regulation contours stability.

7.4.4.6 There shall be means and methods to detect the first contour coolant leakage means and methods, if the leakage is over the design value; also, if possible there shall be means and methods to locate the leakage.

7.4.4.7 There shall be the automated control of the coolant radioactivity, radioactive substances release and the radiation environment in the NP premises as well as in the SPZ and the monitoring zone when the NP is operated (including accidents) and decommissioned.

7.4.4.8 There shall be the automated control of the safe storage of nuclear fuel and radioactive wastes and the alarm to inform of the safety conditions deviation.

7.4.5 Safety Management Systems

7.4.5.1 An NP block shall have an SMS.

7.4.5.2 SMS shall work automatically in the occurrence of design conditions.

7.4.5.3 SMS shall be constructed in a way to block the personnel possibility to switch it off within 10-30 minutes after the auto-start.

7.4.5.4 SMS shall be constructed in a way to perform their actions completely. The safety system return to its initial state shall require successive actions from its operator.

7.4.5.5 They shall provide for the possibility to activate safety systems remotely and to handle fittings manually in its location place. A failure in automated switch chain shall not prevent from the remote activation and performance of safety functions. For remote and manual activation an impact on a minimal number of control elements shall be sufficient.

7.4.5.6 The design of an SMS shall minimize false responses. The remote control of safety system mechanisms shall have at least two logically bracketed actions to activate the systems (two keys, a switchboard and a key etc.).

7.4.5.7 SMS shall be independent from NOMS so that no failure or breakdown of any NOMS element of channel could affect SMS performance.

7.4.5.8 SMS shall comply with the following safety principles:

– redundancy;

– independence;

– diversity.

7.4.5.9 The redundancy, independence and diversity shall help prevent any single failures of SMS from its work disruption and help protect from common cause failures per 7.1.7.

7.4.5.10 SMS shall include:

– the uninterrupted automated diagnostics of control systems working ability;

– regular diagnostics of SMS channels and equipment health according to 7.1.11 from BCU and RCU boards.

7.4.5.11 Technical and software SMS means failures shall lead to the appearance of signal on control boards (BCU, RCU etc.) and trigger actions to guarantee the NP safety.

When it is technically impossible, SMS regular inspection methods and means shall detect violations without any deterioration of the functional readiness to act of other safety-important systems and elements of safety classes 1 and 2.

7.4.5.12 The SMS design materials shall contain the analyses in the amount similar to the requirements of 7.4.4.5.

7.4.6 Autonomous Means of Data Registration and Storage

They shall provide for the autonomous means of data registration and storage, which is necessary for accident investigations. These means shall be protected from an unauthorized access and be able to work even under the conditions of design basis and beyond design basis accident. The amount of the information to register and store is specified in an NP project.

7.5 Protection Safety Systems

7.5.1 An NP project shall provide for the safety systems of reliable emergency shutdown of the reactor and keeping it in the undercritical state in any normal or abnormal operations including design basis accidents.

7.5.2 The efficiency and quick response of the reactor emergency shut-down systems shall be sufficient to restrict the energy release to the normal operation (of design basis accident) limits for FE damage and to suppress positive reactivity resulting from any reactivity effect or a combination of reactivity effects.

7.5.3 The emergency shutdown of the reactor shall function independently from the availability of the energy source.

7.5.4 The structure of protection systems shall include emergency heat removal systems containing several independent channels and following the effectiveness requirements of 4.16 and 4.17.

7.5.5 It is possible to use cooling systems (channels) of normal operation as emergency heat removal systems (channels).

In this case, they shall comply with the requirements to safety systems.

7.5.6 There shall be measures to prevent the reactor from becoming critical and the pressure limits be exceeded in reactor coolant contour when the emergency heat removal system is on.

The activation of safety systems shall not trigger the failures of normal operation system equipment. The number of protection safety systems responses (including false ones) within the lifetime of an NP block shall be specified in the project depending on their impact of the equipment operational life.

7.6 Localization Safety Systems

7.6.1 They shall provide for the localization safety systems to keep radioactive substances and ionizing radiation within the design limits in case of an accident.

7.6.2 The reactor and NP systems and elements containing radioactive substances shall be kept in leak-tight premises to localize radioactive substances within the limits in case of design basis accidents. Also, as well as in the case of elsewhere location, it is necessary to avoid exceeding the human exposure limits and radioactive substances release limits to the environment [2], [3]. The necessity and acceptability of directed radioactive substances release in case of beyond design basis estimates shall be justified.

7.6.3 Every NP block shall have localization safety systems and the systems shall function in case of design basis and beyond design basis accident per 4.21 and 4.22.

7.6.4 In cases when they provide heat removal systems with active elements to avoid the pressure increase in leak-tight premises, there shall be several independent heat removal channels that provide the required effectiveness with the account for the requirements 4.16.

7.6.5 Every intermediate border of the leak-tight communication enclosure that can let radioactive substances outside the leak-tight premises in case of accidents shall be equipped with insulating elements.

7.6.6 An NP project shall justify the allowable limits of the enclosure leakiness and the way to reach the level. The compliance of the actual leakproofness with the design one shall be proved before the reactor is charged with nuclear fuel and also checked during the operation according to the design routine.

7.6.7 The leak-tight enclosure shall be tested during the commissioning at the design pressure, the following test are done at the pressure justified by the project. The equipment inside the leak-tight premises shall tolerate the tests without any performance loss. The NP project shall provide for the methods and technical means to test the compliance of the leak-tight enclosure with its design parameters.

7.6.8 Measures shall be provided for to prevent / detect explosive gases concentrations in localization safety systems premises.

7.7 Support Safety Systems

7.7.1 An NP project shall provide for necessary support safety systems to supply safety systems with working environment, energy and create necessary conditions for their functioning including the transfer of the heat to the terminal absorber.

7.7.2 The support safety systems shall have design functions reliability targets sufficient enough to help other safety systems function according to the design reliability targets.

7.7.3 To do the functions of 7.7.1 is an ultimate priority for the support safety systems over the action of the internal protections of the elements of these systems it leads to more serious problems for the safety; the list of the internal protections of the elements of the support safety systems that cannot be switched off shall be justified be the NP project.

7.7.4 The NP project shall provide for necessary and sufficient firefighting means including those ones for fire detection and extinguishment in the moderator and coolant. The NP project shall provide for the automated firefighting from the moment the power is supplied to the NP block equipment during the precommissioning.

7.8 Nuclear Fuel and Radioactive Waste Storage System

7.8.1 They shall provide for the storage facilities for nuclear fuel and radioactive waste at the NP. The storing capacity of the nuclear fuel facilities shall be justified with the account for the possibility of full core unloading any time.

7.8.2 The NP SAR shall contain the information about the nuclear fuel and radioactive waste handling safety guaranteeing.

7.8.3 They shall do the safety analysis for the storage facilities for normal and abnormal operations including accidents.

7.8.4 The nuclear fuel shall be handled according to the requirements of NLA including TNLA.

7.8.5 The possibility for the fresh and spent fuel to become critical when stored or moved shall be excluded be the appropriate characteristics of the facilities.

7.8.6 The spent fuel storage facilities shall have reliable residual heat removal systems to avoid any damage of the fuel and the emission of radioactive substances to the NP premises or the environment above the design limits.

7.8.7 The NP project shall provide for transportation and processing operations and special equipment to move nuclear fuel and radioactive wastes in and out.

7.8.8 The NP project shall contain the analysis of the quantity and content of solid, liquid and gas radioactive wastes and substances for the normal operation and their estimation for design basis accidents.

7.8.9 There shall be the means, places and methods of processing, short-time and long-time storage of radioactive wastes and gases, the purification barriers for the air and water to be released to the environment and the radioactive waste transportation means within the NP territory and to the storage facilities.

8 Nuclear Plant Operation Safety Guaranteeing

8.1 Operating Organization and Maintenance Documentation

8.1.1 The NP operating organization (the operator) shall establish necessary structures for the safe operation of the NP, duly authorize them, provide the NP with necessary financial, material, technical resources, NLA including TNLA and scientific and technical support, arrange the NP fire and physical protection, recruit and train the personnel, make the safety a matter of vital issue and personal responsibility of every employee and continuously monitor the NP safety.

8.1.2 The NP operator constantly controls every safety-important activity. NP safe operation inspection results and regular NP safety condition report the operator sends to the nuclear and radiation safety state regulation body.

8.1.3 The safe operation of an NP block is governed by the technical regulation of the NP safe operation that contains the rules and the main techniques of the safe operation, the general order of the safety-related operations and the safe operation limits and conditions.

8.1.4 The NP operator has the technical regulation of the NP safe operation worked out with the involvement of NP and RI designers according to the NP project and NP SAR, also the operator includes into the regulation the documents to be provided to the nuclear and radiation safety state regulation body to obtain the operational license.

Every alteration to be introduced to the technical regulation shall be discussed in the prescribed manner with its developers and approved.

8.1.5 The NP operator, on the basis of the technical regulation of the NP safe operation and the equipment developers' and the NP designer's documentation, shall have the operational instructions developed before the precommissioning begins.

8.1.6 The operational instructions of the equipment and the systems shall contain the specific guidance for the personnel how to work under normal and abnormal operations including pre-emergencies and emergencies.

8.1.7 The operational instructions shall be adjusted according to the NP commissioning results.

8.1.8 The operator, based on the technical regulation of the NP safe operation and NP SAR, has the safety instructions and manuals for the personnel worked out and issued to follow in case of design basis and beyond design basis accidents.

8.1.9 The personnel's actions following the instructions and manuals shall be based on the signs of happening events, reactor installation conditions and possible accident propagation conditions change forecasts. The forecast-based actions shall be aimed to restore the crucial safety functions and to limit the radiation consequences of accidents.

8.1.10 To keep the safety systems in good health and to avoid dangerous failures in the safety-important systems they shall undergo maintenance, repairs, tests and checks.

The above-mentioned types of work are done in compliance with the appropriate instructions, programs and schedules developed by the NPO based on the design requirements and the technical regulation; this work shall be thoroughly documented.

8.1.11 When the safety systems are being prepared for maintenance, repairs, tests and checks the safety conditions specified by the technical regulation shall be observed.

8.1.12 There shall be measures to prevent any unauthorized alteration introduction to SMS circuits, devices and algorithms.

8.1.13 After the maintenance safety systems and their elements shall be checked with respect to their performance and compliance with the design characteristics; the inspection results shall be documented.

8.1.14 The procedure of the storage, work and review of the maintenance documentation is specified by the NPO according to the requirements of NLA including TNLA.

8.1.15 The NP project, its construction documents, test certificates and maintenance execution and repair documents for safety and safety-important systems and elements of safety classes 1 and 2 shall be kept at the NP as long as it works.

8.1.16 The documented data on safe operation limits and conditions control shall be kept at the NP during three campaigns between refuelings or within five years. Before the records are destroyed they shall be included into the periodical reports of the NPO on the NP safety.

8.1.17 NP failure and accident investigation results shall be kept at the NP as long as it works.

8.1.18 An NP block shall be shut down, if its design safe operation limits and condition cannot be complied with when the reactor works.

8.1.19 Any tests at an NP power block unspecified by the technical regulation of the NP safe operation and the operational instructions shall comply with the programs and techniques providing safety measures for these tests.

Test programs and techniques shall be approved by the NP project developers and the NPO. The tests are allowed by the nuclear and radiation safety state regulation body in compliance with the movement from one work stage to another as specified in the license; the NP operator does the tests.

8.1.20 Any violations of the safe operation limits and conditions, including accidents shall be properly investigated by committees acting according to the current NLA including TNLA. The responsibility for the development and implementation of the measures to prevent the same violations of the safe operation limits and conditions belongs to the NP operator.

8.1.21 The operator shall send in the prescribed manner the reports on the NP work abnormalities to the nuclear and radiation safety state regulation body.

8.1.22 The representatives of safety regulating authorities shall have an unimpeded access to the work documents containing the information on the revealed violations and abnormalities.

8.1.23 Before the NP commissioning and then following the regularity specified by the project, NLA including TNLA they shall check the working ability of safety and safety-important systems, management systems, safety-important component metal and welds health.

8.1.24 The frequency and the amount of regular inspections shall be reflected by the schedules developed by the NPO.

These schedules shall comply with the requirements of NLA including TNLA and depend on the part certain systems or elements play in the NP safety guaranteeing with the account for the numerical reliability analysis of the systems and elements.

8.1.25 Upon the request of the nuclear and radiation safety state regulation body they can carry out out-of-sequence inspections of the safety systems performance.

8.1.26 During the NP working life the NP operator shall arrange for the collection, processing, systematization and storage of the data on safety-important system elements failures and wrong actions of the personnel as well as submit this information to any organizations concerned including the NP and RI designers according to the established procedure.

8.1.27 Having determined the remaining life expectancy of the equipment and following other safety feasibility studies, the operator may ask to prolong the operational life of an NP block. In this case, a new license shall be issued to operate the NP block in a prescribed manner.

8.2 Commissioning

8.2.1 An NP project shall describe the requirements to the sequence and the amount of the precommissioning work and that of the physical launch and the reactor power start-up, as well as specify the acceptance criteria for the NP equipment and systems to be commissioned.

8.2.2 The operator is responsible for the development and the implementation of the NP commissioning program. The nuclear and radiation safety state regulation body in the process of the licensing shall approve the program.

8.2.3 The precommissioning, the physical launch, the reactor power start-up and the low power testing shall confirm that the whole NP and its safety-important systems and elements are made and function in compliance with the project and that the detected drawbacks have been eliminated.

8.2.4 The NP operator arranges for the development of and the coordination with the RI and NP designers the programs of the precommissioning, the physical launch and the reactor power start-up. The programs shall be approved by the operator and sent to the nuclear power engineering state regulation bodies and agencies.

8.2.5 The documents that govern the procedure of the precommissioning, the physical launch, the reactor power start-up and the pilot work shall list nuclear-hazardous operations and accident prevention measures.

8.2.6 When they carry out the commissioning program they shall determine and record the characteristics of safety-important systems (element) verify the performance characteristics of systems and equipment and the safe operation limits and conditions to reflect the actual characteristics of systems and equipment.

The appropriate testing programs specify the list of the parameters to be documented.

8.2.7 After the pilot work is over, an NP block undergoes the commissioning. The commissioning is carried out according to the established procedure following the demands of this technical code and other NLA including TNLA.

8.2.8 An NP block after being constructed and during its commissioning shall be isolated from other acting blocks and from the structures under construction to avoid any impact from work or a failure on its safety; should there be an accident in an acting block, the block under the commissioning shall be secured from it.

8.2.9 The nuclear and radiation safety state regulation body issues the license to the NPO for the operation of the NP block after the precommissioning is done properly and the final edition of the NP SAR is available (NP SAR final edition draft – before the first batch of the nuclear fuel arrives to the site, the complete final edition – after the pilot work is over); the NP SAR shall be corrected following the results of the precommissioning, the physical launch, the reactor power start-up and the pilot work and the approval of other safety regulation authorities.

8.2.10 The first arrival of the nuclear fuel, the NP block physical launch, the reactor power start-up and the pilot work are allowed by the nuclear and radiation safety state regulation body according to the sequence of work stages set by the operational license after the NP readiness to be commissioned is checked, other safety regulation authorities give their consent and the human protection plans are available for the case of an NP accident.

8.3 Personnel Recruiting and Training

8.3.1 An NP shall have duly qualified and properly authorized personnel before any nuclear fuel arrives.

8.3.2 The operational personnel are not allowed to do certain jobs unless they have the permissions issued by the nuclear and radiation safety state regulation body.

8.3.3 The list of NP position holders to obtain the permissions to work issued by the nuclear and radiation safety state regulation body is specified by the Government of the Republic of Belarus.

8.3.4 The qualification requirements to the workers that need the permissions are described in special Job Evaluation Catalogues of Posts of Top Managers and Experts approved by the nuclear and radiation safety state regulation body and by the Ministry of Labour and Social Protection of the Republic of Belarus.

The qualification requirements to the rest of the NP personnel are set by the NPO.

8.3.5 The recruiting, training, admitting to work and qualification upgrading of the operational personnel is the job of the NPO. The NP personnel recruiting and training system shall be aimed at the achievement and the maintenance of the right qualification level allowing them to operate the NP safely in every mode and to take actions to eliminate the accident consequences, if it happens. Forming the safety culture of the personnel shall be an integral element of the training.

8.3.6 The personnel training system shall include technical means of education to form working skills including different duly approved simulators. Special attention shall be paid to the drill of actions and interactions related to possible NP work abnormalities (including accidents) and the account for the former errors and accidents.

8.3.7 The NP training center shall begin to work before the physical launch of the reactor.

8.3.8 Before the personnel are allowed to work on their own and from time to time in the future they shall undergo the medical check-up. The health of the personnel shall allow them to perform their jobs reliably and safely.

8.4 Radiation Safety in Operation

8.4.1 The human radiation safety in operation is guaranteed by the compliance with the current NLA and TNLA related to the nuclear and radiation safety.

8.4.2 The NP project shall provide for the control system for the integrity of the physical barriers on the way of the ionizing radiation and radioactive substances to the environment; this system shall help control any deviation from the NP safe operation limits.

8.4.3 The NP project shall provide for the radiation control system to measure the parameters characterizing the radiation situation in the NP and in the environment in certain amounts in every NP work mode as well as in case of design basis and beyond design basis accidents.

8.4.4 The NP project shall provide for the continuous changes of ionizing radiation rates, wind speed and other meteorological parameters in the SPZ and the monitoring zone as well as the periodical changes of the density of radioactive fallouts to estimate the radiation impact on the environment of the NP normal and abnormal operations including design basis and beyond design basis accidents. There shall be technical means for these estimations and forecasts.

8.4.5 The NP administration organizes the strict control of the exposure of the NP personnel other the workers of other companies involved in the maintenance of the NP systems and elements as well as the preparation and implementation of the measures to reduce the personnel exposure to a reasonably achievable limit.

8.4.6 The NP administration organizes the strict control of the nuclear materials, radioactive substances and wastes including fresh and spent fuel, dismounted radioactive equipment, contaminated tools and clothes, production wastes and other sources of ionizing radiation.

8.5 Plans of Measures to Protect Personnel and Population in Case of Accident and Accident Management

8.5.1 Before the nuclear fuel arrives to the NP plans of human protection measures shall be worked out and ready for use in case of an accident; these plans shall account for the radiation consequences of accidents. The plans are based on the NP design characteristics and parameters, the criteria to take human protection measures with due account for economic, natural and other specific features of the area and the emergency hazard degree.

8.5.2 Before the nuclear fuel arrives to the NP the main and backup communication means shall be enabled to get connected with the superior organization, safety regulation authorities and permanent regulatory body authorized to solve the problems of the protection of humans and the environment from emergencies and acting under the auspices of local administrations.

8.5.3 The developed plans of human protection measures shall be duly approved and provided for.

8.5.4 The plan of the measures to protect the personnel in case of an accident at the NP shall be worked out by the NP operator. It shall provide for the coordination of the actions of the NP workers with those of other organizations such as the police, public fire service, the authorities dealing with civil defense and emergency situations, medical establishments and local administrations within the site area and the protective measure planning zone. The NP administration is responsible for the permanent readiness and for the implementation of the plan.

8.5.5 The plan of the measures to protect the population from an NP accident developed properly by the competent authorities of the executive power with the provision for the coordination of the actions of local authorities dealing with civil defense and emergency situations, local administrations, ministries and departments that take part in the actions to protect the population and eliminate the consequences of an accident.

8.5.6 The plans of the measures of the protection of the personnel and the population from an NP accident shall clearly specify the emergency preparedness and emergency action levels, distribute the alarm call responsibilities: who calls, when calls, what communication means are to be used, which organizations are to be informed of the accident and the implementation of the plans. The plans shall provide for the necessary implementation equipment and means; they shall contain the information on their suppliers and origin.

8.5.7 Before the nuclear fuel arrives to the NP, they shall create an emergency center in Minsk and keep it ready permanently; this center shall be equipped with necessary equipment, devices and communication means to supervise the implementation of the plans described in 8.5.4 and 8.5.5, if an accident occurs.

8.5.8 The aim of the control of a beyond design basis accident is to restore the control of the NP block, to stop the chain reaction, to provide for uninterrupted cooling of the fuel and to keep radioactive substances within the design limits.

8.5.9 The NP personnel shall be ready to act in case of design basis and beyond design basis accidents.

8.5.10 The personnel's actions shall be governed by special instructions which shall be developed according to 8.1.8 and 8.1.9 with the account for the analyses of design basis and beyond design basis accidents.

8.5.11 To make the personnel ready to act in an emergency situation there shall be emergency response exercises on a periodical basis.

8.5.12 The operator shall work out the procedures and programs of the preparation and the realization of emergency response exercises to drill the actions under emergencies; also the operator organizes the emergency response exercises holding.

8.6 Nuclear Plant Decommissioning

8.6.1 The decommissioning of the NP (or its block) shall be accounted for at the stages of designing, operating, maintaining and repairing.

8.6.2 The operator shall work out the decommissioning program for an NP block not later than 5 years before the expiration of its service life; this program shall be submitted to the nuclear and radiation safety state regulation body to make the appropriate changes to the NP block operation license in a prescribed manner.

8.6.3 Before the decommissioning begins, a special committee appointed by the NPO shall carry out a complex examination of the NP block.

8.6.4 Based on the results of the complex examination the NPO has the NP block decommissioning project developed and makes a decommissioning feasibility report for the block to get the NP decommissioning license from the nuclear and radiation safety state regulation body.

8.6.5 The NP block to be decommissioned is considered as operated before the spent fuel is removed from it. During this period the requirements to the personnel, documentation and everything else are the same as to an operated NP block.

8.6.6 The reduction of the maintenance, the decommissioning of individual systems and elements, the personnel layoff shall be made in compliance with the duly introduced changes to the operational license conditions.

8.6.7 Any unscheduled decommissioning of an NP block shall be carried out according to the requirements of 8.6.3–8.6.6.

Reference List

[1] Law of the Republic of Belarus *On the Nuclear Energy Use* of July 30, 2008 No 426-3

[2] Hygienic Norms GN 2.6.1.8-127-2000 Radiation Safety Standards (NRB-2000)
Approved by order of Chief State Medical Officer of the Republic of Belarus of January 25, 2000 No 5

[3] Sanitary Rules and Regulations SanPiN 2.6.1.8-8-2002 The Main Sanitary Rules of the Radiation Safety Guaranteeing (OSP-2002)
Approved by order of Chief State Medical Officer of the Republic of Belarus of February 22, 2002 No 6

[4] Regulation of the Council of Ministers of the Republic of Belarus *On the Approval of Charter of the Ministry of Energy of the Republic of Belarus* of October 31, 2001 No 1595

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