REGULATION ON ENSURING THE SAFETY OF RESEARCH NUCLEAR INSTALLATIONS

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Chapter One
GENERAL PROVISIONS

Art. 1. (1) The current regulation defines the basic requirements for ensuring of nuclear safety and radiation protection of research nuclear installations (RNI), resulting from their specificity as a source of possible radiological impact on personnel, population and environment.

(2) The regulation also defines the administrative provisions and the technical requirements for ensuring safety during the stages of site selection, design, construction, commissioning and operation of RNI.

(3) The terms and order for decommissioning of RNI are established in the Regulation for the safety of the decommissioning of nuclear facilities, adopted with CM Decree № 204 of 2004 (SG, issue 73 of 2004).

Art. 2 (1) The regulation is applied to RNI, which include heterogeneous research reactors (RR) having power not greater than 10 MW, including critical or sub-critical assembly, to experimental devices and to all other facilities, systems and premises, associated with the RR, and situated within the site area.

(2) In the sense of the Regulation the RR is a device, designed for self-sustained nuclear controlled chain reaction for generation and use of neutron flux and ionizing radiation for research, training or experimental purposes.

(3) The regulation is not applicable to RR of fast neutrons and sources of cold and hot neutrons.

Art. 3. The radiological impact of a research nuclear installation in all operational states shall be kept below the statutory prescribed dose limits of the personnel and population and at a reasonably achievable low level, and in case of any accident, including those of very low frequency of occurrence, the radiation consequences shall be mitigated.

Art. 4. (1) The RNI safety shall be ensured through consistently applying the defence in depth concept based on the use of a system of physical barriers to the release pathways of ionising radiation and radioactive substances to the environment, as well as on a system of technical and organizational measures to protect the barriers and retain their effectiveness and to protect the population, the personnel and the environment.

(2) The defence in depth concept shall be aimed at retaining the main safety features:

1. power control;
2. fuel cooling;
3. confinement of radioactive substances.

Art. 5. (1) The number and the function of the RNI physical barriers shall be determined in the design. The sufficiency of the defence-in-depth physical barriers and the technical and organisational measures shall be substantiated in the design.

(2) Damage of any physical barrier shall not cause damage to another physical barrier.

Art. 6. (1) The system of technical and organizational measures shall include the following levels of defence in depth:

1. first level – prevention of anticipated operational occurrences:

a) evaluation and selection of an appropriate site;

b) identification of the radiation protection area and the monitored area around the RNI for conducting the control needed for radiation protection purposes and for implementation of planned protective measures;

c) development of a RNI design, based on a conservative approach and providing for inherent safety features of the reactor installation;

d) ensuring the necessary quality of RNI structures, systems and components (SSCs) and of all activities that are being carried out;
e) operation of the RNI in compliance with the respective legislative requirements, the operational limits and conditions, and the operating instructions;
f) maintaining the operability of SSCs important to safety through timely failure detection, implementation of preventive measures, replacement of structures and components with spent lifetime, and establishment of an effective system for documentation of the results of the activities carried out and of related operational supervision;
g) staff selection and providing the RNI personnel with the necessary qualification and safety culture enabling them to take actions in all operational states and in accident conditions;

2. second level – prevention of design basis accidents by the systems for normal operation:

a) detection of the deviations from the normal operation and coping with them;

b) operation with deviations;

3. third level – prevention of beyond design basis accidents by the safety systems:

a) prevention of progression of initiating events into design basis accidents and design basis accidents into beyond design basis accidents by the use of safety systems;

b) mitigation of consequences from non-prevented accidents by localization of the radioactive substances released;

4. fourth level – management of beyond design basis accidents:

a) prevention of beyond design basis accidents progression and mitigation of their consequences;

b) RNI recovery in a safe stable state with termination of the fission process, ensuring of necessary fuel cooling and confinement of radioactive substances within the established boundaries;

5. fifth level – development and implementation of on-site and off-site emergency plans.

(2) The defence in depth concept shall be applied at all stages of RNI safety related activities. Measures to prevent adverse events at the first and second levels of defence shall have priority over other measures related to ensuring safety.

Chapter Two
DESIGN BASIS AND SAFETY ASSESSMENT
Section I
Design Basis

Art. 7. The design basis shall specify the necessary features and capabilities of the RNI to prevent exceeding of the statutory prescribed limits for exposure of personnel and population, and the limits for release of radioactive substances into the environment in all operational states and design basis accidents. The design basis shall include design limits, plant operational states, safety classification of SSCs, important assumptions within the design process, and in individual cases, special methods of analysis.

Art. 8. (1) The design shall be based on the defence in depth concept under art. 4 (1) and shall prevent, to the extent practically achievable:

1. the circumstances causing damage of the physical barrier integrity;

2. the failure of a physical barrier in case of occurrence of the circumstances under point 1;

3. the failure of a physical barrier as a consequence of a failure of some another physical barrier.

(2) The RNI shall be capable of performing the basic safety functions under art. 4 (2) in all operational states and design basis accidents.

(3) The design technical solutions, technologies and procedures shall be defined and justified in compliance with the achievements of science and technology and with the internationally acknowledged operational experience.

Art. 9. The design limits shall at least include:

1. radiological and other technical acceptance criteria for all operational states and accident conditions;

2. criteria on protection of physical barriers;

3. criteria on using of experimental devices.

Art. 10. (1) For all RNI operational states, the annual individual effective dose of the population, received from exposure as a result of liquid and gaseous releases into the environment from all nuclear facilities situated on-site, shall not exceed 0.1 mSv.

(2) The annual individual effective dose of the population at the boundary of the radiation protection area and outside it shall not exceed 5 mSv over the first year following a design basis accident.

(3) The frequency of radioactive releases into the environment that require undertaking of immediate protective measures for the population shall not exceed 1.10^{-7} events per reactor per year.

Art. 11. (1) Initiating events for design basis accidents shall be defined in the design to identify the boundary conditions, according to which the SSCs important to safety shall be designed, manufactured and installed. A typical list of initiating events that shall be considered in safety analysis is included in Annex 1.

(2) The design shall consider the external events typical for the RNI site according to Annex 1. The selection of postulated initiating events shall be based on the use of both deterministic and probabilistic methods or a combination of them. The following groups of initiating events shall be considered:

1. all types of loss of reactor coolant caused by break of pipelines, experimental or other irradiation devices connected with the reactor pressure vessel;

2. all possible operational transient states;

3. possible human errors;

4. all external events considered in the design;

5. fire, explosion and flooding having internal origin;

6. combination of possible internal and external events, based on best estimated assumptions.

(3) The design shall also consider accidents in reactor shutdown state, start-up, refuelling and repair, operation with experimental and other irradiation devices.

Art.12. (1) In addition to the design basis, RNI performance in beyond design basis accidents shall be assessed. Different methods may be used, based on combination of expert judgements and probabilistic methods applying best-estimated assumptions.

(2) The list of beyond design basis accidents shall include the following accidents, if not prevented by the reactor inherent safety features and its structure: total loss of on-site and off-site power; anticipated transients without scram; loss of ultimate heat sink and long term unavailability of safety systems after a postulated initiating event requiring their availability.

(3) If the analysis of severe accident consequences does not confirm the implementation of the criteria under Art. 10, para. 3, the design shall consider additional technical measures for severe accident management aimed at mitigation of the consequences.

Art. 13. All NRI SSCs important for safety, including control system software, shall be identified and classified in safety classes. They shall be designed, constructed, mantled, tested, operated and maintained such that their quality, including their reliability, is commensurate with a classification plan.

Art. 14. Research nuclear installations shall be classified according to their main features and functions performed. The classification is determined in the design of the RR and it is commensurate with the power of the installation, the mass and characteristics of the fissile material, the energy of fluids, the requirement for availability of barriers and their protection in compliance with the defence in depth concept.

Art. 15. Research nuclear installations hall be classified in the following groups:

1. group I: research nuclear installations for which an availability of special fuel cooling systems in accident conditions and systems for long term residual heat removal is not required, for which releases of radioactive substances beyond the barriers stipulated in the design is possible only in case of direct impact on reactor components, caused by different internal and external events;

2. group II: research nuclear installations having greater power and/or operating at higher thermotechnical parameters of coolant for which special safety systems and systems for residual heat removal shall be stipulated in the design to prevent nuclear fuel damage and release of radioactive substances to the environment beyond the authorised limits.

Art. 16. RNI systems and equipment shall be classified according to their importance for safety in the following classes:

1. class “A” – RNI systems which could be determined as important to safety if:

a) their failure lead to radiation exposure of personnel and/or population greater than the established limits in the conditions of normal operation;

b) prevent stipulated by the design operational events leading to accident conditions;

c) perform functions to mitigate the consequences of SSC’ failures;

2. class “B” – all RNI systems, not included under point 1.

Art. 17. The systems and elements of class “A”, according to the functions performed, shall be subdivided in categories, as follows:

1. category 1: RNI elements, the failure of which are initiating events of beyond design basis accidents, as well as elements the failure of which lead to exceeding of the established limits for design basis accidents;

2. category 2: systems and elements, the failure of which is an initiating event, leading to exceeding of the established limits for normal operation, but within the limits established for design basis accidents; the elements which failure lead to failure to perform safety functions are included in this category as well;

3. category 3:

a) structures, systems and components important to safety, not included in categories 1 and 2, as well as systems and elements the failure of which lead to exceeding of the established levels of impact of ionizing radiation on personnel and population during normal operation;

b) systems and elements designed for radiation monitoring and radiation protection.

Art. 18 (1) The classification shall identify for SSCs of safety class “A” for the different groups:

1. the appropriate standards for design, manufacturing, construction and inspection;

2. the degree of redundancy, need for emergency power supply, qualification for operation in specified operational states and accident conditions;

3. the availability or unavailability status of SSCs that shall be considered in the deterministic safety analysis;

4. the quality assurance provisions.

(2) The SSCs included in class “B” shall be designed according to the requirements of the common industrial norms and standards, specified in the design.

Art. 19. (1) Structures, systems and components, included in safety class “A” , shall withstand the conditions of postulated initiating events.

(2) To identify the cases, where application of the principles of diversity, redundancy and independence is needed to achieve the necessary reliability, the potential for common cause failures shall be analysed and considered in the design.

(3) The failure of a SSC belonging to a certain safety class shall not cause a failure of another SSC in a higher safety class. The auxiliary systems, supporting SSCs important to safety, shall be classified in the same safety class.

Art. 20. Qualification procedures of safety important SSCs shall be specified in the RNI design to secure fulfilment of assigned functions throughout their operating lifetime, taking into account possible impacts and environmental conditions, which may be expected in all operational states and in design basis accidents (vibration, temperature, pressure, jet impingement, electromagnetic interference, aging, irradiation, humidity and probable combination thereof).

Section II
Safety Management

Art. 21. The operating organisation shall bear the full responsibility of ensuring safety, during all stages in the lifetime of the RNI - site selection, design, construction, commissioning and operation, including the implementation of modifications of structures, systems and equipment, and decommissioning.

Art. 22. (1) Conditions shall be provided for the personnel implementing the activities under para. 1 for development of safety culture: to conduct an appropriate personnel selection, training and qualification process for any activity; to strictly follow the discipline having clear allocation of personal responsibilities; to develop and strictly adhere to the requirements of operative instructions for implementing the activities, and periodically update them considering own and internationally recognised operating experience.

(2) The personnel under para. 1 shall be well-acquainted with the nature and magnitude of the impact that the activity they perform may cause on nuclear safety and radiation protection, and the possible consequences from violation or not full compliance with the requirements set by the legislative acts and the instructions.

Art. 23 (1) The operating organisation of a RNI shall develop, implement and maintain a quality management system (QMS) at all stages of the lifetime of RNI, including for supervision of the activities of the entities working or providing services.

(2) The entities that perform work or provide services related to safety of RNI shall develop and implement quality management programs for the corresponding type of activity in compliance with the QMS of the operating organization.

Art. 24. (1) The operating organization shall ensure safety, including implementation of measures for accident prevention and mitigation of their consequences, for accounting and control of nuclear material, for physical protection of the RNI and nuclear material, for radiation monitoring of the environment within the radiation protection area and the monitored area.

(2) The operating organization bears the full responsibility of ensuring safety, including when other entities implement activities or provide services to the RNI, as well as in relation to the activities of the specialized regulatory authorities in the fields of nuclear energy and ionising radiation.

Section III
Safety Assessment

Art. 25. To assess safety of the RNI the operating organization shall develop safety analysis report (SAR) having scope and content in compliance with the Regulation for the procedure for issuing licences and permits for safe use of nuclear energy adopted with Decree № 93 of the Council of ministers of 2004 (SG issue 41 of 2004), to the extent applicable to a certain case. The report shall contain also data of the operating history of the RNI, if any, of the modification during the operation of the RNI, as well as of conducted and planned experimental activity or other activity.

Art. 26. (1) Safety shall be analysed using deterministic methods applied in an adequately conservative way based on selection of initiating events and comparison of the results against specified acceptance criteria to confirm the established design basis and the effectiveness of defence in depth arrangements.

(2) The deterministic methods could be complemented by probabilistic methods to get more integral assessment of the interdependence of all SSCs and more accurate risk assessment.

(3) Computer codes, analytical methods and models to be used in the safety analysis shall be verified and validated. Uncertainty of the results shall be quantified.

Art. 27. (1) Deterministic safety analysis shall include:

1. confirmation of the compliance of operational limits and conditions with the design assumptions for normal operation;

2. identification of the postulated initiating events characteristics;

3. analysis and assessment of postulated initiating events’ progression;

4. comparison of analysis results against the radiological acceptance criteria and the design limits;

5. identification and confirmation of the design basis;

6. substantiation of capabilities to manage all anticipated operational occurrences and design basis accidents.

(2) Applicability of analytical methods and degree of conservatism used shall be verified in the design. In the analysis of safety:

1. initial and boundary conditions shall be specified in a conservative way;

2. single failure criteria shall be applied for the systems of class “A”, in addition, any undetected failures challenging the safety limits shall be considered;

3. the systems of class “B”, including the external power supply, shall be considered available only if their functioning has an adverse effect on the consequences of an initiating event;

4. any failure, occurring as a consequence of an initiating event shall be included in the analysis;

5. impact of the uncertainties, that significantly influence the end results, shall be considered.

Art. 28. Probabilistic safety analysis shall be carried out with the objective to:

1. systematically analyse the compliance with the basic safety criteria;

2. demonstrate a balanced design where each initiating event considered has a proportional impact upon the overall risk and the safety is ensured mainly by the first two levels of defence in depth;

3. provide confidence that any impact of small deviations in operational parameters is prevented, when this could lead to aggravation of RNI behaviour;

4. assess the probabilities of large radioactive releases to the environment, requiring short-term protective measures outside the RNI site;

5. evaluate the frequencies of the external events specific to the site;

6. identify SSCs that require design improvements or changes in operational procedures, leading to decrease of severe accident frequency or mitigation of their consequences.

Art. 29. The design basis, the technical and organizational measures providing the implementation of the defence in depth concept and the safety assessment shall be documented in preliminary, intermediate and final safety analysis report at the different stages of the authorization process under the Act on the Safe Use of Nuclear Energy (ASUNE).

Chapter Three
SITE CHARACTERISTICS

Art. 30. Suitability of a site for hosting of a RNI shall be evaluated in the following aspects:

1. effects of external events, natural phenomena or human induces events which may occur in the site area;

2. characteristics of the environment of the site and around it, which can influence the transference of radioactive substances to the people;

3. density and distribution of population and other demographic characteristics of the site area associated with the hazard assessment for the individuals and the population, and necessary for planning of accident measures;

4. presence of other nuclear facilities within the site area;

5. presence of ultimate heat sink and its type.

Art. 31. The factors that shall be investigated, criteria and requirements for site selection are included in Annex 2.

Art. 32. The impact of the ionising radiation shall be analysed with account taken of the specific characteristics of the design of the reactor installation and its safety features.

Art. 33. The analyses performed shall consider prognoses of the social and economic development of the site region.

Art. 34. Site characteristics which have an impact on the RNI safety aspects, and the natural characteristics of the region which may be influenced by the potential effects of ionising radiation during all operational and accident conditions shall be monitored and registered during all stages of RNI lifetime.

Chapter Four
DESIGN
Section I
General Requirements

Art. 35. (1) The design shall provide for maintenance of directly controlled parameters of the RNI within the boundaries ensuring the integrity of the physical barriers.

(2) The design shall consider the impact on the RNI of all facilities and structures connected with it or situated at the same site.

(3) Deviation limits of controlled parameters, determined, as operational limits shall be specified in the design on the base of the RR characteristics, the structural materials used and the technical solutions.

Art. 36 (1) Safety limits may not be determined for a RNI of group I if it is demonstrated in the design that the possibility of occurrence of an accident leading to reactor core melt is inconsiderably small or the volume of radioactive substances released in case of accident is so low that the exposure of the population will not exceed the limits specified under Art. 10.

(2) Safety limits for a RNI of group II shall be specified with account taken of the main physical conditions, determined on the base of neutron-physical and thermotechnical parameters that influence the integrity of physical barriers.

(3) In case found necessary to specify safety limits, without reference to fulfillment of the requirements under para. 1, they may be determined with the view to maximum permissible temperature of nuclear fuel, above which structure degradation and melting begin.

Art. 37. (1) The design shall be developed in compliance with the single failure principle of all systems, ensuring performance of the functions under Art. 4, para. 2.

(2) The necessity of systems performing safety functions shall be determined depending on the type and characteristics of the RNI.

(3) The systems performing safety functions can perform functions of normal operation as well, but the safety functions shall have priority.

Art. 38. (1) Beside with the principle of single failure the design shall consider, in case necessary, the requirements of diversity, redundancy and independence of SSCs.

(2) The design shall be developed in a way that the RNI safety inherent features are implements to maximum extent, with account taken of its type and characteristics, so that in case of SSCs' failure the reactor can reach a stable state without necessity to undertake actions.

Art. 39. The design of the systems, performing safety functions, shall be developed in a way to ensure good conditions for their periodical control, tests and maintenance.

Art. 40. Failure of a system regardless of its importance to safety shall not influence reactor safety. Adequate measures shall be provided to prevent radioactive releases to the environment in case of system failure.

Section II
Reactor Core

Art. 41. (1) Reactor core and research reactor reflector, associated reactor coolant system, reactor control and protection safety systems shall be designed with appropriate safety margins to ensure that the specified design limits for fuel damage are not exceeded in all operational states and design basis accidents with account taken of:

1. design operating modes and their passing;
2. thermal, mechanical and irradiation degradation of core components;
3. physico-chemical interaction of core materials;
4. limiting values of thermo-hydraulic parameters;
5. vibrations and thermal cycles, material fatigue and aging;
6. impact of coolant additives and radioactive fission products on the corrosion of fuel claddings;
7. irradiation and other impacts that deteriorate mechanical characteristics of core materials and fuel cladding integrity.

(2) Design shall specify the limits for damage of fuel elements - in terms of amount and degree) and the associated coolant radioactivity according to reference isotopes.

(3) Reactor core and reflector shall be designed to secure partial loading of nuclear materials for all stipulated configurations of reactor core and operating schedules, and their structure shall exclude unforeseen changes in geometry and composition.

Art. 42. To ensure safe shutdown of the reactor, to maintain the reactor subcritical and to ensure core cooling /heat removal, the reactor core and associated internal components located within the reactor vessel shall be designed and mounted in such a way as to withstand the static and dynamic loads expected in all operation states, design basis accidents and impacts considered in the design.

Art. 43. (1) Reactor core, reflector and its elements that affect reactivity shall be designed in a way that any reactivity change caused by the control rods as well as reactivity effects shall not lead to uncontrolled increase of core heat release and cause damage of fuel and other research reactor components, that exceeds the specified design limits and shall not cause any damage to reactor coolant pressure boundary in all operational states and design basis accidents. The design shall specify the conditions for possible fuel melting in beyond design basis accidents.

(2) The values of the reactivity coefficients shall be negative within the whole range of the reactor coolant system parameters for all operational states and design basis accidents.

(3) Possibilities for recriticality and reactivity excursions following postulated initiating events shall be minimized.

Art. 44. Reactor core and associated coolant, control and protection systems shall be designed to enable adequate inspection and testing throughout the service lifetime of the RR.

Section III

Control and management

Art. 45. (1) The Main Control Room (MCR) of a RR shall provide possibilities to control and monitor the reactor and to undertake measures to maintain it in a safe state or recover such state if needed in all operational states and design basis accidents.

(2) Design shall demonstrate the sufficiency of the arrangements made to secure MCR personnel health and availability, as well as proper functioning of the MCR, in all operational states, design basis and beyond design basis accidents.

(3) Layout of instrumentation and control devices and the way of presenting the information shall be such that the operating staff at the MCR be able to clearly and quickly identify RR status and behaviour, adherence to the operational limits and conditions, identification and diagnosis of the safety system automatic actuation and operation.

(4) MCR design shall provide for:

1. instrumentation to control the fission process, in all core states and conditions in normal operation, including in subcritical state during refuelling;

2. position indicators of the reactivity control devices, and status indicators of all means for reactivity control;

3. a system for information support to the operators;

(5) The changes in normal operation conditions, which may affect safety, shall be accompanied by audible and visible indication.

Art. 46. (1) The Supplementary Control Room (SCR) shall enable the following functions:

1. control of the safety systems;

2. render and maintain the reactor subcritical;

3. heat removal from the reactor core;

4. control of the status of the reactor installation.

(2) Any possibility of parallel actuation of control components, from the MCR and the SCR, as well as of failure of the control circuits of both MCR and SCR due to a common cause, in all postulated initiating events shall be eliminated by technical means.

(3) SCR shall be designed to be easily accessible from MCR and to protect the personnel in all conditions resulting from internal and external events and design basis accidents.

Art. 47. The design shall provide means for control of coolant parameters taking account of changes in the coolant volume and leakage of coolant in all operational states.

Art. 48. (1) Control systems for normal operation shall control and regulate the technological processes, in all operational states, in conformity with the design specified indicators for quality, reliability and metrological characteristics, and shall encompass:

1. means for collecting, treating, documenting and storing of information, which to be sufficient for timely and unambiguous identification of the initiating events for anticipated operational occurrences and accidents, their progression, factual algorithms of operation of the safety systems and the components, which failures are initiating events for design basis and beyond design basis accidents, deviations from the design algorithms and personnel actions;

2. means for automatic control of reactor coolant activity, liquid and gaseous effluents to the environment, and radiation monitoring of RNI compartments, and radiation protection and monitored areas, in all operational states and design basis accidents;

3. means for automatic control of the conditions for safe storing of nuclear fuel and radioactive waste (RAO), and for signalization in case these conditions are violated;

4. means and methods for identification of the locations and quantities of reactor coolant leakages;

5. means for reliable group and individual communications between the MCR, SCR and field operators.

(2) In the design of computer based control systems:

1. special standards and proven practices shall be used in development and verification of the hardware, and especially of the software;

2. development and verification process shall be conducted in compliance with a quality assurance program;

3. level of reliability assumed in the safety analysis shall include a specified conservatism to compensate for the inherent complexity of the technology.

Art. 49. (1) Control safety systems shall be designed to:

1. initiate automatically the operation of appropriate systems, including systems for reactor shutdown, in order to ensure that specified design limits are not exceeded as a result of anticipated operational occurrences;

2. detect the symptoms for design basis accidents and automatically actuate other safety systems necessary to limit the consequences within the design basis;

3. be capable of overriding unsafe actions of the control systems for normal operation.

(2) Design shall provide possibilities for remote actuation of the safety systems and manual actuation of the isolation components at their location. A failure in automatic actuation circuits shall not impede the remote actuation and the implementation of the safety functions. For remote and manual actuation, the operation of a minimum number of control components shall be sufficient.

(3) Possibilities for erroneous operation of the control safety systems shall be minimized. Design of the remote control of the safety systems shall ensure that at least two logically connected operator actions (two switches, buttons, etc.) are needed for their actuation.

Art. 50. The principles of redundancy, independence and diversity shall be applied in the design of control safety systems. Application of those principles shall result in such conditions that any single failure in control safety system does not affect its functionality and a protection against common cause failures is secured.

Art. 51. (1) Design of control safety systems shall provide for:

1. continuous automatic diagnostics of the systems operability;

2. periodical testing from MCR and SCR of the operability of control safety system channels; and diagnosis of the technological components, which failures are initiating events for design basis and beyond design basis accidents.

(2) Any hardware and software failure and control safety system degradation shall lead to indication at the MCR and SCR and result in actions to ensure safety. In case that this is technically not feasible, methods and means shall be provided for periodical testing without reducing the functional availability of other safety systems and technological components, which failures are initiating events for design basis and beyond design basis accidents.

Art. 52. In addition to the requirements set in Art. 48, para. 2, design of computer based control safety systems shall fulfil the following requirements:

1. highest quality requirements and best practices shall be used for selection of the hardware and software;

2. the whole development process, including control, testing and design changes, shall be systematically documented and reviewed;

3. an assessment of the computer based system shall be undertaken by an expert organization, independent of designers and suppliers;

4. the diversity principle shall be applied in order to ensure the necessary reliability of the system.

Art. 53. Design shall make provisions for self-dependent means that ensure registration and storage of the information necessary for accident investigation. These means shall be protected against uncontrolled access and shall be operable in accident conditions. Design shall justify the scope of the information to be registered and stored.

Section IV
Reactivity Control Systems

Art. 54. (1) Design shall make provisions for at least one independent reactor shutdown system. A second system shall be provided in case required by the reactor characteristics.

(2) Reactor shutdown systems shall be designed in compliance with the single failure principle and their characteristics shall be such to provide rendering and maintenance of the reactor core subcritical in all operational states and in design basis accidents, with maximum value of the effective multiplication factor and taking into consideration of possible mechanical, thermal, chemical and other impacts in design basis accidents.

(3) Possibility for manual actuation of reactor shutdown systems shall be provided.

Art. 55. (1) At least one of the reactivity control systems shall be capable of performing the emergency shutdown functions. On the assumption of a failure of the most effective rod, the emergency shutdown system components shall have: fast-acting capabilities and effectiveness, sufficient for rendering the core to subcritical state without violation of the safety limits in anticipated operational occurrences and design basis accidents.

(2) In case that the effectiveness of the emergency shutdown system is not sufficient for long-term maintaining the core subcritical, provisions shall be made for automatic actuation of another reactor shutdown system with adequate effectiveness to maintain the core subcritical, considering possible reactivity increase.

(3) Any possibility for positive reactivity insertion by means of reactivity control shall be excluded by technical means if the emergency shutdown system rods have not been inserted in operating position.

Art. 56. All emergency shutdown system rods shall have intermediate position indicators, end position annunciators and limit switches, actuated where practicable directly by the rod. Other reactor shutdown means shall be equipped with position indicators.

Art. 57. When combining reactivity and power control functions with emergency shutdown functions, design shall include developed and justified procedure for system operation, giving a priority to the emergency shutdown functions.

Art. 58. Absence of a shutdown system is permissible for subcritical assembly, if the possibility to reach critical condition is excluded in all initiating events and common cuase failures.

Art. 59. Rendering the reactor in subcritical condition by means of the shutdown system shall not be dependant on the powersupply availability.

Art. 60. Shutdown system shall be designed in such a way that after its actuation the process to be brought to the end and manual actuation to be possible to the end of the activity and immediately after that. The restoration of the system funtional availability shall be done only by operator command after the cause for system actuation has been eliminated.

Section V
Reactor Structure and Coolant System

Art. 61. (1) Components, pipelines and supporting structures of the reactor shall withstand all accepted in the design static and dynamic loads and temperature effects.

(2) The RR structure and the coolant system layout shall exclude the possibility of unintentional coolant drainage from reactor core or from the experimental devices.

(3) The equipment layout and the selection of coolant geometry shall provide for the development of effective natural circulation of coolant through core, sufficient for cooling and preventing damage of fuel rods and other core elements above the limits established in the design in case of loss of forced circulation.

(4) In case of necessity the design shall include devices to reduce the pressure in the reactor coolant pressure boundary, the operation of which shall not lead to unacceptable releases of radioactive substances in all operational states and design basis accidents.

Art. 62. Materials to be used for fabrication of the components of the reactor coolant system shall be selected so as to minimize their activation and the probability of crack propagation and neutron embrittlement, with account taken of the expected degradation of their characteristics at the end-of-lifetime under the effects of erosion, creep, fatigue and chemical environment.

Art. 63. Reactor pressure vessel and pressure tubes shall be designed and constructed to be of the highest quality with respect to material selection, design standards, capability of inspection and fabrication.

Art. 64. Design of the components contained inside the reactor coolant pressure boundary shall be such as to minimize the likelihood of failure and associated consequential damage to other items in all operational states and in design basis accidents.

Art. 65. Components of the reactor coolant pressure boundary shall be designed, manufactured and situated in a way allowing periodical inspections and tests to be carried out, throughout the service lifetime of the RNI. Implementation of a material surveillance program for the reactor coolant pressure boundary shall control the effects on structural materials of various factors such as irradiation, stress corrosion cracking, embrittlement, and ageing of structural materials particularly in locations of high irradiation.

Art. 66. Design shall provide for systems to cleanup reactor coolant from radioactive substances.

Section VI
Systems important to safety and safety systems

Art. 67. (1) For RNI of group II, as well as in all cases where the RNI characteristics and operational modes require that, the design shall provide for highly reliable systems to remove, to an ultimate heat sink, the residual heat from the core and from SSCs important to safety, in all operational states and design basis accidents.

(2) Reliability of the systems shall be achieved by the use of proven in practice components and the principles of redundancy, diversity, physical separation and isolation in all postulated initiating events and in case of single failure independent from the initiating events.

Art. 68. The effectiveness of the emergency core cooling systems together with the provided by the design technical means for leak detection of the reactor coolant system, negative feedback, and the isolation capabilities, shall be sufficient to:

1. maintain the parameters boundary values under the specified in the design criteria for protection of the fuel cladding or of the fuel, and for protection of the coolant system integrity in design basis accidents;

2. preserve the geometry of the fuel in a condition that allows fulfilment of safety functions;

3. ensure necessary duration of core cooling.

Art. 69. (1) In case of an actuation and operation of any emergency core cooling system, measures shall be provided to prevent:

1. possibility for reactor criticality;

2. violation of the protection criteria of reactor coolant pressure boundary, specified in the design limits.

(2) Actuation of any protection safety system shall not lead to impair or loss of functions of another system.

Art. 70. The use of SSC, operating on passive principle shall be preferred in the design of protection safety systems.

Art. 71. (1) Design of protection safety systems shall provide for means of self-diagnostics, control and testing of functional capability.

(2) Emergency core cooling system shall be designed in a way that allows conducting of periodic inspections of important components and periodic tests intended to confirm:

1. the integrity of the structure and the tightness of system components;

2. the functional capability and the operational characteristics of system active components, during normal operation;

3.the functional capability of the system as a whole under operational states, specified in the design basis.

Art. 72. In case of necessity of core heat removal of greater quantities, generated as a result of severe accidents, the use of additional means for heat removal shall be provided.

Art. 73. (1) Reactor installation design shall include localization systems which functions prevent the reach of the established limits for radioactive releases in design basis accidents in all postulated initiating events, including the assumption of a single failure independent of the initiating event.

(2) In establishment of confinement functions, provisions shall include a leaktight structure, systems and means for control of containment parameters, for containment structure isolation, and for reducing the concentration of fission products, hydrogen and other substances that could be released in the containment atmosphere during and after design basis and severe accidents. The type, characteristics and number of SSC, performing confinement functions shall be specified and justified in the design.

Art. 74. (1) The containment structure and its components shall be designed with sufficient margins on the basis of potential internal overpressure, underpressure and temperatures, dynamic effects such as missiles impact, reaction forces, and the effects of other potential energy sources anticipated to arise as a result of design basis accidents. In calculating the necessary strength of the containment structure and its components, natural phenomena and human induced events shall be taken into consideration, as well as a combination of the effects of design basis accidents.

(2) In case of necessity design shall include means for containment structure surveillance in all operational states and design basis accidents. Design shall make provisions for maintaining the integrity of the containment structure in the event of a severe accident with account taken of the effects of any predicted combustion of flammable gases.

Art. 75. (1) In case of accidents and anticipated high values of containment parameters, containment structure and its components shall be designed and constructed to ensure structural integrity testing under design pressure before commissioning and performing of periodic leaktightness tests. Design shall specify tests requirements and the respective methods and means.

(2) In case of necessity possibilities to control containment radioactive leakages through containment structure leakinesses in case of a severe accident shall be provided.

(3) To prevent radioactive releases outside the containment in case of an accident, any containment penetrating line shall be reliably isolated by isolation devices.

(4) Design shall include the arrangements to maintain the functionality of isolation devices during a severe accident.

Art. 76. In case of necessity to secure personnel access to containment premises, provisions shall be made of lock and block doors as to secure at least one door in a locked position.

Art. 77. Design shall consider the capability of heat removal from the containment, generated as a result of a severe accident.

Art. 78. Selection of coverings and coatings, and methods of their application on SSCs inside the containment, shall ensure the implementation of their safety functions and to minimize interference with other safety functions in the event of degradation of coverings and coatings.

Art. 79. In case of necessity RNI design shall provide for supporting safety systems fulfilling auxiliary services on supply of safety systems with fluids and energy, and maintaining their operational conditions in all operational states and design basis accidents.

Art. 80. (1) Supporting safety systems shall be designed with adequate components' reliability and redundancy to ensure the necessary effectiveness on the assumption of a single failure, independent of the initiating event.

(2) Functional reliability of supporting systems shall be sufficient enough to meet the required reliability criteria of the respective safety system.

(3) Systems' design shall provide possibility for testing of their functional capability and for failure indication.

Art. 81. Fulfilment of safety functions shall have priority over supporting systems own protections, if this will not aggravate safety consequences.

Art. 82. In case of considerable amount of combustible materials in RNI structure design shall make provisions for fire protection means, including detection, fire alarm and fire extinguishing of coolant and moderator to automatically fulfil the specified functions.

Section VII
Experimental Devices

Art. 83. (1) Design shall specify function, mantling and dismantling procedures, and conditions of safe operation of experimental devices.

(2) Experimental devices which failure may be an initiating event of an accident shall be designed on the basis of the requirements to class “A” system with account taken of their arrangement in RR to prevent violation of design limits.

Art. 84. (1) Experimental devices structure shall exclude the possibility of unexpected reactivity excursion during their mantling, dismantling and operation.

(2) Experimental devices shall have technical documentation approved in compliance with established procedure and in case of necessity an experimental assessment of their effect on reactivity, distribution of core power density field and the effectiveness of control rods of protection and control systems.

(3) Experimental devices shall be provided in case of necessity with detectors of flux control, of thermo-physical parameters and other parameters.

Section VIII
Power Supply System

Art. 85. Design shall specify groups of power consumers, on the basis of which the power supply system shall be designed, as follows:

1. first group – consumers of direct and alternating current which allow power breakdown for half a second; they are supplied normally by operationing and emergency transformers, connected to the grid and require provision of power supply after actuation of a reactor emergency protection system;

2. second group – consumers of alternating current, breakdown time for which is specified on the basis of the conditions of safety provision and which need compulsory power supply after actuation of reactor emergency protection system.

3. third group – consumers which do not have requirements to power supply reliability.

Art. 86. For category one and two consumers, according to Art. 17, 1 and 2, the design shall provide for emergency power supply system to ensure performance of their functions in case of power supply system failure.

87. Emergency power supply system shall include autonomous power supply sources, and distribution and commutation devices connected to them.

Section IX
Radioactive Waste Management

Art. 88. (1) Radioactive waste (RAW) management systems shall be designed based on analysis and assessment of the composition and quantities of solid and liquid RAW and the gaseous radioactive substances generated in all operational states and design basis accidents.

(2) Systems for management of gaseous radioactive release to the environment shall be designed so that their quantities and concentrations are kept as low as reasonably achievable in all operational states and within the specified dose limits for the personnel and the dose limits for the population under Art. 10, para 1, as well as within the specified limits for radioactive releases to the environment in case of design basis accidents.

Art. 89. (1) RNI design shall ensure maintaining of the volume and activity of generated liquid RAW as low as reasonably achievable through the use of effective cleanup systems and multiple use of radioactive fluids, leakage prevention in systems containing radioactive fluids, and reduction of the frequency of events that require significant decontamination measures.

(2) Systems for RAW management shall be designed with account taken of the requirements to their safe management during the lifetime of NRI.

Art. 90. Design shall include systems for temporary safe storage of liquid and solid RAW, their treatment or conditioning at RNI site for a period adequate to provide possibility for transportation to RAW management facilities, as well as provisions for transportation to places of temporary storage or treatment on the RNI site area.

Art. 91. Design shall specify the requirements to RAW management systems in compliance with Regulation for safe management of radioactive wastes adopted with CM Decree № 198 of 2004, (State Gazette, Issue 72 of 2004) to the extent applicable to a certain case.

Section X
Nuclear Fuel Management

Art. 92. Facilities for nuclear fuel management shall be designed in a way, as to prevent loss or damage of fuel during overloading, criticality and loss of coolant, as well as to ensure reliable biological shield and adequate ventilation, as:

1. prevent criticality by a sufficient margin, even under the most adverse states, by ensuring related physical means or processes, such as geometrically safe configurations, and characteristics of the components and medium;
2. measures to prevent dropping of heavy objects and unacceptable force stresses on the fuel rods and fuel assemblies;
3. means for identification of the fuel assemblies;
4. means for safe storage of non-tight or damaged fuel assemblies or fuel elements.

Art. 93. RNI design shall provide for systems, equipment and componets for handling and storage of non-irradiated fuel to:

1. ensure appropriate fuel acceptance test, maintenance, periodic inspection and testing of components intended to be used;
2. ensure control of the storage conditions;
3. minimize the possibility of damage or unauthorized access to nuclear fuel.

Art. 94. Structures, systems and components for handling and storage of irradiated fuel shall be designed in compliance with the requirements of Art. 92 and additionally shall have the following:

1. reliable systems for residual heat removal in all operational states and design basis accidents, and suitable composition of the heat removal medium to prevent fuel cladding damage;
2. means or methods to control the concentration of the absorber.
3. means to control the condition and the parameters of heat removal medium and the effectiveness of heat removal;
4. means to control chemical composition and activity of heat removal medium, used during handling and storage of spent nuclear fuel;
5. means for decontamination;
6. systems for local ventilation and other means for radiation protection;
7. means to prevent heat removal breakdown.

Art. 95. Design shall specify the requirements to spent fuel management systems in compliance with Regulation for providing the safety of spent nuclear fuel management adopted with CM Decree № 196 of 2004, (State Gazette, Issue 71 of 2004) to the extent applicable to the specific case.

Section XI
Design Requirements to Radiation Protection

Art. 96. (1) To ensure radiation protection, RNI design shall identify all real and potential sources of ionising radiation and shall provide measures for ensuring the necessary technical and administrative control over their use.

(2) The requirements with regard to the classification of zones and compartments, radiation monitoring, the individual protection means and the access control are established by Regulation for radiation protection during activities with sources of ionizing radiation, adopted with CM Decree № 200 of 2004, (S G, Issue 74 of 2004).

Art. 97. To keep the exposure of personnel and population as low as reasonably achievable during all operational states, design basis accidents and beyond design basis accidents the design of the RNI shall provide for:

1. use of structural materials with minimum content of chemical elements with high activation cross-section and producing long-living radioactive corrosion products;

2. selection and adequate arrangement of biological shield around the experimental devices and shielding of SSC containing radioactive substances;

3. design provisions to limit activities of workers in the controlled access area and the possibilities of personnel radioactive contamination;

4. reduction of quantity and concentration of radioactive substances generated in RNI and spreading inside and outside it;

5. adequate handling, isolation and storage of radioactive materials, generated as a result of the RNI operation.

Art. 98. Design shall provide for radiation protection of personnel operating the experimental devices.

Art. 99. (1) The layout of the RR, its buildings and SSCs shall facilitate the operation, inspections, maintenance, repair and replacement of equipment and shall limit the personnel exposure to ionising radiation.

(2) Selection and layout of hot sell rooms, laboratories and their equipping, selection of routes and development of technological equipment for transportation of irradiated products shall ensure minimal exposure of personnel.

(3) The buildings, compartments and components, which may be contaminated with radioactive substances, shall be designed in a way that allows easy decontamination by chemical or mechanical means.

Art. 100. The personnel access to compartments of potentially high risk of exposure or radioactive contamination shall be controlled by means of locking devices with interlocks and indication for actuation and unavailability.

Art. 101. Biological protection shall be designed in a conservative way, taking into account the build-up of radionuclides over the RNI lifetime, the potential loss of shielding efficiency due to effects of interactions of neutron and gamma rays with the shielding, with other materials, with decontamination solutions, and the expected temperature conditions in design basis accidents.

Art. 102. (1) Design of RNI shall provide for ventilation systems to:

1. prevent spreading of gaseous radioactive substances in RNI compartments;

2. reduce and maintain compartments' airborne concentrations below the established limits and as low as reasonably achievable in all operational states and design basis accidents;

3. cleanup the air in premises containing radioactive or harmful gases.

(2) In designing a ventilation system, the following factors shall be taken into account:

1. mechanisms of thermal and mechanical mixing;

2. limited effectiveness of dilution in reducing airborne contamination;

3. exhausting of the air from areas of potential contamination at points near the source of contamination;

4. ensuring adequate distance between exhaust air discharge point and the intake point;

5. providing a higher pressure in the less contaminated zones in comparison with the zones of higher contamination level.

(3) Air cleaning systems shall be designed adequate reliability and redundancy of components to ensure the required effectiveness of the systems in case of single failure independent of the initial condition.

Art. 103. (1) Design shall provide for air cleaning systems of air discharged to the environment capable to maintain the emission concentrations of radioactive substances below the established limits and as low as reasonably achievable.

(2) Filters of air cleaning systems shall be sufficiently reliable to perform their function in all operational modes and design basis accidents. The design shall provide means to test their efficiency.

Art. 104. Provisions shall be made in the RNI design for radiation monitoring in all operational states, design basis and severe accidents, including:

1. stationary dosimeters for local monitoring of dose rate and total surveillance of radiation environment with possibility to receive information at MCR;

2. means to measure radioactivity in the compartments, where personnel is working and where increase of radioactivity is expected as a result of gaseous and airborne releases, with possibility to receive information at MCR

3. stationary and laboratory equipment to monitor the concentration of selected radionuclides in process medium, samples and emissions in environment having possibility to be measured in normal operation and in accident conditions;

4. means to measure radioactive surface contamination;

5. means for monitoring of individual doses and radioactive surface contamination of personnel;

6. means for radiation monitoring of monitored area to evaluate the effects on the ways of population exposure, on local ecosystem and accumulation of radioactive substances in the environment;

7. evaluation, assessment and prognosis of radiation environment in RNI compartments and in the areas with special statute;

8. evaluation, assessment and prognosis of the equivalent dose of personnel and all people within the boundaries of the radiation protection area;

9. radiation monitoring of transport means and the materials taken out of the boundaries of the RNI site.

Art. 105. Design shall establish requirements to provision of radiation protection in compliance with Regulation for radiation protection during activities with sources of ionizing radiation, to the extent applicable to a certain case.

Chapter Five.
CONSTRUCTION, COMMISSIONING AND OPERATION
Section I
Operating Organization

Art. 106. (1) The operating organization shall establish a document defining the safety policy, which gives the highest priority to safety over all other activities, including clear commitment to continuously improve safety and stimulating personnel for critical attitude to the tasks performed, aimed at achieving of best results.

(2) The safety policy shall be brought to the knowledge of personnel and entities that perform work at or provide services for the RNI.

Art. 107. (1) To implement the safety policy, the operating organization shall develop a strategy comprising safety objectives, targets and methods of implementation that can easily be followed and monitored.

(2) The adequacy and the implementation status of the safety policy shall be evaluated on a regular basis and the results shall be communicated to the personnel.

Art. 108. (1) The operating organization shall ensure the safe operation in accordance with the Act on the Safe Use of Nuclear Energy and the regulations for its implementation.

(2) During operation of RNI:

1. decisions on safety matters shall be preceded by appropriate investigation and consultation;

2. personnel shall be provided with the necessary resources and conditions to carry out work in a safe manner;

3. activities associated with ensuring safety shall be continuously monitored;

4. own and international operational experience and the developments of nuclear science and technology shall be systematically analysed and used for continuous improvement of activities.

Art. 109. (1) The operating organization shall establish a justified organizational structure clearly defining the functions and responsibilities, authorities and lines of communication of the personnel who perform activities associated with ensuring and supervising safety.

(2) Changes to the organizational structure, which might be significant for safety, shall be justified in advance, systematically planned and assessed after their implementation.

Art. 110. (1) RNI operation shall be conducted by sufficient in number and qualification personnel who know and understand the design basis, the safety analyses, the RNI design and operational documentation for all operational states and design basis and beyond design basis accidents.

(2) The sufficiency of the personnel and their qualification shall be analysed and verified in a systematic and documented way. The operating organization shall develop long term staffing plans for implementation of the activities associated with ensuring and supervising safety.

(3) Any changes in the number of staffing, which may be safety significant, shall be justified in advance, planned and evaluated after implementation.

(4) The operating organization shall maintain sufficient number of qualified personnel to assign, manage and control the activities of the entities that perform work at or provide services to the NRI.

Art. 111. (1) The management body of the operating organization shall apply and maintain an effective quality management system based on the following quality principles:

1. managers ensure the planning process, directions, resources and commitment in implementing of the assigned goals in a safe manner;

2. the personnel is familiar with their duties and trained to fulfil them in accordance with the established rules;

3. performing of independent assessment of the management processes and of the activities implementation, resulting in achievement of high quality and undertaking of corrective measures where necessary.

(2) The quality management system of the operating organization shall cover all activities graded according to their safety significance, including:

1. defining of organizational structure, responsibilities, authority, interrelations and management processes;

2. improving and maintaining the qualification of the personnel performing tasks associated with ensuring and supervising safety;

3. supplies, construction, installation, operation, maintenance, repair, modification of SSCs important to safety;

4. providing of sufficient resources for implementation of safety requirements.

(3) The documentation of the quality management system shall reflect the intentions of the operating organization management in a clear, concise, unambiguous and consistent way, and shall be developed, agreed, approved and used in accordance with proven procedures.

(4) For each safety related technical activity shall be developed:

1. preliminary validated procedures describing the key measures of quality assurance, the specific conditions to be met before the activity implementation, the steps required for conducting the activity and for responding to any identified deviation;

2. procedures on reporting, evaluation and approval of the results, as well as on decision making with respect to further corrective actions.

Art. 112. (1) The management body of the operating organisation shall develop procedures for review and approval of the proposals and plans for carrying out experiments and for control in the process of their implementation.

(2) Procedures for performing experiments shall comprise requirements for:

1. description of the experiment objective;
2. justification of the experiment necessity;
3. assessment data of safety condition;
4. assessment of possible radiation hazards;
5. additional measures and plans to ensure safety in normal and accident conditions;
6. radioactive wastes management that might me generated;
7. necessity of preliminary training of the people performing the work and of personnel.

(3) The experiments shall be conducted according to procedures, specifying the use of experimental devices with account taken of possible effects on the reactor, including reactivity excursion.

Section II
Construction

Art. 113. (1) The operating organization shall exercise control over the implementation of design, construction and assembling works, and over the quality of used materials, constructions and components by the aid of its own organizational structure and in compliance with the requirements of the quality management system.

(2) The construction materials towards which significant requirements have been specified shall pass verification for compliance and shall hold the necessary documentation and identification mark in conformity to the Act on the Technical Requirements to Products.

Art. 114. For technical assistance during the implementation of the detailed design, the operating organization shall ensure supervision by the NRI designer, which shall continue during the RNI commissioning as well.

Art. 115. Documents confirming compliance with significant requirements pursuant to the Act on the Technical Requirements to Products, those proving the execution of construction and assembling work in accordance with the design and changes performed, as well as the results of the acceptance tests of the materials and components and the individual components tests shall be submitted to the operating organization for analysis and storage.

Section III
Commissioning

Art. 116. (1) The operating organization shall develop and carry out a RNI commissioning program that shall specify the stages of commissioning, activities to be performed at each stage and planned duration of each stage.

(2) The program shall comprise detailed schedule of test performance, with account taken of their sequence. The tests shall be grouped with respect to their functionality and shall be performed in logical sequence in accordance with approved procedures.

(3) The commissioning program shall be assessed with respect to tests' completeness and their applicability to SSCs important to safety. The assessment shall be performed by qualified experts, who do not take part in its implementation.

Art. 117. (1) Functionality of all systems necessary for carrying out the planned tests shall be ensured for the implementation of each stage, and functional capability and calibration of measuring devices shall be demonstrated.

(2) The implementation of each subsequent stage shall be preceded by results' evaluation of the previous one and demonstration that the objectives have been met.

Art. 118. (1) The test procedures shall specify the way to put into operation each structure, system or component, following the procedures for normal operation aimed at their verification.

(2) Procedures shall comprise the objective of test, methods and activities for its implementation, required initial and final conditions, required equipment and personnel, acceptance criteria of implementation, procedure for documenting of test results.

(3) Procedures shall be an integrand part of the quality management system documentation and shall specify undertaking of measures in case of unexpected results or deviations from the design requirements.

Art. 119. (1) Before the initial fuel loading of the reactor core the systems important to safety required for this stage shall be installed, tested and operable and the reactor coolant system characteristics shall be determined by tests.

(2) Before the initial RR criticality, functional tests of the safety important SSCs shall be carried out to confirm the implementation of intended functions and the compliance with design characteristics.

(3) Transition to next power levels shall be made after successful neutron physics experiments, biological shielding effectiveness tests, calibration of RR control rods and determination of the influence of coolant, reflector and experimental equipment on reactivity.

(4) The operating organisation shall perform radiation monitoring of compartments, site, radiation protection and monitored areas before RNI commissioning.

Section IV
Operation

Art. 120. (1) During normal operation, all physical barriers shall be effective and all levels of defence shall be available. In case of a failure of a physical barrier or unavailability of a level of defence, the RR shall be brought to a safe shutdown condition.

(2) The inefficiency of a physical barrier or unavailability of a level of defence at specified operational states shall be justified in the RNI design.

Art. 121. (1) To maintain the level of defence of the physical barriers available, the RNI operation shall be conducted in compliance with the limits and conditions for operation.

(2) The limits and conditions for operation shall be identified and justified on the basis of design, safety analyses and commissioning tests, and shall be reviewed periodically and as necessary to consider the operational experience, modifications in SSCs important to safety, new safety analyses and developments in science and technology.

Art. 122. (1) The limits and conditions for operation shall cover all operational states of RNI, including power operation, reactor subcritical and refuelling, and all transitions between these states, and shall include as a minimum:

1. safety limits and conditions;
2. limiting safety systems settings;
3. operational limits and conditions;
4. requirements for tests, inspections, surveillance and in-service inspection of SSCs important to safety;
5. minimum number of operating personnel in the operational states, including qualified and authorized MCR staff;
6. actions to be taken in the case of deviations from the limits and conditions for operation.

Art. 123. The limits and conditions for operation shall include requirement for safe use and modification of RNI. Exemplary list of operational parameters and equipment for which limits and conditions for operation shall be specified is included in Annex 3.

Art. 124. (1) In case of non-conformity with the limits and conditions for operation, immediate actions shall be undertaken to bring the RNI in compliance with them. Such cases shall be analysed and measures taken to prevent their recurrence in future.

(2) In case RNI cannot be brought in compliance with limits and conditions for operation, the reactor shall be shutdown and maintained in safe condition until the reason for non-compliance has been eliminated.

Art. 125. The limits and conditions for operation, collected in a single document (technical specifications), shall be easily accessible to the MCR personnel, who shall be highly knowledgeable of them and their technical basis. The management personnel of the operating organization shall be aware of their significance for safety.

Art. 126. (1) The operating personnel shall operate the RNI in accordance with written operating instructions and procedures, developed on the basis of the design and technical documentation, the limits and conditions for operation and the results of RNI commissioning.

(2) The operating instructions and procedures shall comprise responsibilities of the operating personnel, methods of operative interface and specific directions for implementation of the actions in all operational states.

Art. 127. (1) The operating organization shall establish and implement a program to collect, analyse, document and disseminate their own and the others' operational experience, aimed at identifying the good operational practice as well as events, precursors and tendencies towards degrading the safety performance or reducing the safety margins, and undertaking of corrective actions.

(2) Safety significant operational events shall be analysed based on procedures, which specify the evaluation methods of the behaviour of SSCs and personnel aimed at:

1. establishing the chronological event sequence;
2. identifying the deviations and erroneous actions;
3. direct and root cause analysis;
4. assessment of event safety significance, including possible consequences;
5. identifying corrective actions.

Art. 128. (1) Personnel actions in case of design basis accidents shall be specified in instructions, developed on the basis of the final safety analysis report, the limits and conditions for operation and additionally performed investigations and analyses of reactor behaviour in accident conditions.

(2) The prescribed in the instructions personnel actions shall lead to recovering the RNI state to a condition covered by instruction for normal operation, or to achieving a safe extended shutdown under accident conditions.

Art. 129. Actions and measures to mitigate and eliminate the consequences of an accident shall be planned, specified and implemented in compliance with the Regulation for emergency planning and emergency preparedness in case of nuclear and radiation accident adopted with CM Decree № 189 of 2004 (SG issue 71 of 2004).

Art. 130. (1) The RNI operational state and the changes therein shall be controlled and managed by authorized and qualified personnel under the terms and procedures of the Act on the Safe Use of Nuclear Energy.

(2) At least two operators shall be available at the MCR during RNI operation, who have a formal authorization (certificate) issued by the Chairman of the Nuclear Regulatory Agency.

(3) The responsibilities and authority of the operating personnel and the persons in charge of safety during operation shall be identified in the RNI organisational documents.

Art. 131. The operating organisation shall develop core management program, to include the following activities:

1. determine the position of nuclear fuel, reflector, reactor control rods and experimental devices in the reactor core, using validated methods and computer codes;
2. store the information of nuclear fuel, parameters and configurations of reactor core;
3. load nuclear fuel in reactor core in compliance with design requirements, limits and conditions for operation and following the operating instructions;
4. preserve containment integrity by keeping the core parameters in compliance with the design requirements and the limits and conditions for operation;
5. detect and remove out of reactor core nuclear fuel with damaged cladding;

6. remove spent nuclear fuel and reload new fuel to maintain reactivity excess.

Art. 132. (1) Fresh and spent nuclear fuel management activities shall be specified in separate programs, which shall be developed by the operating organization and are part of quality assurance system.

(2) Spent nuclear fuel management program shall be developed and implemented in compliance with the requirements of Regulation for providing the safety of spent nuclear fuel management.

Art. 133. (1) The operating organisation shall develop, periodically review and implement programs for testing, maintenance, repair, inspection and control for maintaining the operability and reliability of SSCs important to safety, according to the RNI design. The frequency of testing, maintenance, repair, inspection and control shall be determined based on:

1. their safety importance;

2. their reliability and requirements of manufacturer;

3. operational experience and in-service control results;

4. possible influence of fulfilled activities to RNI safety.

(2) To conduct the various types of testing, maintenance, repair, inspection and control, written procedures shall be developed in accordance with the quality assurance system.

(3) Technical means for testing, maintenance, repair and inspection shall be operable, instrumentation and control means – calibrated.

Art. 134. Data collected from SSC failures and results from testing, maintenance, repair, inspection and control shall be registered, classified, kept and analysed, and also be used for resource management of SSC.

Art. 135. Tests or experiments on SSCs important to safety, which are not included in the technical specifications or in the operating instructions, shall be carried out in compliance with special programs and procedures following a positive statement by the Nuclear Regulatory Agency.

Art. 136. (1) The operating organization shall plan, control and implement permanent and temporary changes to SSCs important to safety in a way that does not affect plant's ability to be operated safely. The modifications, including those to instructions and procedures, to evaluation methods in the safety study and to other aspects related to the safe operation, shall be classified according to their safety significance.

(2) For management of changes, procedures shall be used, which depending on the classification of the modification include:

1. responsibilities in the management of modifications and the criteria for proceeding to implementation of next phase;

2. reason and justification for modifications;

3. feasibility study;

4. design requirements;

5. comprehensive safety assessment of the modifications leading to changes in the core configuration or in the limits and conditions for operation of RNI;

6. methods for fabrication, installation and testing;

7. commissioning of the modification.

(3) The comprehensive safety assessment shall consider all safety aspects, applicable legal requirements and standards and shall be performed by personnel independent of those responsible for the design and implementation of the modification.

(4) Before commissioning of modifications, personnel shall have been trained and all relevant operational documentation shall have been revised or updated.

(5) The management of temporary modifications shall include their clear identification and marking, informing the personnel about them, assessment of their impact upon operation, limiting their number and period of application, and periodic review of the need for these modifications.

Art. 137. (1) The operating organisation shall develop and implement ageing management program for the structures, systems and components important to safety so, as to secure protective barriers integrity and RNI operation within the safety limits and conditions during the lifetime specified by the design.

(2) The program shall include as a minimum: methods for detection and management of ageing, procedures for surveillance and assessment of the resource of SSC important to safety; interrelation with the operating procedures for testing, maintenance, repair, inspection and control; procedures for collecting and analysis of data on the current condition of SSC important to safety; corrective actions and replacement of overworked equipment with new one.

(3) The operating organisation shall review and periodically update ageing management program, with account taken of accumulated operational experience, the results of the assessment of reasons for material degradation, leading to safety important SSC failures, as well as new technology for detection and management of ageing.

Art. 138. (1) The operating organisation shall perform periodic safety assessment in compliance with written procedure, which shall present a detailed analysis of the safety important SSC condition, the impact of modifications and replacement of overworked equipment upon the reactor installation, as well as the applicability of the corrective measures undertaken to manage ageing.

(2) The operating organisation shall plan corrective measures to enhance RNI safety if necessary.

Section V
Conducting of experiments and irradiation

Art. 139. The operating organisation shall develop a RNI utilisation plan, with account taken of existing capacity of the installation, potential capabilities and users' requirements. The plan shall be reviewed and periodically updated.

Art. 140. (1) The operating organisation shall ensure RNI utilisation in compliance with the design requirements.

(2) In case of necessity of conducting of a new experiment the operating organisation shall assess the impact of the intended experiment on RNI safety and shall develop a report of the assessment results and on the basis of these shall decide to conduct or reject it.

Art. 141. The use and maintenance of experimental devices shall be performed in accordance with internal rules, specified in the RNI operating and maintenance instructions.

Art. 142. (1) To perform neutron-activation analysis and irradiation of samples with various purposes the following shall be defined: the way to confine and irradiate the samples, insert the sample in and retrieve it from the irradiation channel, and transmit the samples to the laboratories for measuring or return them to contractors.

(2) The operating organisation shall determine specific requirements with regard to getting into the RR and in the experimental devices of materials with high chemical and corrosion activity, as well as materials with low resistance to radioactivity, and their effect on reactivity shall be considered.

(3) Irradiation of samples with high cross-section of thermal neutrons absorption shall be permitted only after additional justification of safety during reactor control and management.

(4) Getting into and irradiation of samples in reactor core shall not lead to insertion of additional reactivity, higher than the stipulated margins for experiments and irradiation.

(5) Irradiation of samples, which results in release of gases or contain explosive or toxic materials shall not be allowed. Irradiation of samples with unknown composition shall not be allowed.

Art. 143 (1). For the purpose of producing radioactive isotopes the operation organisation shall perform safety analysis to demonstrate that the reactor operation is maintained within designed limits and conditions of operation in case of unexpected events.

(2) Production and use of radioactive isotopes shall be performed after a licence has been obtained from the Nuclear Regulatory Agency under the requirements of ASUNE.

Art. 144. (1) The operating organisation shall plan and optimise the performance of experiments and irradiation on the basis of assessment of their impact on RNI safety, with account taken of:

1. damage of fuel rod cladding as a result of reactivity effect, thermal effects with local overheating of fuel, mechanical stress of cladding as a result of experimental device failure, chemical damage as a result of corrosion;

2. experiments which can cause violation of critical safety functions or changes in performance of the control system as a result of neutron flux fluctuation, and disruption of calibration of instrumentation and control devices, physical interaction of the experimental devices and reactor components;

3. experiment which can cause additional radiological risk as a result of additionally generated radiation fields or unsealed radioactive materials' wraps;

4. interaction with other experiments or operating activities which cause radioactivity effects, use of common supporting systems, blocking of access routes in case of accident, industrial risk as a result of the experiment which can compromise the performance of safety functions.

(2) The assessment shall include justification of radiation protection to demonstrate that the personnel doses are maintained under the established limits, and the population doses are under the limits specified in Art. 10, para 1.

(3) Council of operating organization representatives, people conducting the experiment and independent experts shall take decision to conduct the experiment or justify its rejection on the basis of the results of the safety assessment.

Art. 145. (1) The internal rules for conducting experiments and irradiation, as well as the documents managing their performance shall be an integral part of the quality management system.

(2) The internal rules shall be in compliance with the operating and accident instructions.

Art. 146. (1) The operating organization shall develop and agree with the competent state authorities programs for radiation protection of NRI personnel and for radiation monitoring of the environment, and shall periodically review and update them on the basis of the operational experience. The programs shall include requirements to:

1. classification of areas in compliance with the regulations and access control of personnel and materials;

2. co-operation in establishing operating and maintenance procedures and experimental programs for activities when radiological hazard is anticipated;

3. instrumentation and equipment for monitoring;

4. means for collective and individual personnel protection;

5. on-site radiological monitoring;

6. decontamination structures and systems;

7. environment radiological monitoring;

8. monitoring of radioactive liquid and gaseous discharges;

9. radiation control of radioactive substances and irradiated sources taken out of RNI;

10. control to limit the extent of radioactive release outside the NRI site.

(2) The operating organization shall ensure sufficient independence and resources to the organizational unit implementing radiation protection function and control of working conditions.

Art. 147. (1) All NRI personnel shall be aware of the radiological risk of the activities and shall have individual responsibility for putting into practice exposure control measures.

(2) The operating organization shall provide for preliminary and periodic medical examination of the RNI personnel to ascertain their health and psycho-physiological fitness to occupy relevant position.

Art. 148. (1) The generation of radioactive waste shall be kept to the minimum practicable in terms of both activity and volume, by appropriate operating practices.

(2) Treatment and interim storage of radioactive waste shall take account of the requirements for their final disposal.

Art. 149. The operating organization shall perform periodic analysis and assessment of the radioactive discharges to the environment to demonstrate that the radiological impacts and doses to the public do not exceed the limit specified under Art. 10, para 1, and are kept as low as reasonably achievable.

Section VII
Personnel Training, Qualification and Certification

Art. 150. (1) The operating organization shall ensure that the activities related to ensuring and control of safety during RNI operation are performed by personnel having the necessary qualification and experience.

(2) The personnel training and qualification shall ensure sufficient knowledge about the characteristics and behaviour of SSCs important to safety, and the RNI as a whole, in all operational states and accident conditions.

(3) The training programs of the operating personnel shall include design basis of RNI, final safety analysis report, limits and conditions for operation, on-site emergency plan of RNI, operational event analysis, and documentation on modifications of SSCs important to safety, and experimental devices.

Art. 151. (1) Personnel responsible for handling and storage of nuclear fuel shall pass practical training in working conditions for work with nuclear fuel handling systems and its transfer to the storage facility.

(2) Maintenance personnel shall be trained using scaled models or real components for improvement of their professional skills and reducing the duration of operations before implementation of work under radiation hazard.

(3) Personnel taking part in experiments and irradiation shall be familiar with the experimental devices, with the techniques of sample sealing and putting them into the irradiation channels and to be aware of the rules for manipulation of irradiated materials and their transfer to contractors.

(4) Prior carrying out of key operating actions and tests of SSCs important to safety, the personnel involved shall be instructed.

Section VIII
Management of Documentation

Art. 152. (1) The operating organization shall develop and apply procedures for management of documents and records related to safety, such as:

1. design specifications;
2. safety analyses;
3. data on equipment and materials;
4. as-built installation drawings of systems and experimental devices;
5. SSC manufacturers' documentation;
6. commissioning data;
7. RNI operational data;
8. reports on events and incidents;
9. records of amounts and location of fissile, radioactive and other special materials and substances;
10. documents from maintenance, testing, surveillance and inspections;
11. data on modifications;
12. quality assurance documents;

13. data on personnel qualification, positions, medical examinations and training;
14. plant chemistry records;
15. data on occupational exposure;
16. data on radiation monitoring at the premises and on the site;
17. effluents discharge records;
18. environmental monitoring data;
19. data on storage and transport of radioactive waste;
20. periodic safety reviews.

(2) The documents under Para. 1, items 1-4, 8, 11 and 15 shall be kept in two copies in two physically separated premises, protected against fire and flooding.

(3) The on-site emergency plan and the procedures to be used under accident conditions, as well as other important documents may be stored outside the NRI site, as necessary.

Art. 153. The document management system shall ensure that only the latest versions of all documents and programs are being used.

Additional provisions

§ 1. Within the meaning of this regulation:

1. "Accident conditions" are deviations from normal operation more severe than anticipated operational occurrences, including design basis and beyond design basis accidents.

2. "Active component" is a component whose functioning depends on an external input such as actuation, mechanical movement or supply of power.

3. "Capable fault" is a tectonic fault, along which a relative shifting of the adjacent earth crust blocks has been realized at half a meter or more over the last one million years (Quaternary period).

4. "Fail safe" is a failure of a system or component as a result of which the research nuclear installation passes to a safety state with no necessity for any actions to be initiated by control safety systems.

5. "Main control room" is part of a RNI situated in specially designed premises and intended for centralized control of the technological processes performed by the operating personnel and the instrumentation and controls.

6. "Validation" is the process of determining whether the product (such as computer programs, analytical methods, RNI models, procedures and instructions) is suitable for satisfactory implementation of the intended function.

7. “Verification” is the process of determining whether the product’s quality or characteristics (such as computer programs, analytical methods, RNI models, procedures and instructions) are exactly the same as declared, as foreseen, or as required.

8. "Probabilistic safety assessment" is a comprehensive, structured approach to identify failure scenarios, constituting a conceptual and mathematical tool for deriving numerical estimates of risk.

9. “ Vertical channel” is a channel intended to irradiate samples outside the core separator, the upper end of which is under water.

10. “External neutron source” is a device periodically situated inside core, generating neutrons intended to increase the flux density inside RNI core in reactor start up mode and in power operation.

11. “External event” is an event unconnected with the RNI operation, which could have an effect on the RNI safety.

12. "Internal event" is an event connected with the RNI operation, which could have an effect on the RNI safety.

13. "Inherent safety feature of a reactor installation” is the reactor installation capability to ensure safety on the basis of natural feedbacks, processes and characteristics.

14. “Single failure” is a failure which results in the loss of capability of a component to perform its intended safety function(s), and any consequential failure(s) which result from it.

15. "Operational states" are the states defined under normal operation and anticipated operational occurrences.

16. “Experimental device” is a device intended for use of neutron flux and ionising radiation for all activities, provided for in the design of a research nuclear installation.

17. "Operational limits" are values of the parameters and characteristics of the status of systems (components) and of the RNI as a whole, specified in the design for normal operation.

18. “Operational conditions” are conditions specified in the design with regard to amount, characteristics, functional capability and maintenance of the systems (components), necessary for operation without violation of the operational limits.

19. “Operation” is all activities performed to achieve the purpose for which the research reactor was constructed, including power operation, start up, shutdown, testing, maintenance, repairs, refuelling, in-service inspection and other related activities.

20. "Operating organization” is the organization that is licensee or permit holder under the Act on the Safe Use of Nuclear Energy.

21. “Protection safety system" is a system intended to prevent or limit a damage of the nuclear fuel, of the fuel claddings, and the components that contain radioactive substances.

22. “Qualification” is the process of establishing evidence that the structure, system or component will operate on demand, under specified service conditions to meet the system performance requirements.

23. “Component” is devices, piping, cables, and other articles that ensure the performance of preset functions either on their own or within systems, and conceived as structural units in the reliability and safety analyses.

24. “Conservative approach” is an approach to the design and construction, in the analysis and calculations of which are accepted values and limits for the parameters and characteristics that definitely lead to more unfavourable results.

25. “Reactor coolant system” is the system intended for circulation of the coolant through the reactor core within the operational modes and conditions established in the design.

26. “Structures, systems and components important to safety” are the safety systems and the SSCs for normal operation, the failures in which either result in deviation of the plant normal operation or prevent the response to deviations of the normal operation and can lead to design basis or beyond design basis accidents.

27. “Ultimate heat sink” is a medium to which the residual heat can always be transferred, even if all other means of removing the heat have been lost or are insufficient.

28. “Critical assembly” is a device for experimental study of the characteristics and parameters of neutron fission medium, the composition and geometry of which facilitate controlled nuclear reaction and fission, power operated without need of compulsory cooling of medium and having no influence on neutron-physical characteristics.

29. “Safety culture” is personnel qualification and psychological attitude, which establishes that ensuring the RNI safety is an overriding priority and inherent necessity, leading to the conscious of responsibility and self-control in performing all activities that affect safety.

30. “Localization safety system” is a system intended to prevent or limit the dispersion of accidentally released radioactive substances and ionising radiation outside the designed boundaries to the environment.

31. “Beyond design basis accident” is an accident with consequences more severe than the design basis accident and not involving significant core degradation, as in a severe accident.

32. “Undetected (latent) failure” is a failure of a system (component) which is not developed at the moment of its occurrence during normal operation and is not identifiable with the inspection means according to the programs for maintenance and inspection.

33. “Neutron-activation analysis” is a quantitative method used to determine the content of chemical elements in different samples.

34. “Normal operation” is the operation within specified operational limits and conditions.

35. “Supporting safety system” is a system intended to supply the safety systems with energy and fluids and to maintain appropriate conditions for their operation.

36. “Common cause failure” is a failure of two or more systems or components due to a single specific event or cause.

37. “Reflector” is a device intended to reduce the neutron releases from the RR.

38. “Anticipated operational occurrence” is an operational process deviating from normal operation which is expected to occur at least once during the RNI operating lifetime but which, in view of appropriate design provisions, does not cause any significant damage to SSC important to safety or lead to accident conditions.

39. “Passive component (passive system)” is a component (system) whose functioning does not depend on an external input such as actuation, mechanical movement or supply of power.

40. “Periodic safety review” is a systematic reassessment of the safety of an existing RNI carried out at regular intervals to deal with the cumulative effects of ageing, modifications, operating experience and technical developments, and aimed at ensuring a high level of safety throughout the service life of the RNI.

41. “Personnel” means all people working permanently or temporarily on the RNI site.

42. “RNI site” is the area inside the boundaries of the protected area, where RNI buildings and facilities are situated.

43. “Postulated initiating event” is a single failure in system (component), external event or human error identified during design as capable of leading to anticipated operational occurrences or accident conditions.

44. “Safety limits” are values of operational parameters, specified in the design, the deviations from which may result in an accident.

45. “Limits and conditions for operation” is a set of rules setting forth parameter limits, the functional capability and the performance levels of SSCs and personnel approved following a specified procedure for safe operation of a RNI.

46. “Design basis accident” is an accident against which a RNI is designed according to established design limits, including damage to the fuel and the release of radioactive material to the environment.

47. “Design basis” is a combination of conditions and events explicitly taken into consideration in the design according to established criteria, which the RNI can withstand without exceeding the specified limits supported by safety systems.

48. “Design limits” are values of parameters and of characteristic status of SSCs important to safety and of RNI as a whole, specified in the design for all operational states and accident conditions.

49. “Diversity” is the presence of two or more redundant components or systems or components to perform an identified function, where the different systems or components have different attributes so as to reduce the possibility of common cause failure.

50. “Region of situating of a RNI” is a territory, incorporating the RNI site, for which the RNI location conditions have to be identified and where the occurrence of phenomena, processes and factors of natural and human induced origin that may affect the plant safety is possible.

51. “Supplementary control room” is part of a RNI situated in a specially designed premise and intended to reliably bring and maintain in a long term the reactor in cold subcritical state and its unlimited maintenance in this state, to actuate the safety systems and to receive information on the reactor state, should there be a loss of functions of the MCR.

52. “Redundancy” is provision of alternative (identical or diverse) structures, systems and components, so that any one of them can perform the required function regardless of the state of operation or failure of other structures, systems and components.

53. “Safety system” is a system important to safety, provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents.

54. “RNI states” are the operational states and accident conditions.

55. “Severe accident” is an accident that can cause significant core degradation.

56. “Accidents management” is the undertaking of a set of actions during the evolution of a beyond design basis accident to prevent the escalation of the event into a severe accident; to mitigate the consequences of a severe accident; to achieve a long term safe stable state.

57. “Control safety systems” are the systems intended to actuate the safety systems and to control their operation in the process of performing the designated function.

58. “Safety function” is the specific objective to be achieved in order to ensure the safety.

59. “Containment structure” is an assembly of structural and other components packaging the reactor installation space that forms the physical barrier specified in the design and prevents the spreading of radioactive substances to the environment. The space encircled within the containment structure boundaries constitutes the containment.

60. “Horizontal channel” is a channel utilised to lead neutron bundle and gamma radiation with different characteristics to devices for conducting experiments or irradiation.

§ 2. (1) The site selection, design, construction and commissioning of RNIs, as well as their reconstructions, major repairs and modernizations shall be accomplished observing the technical safety requirements in conformity with the regulation, under the terms of and following the procedure of the Act on Territorial Structure (ATS) and the Act on the Safe Use of Nuclear Energy (ASUNE).

(2) The permit referred to in Art. 33, Para. 1, item. 1 of the ASUNE as to site location (site selection) is a basis of issuing a permit by the Minister of regional development and public works under Art. 124, paragraphs 2 and 4 of ATS – for the purpose of elaboration of a detailed lay-out plan.

(3) The orders under Art. 33, paragraph 4 of ASUNE concerning the approval of the selected site and basic design are a ground for approval by the Minister of regional development and public works of the detailed lay-out plan and of the technical investment project covered by the ATS.

(4) The construction permit issued under Art. 33, Para. 1, item. 3 of the ASUNE is a ground for issuing a permit for construction under the ATS by the Minister of regional development and public works.

(5) The permit allowing usage under ATS is a ground for issuing a permit for commissioning under Art. 33, Para. 1, item 4 of the ASUNE.

Transitional and Final Provisions

§ 3. (1) The regulation provisions are respectively applied to the existing RNIs that have had issued design permit prior to the regulation enforcement.

(2) The consequences of accidents shall be mitigated in the boundaries of research nuclear installation site of the reactors under para 1.

§ 4. When some of the activities covered by this regulation are assigned by a contract to another entity, the assignor bears the responsibility for ensuring the compliance of the work done with the regulation’s requirements.

§ 5. Guidance and interpretations as to the regulation application are given by the Chairman of the Nuclear Regulation Agency, who issues guides, metodologies and other document on its implementation.

§ 6. This Regulation is adopted on the grounds of Art. 26, paragraph 2 of the ASUNE.

Annex № 1
to Art.11, paragraph 1 and 2

Typical list of events to be considered in the safety analysis of a RNI

1. Failure of power supply sources:
1.1. failure of the systems for normal power supply.
2. Positive reactivity insertion:
2.1. criticality during spent fuel activities (mistake in refuelling);
2.2. accident in reactor start up;
2.3. failure of control rod or its mechanical component;
2.4. failure of a control rod drive or of a control rods system
2.5.failure of other elements for reactivity control (moderator, neutron reflector);
2.6. unbalanced position of control rods;
2.7. failure or degradation of structural components;
2.8. adding of cold water;
2.9. changes of moderator (for example forming or filling in cavities);
2.10. Effects of experiments or experimental devices (for example water flooding, forming of cavities, thermal effects, placing or removing fissile or absorbing materials);
2.11. insufficient reactivity for shutdown;
2.12. iinadvertent withdrawal of control rods;
2.13. mistakes during maintenance of reactivity control systems.
3. Termination of reactor core circulation:
3.1. failure of circulation pump;
3.2. reactor coolant flow reduction (for example failure of a valve, blocking of a pipe or heat exchanger),
3.3. effect of a failure or wrong performance of activities while conducting an experiment;
3.4. failure of emergency cooling system;
3.5. reactor coolant pipelines break, leading to stop of circulation;
3.6. blocking of nuclear fuel channel;
3.7. incorrect power distribution (for example due to unbalanced position of control rods, experiments in reactor core or refueling);
3.8. reduction of coolant volume as a result of core bypass;
3.9. malfunction of reactor power control system;
3.10. deviation of system pressure and violation of the established limits;
3.11. discontinuation of heat removal (for example failure of a valve or a pump, degradation of system component).
4. Loss of coolant:
4.1. Coolant pipe break in reactor coolant boundary;
4.2. pool damage;
4.3. pool drainage;
4.4. damage of experimental channels or other devices connected to the reactor.
5. Incorrect use of equipment or components, or their failure
5.1. damage of fuel elements cladding;
5.2. mechanical damage of core or fuel (for example during activities with fuel or container drop on fuel);
5.3. criticality of stored nuclear fuel;
5.4. failure of localization or ventilation system;
5.5 coolant penetration inside fuel during transportation or storage;
5.6. failure or decrease of biological shielding level;
5.7. failure of experimental devices or materials;
5.8. exceeding of rated parameters of nuclear fuel.

6. Particular internal events:
6.1. internal fire and explosion;
6.2. internal flooding;
6.3. failure of supporting system;
6.4. incidents associated with physical protection and security;
6.5. incorrect reactor performance as a result of experiments;
6.6. unapproved access to controlled areas.
7. External events:
7.1. earthquake;
7.2. flooding (inclusive dam rupture);
7.3. tornado and missiles;
7.4. hurricane, storms and lighting;
7.5. explosion;
7.6. aircraft;
7.7. fire;
7.8. toxic substances spilling;
7.9. transportation accidents;
7.10. impact of adjacent installations.
8. Human errors.

Annex №2
to Article 31

Factors, conditions and criteria for research reactors site selection

1. RNI location is not allowed: on sites directly situated on capable faults; on sites with intensity of safe shutdown earthquake (SSE) with frequency of 1.10(-4) events per year higher than level 9 according to the seismic intensity scale of Medvedev-Sponheuer-Karnik (MSK-64), and on territories where the location is forbidden by a legislative act, or act of Council of ministers of the Republic of Bulgaria.

2. Unfavourable for hosting of a RNI are the sites located on/in:

2.1. territories around active volcanoes or active mud vulcanise;

2.2. territories exposed to effects of tsunami-waves, disastrously high water levels or floods;

2.3. territories that might be flooded by a wave resulting from dam failures;

2.4. zones where mudflows appear;

2.5. zones having intensity of safe shutdown earthquake, greater than level 7 according to MSK-64 scale;

2.6. territories with registered contemporary differential movements of the earth crust (vertical with speed higher than 10 mm per year, horizontal – over 50 mm per year);

2.7. zones of tectonic cracks;

2.8. regions with developing karst (thermal karst);

2.9. territories with disused mines or other excavation works;

2.10. regions with potentially active landslides, or other dangerous slope processes;

2.11. coastal and estuary floodplains where the displacement speed of the cutting line and the upper plain of the abrasive ledge is more than 1 m per year;

2.12. regions abounding in structurally and dynamically unstable earth layers, alluvial earth layers, as well as earth layers having a deformation module below 20 MPa;

2.13. territories enclosing facilities within their boundaries, including military facilities, with possibility of release of toxic substances in case of fire and explosion or other impacts, exceeding those provided for in design;

3. Location of a RNI in unfavourable regions and zones characterized by the presence of dangerous processes, phenomena and factors of natural or human induced origin could be accepted if technical and organizational measures to ensure safety have been implemented.

4. Engineering surveys and investigations of natural processes, phenomena and factors having potential impact on RNI safety shall be conducted for the region and the site for situating a RNI:

4.1. the following tectonic characteristics shall be defined:

4.1.1. location of faults, of potential earthquake foci zones, indicating the orientation and boundaries of potentially dangerous fault zones;

4.2.2. amplitudes, speed and gradients of the latest and contemporary movements of the earth crust, parameters of potential dislocations;

4.1.3. characteristics of capable fault areas (geometric schemes, dislocation amplitudes and directions along the faults, data of the latest activity known);

4.2. within the RNI site boundaries, the following shall be identified:

4.2.1. characteristics of the input ground motion in earthquakes of intensity of safe shutdown earthquake at the zero level of the site;

4.2.2. the hazard of landslide displacements of the slopes considering the ground layers conditions and seismic motions with an intensity up to safe shutdown earthquake inclusive and accounting also for the impact of ground-waters, tectonic characteristics, contemporary geodynamic processes;

4.2.3. the possibility of development of karst (thermal karst), syphusion and karst-syphusion processes and their impact on RNI safety;

4.2.4. the availability of specific earth layers (biogenic, collapsing, swelling, salted, alluvial, human induced), their power and physical-mechanical properties (deformation modules, strength characteristics, etc) and their impact on the non-uniform subsidence beneath the RNI buildings and facilities, their inclination during earthquakes with an intensity up to safe shutdown earthquake inclusive;

4.2.5. the zones of water saturated disconnected earth layers yielding to self-liquefaction when exposed to seismic impacts with an intensity up to safe shutdown earthquake inclusive;

4.2.6. the impact of the groundwater level uplift and flooding the site as a result of spreading of underground water uplift coming from dams, filtration of irrigated lands, water flows, precipitation, snow melting;

4.2.7. tornado intensity, the peak tangential values of the periphery speed and the speed of the tornado progressive motion; the pressure drop between the tornado periphery and the centre;

4.3. for site shall be defined the maximum water level and the duration of possible flooding due to rainfall, intensive snow melting, high water level in water basins, river blocking by ice, avalanche and slide. For coastal site shall be evaluated the probability of for the NPP site shall be evaluated the characteristics of possible maximum run off floods from tsunami or combination of high tides and waves caused by winds. Occurrence of tsunami (seiches) waves shall be evaluated considering the seismic tectonic conditions, the shore configuration, landslides and collapse in the water;

4.4. for a site, the impact of other processes, phenomena and factors of natural origin shall be determined (hurricane, extreme rainfalls, air and water temperatures, icings, thunderstorms, dust-storms and sand-storms, erosion of river and water basins banks).

5. The region to locate a RNI and the respective site shall be investigated to identify sources of potential human induced hazards:

5.1. The analysis and assessment of impact on safety of sources of human induced hazards shall be performed with account taken of their distance to RNI. It is allowed to neglect sources of human induced hazards with a frequency of occurrence lower than to 10^{-6} events per year.

5.2. Sources of human induced hazards shall be characterized by possible accidents causing explosions, fires, and release of explosive, toxic and corrosive substances.

5.3. The impact on safety shall be analysed from all stationary and mobile explosives, including all industrial facilities for production, processing, storage or transportation of chemical and explosive substances situated at a distance up to 5 km, and ammunitions warehouses – at a distance up to 10 km from site boundaries. The impact of the most dangerous explosion shall be determined and RNI safety shall be justified considering the detonation and the follow-up consequences of the explosion in terms of ground layers shaking, missiles and local migration conditions of the gaseous cloud.

5.4. Impact on RNI safety shall be analysed of all stationary and mobile sources of accidental release of chemically active substances at a distance up to 5 km from site boundaries, including industrial facilities where processing, usage, storage and transportation of toxic and corrosive substances is being performed.

5.5. Characteristics of the impact on the RNI and respective probabilities shall be determined for events induced by:

5.5.1. explosions and fires, as well as release of explosive, inflammable, toxic and corrosive gases and substances from industrial facilities, ground and water transportation facilities;

5.5.2. airplane crashes (planes, helicopters);

5.5.3. floods, including those resulting from failures of dams located upstream of the site;

5.5.4. accidents of water transportation facilities and in shore harbour zones occurring together with explosions and fires, chemically dangerous release, if the RNI is situated on the shore;

5.5.5. electromagnetic emissions (fields);

5.5.6. external fires (forest areas, peateries, burning fluids);

5.5.7. developing underground resources deposits, mine excavation works (tunnel construction, shafts and quarries);

6. The aerologic, hydrometeorologic, hydrogeologic and geochemical conditions of radionuclide dispersion, migration and accumulation, and also the natural radiation background shall be studied in the monitored area and prediction shall be made of conditions behaviour over the RNI operating lifetime.

6.1. Atmospheric dispersion shall be assessed by taking into consideration slight wind, calm weather, air temperature, near-surface and altitude inversions, atmosphere stability, precipitation and fogs in the region of the RNI.

6.2. Characteristics of radionuclide migration in surface- and ground-water and of radionuclide deposition at the bottom of water basins shall be defined considering the following:

6.2.1. possible radioactive contamination of drainage and groundwater;

6.2.2. radionuclide physical and chemical properties;

6.2.3. kinetics of geochemical reactions and possible change in the mineralogical features of layers;

6.2.4. lithological composition and power of water-bearing and water-tight layers, the earth layers in the weathering zone and the soil layer;

6.2.5. sorption capacity of the embankment sediments, earth layers and soil layer with respect to radionuclides and hazardous chemical substances;

6.2.6. direction and speed of contaminated flows towards the release places (drain-pipes, water basins, water output wells, etc.);

6.2.7. characteristics and stratification of water-bearing horizons;

6.2.8. hydraulic connections between underground and surface waters;

6.2.9. characteristics of water basins, hydro facilities, water consumption data, water levels and flow rates, river stream velocity, possible mechanisms of radionuclide transport and deposition.

6.3. For site selection, the radiological consequences for normal operation, design basis and beyond design basis accidents shall be substantiated and technical and organizational measures shall be planned to ensure the safety of the population. The radiological consequences assessment for normal operation of RNI shall be conduced by applying probabilistic distribution of the atmospheric dispersion parameters typical for the region. Assessment of radiological consequences in , design basis and beyond design basis accidents shall be conducted for the most adverse weather conditions specific to the region of the RNI.

6.4. Consequences to the population and the environment shall be determined of possible radiation impact from an accidental radioactive release from RNI, considering the following:

6.4.1. results of the assessment of the radiation conditions;

6.4.2. characteristics of the water output facilities in the monitored area;

6.4.3. characteristics of water basins important to fishing, fish population reproduction and other biological resources in the monitored area;

6.4.4. data on the existing and planned population distribution in the region of situating of the RN.;

Annex 3
to Article 123

Factors to be considered in developing the RNI limits and conditions for safe operation

The operating organization shall determine specific factors according the type and characteristics of RNI and shall specify operational limits and conditions which may be limitations to operation and administrative limitations, on the basis of the list presented below:

Grouping of elements into systems or activities with common origination is exemplary.

The list presented does not exhaust all possible factors.

1. Fuel, fuel elements and assemblies:

1.1. uranium -235 enrichment;

1.2. fuel fabrication materials;

1.3. geometry;

1.4. Uranium content;

1.5. burnup limits;

1.6. fuel failure criteria;

1.7. inspection and testing of fresh fuel elements and assemblies.

2. Fuel handling and storage:

2.1. storage of fresh fuel;

2.2. storage of spent fuel;

2.3. storage of failed fuel;

2.4. capacity to unload and store core components;

2.5. requirements for preparation of fuel for transport.

3. Reactor core:

3.1. permissible internal or peripheral cavities;

3.2. maximum and minimum number of fuel elements;

3.3. conditions of reflection (e.g. type of reflector and configuration);

3.4. number of control elements;

3.5. mixed cores (e.g. cores containing fuel of different enrichment);

3.6. permissible configurations;

3.7. requirement for determining new configurations;

3.8. reactor power;

3.9. average and maximum (pick) fuel element power;

3.10. critical heat flux margin or flux instability.

4. Reactivity. Control system:

4.1. maximum excess reactivity;

4.2. reactor shutdown reactivity margin during operation and during fuel movement;

4.3. reactivity worth of the reactivity control elements

4.4. reactivity rates insertion by means of reactivity control mechanisms, experiments or fuel elements;

4.5. total reactivity worth of all experiments;

4.6 maximum reactivity worth of specific types of experiments;

4.7. reactivity worth of backup shutdown system (if any);

4.8. reactivity balance (e.g. pattern of withdrawal levels of the reactivity control mechanisms, fuel burnup distribution in the core);

4.9. type and number of reactivity control rods.

5. Experimental devices:

5.1. materials: compatible with internal conditions, irradiation samples encapsulation, sealing, fissile products, etc.;

5.2. explosive materials;

5.3. effect of experiment failure upon the reactor and effect of reactor failure on the experiment.

6. Protection system and reactor shutdown system:

6.1. type and minimum number of neutronic measuring equipment items necessary to scram the reactor in each mode of operation;

6.2. type and minimum number of other measuring equipment items (temperature, fllow, radiation field, etc.) necessary to scram the reactor;

6.3. Alarms and scram limits for aforementioned equipment;

6.4. interlocks and trips;

6.5. bypassing channels;

6.6. other safety instrumentation;

6.7. reactor shutdown delay time (e.g. rod drop time);

7. Localization system, including ventilation system:

7.1. temperature, humidity and air flow in different areas of the reactor;

7.2. pressure drop across filters;

7.3. localization system pressure relative to the atmosphere (normal and under emergency conditions);

7.4. Capability for isolation of localization system and starting of emergency ventilation system;

7.5. operation requiring localization;

7.6. configuration and minimum equipment for ventilation;

7.7. rate of ventilation system;

7.8. hazardous materials inside localization system;

7.9. filters and efficiencies of iodine traps;

8. Cooling system:

8.1. coolant chemistry (content of solids and dissolved gases, pH and conductivity);

8.2. temperature, pressure and flow at particular points;

8.3. system configuration for different modes of operation (e.g. how many and which pumps should be operable, which main valves should be open or closed);

8.4. changeover conditions from natural to forced convention mode of cooling and vice versa;

8.5. coolant and moderator level;

8.6. emergency core cooling;

8.7. leak detection and loss of coolant alarm limits;

8.8. radionuclide content in the coolant;

8.9. content of fission products in the coolant;

8.10. coolant availability;

8.11. ultimate heat sink.
9. Electric power supply system:
9.1. emergency power supply for all operational states (e.g. configuration of electrical bus-lines, a list of equipment connected to a bus-line, star up and operation of diesel generators or batteries, etc.);
9.2. testing of emergency power supply system.
10. Operational radiation protection:
10.1. type (gaseous, particulate, gamma, neutrons, etc.) and location of radiation monitoring systems;
10.2. Alarm settings for monitoring instruments for radiation (including monitoring instruments for initiating scrams, if any);
10.3. limits to the concentration of radionuclides and other limits on the liquid and gaseous effluents that may be released in a given time period, such as maximun annual releases (site limits may apply where more than one reactor installation is located at the same site);
10.4. dose control values for operation, such as annual dose limits;
10.5. operating limits for surface contamination;
10.6. collective dose for operation;
10.7. criteria for respiratory protection and special protective clothing;
10.8. criteria for bioassay or whole body counting;
10.9. storage capacity for liquid and solid radioactive wastes.
11. Control and management system:
11.1. type and number of items of measuring equipment associated with safety systems;
11.2. startup instrumentation;
11.3. display monitors;
11.4. data acquisition systems;
11.5. requirement for the calibration of instrumentation and its periodic control, including updating of the related documentation.
12. Auxiliary systems and equipment:
12.1. fire protection systems;
12.2. communication systems;
12.3. security equipment;
12.4. cranes (e.g. limitation of manipulation and loading);
12.5. emergency lighting systems.
13. RNI startup and operation:
13.1. completion of inspections and fulfillment of inspection checklists;
13.2. visual inspection of reactor core, horizontal beam tube shutters and biological shielding;
13.3. additional conditions startup following an unintended trip.
14. Other limitations:
14.1. other design features;
14.2. site features;
14.3. administrative controls.