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**FEDERAL RULES AND REGULATIONS
IN THE FIELD OF NUCLEAR ENERGY USE**

**DRY STORAGE OF SPENT NUCLEAR FUEL.
SAFETY REQUIREMENTS**

NP-035-02

Effective
as of January 1, 2003

These Federal rules and regulations "Dry storage of spent nuclear fuel. Safety requirements" regulate safety issues specific for dry storage of spent nuclear fuel as sources of potential radiation impact on the workers (personnel), the public and the environment and establish safety requirements for dry storage of spent nuclear fuel. The regulatory document shall be applicable to designed, constructed, operated and decommissioned dry storage of spent nuclear fuel.

The regulatory document is issued for the first time <*>.

<*> The regulatory document is developed in the Scientific and Technical Center for Nuclear and Radiation Safety of the Federal Nuclear and Radiation Safety Supervision Authority with contributions from V.M. Iryushkin (Gosatomnadzor of Russia), V.A. Starchenko (Scientific and Production Association "Radium Institute n.a. V.G. Khlopin"), M.I. Sysoev (the Russian Ministry of Nuclear Energy), R.B. Sharafutdinov (Scientific and Technical Center for Nuclear and Radiation Safety).

Comments from the following organizations were reviewed and taken into account in development of the regulatory document: Federal Department for Biological, Medical and Extreme Problems of the Russian Ministry of Health, Nuclear Fuel Cycle Department of the Russian Ministry of Nuclear Energy, Safety and Emergency Department of the Russian Ministry of Nuclear Energy, VNIPIET, Mining and Chemical Works, Production Association Mayak, State Scientific Center of the Russian Federation "Institute of Physics and Power Engineering", Scientific and Production Association "Radium Institute n.a. V.G. Khlopin", etc.

The regulatory document is developed on the basis of Federal Law "On nuclear energy use" (Collected Acts of the Russian Federation, 1995, N 48, art. 4552) with due regard for the Federal rules and regulations approved by Gosatomnadzor of Russia, Basic Sanitary Rules for Radiation Safety Assurance (OSPORB-99), Radiation Safety Standards (NRB-99) as well as the IAEA recommendations for design, operation and safety assessment of spent nuclear fuel storage facilities (Safety Series No. 116, 117, 118), etc.

The regulatory document has passed legal examination at the Ministry of Justice of Russia (Letter of the Ministry of Justice of Russia No. 07/6740-UD dated 16.07.2002).

Abbreviations

DSSNF SAR - Safety analysis report for dry storage of spent nuclear fuel

IFA	- Irradiated Fuel Assembly
SNF	- Spent Nuclear Fuel (irradiated fuel assembly or irradiated fuel element)
DSSNF	- Dry storage of spent nuclear fuel
SSCR	- Self-sustained chain nuclear reaction
FE	- fuel element
NFC	- Nuclear fuel cycle

1. GENERAL TERMS AND DEFINITIONS

The following terms and definitions are used for the purposes of this document.

Leak-tight bottle - a leak-tight vessel intended for placement of SNF (IFA or irradiated fuel elements).

Storage pocket - a leak-tight device intended for placement of one or several leak-tight bottles.

Storage compartment - the DSSNF section intended for location of several storage pockets.

Dry storage for SNF - a stationary facility (structure) intended for SNF storage where heat is removed from the SNF via air.

2. PURPOSE AND SCOPE

2.1. The regulatory document "Dry storage facility for spent nuclear fuel. Safety requirements" develops and particularizes the Federal rules and regulations approved by Gosatomnadzor of Russia with regard to safety assurance for DSSNFs located at the NFC facilities and establishes safety requirements specific for DSSNFs as the source of potential radiation impact of the workers (personnel), the public and the environment.

2.2. This document shall be applicable to DSSNFs intended for storage of spent nuclear fuel from power and research reactors and transport power installations with residual heat removal arranged through forced air circulation and (or) natural convection.

2.3. This document shall be applicable to designed, constructed, operated and decommissioned DSSNFs.

2.4. This document shall not be applied to DSSNFs intended for container dry storage of spent nuclear fuel.

3. PRINCIPLES AND CRITERIA OF SAFETY ASSURANCE FOR DRY STORAGE FOR SPENT NUCLEAR FUEL

3.1. The DSSNF meets the safety requirements if its radiation impact on the workers (personnel), the public and the environment under normal operation conditions and in case of any operational occurrences including design basis accidents does not lead to exceedance of the radiation exposure dose limits for the workers (personnel) and the public, norms of radioactive substance releases and discharges and content of radioactive substances in the environment and is also limited in case of beyond design basis accidents.

3.2. The DSSNF safety shall be provided by consistent implementation of the defense-in-depth concept based on the system of physical barriers in the way of ionizing radiation, nuclear material and

radioactive substance propagation to the environment and also the system of technical and administrative measures for protection of the physical barriers and maintenance of their efficiency as well as for protection of the workers (personnel), the public and the environment.

3.3. The DSSNF shall have the system of physical barriers in order to prevent propagation of ionizing radiation, nuclear materials and radioactive substances into the environment.

The system of physical barriers for the DSSNF shall include at least two barriers:

the first barrier - a leak-tight bottle;

the second barrier - a storage pocket.

The purpose and quantity of physical barriers for the DSSNF shall be defined in the design and substantiated in the DSSNF SAR.

3.4. The system of technical and administrative measures shall form the levels of defense-in-depth. The defense-in-depth levels adopted for the DSSNF shall be substantiated in the DSSNF SAR.

3.5. During normal operation of the DSSNF all physical barriers shall be operable and the system of measures for their protection shall be in the state of availability. In case inoperability of any physical barrier or unavailability of any protective measures for the barriers is detected measures shall be taken to prevent potential propagation of ionizing radiation, nuclear materials and radioactive substances to the environment.

3.6. Spent nuclear fuel shall be accepted for storage in the DSSNF only subsequent to its hold-up at the nuclear installation within the time period specified in the DSSNF project and substantiated in the DSSNF SAR.

4. SAFETY ASSURANCE REQUIREMENTS FOR DRY STORAGE FOR SPENT NUCLEAR FUEL

4.1. Safety assurance requirements implemented in design of dry storage facilities for spent nuclear fuel

4.1.1. The site characteristics capable of affecting the DSSNF safety and impact of the DSSNF on the public and the environment shall be studied and assessed in the course of site selection for the DSSNF. The site shall be suitable for location of the DSSNF in case there is the possibility for its safe operation with due regard for natural phenomena, processes and factors of natural and human-induced origin typical for the DSSNF location area.

4.1.2. The DSSNF project shall provide for arrangement of a control system for spent nuclear fuel supplied for storage in order to check the actual SNF characteristics for compliance with the nominal data.

4.1.3. The DSSNF project shall incorporate systems (components) aimed to prevent:

- deviations from normal operation limits;
- deviations from safe operation limits and conditions;
- design basis accidents and mitigation of their consequences.

The design shall provide for the engineering features and (or) administrative measures aimed to mitigate any potential consequences of beyond design basis accidents unless they are eliminated due to

inherent self-protection properties of the DSSNF.

4.1.4. Stability of the DSSNF under any external impacts of natural and human-induced origin typical for the site selected for the DSSNF location and (or) any potential internal impacts occurring in case of design basis accidents shall be substantiated in the DSSNF project and the DSSNF SAR.

4.1.5. The DSSNF project shall provide for normal operation systems (components) including safety-related ones and safety systems (components).

Pertaining of components to the relevant safety classes shall be determined by the DSSNF projector and shall be specified in the documentation for development, manufacturing and supply of the DSSNF systems (components) and in the DSSNF project.

4.1.6. The approximate list of initiating events for design basis accidents and the approximate list of beyond design basis accidents at the DSSNF are given in the Appendix.

The final list of initiating events for design basis accidents and the final list of beyond design basis accidents, their realistic analysis containing consequence assessment for beyond design basis accidents as well as functional analysis for the safety systems shall be presented in the DSSNF project and substantiated in the DSSNF SAR.

4.1.7. The DSSNF project shall determine the cooling method (forced circulation and (or) natural air convection) eliminating any possibility for the SNF temperature increase above the values specified in the design for normal operation conditions and design basis accidents. In selection of the SNF cooling method preference shall be given to the cooling method with natural air convection.

4.1.8. The DSSNF ventilation systems shall prevent contamination of air in the rooms and the environment with radioactive substances and maintain the conditions required for normal operation of the equipment. Separate ventilation of non-attended rooms, periodically attended rooms and rooms with permanent stay of the workers (personnel) shall be provided in the DSSNF project.

Cooling systems of the SNF storage compartments shall be separated from the ventilation systems of the DSSNF building and shall prevent any ingress of air from the SNF storage compartments to periodically attended rooms and rooms with permanent stay of the workers (personnel).

4.1.9. All potential sources of continuous and periodic ingress of radioactive gases and aerosols to the process venting systems and to the air in the rooms shall be taken into consideration in the DSSNF project.

Air flows containing radioactive gases and aerosols generated in the course of the DSSNF operation shall be subject to treatment so that the content of radioactive substances in periodically attended rooms and rooms with permanent stay of the workers (personnel) and also in the DSSNF releases under normal operation conditions and in case of any design basis accidents would not exceed the limits established in the Federal rules and regulations in the area of nuclear energy use.

4.1.10. The DSSNF project shall provide for fire and explosion safety assurance in accordance with the requirements of Federal rules and regulations in the area of nuclear energy use and any other regulatory documents.

The DSSNF project shall provide for the measures aimed to prevent the possibility for SSCR occurrence in case of a fire and during fire extinguishing.

4.1.11. The possibility for remote actuation of safety systems and manual operation of valves in situ shall be provided in the DSSNF project. Any failure in the automatic actuation circuit shall not prevent remote actuation of the components and performance of safety functions. Impact on the minimal number of control elements shall be sufficient for remote and manual actuation.

4.1.12. Lists of controlled parameters of the systems (components) and equipment shall be presented and substantiated in the DSSNF project.

Power supply of the control systems within the scope substantiated in the DSSNF project shall be provided under normal operation conditions and in case of any operational occurrences and design basis accidents including complete blackout.

4.1.13. The DSSNF project shall provide for radiological control in the DSSNF rooms, at its location site, in the sanitary-protective area and the supervised area. The scope of radiological control shall be defined in accordance with the requirements of Federal rules and regulations in the area of nuclear energy use, sanitary rules and standards and hygienic regulations.

The design shall include the systems for continuous and periodic monitoring of radioactive substance content in the air of the DSSNF rooms and in the DSSNF releases and discharges.

4.1.14. The scope, methods and means of radiological control at the DSSNF shall ensure:

- control of exposure level for the workers (personnel);
- timely detection of any radiation situation changes in the DSSNF rooms, at the site, in the sanitary-protective area and the supervised area.

The DSSNF project shall also provide for the use of:

- the system for compulsory dosimetric monitoring of the workers (personnel);
- the radiological control system for vehicles and materials on the DSSNF site border;
- metrologically validated measuring means and methods;
- acoustic and light alarms in case of any radiation situation deterioration.

4.1.15. Nuclear safety of the DSSNF shall be ensured by:

- limitation of the interval between leak-tight bottles and storage pockets in the SNF storage compartments;
- control of the position of leak-tight bottles and storage pockets in the SNF storage compartments unless it is fixed due to design of the storage compartment equipment with restriction of any possible movements of leak-tight bottles;
- monitoring of the parameters of any systems (components) affecting nuclear safety in the course of SNF handling.

4.1.16. The effective neutron multiplication factor K_{eff} shall not exceed 0.95 under normal operation of the DSSNF and in case of any design basis accidents. The DSSNF project shall substantiate sub-criticality assurance for the SNF storage compartments under normal operation conditions and in case of design basis accidents; the relevant design or experimental values of K_{eff} for the SNF storage compartment and the SNF handling and transportation operations shall be provided.

Compliance with the nuclear safety requirements shall be reflected in the DSSNF project and substantiated in the DSSNF SAR on the basis of conservative approach. Nuclear safety analysis shall be performed with due regard for the conditions when the SNF storage and handling systems have the maximum K_{eff} .

Calculations of K_{eff} shall be performed in accordance with validated programs.

4.1.17. The DSSNF design shall ensure nuclear safety due to:

- SNF location with definite grid spacing;
- SNF deployment only in the areas designated in the DSSNF project;
- prevention of any uncontrollable spontaneous movements of the equipment in the course of SNF handling.

The DSSNF layout shall prevent any ingress of neutron moderating materials to the SNF storage compartments.

4.1.18. The DSSNF project shall ensure complete radiation protection against any SSCR consequences in accordance with the requirements of regulatory documents. Nuclear-hazardous areas where any deviations from nuclear safety conditions are not eliminated by design shall be equipped with the emergency alarm system.

4.1.19. The DSSNF project shall provide for safe handling of spent nuclear fuel in all DSSNF operation modes as well as for the engineering features and administrative measures aimed to prevent any accidents.

4.1.20. The DSSNF project shall provide for the following:

- the radiological control system in the room for unloading of the SNF transport packings and the system of protections and interlocks aimed to ensure safety of the workers (personnel) in the course of handling works;
- prevention of radiation contamination of the railway track and carriages (motorway and motor vehicles) during unloading of the SNF transport packings and the possibility for their decontamination in case of radioactive contamination;
- hoisting and transportation equipment for SNF handling, its maintenance and repair;
- engineering features for storage and handling of leaky and defective IFAs (irradiated fuel elements).

4.1.21. Transportation of spent nuclear fuel within the DSSNF site shall be arranged along the shortest safe routes. Transportation and handling equipment shall prevent falling of any transport packing or leak-tight bottle with spent nuclear fuel under normal operation conditions and also damages of any transport packing or leak-tight bottle with spent nuclear fuel capable of causing an accident. Movement of any loads above the stored spent nuclear fuel shall be prevented unless they are parts of transportation and handling equipment.

4.1.22. The processes incorporated in the DSSNF project shall be motorized and automatized with the possibility for remote control.

4.1.23. All processes taking place in the structures and structural materials of the DSSNF and in SNF under normal operation conditions and in case of any design basis accidents including corrosion, creep, fatigue, settlement, ageing, radiation-induced changes and any other potential processes shall be taken into account in the DSSNF project.

4.1.24. The DSSNF project shall provide for the equipment layout ensuring convenience of the workers (personnel) in the course of its operation, maintenance, monitoring and decontamination. The DSSNF layout shall enable urgent evacuation of the workers (personnel) from their workplaces in case of any accidents.

4.1.25. Structural materials and coatings of the DSSNF pipelines, equipment and rooms shall have

minimum radionuclide absorption capacity, resistance to corrosion under the impact of decontamination solutions, radiation and thermal stability and also shall be easy to decontaminate.

4.1.26. The DSSNF project shall include the methods and means for:

- decontamination of the rooms and equipment;
- elimination of any emergency radioactive contaminations of the rooms and equipment;
- handling of SNF spillages, damaged IFAs and damaged irradiated fuel elements.

4.1.27. The DSSNF project shall provide for the following:

- physical protection system for the DSSNF and SNF;
- SNF record and control system.

4.1.28. The DSSNF project shall provide for safe management of radioactive wastes.

4.1.29. The DSSNF operating life shall be defined and substantiated in the DSSNF project, and the DSSNF equipment lifetime shall be specified.

The DSSNF project shall provide for SNF withdrawal from storage compartments.

4.1.30. The system of DSSNF safety technical and administrative measures shall be presented and substantiated in the DSSNF SAR.

4.2. Safety assurance in operation of dry storage for spent nuclear fuel

4.2.1. The operating organization shall establish the required organizational structure for safe operation of the DSSNF.

4.2.2. The operating organization shall ensure continuous supervision over all safety-related activities in the DSSNF and submit regular (annual) safety assessment reports for the DSSNF to Gosatomnadzor of Russia.

4.2.3. Prior to commissioning for pilot operation the DSSNF shall be staffed with the workers (personnel) having the required proficiency level and duly admitted to unsupervised works.

4.2.4. The operating organization shall provide selection, training, admittance to unsupervised works and proficiency maintenance for the workers (personnel). The personnel selection and training system at the DSSNF shall be aimed to achieve, control and maintain the relevant proficiency level for safe operation of the DSSNF and also for performance of all actions aimed at mitigation of any accident consequences.

Formation of safety culture in the workers (personnel) shall be an integral part of the training.

4.2.5. Technical training aids shall be used in the personnel training system in order to exercise practical skills of the DSSNF operation. Special attention shall be paid to drilling of the actions in case of any operational occurrences (including accidents) and consideration of the previous errors and accidents.

4.2.6. Pre-commissioning works shall confirm that the entire DSSNF as well as its systems (components) and equipment are arranged and functioning in accordance with the design and any revealed defects are eliminated.

4.2.7. Operability of the systems (components) shall be verified, and condition of metal and weld joints of the DSSNF systems (components) and equipment shall be controlled prior to commissioning of the DSSNF and also regularly in the course of the DSSNF operation in accordance with the requirements of the design and regulatory documents. The scope and frequency of regular inspections shall be defined in the schedules developed in accordance with requirements of the regulatory documents.

4.2.8. Process regulations containing rules and basic techniques of safe operation, the general procedure for safety-related operations as well as safe operation limits and conditions shall be the main documents regulating safe operation of the DSSNF.

The operating organization shall arrange development of the process regulations based on the design documentation in accordance with the DSSNF SAR.

4.2.9. Operation manuals for the DSSNF systems (components) and equipment shall contain specific instructions for the workers (personnel) related to work practices in the course of normal operation and in case of any operational occurrences including accidents. The manuals shall be updated subsequent to the DSSNF commissioning results.

4.2.10. Maintenance, repair, testing and inspections shall be provided in order to maintain operability of the DSSNF systems (components) and equipment and prevent any dangerous failures in the systems. The above-mentioned works shall be performed in accordance with the relevant guidelines, programs, schedules and flow sheets developed by the operating organization on the basis of the design requirements and process regulations and shall be documented. The DSSNF safety conditions established in the process regulations shall be observed in the course of maintenance, repair, testing and verification of the systems (components) and equipment.

4.2.11. Collection, processing, analysis, systematization and storage of information on any failures of systems (components) and erroneous actions of the workers (personnel) shall be arranged in the course of the DSSNF operation. Results of analysis and systematization of the above-mentioned information shall be included into the regular reports developed by the operating organization.

The operating organization shall arrange collection, systematization and reliable storage of information required for the DSSNF decommissioning in the course of the DSSNF operation.

4.2.12. Action plans for protection of the workers (personnel) and the public in case of any accident at the DSSNF shall be developed and ready for implementation prior to commencement of the DSSNF operation. The main and redundant lines for communications with any organizations specially authorized in protection of the public and territories against emergencies shall be implemented prior to commencement of the DSSNF pilot operation in accordance with the plans for protection of the workers (personnel) and the public.

4.3. Safety assurance in decommissioning of spent nuclear fuel dry storage facilities

4.3.1. Future decommissioning of the DSSNF shall be taken into account when designing the DSSNF project, operation, maintenance and repair of the DSSNF systems (components) and equipment. The procedure and measures for the DSSNF decommissioning shall be incorporated in the DSSNF project.

4.3.2. Any DSSNF where acceptance of spent nuclear fuel is stopped in order to prepare for the DSSNF decommissioning shall be deemed to be in operation till SNF removal from the DSSNF. All safety assurance requirements imposed on an operating DSSNF shall be applicable to it within this period.

Reduction of maintenance scope and the personnel size shall be arranged in accordance with the requirements specified in the design and substantiated in the DSSNF SAR.

4.3.3. The operating organization which has made the decision on the DSSNF decommissioning shall arrange development of the DSSNF decommissioning program.

4.3.4. Integrated survey of the DSSNF shall be performed prior to the DSSNF decommissioning by the commission appointed by the operating organization. The operating organization shall develop the DSSNF decommissioning project and prepare the safety analysis report for the DSSNF decommissioning based on the results of the integrated survey.

Appendix

1. Approximate list of initiating events for analysis of design basis accidents

1.1. External impacts of natural origin typical for the DSSNF location area (floods, hurricanes, etc.). The safe shutdown earthquake (SSE) shall be considered in the analysis of seismic phenomena.

1.2. External impacts of human-induced origin (air shock wave due to any explosion at the adjacent facility, passing-by transport, etc.).

1.3. Total loss of the DSSNF power supply.

1.4. Fire at the DSSNF.

1.5. Falling of irradiated fuel assemblies or irradiated fuel elements, leak-tight bottles with spent nuclear fuel, transport packings with spent nuclear fuel in the course of transportation and handling operations.

1.6. Human errors.

1.7. Generation of explosive mixtures in the DSSNF.

1.8. Failures of the SNF handling system equipment.

1.9. Failure of the SNF cooling system.

2. Approximate list of beyond design basis accidents

2.1. SSCR occurrence.

2.2. Falling of process equipment and building structures on the roof of the SNF storage compartments.

2.3. Airplane crash.

3. The following possibilities shall be considered in the analysis of initiating events specified in par. 1 and 2 of this Appendix:

- rearrangement of irradiated fuel assemblies or irradiated fuel elements in the storage compartments resulting in increase of K_{eff} ;

- any changes in the geometry of irradiated fuel assemblies and irradiated fuel elements (bending, flattening, etc.) and also change of the interval between irradiated fuel elements in the IFA resulting in increase of K_{eff} .
