TCP 565-2015 (33130)

TECHNICAL CODE
OF COMMONPRACTICE

SAFETY RULES FOR NUCLEAR POWER PLANT RADIOACTIVE WASTE MANAGEGEMENT

ПРАВІЛЫ БЯСПЕКІ ПРЫ АБЫХОДЖАННІ З РАДЫЕАКТЫЎНЫМІ АДХОДАМІ АТАМНЫХ ЭЛЕКТРАСТАНЦЫЙ

The present draft technical code shall not be subject to use prior to its approval

The Ministry of Emergency Situations of the Republic of Belarus

Minsk

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Key words: nuclear power plant, gaseous radioactive waste, liquid radioactive waste, radioactive waste management systems, solid radioactive waste

Foreword

Aims, basic principles, provisions of governmental regulation and management in the sphere of technical rate setting and standardization are established by the Law of the Republic of Belarus “On technical rate setting and standardization”.

1 DEVELOPED by “The United Institute for Energy and Nuclear Research – Sosny” of NAS Belarus State Scientific Institution

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ПРАВІЛЫ БЯСПЕКІ ПРЫ АБЫХОДЖАННІ З РАДЫЕАКТЫЎНЫМІ АДХОДАМІ АТАМНЫХ ЭЛЕКТРАСТАНЦЫЙ

Safety rules for nuclear power plant radioactive waste management

Effective date: 2015-08-01

1 Scope of application

1.1 The present technical code of common practice (hereinafter: technical code) establishes the principles and requirements for maintaining safety when handling nuclear power plant radioactive waste at production sites which are the source of potential radioactive impact on employees (personnel), inhabitants and environment.

1.2 The present technical code covers the nuclear power plants in the process of designing, under construction, in operation and being put out of operation.

2 Normative references

In the present technical code references to the following technical regulatory legal acts in the sphere of technical rate setting and standardization (hereinafter: Acts) are made:

TCP 170-2009 (02300) General safety precautions for nuclear power plants

TCP 171-2009 (02300) Nuclear safety regulations for reactor plants of the nuclear power plants

TCP 294-2010 (02300) Requirements to the contents of safety analysis report for a nuclear power plant with VVER type reactor

Note. When using this technical code it is reasonable to check the effect of the Acts according to a catalogue made as of January 1 of the current year and corresponding informational indices published the current year.

In case the referential Acts are substituted (amended), one should be governed by the substituted (amended) Acts when using this technical code. If the referential Acts are canceled without any substitution, the clause containing a reference to them shall be used in the part not containing this reference.

3 Terms and definitions

In the present technical code the terms established in [1-7], TCP 170, TCP 171, TCP 294 are used, as well as the following terms with the corresponding definitions:

3.1 barrier: An obstacle on the path of ionizing radiation, radioactive substance (radionuclides) propagation into environment. Barriers are leak-tight enclosures of departments and depositories, containers, equipment and pipelines containing radioactive waste, physical-chemical form of conditioned radioactive waste.

3.2 radioactive waste solidification: transformation of liquid radioactive waste into the solid aggregate state in order to restrict migration of radionuclides into environment.

3.3 gaseous radioactive waste: Radioactive waste in the form of aerosol sprays, inactive gases, vapours of iodine and its compounds.

3.4 liquid radioactive waste: Radioactive waste in the form of liquid products (aqueous or organic) or pulps containing radionuclides in the form of dissolved or suspended matter.

3.5 solidified radioactive waste: Liquid radioactive waste transformed into solids.

3.6 solid radioactive waste: PRadioactive waste in the form of the solid matter.

3.7 **radioactive waste management systems:** Technological systems for collection and (or) storage and (or) recycling and (or) conditioning and (or) transportation of radioactive waste.

4 Conventional signs and abbreviations

The following conventional signs and abbreviations are used in this technical code:
GRW – gaseous radioactive waste;
LRW – liquid radioactive waste;
NPP – nuclear power plant;
RAW – radioactive waste;
RLA – regulatory legal acts;
SRW – solid radioactive waste.

5 Basic safety principles of handling nuclear power plant radioactive waste

5.1 At handling NPP RAW any exposure of employees (personnel) and population should be narrowed down to the reasonably achievable low level, taking into account both maximum permissible doses [1, 3-7] and economic and social factors.

5.2 Safety at handling RAW shall be achieved by the consistent observance of the defence-in-depth principle.

5.3 The barrier system at handling NPP RAW shall include the physical-chemical form of conditioned RAW, leak-tight enclosures of departments and depositories, walls of vessels (equipment), caskets and pipelines containing RAW.

5.4 Administrative and technical activities at handling NPP RAW include:

- basing on prudent approach, designing RAW management systems which guarantee safety at RAW collection, recycling, conditioning, transportation and storage;
- quality production of equipment, pipelines and other elements of RAW management systems;
- attending personnel recruitment and adequate level of its training.

5.5 Under normal operating conditions, all barriers and their protection means shall be in good operating condition and meet the specified requirements.

5.6 RAW management systems shall provide for collection, deactivation, recycling, conditioning and storage of RAW which are the result of normal operation in all the modes and at NPP design basis accidents.

5.7 NPP RAW are classified by radionuclide composition, specific activity rate, physical and chemical properties and recycling modes.

Waste labeling as radioactive, its classification, requirements to radioactive waste management shall be performed according to the criteria specified by certain RLA, including TRLA.

5.8 According to its aggregate state, RAW is broken down into liquid, solid and gaseous.

5.9 LRW is classified depending on the physical and chemical properties:

- homogeneous and heterogeneous;
- organic (oils, oil-in-water emulsions, detergent solutions);
- nonorganic, including low-salt aqueous solutions (salt concentration less than 1 g/l), high-salt aqueous solutions (salt concentration more than 1 g/l).

5.10 SRW is classified depending on:

- recycling modes: entitled to pressing (compressible), entitled to burning (incinerable), entitled to remelting (remeltable), entitled to grinding (grindable) and unrecyclable;
- fire hazard: flammable and inflammable.

SRW presorting shall be performed on the basis of criteria specified in RLA, including TRLA in the field of nuclear and radioactive safety. The criteria concern the level of radioactive contamination and gamma-radiation intensity at 0.1 m from the surface.

6 Basic safety requirements observed at designing nuclear power plant radioactive waste management systems

6.1 General requirements

6.1.1 RAW management systems shall be designed according to the safety requirements presented in this technical code.

6.1.2 Design documents shall provide for safety and reliable management of RAW of all types generated in all NPP operating modes, including design basis accidents at NPPs and decommissioning.

6.1.3 Zero-waste and (or) low-waste technologies and closed technological cycles shall be used when choosing RAW recycling methods.

6.1.4 Design documents shall provide for division of RAW management systems and cold systems.

6.1.5 Design documents shall determine:

- sources of generation, quantity, physical-chemical properties and radionuclide composition of GRW, LRW and SRW;
- annual planned and accidental quantity of generated GRW, LRW and SRW, their activity per specific radionuclides;
- RAW separation and sorting methods;
- RAW management system selection justification, including RAW conditioning;
- RAW chemical and radionuclide composition control methods, conditioned RAW physical-chemical form quality control methods;
- safety barrier reliability justification;
- RAW management system safe operating conditions and actions to be taken in case of their violation.

6.1.6 Design documents shall provide the possibility of direct total control of RAW management systems for their compliance with the design characteristics.

6.1.7 Design documents shall provide for:

- separation of cold waste and RAW at sorting;
- representational sampling at all stages of RAW and cold waste handling;
- reliable and safe storage of reagents for RAW recycling;
- fire and explosion safety precautions at all stages of RAW handling;
- radiation survey at all stages of RAW handling.

6.1.8 RAW management system equipment and pipeline design and arrangement shall provide for the possibility of their inspection, repair, hydraulic (pneumatic) tests, metal and welded joints after production (assembly) and in the process of operation, equipment and pipeline replacement.

It is required to ensure:

- leakage and spillage collection which eliminates radioactivity penetration beyond the barriers;
- minimum possible pipeline length and minimum possible amount of armature, welded and detachable joints;
- absence of nondrained stagnant zones;
- devices for flushing the pipelines transporting radioactive high-salt solutions, resins, slimes and other similar substances.

6.1.9 Design documents shall provide for the possibility of deactivation, dismantlement and removal of equipment and pipelines.

6.1.10 RAW management systems shall be equipped with control and management facilities which make it possible to monitor technological process, effectively control them and counteract any unmanageable penetration of radionuclides into environment at all design basis conditions. For this, design documents shall provide for:

- making records of all parameters necessary to control and monitor the processes;
- warning and alarm signaling, relevant blocking and protective systems;
- automated startup, operations and shutdown control of equipment and system components.

6.1.11 Design documents shall provide for safe and reliable RAW storages and specify reasonable retention periods for unconditioned and conditioned RAW in storages.

In normal operating conditions and at design basis accidents, the storage design shall prevent radionuclide penetration into environment in amounts exceeding the levels stated in design documents according to RLA, including TRLA in the field of nuclear and radiation safety.

6.1.12 Design documents shall specify conditions for RAW safe transportation within the NPP site, including:

- lifting and conveying equipment use, maintenance, revision, repair and deactivation;
- use of radioprotection means;
- survey of gamma-radiation intensity and surface contamination by short-range nuclide emitting RAW packages;
- use of special vehicles for RAW transportation;
- RAW transportation on the shortest itineraries according to the technological layout of transportation within the NPP site.

6.1.13 Design documents shall provide for the possibility of conditioned RAW transportation for storage and (or) disposal outside the NPP site.

6.1.14 Design documents shall provide for use of certified unified containers for conditioned RAW.

Container structures and constructional materials shall have the mechanical strength and corrosion stability (internal and external) sufficient to guarantee the integrity of RAW forms at its transportation within the NPP site and storage at the NPP within the period of time specified in design documents, as well as RAW transportation for long-term storage and (or) disposal.

6.1.15 RAW packages shall have:

- radiation precaution sign;
- NPP code or denomination;
- RAW package individual number;
- container certification data ;
- date of RAW package manufacture.

RAW package transportation accompanying certificate shall comply with the requirements specified in [8].

6.1.16 Gamma-radiation intensity rate on RAW package and RAW package surface contamination rate are subject to RLA, including TRLA in the field of nuclear and radiation safety.

6.1.17 At designing, the possibility of RAW management systems decommissioning shall be taken into account.

6.1.18 In design documentation the following data shall be determined and justified: permissible quantity of liquid and solid radioactive waste stored in NPP site, its radionuclide composition, LRW and SRW activity rates, places (departments, depositories) of storage, retention periods.

6.2 Liquid radioactive waste management systems

6.2.1 LRW collection, deactivation, recycling, storage and conditioning shall comply with the requirements of the present technical code and other RLA, including TRLA in the field of nuclear and radiation safety which regulate safety assurance at handling LRW.

When designing LRW management systems, the following shall be provided:

- eliminate water discharge or reasonably minimize debalance water discharge by its utmost use for NPP technological needs;
- prevent NPP process media contamination with radioactive waste;
- avoid uncontrolled tipping of radioactive substances from NPP into water bodies, subterranean waters (wells, boreholes, shafts and others), onto the ground (the lie of the ground) and into the systems of domestic, production sewage and storm water drainage;
- purification of all discharges from NPP which can result in radioactive buildup in environment above the limits specified in RLA, including TRLA in the field of nuclear and radiation safety;
- organized collection and separate temporary storage of all liquid radioactive waste generated by NPP depending on its massic activity, chemical nature and phase state;
- availability of a system of tanks for LRW storage. Tank design and constructional materials shall ensure the working lifespan no less than that of NPP. The tank volume shall provide for 3-month technological seasoning of LRW (not less) till its recycling for decay of short-lived radionuclides;
- availability of recycling systems for all LRW with the aim of its volume contraction and conditioning.

6.2.2 Tanks for LRW storage shall be equipped with:

- pipelines and armature for LRW reception, LRW forwarding for recycling and (or) conditioning, full discharge;
- inspection and measuring devices for in-process monitoring temperature, pressure, level, tank higher level signaling, including LRW leak control;
- sampling systems for sampling throughout the tank height;
- devices for dispersing and discharging slimes (scales) and sediments;
- equipment and pipelines for pumping solutions, slimes, sorbents and resins from one tank into another;
- devices for preventing LRW transfer from tanks to compartments;
- process vent for prevention of explosive hydrogen concentration generation in tank outage;
- means of hydrogen concentration inspection and alarm system signaling about the presence of hydrogen in tank outage;
- devices preventing tank damage in case of tank overpressurization or vacuuming.

Tank design shall provide for leak detection and repair works.

6.2.3 Compartments for LRW storage tanks shall have no less than three-layer insulation and stainless steel coating. Coated compartments shall hold all the amount of LRW in tanks. State of coating metal and welded joints is subject to periodical non-destructive inspection. Inspection scope and periodicity are specified in design documents according to RLA, including TRLA in the field of nuclear and radiation safety.

6.2.4 The distance between LRW tank bottom level and ground water level shall be justified basing on the condition of infeasibility of ground water pollution. Monitoring boreholes for ground water sampling shall be situated around compartments with LRW storage tanks. Their number and location shall be justified in design documents taking into account the conditions of NPP site positioning.

6.2.5 Compartments for LRW tanks storage shall have:

- tank leakage alarm;
- leakage collection and return system;
- ventilation;
- deactivation facilities;
- radiation control (gamma radiation intensity rate).

6.2.6 In LRW storage tanks water chemistry shall be maintained, which ensures their safe and reliable use within the period of NPP life extension specified in design documents, including decommissioning.

6.2.7 Design documents shall provide for reserve tanks for LRW resulting from accidents. Minimum reserve volume of those tanks shall be justified in design documents. Reserve tanks and compartments for their location shall meet the same requirements as main tanks.

6.2.8 Design documents shall provide for monitoring the LRW state at all stages of their handling, including:

- radiation and process control of all discharges from NPP into environment;
- inspection of LRW arriving at the places of collection and temporary storage;
- inspection of LRW arriving for recycling and conditioning;
- conditioned LRW quality control;
- conditioned LRW activity and radionuclide composition inspection.

6.3 Solid radioactive waste management systems

6.3.1 SRW collection, deactivation, recycling, storage and conditioning shall be performed according to the requirements of the present technical code and other RLA, including TRLA in the sphere of nuclear and radiation safety which regulate safety assurance at SRW handling.

Design documents for SRW management systems shall provide for:

- separate collection of cold and radioactive waste in special places out of the controlled access zone;
- SRW collection at specialized compartments;
- SRW sorting according to their classification;
- use of containers, lifting and conveying equipment and special vehicles for SRW transportation.

6.3.2 Design documents shall provide for equipment for pressing the compressible SRW, burning the ignitable SRW, shredding (cutting) the bulky SRW and joint grouting the fine and dusty SRW.

6.3.3 Design documents shall provide for storages for unconditioned and conditioned SRW. Storage barriers shall prevent radionuclides penetration into environments above the limits specified in RLA, including TRLA in the field of nuclear and radiation safety at normal operation, design basis accidents and decommissioning.

At storage designing, the following shall be provided:

- the equipment for picking unconditioned SRW out of storages;
- the possibility of conditioned SRW packages inspection, revision and picking out of storages;
- if necessary, possibility of repacking damaged SRW packages;
- the remote control of SRW packages transportation in case of increased gamma radiation intensity;
- the drainage system for leakage collection;
- maintaining SRW storage environmental conditions within tolerable limits;
- possibility to increase storage capacity or to construct additional storages;

- separate SRW positioning according to the classification;
- SRW packages positioning in specified storage places with identified position.

Storage conditions shall not cause SRW packages damage and alteration of conditioned SRW form and solidified conditioned RAW.

6.3.4 Design documents shall provide for radiation and in-process inspection of RAW state at all stages of handling, including inspection of:

- SRW sorting according to its classification;
- SRW arriving for recycling;
- conditioned SRW quality;
- conditioned solidified SRW quality;
- conditioned RAW activity and radionuclide composition;
- conditioned solidified RAW activity and radionuclide composition.

6.4 Gaseous radioactive waste management systems

6.4.1 GRW management systems shall provide for gas cleaning from radioactive aerosols, inactive gases, iodine vapours and compounds.

At designing, all the possible sources of permanent and periodical GRW penetration into process vent systems and vented compartment air shall be taken into account.

6.4.2 Design documents for GRW management systems shall provide for:

- maximum possible radionuclide reduction in GRW;
- organized process vents. GRW flow integration shall be justified;
- process vent cleaning from radioactive gases and aerosols before discharge into air. GRW cleaning system throughput and effectiveness of the methods used shall be justified and shall exclude the possibility of excess radioactive discharge at all operating modes and at design basis accidents at NPP;
- gas cleaning systems activated at design basis accidents at NPP (emergency gas treatment systems) in order to prevent increase of allowable level of radioactive discharge into atmosphere;
- organized discharge of process vents after their cleaning and (or) ageing into tall ventilation chimneys, airflow and exhaust air massic activity uninterrupted monitoring;
- possibility of fabrication of local gas cleaning systems;
- the periodical control of the performance of the gas cleaning systems;
- quality control of equipment of gas cleaning systems (filters, adsorbers etc.) before their installment into gas cleaning systems;
- means and methods of periodical inspection of correspondence of gas cleaning operating equipment to technical characteristics;
- means and methods of preventing generation of combustible hydrogen concentrations (hydrogen afterburning, inactive gas delusion) in GRW management systems.

7 Safety requirements at operating nuclear power plant radioactive waste management systems

7.1 RAW management systems shall be operated according to regulations and instructions elaborated in accordance with design documents and RAW management layout elaborated according to [9].

7.2 Prior to power unit startup at NPP, conditions for RAW collection, recycling, conditioning, transportation in volumes planned in design documents shall be provided, including transformation of liquid radioactive waste into solidified form in accordance with RLA requirements, including TRLA in the field of nuclear and radiation safety.

7.3 An operating body shall elaborate a quality assurance programme at RAW handling in the framework of the general programme of quality assurance.

7.4 At NPP operation, the operating body shall:

- provide for effective management of all types of activities connected to operation and maintenance of RAW management systems aimed at prevention of accidents and timely RAW recycling, which excludes their unplanned accumulation;
- prevent unconditioned RAW storage if not provided by design documents;
- operate NPP with minimum RAW generation, both in their activity rate and their quantity;
- provide for decrease of generated RAW;
- enhance safety and personnel qualification, carrying out the relevant organizational arrangements;
- elaborate instructions and regulations on RAW management;
- lay down the norms of LRW and SRW generation and periodically revise them in accordance with the order specified by the operating body, taking into account the positive experience in handling RAW;
- annually analyze the safety of handling RAW;
- prevent spontaneous discharges into atmosphere and radioactive waste disposal from NPP into water objects, subterraneous waters (wells, boreholes, shafts and others), onto the ground surface (terrain relief), into household, production and storm water sewage systems.

7.5 On the NPP site, RAW shall be transported:

- by special means of transportation;
- by the itineraries specified in the design according to the technological layout of transportation on NPP site;
- in special transport containers, taking into account RAW mass and overall dimensions, their physical state, activity, radiation type and dose rate intensity on the container outer surface.

7.6 Outside the NPP site RAW shall be transported according to RLA, including TRLA in the field of nuclear and radiation safety and transportation of dangerous materials.

7.7 At NPP operation, RAW in-process inspection and radiation survey on all the routes of possible radioactivity penetration from RAW management systems shall be provided. RAW in-process inspection results shall be registered and recorded.

7.8 The operating body shall submit the information on RAW into the unified state system of accounting and control of ionizing radiation sources according to [10].

и The operating body shall provide for annual RAW accounting and control. The accounting documents shall contain the following data:

- RAW characteristics according to classification;
- RAW quality and quantitative composition;
- RAW source and place of generation;
- RAW quantity according to classification;
- recycling methods;
- RAW collection and packaging date;
- type of RAW packaging;
- RAW packaging and identification sign;
- RAW package surface contamination;
- RAW (RAW package) storage place;
- RAW (RAW package) position in depository;
- RAW (RAW package) massic activity and radionuclide composition, date of measuring;
- officials and executives, carrying out RAW management;

- date of RAW transportation for long-term storage and (or) disposal outside the NPP site;
- RAW quantity transported for long-term storage and (or) disposal. According to RLA requirements, including TRLA in the field of nuclear and radiation safety, once in 5 years the operating body shall provide for RAW inventory by checking the factual availability and comparing the evidence with the data of accounting documents.

At NPP normal operation, its radiation effect on population and environment by each of the ways (gas-aerosol emissions, liquid effluents) shall be limited to the minimum significant dose (10 μSv per year) according to [4].

Permissible emissions and effluents calculated on the basis of minimum significant doses shall be specified for a NPP as a whole, notwithstanding the number of blocks in operation on the site.

7.11 The operating body shall:

- provide for an effective system for registration, maintenance and keeping of documents on RAW handling;
- draw up a plan of measures of protection of employees (personnel) and population from radiation accidents and their consequences, taking into account possible accidents in RAW management systems;
- timely inform the national bodies of state administration regulating activities aimed at ensuring the safe application of atomic energy about violations in operation of RAW management systems and accidents resulting in contamination of work space, NPP site and environment;
- submit the information on ensuring safety at RAW management to the republican bodies of state administration regulating activities aimed at safe application of atomic energy, in the scope and form prescribed by the said bodies.

Bibliography

[1] Law of the Republic of Belarus *On the Radiation Safety of the Population* of January 5, 1998 No 122-3

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

[3] Nuclear and Radiation Safety Rules *Radioactive Waste Handling Safety. General Provisions.*
Approved by Regulation of the Ministry of Emergency Situations of the Republic of Belarus of September 28, 2010 No 47

[4] Sanitary Norms and Rules
Requirements to the Radiation Safety.
Approved by Regulation of the Ministry of Health of the Republic of Belarus of December 28, 2012 No 213

[5] The Hygienic Standard
Radiation Impact Estimation Criteria.
Approved by Regulation of the Ministry of Health of the Republic of Belarus of December 28, 2012 No 213

[6] Sanitary Norms and Rules *Requirements to the Radiation Safety of Personnel and Population When Using Nuclear Energy and Radiation Sources*

Approved by Regulation of the Ministry of Health of the Republic of Belarus of December 31, 2013 No 137

[7] Sanitary Norms, Rules and Hygienic Standards
Hygienic Requirements Nuclear Plant Design and Operation.
Approved by Regulation of the Ministry of Health of the Republic of Belarus of March 31, 2010 No 39

[8] The Form of the Radioactive Waste Transportation Accompanying Certificate and the Instruction How to Fill the Certificate in.
Approved by Regulation of the Ministry of Emergency Situations of the Republic of Belarus of April 30, 2009 No 20

[9] The Instruction on the Procedure of the Development, Adjustment and Approval of the Radioactive Waste Handling Scheme.
Approved by Regulation of the Ministry of Emergency Situations of the Republic of Belarus of April 30, 2009 No 21

[10] The Regulation on the Procedure of the State Registration of Ionizing Radiation Sources and the Establishment of the Uniform State System for the Accounting and Control of Ionizing Radiation Sources.
Approved by Regulation of the Council of Ministers of the Republic of Belarus of April 30, 2009 No 562.

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