**TECHNICAL CODE OF COMMON PRACTICE**

**TCP 097-2007 (02300)**

**Siting of Nuclear Power Plant**

# MAIN CRITERIA AND DEMANDS TO THE SAFETY

**Official Edition**

**Ministry of the Emergency Situations of the Republic of Belarus**

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## Foreword

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

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

INTRODUCED BY the Ministry of Energy of the Republic of Belarus

2 APPROVED BY order of the Ministry of the Emergency Situations of the Republic of Belarus of September 17, 2007 No 139

3 FIRST EDITION (canceling Requirements to Nuclear Plants Siting, approved by protocol of the Bureau of Fuel and Energy Complex of the Cabinet of Ministers of the USSR of October 22,1987 No 14. Effective from December 1, 1987)



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# Content

# Introduction

The safe development of the nuclear power engineering industry shall be provided for due to:

- justified siting of a nuclear plant;
- the nuclear plant project quality;
- high-quality technological processes implementation;
- the operational staff quality level;
- supervision bodies quality level;
- area zoning around the nuclear plant;
- radiation control system availability;
- planning and executing radiation safety measures for its normal operation, its restructuring, decommissioning and radiation accident.

Siting a nuclear plant is a most important thing for the safe development of the nuclear power engineering industry; the process of siting is a multifactor task related to the study of the nuclear plant impact on the environment and the environmental impact on the nuclear plant.

Therefore, the decision about the nuclear plant site selection shall include the accounting for prohibitive factors (preventing the construction of a nuclear plant) and limiting factors (abusing which may badly affect the safety of a plant operation).

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

- regulation of the Council of Ministers of the Republic of Belarus *On the Approval of the List of the State Scientific and Technical Programs for 2006 – 2010* of January 4, 2006 No 5;
- state scientific and technical program *Nuclear Physics Technologies for the Economy of Belarus*, approved by order of the Chairperson of the State Committee on Science and Technology of July 6, 2006 No 180;
- the plan of main preparation work to be finished before the beginning of the construction of the Nuclear Plant of the Republic of Belarus, approved by regulation of the Council of Ministers of the Republic of Belarus of July 18, 2006 No 905-9.

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

- Requirements to Nuclear Plants Siting, approved by protocol of the Bureau of Fuel and Energy Complex of the Cabinet of Ministers of the USSR of October 22,1987 No 14;
- Nuclear Power Industry Rules 03-33-93 Siting of Nuclear Plant. Main Criteria and Demands to the Safety. Approved by regulation of *Gosatomnadzor* (federal nuclear and radiation safety authority of Russia) of December 2, 1993 No 11;
- Regulatory Act 032-01 Siting of Nuclear Plant. Main Criteria and Demands to the Safety. Approved by regulation of *Gosatomnadzor* of Russia of November 8, 2001 No 10.

This technical code of common practice was developed with due account for the laws of Belarus: the law of Belarus *On Radiation Safety of Population* of January 5, 1998 No 122-3; the law of Belarus *On the Industrial Safety of Hazardous Production Sites* of January 10, 2000 No 363-3; the law of Belarus *On the Protection of the Population and the Territory from Natural and Man-Made Disasters* of May 5, 1998 No 141-3; the law of Belarus On Fire Safety of June 15, 1993 No 2403-XII; the law of Belarus *On the Environmental Protection* of June 17, 2002 No 126-3; the law of Belarus *On Specially Protected Natural Reservations and Sites* of May 26, 2000 No 396-3; the law of Belarus *On the Sanitary Welfare of the Population* of May 26, 2000 No 397-3; the Land Code of Belarus of January 4, 1999 No 226-3; the Water Code of Belarus of June 15, 1998 No 191-3; the Forestry Code of Belarus of July 14, 2000 No 420-3.

This technical code of common practice was developed with due account for the recommendations and requirements of IAEA, specified in IAEA code of regulations on nuclear plants safety 50-C-S (Rev. 1), IAEA safety requirements NS-R-3, IAEA safety manuals of series NS-G-3 and 50-SG-S, and with account for the research experience in the siting of nuclear plants in Belarus between 1962 and 1982 and later from 1992 to 1997.

Since there is no complete set of regulative acts that govern the development of the nuclear power engineering industry in Belarus, they used legal and technical regulations of the former USSR and Russia to work out this technical code of common practice.

The majority of the developers of technical code of common practice took part in the search of sites for nuclear power plants from 1992 to 1997, some of them even participated in earlier similar researches and explorations.

**TCP 097-2007**
**(02300)**

**TECHNICAL CODE OF COMMON PRACTICE**

**Siting of nuclear power plants**

**MAIN CRITERIA AND DEMANDS TO THE SAFETY**

**Effective from 2007-12-29**

## 1 Scope of Application

**1.1** This technical code of common practice (hereinafter – TCP) specifies main criteria and demands for the siting of a nuclear power plant (hereinafter – NPP) in Belarus with the account for natural and man-induced factors and phenomena as well as the NPP impact on the population and environment.

**1.2** The requirements of this TCP are mandatory for the parties of the technical rate setting and standardization taking part in NPP siting.

**1.3** The requirements of this TCP do not apply to the explorations for small-power NPPs, underground NPPs and fit-for-purpose nuclear installations.

## 2 Terms and Definitions

This TCP includes the following terms with their appropriate definitions:

**2.1 active fault**: a tectonic fault, which zone during the quaternary of its geological development had some shift of adjacent blocks of the Earth crust to 0.5 m and more, or which relative shifts with the speeds of modern movements of 5 mm/year and more can be observed.

**2.2 control area**: The territory outside the sanitary protection zone where the environment is monitored.

**2.3 protective measure planning zone**: The territory around the nuclear plant where a radiation impact can take place in case of a beyond design basis accident and where population protection measures are planned in compliance with the current norms of the radiation safety. Outside this zone no activities to protect the population have to be planned in case of the above-mentioned disaster.

**2.4 compulsory evacuation planning zone**: The territory of anticipated radiation exposure in case of a beyond design basis accident where the upper dose limit for people evacuation according to the valid radiation safety standards can be reached over trespassed during the initial stage of a radiation accident.

**2.5 nuclear power location site (NPP site)**: The secured territory where the main and auxiliary buildings and structures of the nuclear plant are located.

The site secured territory where the main and auxiliary buildings and structures of the nuclear plant are located (the working site) and the territory outside the fence where integrated distribution gears, external hydrostructures (heat sinks, pump stations, inlet and outlet canals), waste treatment facilities, drilling waste disposal sites, builders' base, a terminal, a settlement for the plant staff etc.

**2.6 maximum permissible emergency discharge**: The value of the discharge of basic dose forming radionuclides to the environment in case of a beyond design basis accident when the radiation doses to which people at the border of the protective measure planning zone and outside it with the probability of $10^{-7}$ reactor/year shall not be over the correspondent values specified by the current radiation safety norms that require taking decisions respecting people protection measures.

**2.7 nuclear plant location**: The territory of the area explored to locate a nuclear plant that allows for several NPP sites, which geography, landscape and situation (the relative position of the NPP and towns, cities, big enterprises and other objects, water supply, transport conditions, social and demographic, agricultural and industrial factors) are similar in their characteristics.

**2.8 nuclear plant area**: The territory that includes the nuclear plant site where natural and man-induced factors, processes and phenomena can impact the nuclear plant safety.

**2.9 sanitary protection zone**: The territory around the nuclear plant where the radiation exposure of people under normal operational conditions can be over the limits set by the current radiation safety norms and where the business activities are limited, people may not live temporally or permanently and the environment is monitored.

## 3 Abbreviations

This TCP has the following abbreviations:

**annual effective dose; AED**
**feasibility study of investments to nuclear plant construction; FSI NPP**
**heat supply nuclear plant; HSNPP**
**integrated distribution gears; IDG**
**Medvedev–Sponheuer–Karnik scale; MSK-64**
**maximum calculated earthquake; MCE**
**nuclear plant; NPP**
**nuclear power engineering plant; NPEP**
**nuclear power plant; NPP**
**potential earthquake source zone; PES zone**
**sanitary protection zone; SPZ**
**strength-level earthquake; SLE**
**technical code of common practice; TCP**
**technological regulation; TR**

## 4 General Provisions

**4.1** When siting an NPP they shall first and foremost follow the requirements of risk minimization for people and the environment under normal operations and in case of an

accident, including a beyond design basis one.

**4.2** This TCP regulates the siting of an NPP in Belarus and contains criteria for radiation and safety demands for the NPP, people and the environment as well as the requirement for the accounting for:

- external natural factors, phenomena and processes that may have an impact on the NPP safety;
- external man-induced factors, phenomena and processes that may influence on the NPP safety;
- the NPP impact on the population and the environment.

**4.3** This TCP is binding for every legal entity planning to take part in the construction of this NPP of non-military nature in it or already taking part in it, which includes feasibility studies of investments to the construction (projects).

**4.4** When siting an NPP they shall comply with other norms and rules according to their application areas.

**4.5** When siting an NPP near a border of a neighboring state they shall comply with current international agreements, treaties and conventions including [1].

# 5 Site Acceptability Estimation Requirements

## 5.1 Basic Safety Requirements to NPP Site

**5.1.1** The site can be considered suitable for NPP, if there is a possibility to operate it safely with due account for natural and man-induced factors, phenomena and processes that may have an impact on the NPP safety and radiation safety of the population and the environment from radiation impact under normal operation and in case of a design basis accident is provided for as well as the limitation of these impact in case of a beyond design basis accident.

**5.1.2** NPP site acceptability feasibility estimation shall include the accounting for:

- natural and man-induced factors, phenomena and processes that have an impact on the NPP safety;
- NPP radioactive impact on the population and the environment;
- specific characteristics of the NPP site area that may support the migration and the accumulation of radioactive substances (topography, hydrogeology, air mass stratification, rivers, other water bodies etc.);
- the size of SPZ, the monitoring zone, the protective measure planning zone, the compulsory evacuation planning zone;
- taking necessary civil defense measures.

**5.1.3** An NPP may not be sited:

- over a site situated directly on a tectonically active fault;
- over a site, which seismicity is over 9 points MCE of MSK-64 scale;
- over water supply sources with confirmed stores of underground water that used or is planned to be used for drinking unless the impossibility to contaminate the sources with radioactive substances can be proved;
- in areas not having as much as 97% of water sources to restore the losses of NPP cooling systems and no reliable sources to restore water losses in the cooling systems of reactor units, which is vital for the NPP safety;
- in areas where active karst is found or karst diffusion processes may begin;
- in areas where landslide and other dangerous downslope processes (landslip cloudburst flood) may take place;
- in areas that can be affected by superfloods and floods with once-in-10000-

years cycle with the account for ice cloggings, wind-induced surges and tides;

- in areas that can potentially be flooded with a breakthrough wave of the waterfronts of storage facilities located upstream;
- in areas where NPPs may not be built due to wildlife conservation laws prohibition;
- in areas with the average population density (including the builders and NPP staff) of 100 people per 1 $km^2$ and more.

**5.1.4** The following is unfavorable for an NPP:

- the areas which seismicity is over 7 points MCE of MSK-64 scale;
- the areas where modern differentiated movements of the Earth crust have been detected (vertical ones – at the speed over 10 mm a year, horizontal ones – at the speed over 50 mm a year);
- areas with salted ground and progressing salinization or desalination;
- areas with abandoned rock and other diggings;
- floodplain river terraces, banks and shores of water basins with the speed of edge line abrasion step shift over 1 m a year;
- slopes with 15º or greater fall;
- sites with water supply sources are contaminated biologically and chemically to a greater extent than permitted by the specified standards;
- main water-bearing strata gathering zones;
- sites with underground water situated less than 3 m deep from the planning surface in the grounds of or over10 m depth with the permeability coefficient of or over 10 m a day and with deeply crumbling and high-fragmental grounds of low sorption capacity;
- areas with frequent structurally and dynamically unstable grounds, permafrost non-rock grounds and the grounds with the deformation module less than 20 MPa;
- areas that can be affects by tornadoes and hurricanes;
- the areas with certain facilities including ammunition establishments that can produce toxic exhausts or make other actions surpassing the projected ones when on fire or under an explosion;
- the areas where surface and underground waters can change their regime, temperature or surface content due to the expected industrial or public construction, water-resource development or irrigated agriculture.

**5.1.5** In the areas where an NPP can have an unfavorable impact on the population and the environment and in the areas with dangerous natural or man-induced processes, phenomena and factors that may influence the NPP safety, an NPP can be built if appropriate technical and organizational safety measures are taken.

**5.1.6** The estimation of a site acceptability (with compliance with appropriate demands) shall include the demonstration of the possibility to store and bury radioactive wastes and to transport new and used-up fuel.

**5.1.7** The choice of technical solutions respecting the foundations of NPP buildings and structures shall include the due account for the occurrence of natural and man-induced processes, events and phenomena that are not uncommon for this site; also, geotechnical characteristics of the foundation materials shall be studied.

The estimation of the foundation resistance to static and dynamic loads and impacts shall account for the possibility of man-induced changes in physical and mechanical properties of grounds, underground and surface water regime, temperature and chemical structure.

The solutions respecting the foundations of NPP buildings and structures including engineering measures to meliorate grounds shall provide for the NPP buildings and structures resistance to foundation deformations within the NPP safety limits.

**5.1.8** The borders of SPZ, the monitoring zone, the protective measure planning zone and the compulsory evacuation planning zone shall be justified in the project with the

account for the following conditions.

**5.1.8.1** The borders of NPP SPZ shall be specified in compliance with the sanitary norms and rules so that:

- NPP normal operations, violations of normal operations (except accidents) and decommissioning shall not expose the population (a critical group) outside NPP SPZ to the radiation over the quota of the main dose limit;
- in case of design basis accidents the forecast radiation dose at NPP SPZ border and outside it shall not exceed the values demanding taking decisions to protect people from a radiation accident with a radioactive contamination of the area.

**5.1.8.3** The protective measure planning zone border shall allow for the human expose doses at the border and outside it not exceeding the standard limit values requiring population protection measures from a radiation disaster with the radioactive contamination of the area in case of a beyond design basis accident.

**5.1.8.4** The compulsory evacuation planning zone border shall allow for, in case of a beyond design basis accident with a maximum allowable emission of radiation to the environment, the reach or trespass the upper limit of the dose criteria demanding the evacuation of the critical group of population during the initial phase of a radiation accident as specified by the current norms of radiation safety.

**5.1.9** NPP SPZ and the monitoring zone borders at the project design stage shall be approved by the bodies and agencies exercising state sanitary supervision.

**5.1.10** If there is enough data for every type of event in compliance with special norms, rules and certified techniques, they shall establish maximum values for their impact on the NPP and the size of the areas for which the impact is estimated. If no special norms and rules are available and / or if the initial data is insufficient, they may use conservative estimates of the location area characteristics.

**5.1.11** If uncertified techniques and / or calculation programs are used to determine the site characteristics and the human exposure doses, it is necessary to provide materials that justify their use.

**5.1.12** An appropriate quality provision program shall be developed and implemented for the feasibility studies of the site acceptability.

## 5.2 Estimation Requirements for Natural Processes, Phenomena and Factors Impact on NPP Safety

**5.2.1** In the area and at the site of the NPP location they shall explore and research the natural processes, phenomena and factors, which may have an impact on the safety of the NPP.

**5.2.2** The seismicity and tectonic activity parameters and characteristics shall be accounted for when choosing an NPP site:

- faults, cracks, PES zones location schemes in relation to the NPP site with the indication of the orientation and borders of potentially dangerous faultings;
- the amplitudes, velocities and gradients of the present-day movements of the Earth crust and possible adjustment movement parameters;
- active fault zones characteristics (geometrical ones, fault shifts and amplitudes, time when it was last active).
- the intensity of the seismic load on constructions according to the MSK-64 scale: for an MCE – with once in 10000 years cycle, for an SLE – once in 100 years.

**5.2.3** Within the territory of the NPP site they shall determine:

- the superincumbent bed location depth and the strength of the weathering crust of rocky grounds as deep as two diameters of the foundation of the main building (from the grade elevation); to estimate the foundation geotechnically this depth or another is taken

from the depth of the foundation of the main building;

- the characteristics of the initial fluctuations of grounds during an earthquake as intensive as an MCE or less at grading surface marks;
- slope sliding danger with account for the terrain, ground characteristics and seismic vibrations as intensive as an MCE or less as well as the impact of underground waters, tectonic abnormalities, modern geodynamic processes;
- the terrain impact on the existent or potential gully erosion, sheet erosion (wash) over slopes, lowland waterlogging;
- the intensity of the underground carbonate (dolomites, limestones, chalk) and salt karst, the spread of suffusion swallow holes and hollows in the masses of loess-like deposits, the possibility of the development of karst (thermokarst), suffusion and karst-suffosion processes and their impact on the NPP safety;
- the presence of specific grounds (biogenic, gilgaied, shrinkable, swelling, saline, permafrost, eluvial, man-made), their depth and physical and mechanical properties (deformation modules, strength characteristics etc.); it is also necessary to estimate their impact on the differential settlement of NPP buildings, reactor building inclinations during an earthquake as intensive as an MCE or less;
- water-saturated loose soil zones disposed to fluidization, vibro settlement and floating under seismic vibrations as intensive as an MCE or less as well as clayey ground and chalky clay zones that are apt to swell and to soften thixotropically;
- the hydrochemical and temperature regime of ground waters as well as the maximum water level, yield and duration of the site underflooding as often as once in 10000 years, which may happen at the expansion of underground water backing from water reservoirs, filtrations from irrigated fields, water leakage from water-bearing communications and structures, atmospheric precipitations, snow melting; it is necessary to forecast the ground water change for the expected operation life of the NPP with the estimation of the impact on the seismicity increase and the change of the mechanical properties of the grounds;
- The impact of the ground water level and pressure (reservoir bottom swelling up, water breakthrough to reservoirs, the uplift of structures);
- maximum water level, yield and flooding duration as often as once in 10000 years, that may happen due to falls, intensive snow melting, high water level in a water basin caused by a breakthrough of a dam (dams) in water reserves or immersed lakes, riverbed blocking with jam, avalanche or soil slip;
- calm territories and areas with gentle breeze at the speed up to 2 m/sec, inversions and fogs with the frequency for each phenomenon over 40 % a year or 60 % during the cold season of the year (from days with the average daily temperature lower than 8 ºC);
- the possibility of the occurrence of hurricanes and tornadoes and their parameters of impact on the NPP: the intensity class, the maximum wall rotation speed and the maximum tornado forward speed values, the pressure and its difference between the tornado center and outskirts, the possible action of flying objects.

**5.2.4** To site an NPP in the water protection zone of a water body they shall estimate the parameters of a possible maximum flood when a tide in combined with a wind onset.

**5.2.5** In the siting area they shall study and account for the spreading and the mode of occurrence of water-bearing strata and complexes that influence on the buildings construction and operation environment; the permeability and depth of the aeration zone grounds and aquicludes, the hydrogeological parameters of water-bearing strata and complexes, underground water delivery and discharge conditions, their movement directions, hydraulic interconnection of underground waters and their connection with surface waters.

**5.2.6** They shall estimate the present-day and the expected flowing reduction due to evaporation losses, irreclaimable water consumption, the move of the flowing outside its

basin and they shall prove the availability of reliable sources to restore the losses of the reactor unit cooling systems at any event including the frost penetration of a water body.

**5.2.7** The quality of the water applied in the NPP cooling system shall be examined: the chemical and bacteriological water content, the silt content and its seasonal fluctuations, the size of suspended particles.

**5.2.8** They shall account for the NPP siting area climatic characteristics: temperature and wind conditions, precipitation regime, microclimate, area windiness and air meteorology parameters of the atmospheric boundary layer over for the NPP siting area: temperature and wind conditions, atmospheric stability, local atmospheric circulation specific features, atmospheric pollutant dispersion.

**5.2.9** They shall estimate the possibility of the occurrence of other natural processes phenomena and factors and their impact on the NPP siting safety: extremal fallouts, air and water temperature, glazes, storms, fogs, dust and sand storms, shoreline erosions etc.

### 5.3 Estimation Requirements for Man-Made Impact on NPP Safety

**5.3.1** They shall study the potential sources of man-made danger over the NPP site and around it. The analysis and the estimation of the sources of a man-induced dangerous impact on the NPP safety shall be estimated with the account for the distance between them and NPP. It is allowed not to account for the sources of man-made danger, which probability to cause an accident is less than $10^{-6}$ a year.

**5.3.2** The sources of man-made danger shall include the facilities that are characterized by the possibility of trouble causing explosions and fires as well as emissions of explosive, flammable, toxic and corrosive substances.

**5.3.3** The analysis of flight accident opportunities to happen at the site area shall include the distance from the site to airdromes (including military ones), air flow paths, training ranges, types of air flows and aircraft, airfield operations and flights number and intensity, air routes intersection, local specificity of air-borne dangers.

**5.3.4** In three-kilometer distance from the site the possible fire and fumigation sources (stores of combustibles, forests, peateries etc.) shall be detected and the estimation of possible fire hazard impact on the NPP shall be made with the account for the protective measures.

**5.3.5** They shall analyze the impact on the NPP safety of every possible stationary and movable sources of accidental explosions including industrial facilities that manufacture, process, store and transport chemicals and explosives, if they are located 5 km away from the NPP site border or less, and ammunition depots if they can be found 10 km away from the NPP site border or less.

The impact parameters of the most dangerous accidental explosion shall be determined and the NPP safety shall be justified with the account for the local conditions of a gas cloud migration, the NPP site location and the planned terrain topography, the shockwave and the secondary consequences of the hypothetical blast in the form of the ground shake, flying objects; also the areas of possible increased accumulation of toxic substances.

**5.3.6** They shall analyze the impact on the NPP safety of every possible stationary and movable sources of accidental emissions of chemically active substances, if they are located 5 km away from the NPP site border or less, including industrial facilities that manufacture, process, store and transport toxic and corrosive substances.

**5.3.7** The following sources of impact on an NPP shall be studied respecting their parameters and their occurrence probability:

- explosions and fires, emissions of explosive, flammable, toxic and corrosive substances and gases in industrial facilities;

- aircraft crash (planes, helicopters);
- accidents with oil and gas pipelines;
- accidents with surface transport;
- accidents with water transport and in port zones accompanied by explosions, fires and chemically dangerous emissions, if the NPP is in the coastline;
- electromagnetic fields;
- external fires (fires in forests, peateries, fires of combustibles);
- mining operations (tunnels, mines, pits);
- floods with the breakthrough of reservoir water fronts located upstream from the NPP site;
- water level fluctuations in the NPP supply source due to water intake exploitation.

### 5.4 Estimation Requirements for NPP Impact on Population and Environment

**5.4.1** In the monitoring zone and the protective measure planning zone they shall study the aerologic, hydrometeorological and geochemical conditions or radionuclide dispersion, migration and accumulation as well as the natural radiation background; they shall forecast the changes of the conditions for the whole operational life of the NPP.

**5.4.2** The atmospheric dispersion shall be estimated with the account for the gentle wind, calm weather, air temperature, surface and updrawn inversions, atmospheric stability, fallouts, fogs, extreme atmospheric phenomena occurrence probabilities in the NPP location area.

They shall estimate the impact of the heat and moisture exhaust from NPP coolers on the microclimate and atmospheric processes (cloudiness, fallouts, temperature and humidity increase, fog and hoarfrost formation); possible interactions between cooler torches and radionuclide exhausts from NPP ventilation pipes.

**5.4.3** The NPP siting shall be justified by the availability of natural sources of technical water supply for uniflow cooling or circulation cooling supply of an NPP with evaporate cooling towers.

The possibility to use natural lakes and water bodies as NPP heat sinks shall be confirmed with a special ecological feasibility study.

If there are too few or no water-cooling sources, the necessity and possibility to create an artificial water reservoir or to use an air-cooling system with dry cooling tower shall be justified.

**5.4.4** The characteristics of the migration of radionuclides in surface and underground waters and the accumulation of radionuclides on a water basin bottom with the account for:

- possible radioactive contamination of drain and ground waters;
- radionuclides physical and chemical properties;
- radionuclide occurrence forms in bottom sediments and water catchment area grounds;
- the kinetics of geochemical reactions and possible change of rock mineral properties;
- the lithologic content and the depth of the water-absorbing and water-resisting layers and grounds of the aeration zone and soils;
- the sorption capacity of rocks, grounds and soils respecting radionuclides and dangerous chemicals;
- the direction and the movement speed of contaminated streams to discharge areas (waterways, basins, water supply wells etc.);
- water-bearing strata and complexes characteristics and stratification;

- the hydraulic relation between underground and surface waters;
- the characteristics of water bodies, hydrostructures, the data of water use, levels and consumption, river flow velocities, possible ways to transfer and deposit radionuclides.

**5.4.5** The siting feasibility documentation shall include the radiation environment forecast in the NPP monitoring zone under normal operation, under decommissioning and in case of an accident including a beyond design basis one taking into account the radioactive contamination from Chernobyl disaster.

**5.4.6** The radiation environment justification for the NPP normal operation, design basis and beyond design basis accidents and the working-out of technical and organizational population safety measures shall be done at the FSI NPP stage.

The radiation environment and human exposure doses estimation for the NPP normal operation shall be made with the involvement of the atmospheric dispersion parameter probability distribution as typical for the NPP location.

The radiation environment and human exposure doses estimation for NPP design basis and beyond design basis accidents shall be done with the account for the least favorable weather conditions as typical for the NPP location.

**5.4.7** If an NPP is sited in the water protection zone of a communal-use water body, the distance between its water edge and the NPP in a low-water season shall be at least 1 km.

The project shall include the feasibility of the protection against the radioactive contamination of an economically important water area under the NPP normal operation, failures to operate normally and decommissioning and measures shall be taken to protect this area from a contamination in case of an accident.

**5.4.8** The consequences of a possible radiation impact of the NPP radioactive emissions on the population and the environment shall be determined with the account of the following issues:

- the radiation environment estimation results;
- water intake facilities characteristics in the monitoring area;
- the characteristics of water bodies used for fishing, fish and other biological resources restoration in the monitoring area;
- the data on the flora and fauna in the NPP site location area (species composition, population level, habitats, migration ways etc.);
- the data on the existing and expected for the whole service life of the NPP population distribution and density in the NPP site area; on the distance between the NPP and inhabited localities, on the availability and location of hospitals, polyclinics and medical centers;
- the data on the nature the economic activities of the population in the NPP siting area.

**5.4.9** According to the standards acting in Belarus, they shall estimate the losses of the agriculture caused by the withdrawal of the land for the NPP construction (including the heat sink pond area and transport communication area).

**5.4.10** The NPP siting documentation shall show that the estimated value of the probability of the maximum emergency emission does not exceed $10^{-7}$ per reactor a year. The adjustment of the estimation results is made at the project design stage and is described in the NPP Safety Case Report.

**5.4.11** The protective measure planning zone borders for NPPs and NPPEPs shall not be as far as 25 km from the site edge and for HSNPPs – 5 km from the site edge.

**5.4.12** Outside the protective measure planning zone in case of a beyond design basis accident temporal restrictions can be established for certain local agricultural food products.

**5.4.13** Within the protective measure planning zone it is not allowed to locate any institutions that may have problems with the evacuation of their people including its impossibility (prisons, specialized hospitals with non-transportable patients etc.).

**5.4.14** Within the compulsory evacuation planning zone the average population density (including NPP builders and personnel) for the whole service life of the NPP shall not be over 100 people per $km^2$.

**5.4.15** Within the compulsory evacuation planning zone there shall be transport communications that allow for the evacuation of the population within the time that complies with the current radiation safety norms.

**5.4.16** They shall also estimate the possible non-radiation impact of the NPP on the population and the environment with the account for:

- the environment contamination sources, natural and man-induced;
- the background contamination level in the atmosphere, related to industries, municipal infrastructure and services and the agriculture;
- the background contamination level in surface and underground waters (their sanitary, toxicological, parasitological, chemical and thermal conditions);
- pesticide, herbicide and heavy metal content in soils.

**5.4.17** They shall consider about the possible interactions between radioactive and non-radioactive emissions.

## 6 Providing Radiation Safety of Population

**6.1** The population safety is provided for as follows:

- establishing human living environment in compliance with the current radiation safety norms and main sanitary regulations;
- fixing up quotas for different sources of radiation;
- establishing radiation control;
- efficient planning and taking radiation safety measures under normal conditions and in case of a radiation accident;
- establishing the radiation environment reporting system.

**6.2** According to [2] and [3], regulative requirements of the principal document of the radiation safety of the population [4], they shall apply the following radiation safety provision criteria.

**6.2.1** Under the normal operation and decommissioning of the NPP the annual effective radiation dose from man-made sources including the NPP for the critical population group shall not be over 1 mSv a year on average within any successive 5 years, but not over 5 mSv a year (according to Attachment A to this TCP).

**6.2.2** If an NPP radiation accident happens the radiation dose limits indicated in 6.1 are not applicable; they take protective measures (interventions) to prevent an exposure or reduction of radiation amounts, number of affected people and contamination amounts.

**6.3** The intervention levels are the levels of the radiation factor (the doses and their rates, radioactive contamination levels) that require the need to take certain protective measures if surpassed; if an NPP radiation accident happens the intervention levels are specified by the bodies and agencies exercising sanitary control respecting the appropriate NPP, its location environment with the consideration about probable accident types, emergency development scenarios and the radiation situation on the ground.

**6.4** At the NPP project design stage they shall develop and approve as appropriate the regulations of the remedial actions following different types of potentially possible NPP accidents based on the rules and criteria of the current radiation safety norms.

**6.4.1** If the radiation level prevented by a protective measure does not exceed level A, there is no need to take the protective measures related to the disruption of normal life

activity of the population including economic and social functioning of the area.

**6.4.2** If the radiation level prevented by a protective measure exceeds level A, but does not reach level B, the decision to take protection measures is made in compliance the principles of feasibility and optimization according to the situation on the ground.

**6.4.3** If the radiation level prevented by a protective measure reaches and exceeds level B, the appropriate protective measures shall be taken, even if they are related to the disruption of normal life activity of the population including economic and social functioning of the area.

**6.5** If local radioactive contaminations are found the AED value shall be defined any way as well as the does expected in 70 years. By AED they hereby understand the average effective dose for the inhabitants of a locality for the current year, this dose is associated with man-made radionuclides that were released into the environment as a result of a radiation accident.

The intervention criteria for local radioactive contaminations is the AED value equal 0.3 mSv a year. This is the radiation impact level that requires protective measures to limit the human exposure to the radiation, if surpassed. The scale and the nature of the measures is specified by the intensity of the radiation impact on humans with the expected collective effective dose for 70 years.

**6.6** The personnel and population radiation safety system shall, in case of a radiation accident, minimize the negative consequences of the accident, prevent the occurrence of deterministic effects and reduce the probability of the occurrence of a stochastic effect to the minimum.

**6.7** The NPP project documentation shall define possible accidents caused by the equipment failures, the personnel errors, natural disasters and other reasons that may lead to the loss of the control of the radiation sources, to the radiation exposure of humans and / or the radioactive contamination of the environment. The list of possible accidents for particular situations shall be agreed with the bodies and agencies exercising state sanitary control.

**6.8** The NPP project documentation shall have the section entitled *Civil Defense Engineering Measures, Measures to Prevent Emergencies* including the nomenclature, amount and storage of means of individual protection, medical supplies, reserve supplies of radiometric and dosimetric devices, decontamination and sanitization means, tools for remedial actions required after a radiation accident.

# Appendix A

(Reference)

## Main Limits of Radiation Doses [2]

### Table A1 – Main Limits of Radiation Exposure Doses

| Standardized Values* | Dose Limits, mSv | |
|---|---|---|
| | For Personnel | For Human Population |
| Effective Dose | 20 mSv a year on average within any successive 5 years, but not over 50 mSv a year | 1 mSv a year on average within any successive 5 years, but not over 5 mSv a year |
| Annual equivalent dose in:<br>- crystalline lens**<br>- skin***<br>- hands and feet | <br>150<br>500<br>500 | <br>15<br>50<br>50 |

* One-time exposure to the limits for every standardized value is allowed.

** Refers to the dose at the depth of 300 mg/cm$^2$.

*** Refers to the average value of 1 cm$^2$ area in the basal layer of the skin 5 mg/cm$^2$ deep under the coating layer 5 mg/cm$^2$ deep. For the palms the coating layer depth is 40 mg/cm$^2$. This limit allows the whole human skin exposure if the average value of 1 cm$^2$ of skin area will not exceed this limit. The limit or the face skin radiation exposure provides for the non-violation of the crystalline lens exposure limit for beta-particles.

# Appendix B
(Reference)

## Decision Criteria for Measures to Protect Population in Case of Significant Radiation Accident with Radioactive Contamination of Area [2]

### Table B1 – The Criteria for Emergency Measures to Be Taken in the Initial Period of a Radiation Accident

| Protective Measures | Prevented Dose in First 10 Days, mGy | | | |
|---|---|---|---|---|
| | For Whole Body | | For Thyroid, Lungs and Skin | |
| | Level A | Level B | Level A | Level B |
| Shelter | 5 | 50 | 50 | 500 |
| Iodine prevention:<br>- adults<br>- children | —<br>— | —<br>— | 250*<br>100* | 2500*<br>1000* |
| Evacuation | 50 | 500 | 500 | 5000 |

* For thyroid only.

### Table B2 – The Criteria for Making the Decision to Evacuate or to Restrict the Consumption of Contaminated Foods

| Protective Measures | Prevented Dose, mSv | |
|---|---|---|
| | Level A | Level B |
| Restricted consumption of contaminated foods and water | 5 for first year and 1 for successive years annually | 50 for first year and 10 for successive years annually |
| Evacuation | 50 for first year | 500 for first year |
| | 1000 for whole evacuation period | |

### Table B2 – The Criteria for Making the Decision Restrict the Consumption of Contaminated Foods

| Radionuclides | Specific Activity of Radionuclides in Foods, kBq/kg | |
|---|---|---|
| | Level A | Level B |
| I-131, Cs-134, Cs-137 | 1.0 | 10.0 |
| Sr-90 | 0.1 | 1.0 |
| Pu-238, Pu-239, Am-241 | 0.01 | 0.1 |

# Reference List

[1] Convention on Nuclear Safety. Adopted on June 17, 1994. Ratified by the Republic of Belarus on January 27, 1999

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

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

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

Director-General SSI "JIPNR - Sosny"
Nat. Academy of Sciences (NAS) of Belarus, Dr. Phys.-Math.Sci., Prof. V.I. Kuvshinov

Executive in charge, Cand. Sci. (Eng.) A.P. Malykhin

The following people took part in the development of this TCP:

From SSI "JIPNR - Sosny" of NAS of Belarus:

Cand. Sci. (Eng.) O. I. Yaroshevich, Cand. Sci. (Eng.) I.V. Zhuk, Cand. Sci. (Eng.) A.P. Malykhin, E.M. Lomonosova, A.M. Borovikova, N.N. Gluboki, T.Y. Yakobovskaya, A.A. Ternova

From SSI "Institute of Geochemistry and Geophysics" of NAS of Belarus: Geo. Doc. A.K. Karabanov, Academy Member A.V. Matveyev

From RUE “Central Research Institute for Complex Use of Water Resources”: G.V. Vasilchenko

From RUE “Geoservice”: late V.G. Lobodenko

From RUP “BelNIPIEnergoprom”: A.I. Strelkov, V.A. Yushko

From RUE “Belgeologiya”: Geo. Doc. S.P. Gudak

From RUE “Institute of Pedology and Agrochemistry” of NAS of Belarus: Cand. Agr. A.F. Chernysh

From RUE “Institute of Experimental Botany of NAS of Belarus: A.I. Zabolotny

APPROVAL PAGE

TCP 097-2007 (02300)

Siting of Nuclear Power Plant
MAIN CRITERIA AND DEMANDS TO THE SAFETY

APPROVED:
Minister (Deputy Minister) of Energy of the Republic of Belarus
Letter No 08-01-2/2983 of July 5, 2007

_____ M.I. Mikadziuk
personal signature print full name

Date_____
Stamp here

APPROVED:
Minister (Deputy Minister) of Natural Resources and Environmental Protection of the Republic of Belarus
Letter No 14-09/2175-BH of August1, 2007

_____ A.N. Apatski
personal signature print full name

Date_____
Stamp here

APPROVED:
Minister (Deputy Minister) of Architecture and Construction of the Republic of Belarus
Letter No 02-2-09/3071 of August 6, 2007

_____ A.I. Nichkasau
personal signature print full name

Date_____
Stamp here

APPROVED:

Chairperson of the National Committee of the Radiation Protection for the Council of Ministers of the Republic of Belarus
Letter No 1I/06/07 of June 27, 2007

_____ Y.I. Kenigsberg
personal signature print full name

Date_____
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