NEW NUCLEAR POWER PLANT AT THE JASLOVSKÉ BOHUNICE SITE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT ON THE PROPOSED ACTIVITY

August 2015

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Document annotation

The submitted document includes the Assessment Report for the proposed activity as required under Section 31 and Annex No.11 of the Act No. 24/2006 Coll. on the Environmental Impact Assessment and on the amendment of certain acts. The Assessment Report constitutes a next successive stage of the environmental impact assessment process following the completion of the Preliminary Study in compliance with the Section 22 of the Act (March 2014) and the issue of the Scope of the Assessment under section 20 of the Act (SR Ministry of Environment, May 2014).

The subject of the proposed activity is development of *the new nuclear power plant at the Jaslovské Bohunice site*, including the construction of the new nuclear power plant and all related building structures and technological facilities.

The proposed activity is situated in the western region of the Slovak Republic in Trnava Self-Governing Region; the siting area for the nuclear power plant directly adjoins the existing Jaslovské Bohunice nuclear facilities site (EBO) using a certain part of the JE A1 and JE V1 that are being decommissioned.. From the technical viewpoint, the power plant represents the generation III+ with pressurized water reactor (PWR) designed as one unit. The net electric power is intended to reach maximum of 1700 MW. The operational lifetime of the new nuclear power plant will be 60 years. The project will be developed in a way that ensures compliance with all relevant legislative regulations and safety standards in accordance with the regulations and requirements as set out by the Nuclear Regulatory Authority of the Slovak Republic (UJD SR), IAEA and WENRA. The intention to build the new nuclear power plant is in line with the key strategic documents of the Slovak Republic in the energy sector. The activity is presented in one siting variant and/or the technical solution.

In compliance with the requirements of the above-mentioned Act, the Assessment Report presents the basic characteristics of the proposed activity, the data on the current environmental baseline of the area where the activity is to be in operation and the area to be affected by the proposed activity, the comprehensive identification, description and assessment of potential impacts of the proposed activity including its comparison with the existing environmental baseline in the place of its operation and in the area of the assumed impact, the outline of operational risks and their possible effect on the region and population, the monitoring proposal for the observation and evaluation of the impact of the activity on the environment and the public and the proposal of measures to prevent or reduce adverse impacts of the proposed activity during the preparation, operation and operation decommissioning phases. The Report takes into consideration the character of the proposed activity (that is the electricity generation by nuclear facility) and particularities of the area (where a group of other nuclear facilities is located). From this perspective, the specific attention is devoted to a problem of impact on the public and public health (particularly in the area of ionizing radiation impacts) including the concerned cumulative impacts of the proposed activity along with other existing or upcoming activities at the site.

The detailed assessment of the new nuclear power plant impact on the individual environmental components and public health has been undertaken based on the a detailed analysis in accordance with section 31 of the above mentioned Act and in compliance with the issued Scope of Assessment set by the SR Ministry of Environment.

The predicted environmental impacts of the proposed activity are insignificant in all assessed aspects (population, air and climate, noise, ionizing radiation and other physical and biological agents, surface water and groundwater, rock and natural resources, fauna, flora and ecosystems, landscape, tangible property and cultural monuments, traffic and other infrastructure or the other). No facts that would prove exceeding of limits set by valid regulations (or, if there are no restrictions set, unacceptable impact) have been identified. Taking into account cumulative impact of the existing activities at the site (especially the other nuclear facilities being in particular stages of their life cycle), the potential negative impacts are acceptable in all aspects being completely within admissible and/or acceptable values.

Under the Annex No. 13 of the corresponding Act, the proposed activity is on the list of activities that are subject to the compulsory international assessment from the perspective of the environmental impact exceeding state boundaries. The potentially most affected area and the so-called critical population groups are found in the immediate surrounding of the proposed activity area. According to the results of the performed public health and environment impact assessment including the analysis of special situation impact, all the public health and environmental requirements are already met in the vicinity of the development site. As such, the emergence of significant cross-border impacts is excluded as all environmental and public health requirements are met in the close proximity to the proposed development site. Regardless this fact, the Report presents the analyses of radiation impacts for border areas of the closest neighbouring states regarding operation of the new power plant as well as representative conservative cases of design based and severe accident.

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Identification Data of the Customer

Company name:	Jadrová energetická spoločnosť Slovenska, a. s. Tomášikova 22 821 02 Bratislava Slovak Republic
Registered:	in the Business Register of the Bratislava I District Court, Section: Sa, Insert No. 4930/B
Place of business:	Slovak Republic
Company Reg. No.: Tax Reg. No.: VAT Reg. No.:	45 337 241 202 293 79 39 SK 202 293 79 39
Bank connection: Account number: IBAN code: BIC (SWIFT):	Poštová banka, a.s., Prievozská 2/B, 821 09 Bratislava 20311017/6500 SK4765000000000020311017
Represented by:	Ing. Ján Červenák Chairman of the Board of Directors Ing. Petr Závodský Vice-chairman of the Board of Directors
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Identification Data of the Supplier

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Place of business:	Czech Republic
Reg. No.: Tax Reg. No.: VAT. Reg. No.:	262 11 564 CZ 262 11 564 CZ 262 11 564
Bank connection: Account number: IBAN code: BIC (SWIFT):	UniCredit Bank Czech Republic, a. s., Divadelní 2, Brno 1002064985/2700 CZ812700 0000 001002064985 BACX CZ PP
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Introduction

General data

The Assessment Report on Environmental Impacts of the Proposed Activity (hereinafter referred to as "Report" or "Assessment Report")

NEW NUCLEAR POWER PLANT AT THE JASLOVSKÉ BOHUNICE SITE

(hereinafter referred to as "activity" / "proposed activity") is elaborated in accordance with Section 31 of the Act No. 24/2006 Coll. on the Environmental Impact Assessment and on amendment of certain acts[1] (hereinafter referred to as "the Act").

In compliance with the Act, the purpose of this Report is the comprehensive identification, description and assessment of assumed impacts of the proposed activity including its comparison with the existing environmental state in the place of its operation and in the area of its assumed impact.

The Report elaboration constitutes the next successive step in the process of the environmental impact assessment of the proposed activity. Specification of the Scope of Assessment of the proposed activity[2] (hereinafter referred to as "Scope of Assessment") had been done before the elaboration of the Report pursuant to Section 30 of the Act. Along with the Preliminary Study under Section 22 of the Act, the Scope of Assessment is one of the basic documents for the development. The Assessment Report follows these documents procedurally as well as mater-of-fact.

Formal structure of the Report

The structure of the Report formally conforms to the requirements of the Act and the specified Scope of Assessment. The Report is structured in compliance with the Annex No. 11 of the Act (Content and Structure of Assessment Report of the proposed activity). Simultaneously, the Report respects the Annex No. 15 of the Act (Content of Assessment Documentation on Proposed Activities Impacts Exceeding State boundaries).

The way of application of these formal requirements is presented in the following outline:

Formal requirements of the Annex No. 11 of the Act:

The Report contains the elaboration of all points of the Annex No. 11 of the Act (Content and Structure of Assessment Report of the proposed activity) the requirements of which are strictly respected. Headings of component Chapters of the Report conforming to the statutory structure under the Annex No. 11 of the Act are especially indicated by a frame (for example: **B.I.1. Soil**). In some cases, the chapter headings are shortened intentionally, the exact statutory wording is stated beneath the chapter heading (for instance: *1. Soil – Total Soil Occupation in ha, including Developed Area (ha, Agricultural-Land Resources, Forest Land, Soil Quality), including Temporary and Permanent Occupation.)*

In some cases, this statutory structure is further subdivided into subchapters. This division into subchapters is not set by the Act but it has been applied by the Supplier of the Report to present data in a transparent manner. The subchapter headings in this Report, corresponding to the embedded structure, are not framed specifically.

With respect to the fact that the structure under the Annex No. 11 of the Act does not exactly correspond in the sections C.II (Characteristics of the Current Environmental State) and C.III. (Environmental Impacts Assessment) herein, the following

[1] Act No. 24/2006 Coll. as of 14 December 2005 on the Environmental Impact Assessment and on the amendement of certain acts, as amended (amendments: 275/2007 Coll. effective as of 1 July 2007, 454/2007 Coll. effective as of 1 December 2007, 287/2009 Coll. effective as of 1 September 2009, 117/2010 Coll. effective as of 1 May 2010, 145/2010 Coll. effective as of 1 May 2010, 258/2011 Coll. effective as of 3 August 2011, 408/2011 Coll. effective as of 1 December 2011, 345/2012 Coll. effective as of 1 January 2013, 345/2012 Coll. effective as of 1 January 2013, 39/2013 Coll. effective as of 15 March 2013, 180/2013 Coll. effective as of 1 October 201, 314/2014 Coll. effective as of 1 January 2015.

[2] For further data see Annex 2 of this Report.

table outlines the Chapters of the Report where the data concerned are included. The list and structure of environmental components used in the Preliminary Study that had been developed earlier, was selected to be a starting point.

Tab. 0.1: The outline of incorporated data on individual environmental and public health components into the Report structure

1. The Population and the Public Health	
Inputs:	---
Outputs:	---
Existing state:	C.II.11. Population (page 195 hereof)
Assumed impact:	C.III.1. Impacts on the Public (page 266 hereof)
2. The Air and Climate	
Inputs:	---
Outputs:	B.II.1. The Air (page 130 hereof)
Existing state:	C.II.4. Climatic Conditions (page 157 hereof) C.II.5. The Air (page 160 hereof)
Assumed impact:	C.III.3. Impact on Climatic Conditions (page 286 hereof) C.III.4. Impacts on the Air (page 289 hereof)
3. Noise	
Inputs:	---
Outputs:	B.II.4. Noise and Vibrations (page 136 hereof)
Existing state:	C.II.15. Environmental Pollution sources (page 227 hereof): C.II.15.1. Noise (page 227 hereof)
Assumed impact:	C.III.16. Other Impacts (page 319 hereof): C.III.16.1. Noise Impacts (page 319 hereof)
4. Ionizing radiation	
Inputs:	B.I.3. Raw materials (page 128 hereof)
Outputs:	B.II.5. Radiation and Other Physical Fields (page 137 hereof)
Existing state:	C.II.15. Environmental Pollution Sources (page 227 hereof): C.II.15.3. Ionizing Radiation (page 230 hereof)
Assumed impact:	C.III.16. Other Impacts (page 319 hereof): C.III.16.3. Ionizing Radiation Impacts (page 325 hereof)
5. Other Physical and Biological Characteristics	
Inputs:	---
Outputs:	B.II.4. Noise and Vibrations (page 136 hereof)
Existing state:	C.II.15. Environmental Pollution Sources (page 227 hereof): C.II.15.2. Vibrations (page 229 hereof) C.II.15.4. Other Physical and Biological Characteristics (page 259 hereof)
Assumed impact:	C.III.16. Other Impacts (page 319 hereof): C.III.16.2. Vibration Impacts (page 324 hereof) C.III.16.4. Impact on Other Physical and Biological Characteristics (page 350 hereof)
6. Surface water and Groundwater	
Inputs:	B.I.2. Water (page 126 hereof)
Outputs:	B.II.2. Waste Water (page 132 hereof)
Existing state:	C.II.6. Hydrological Conditions (page 161 hereof)
Assumed impact:	C.III.5. Impacts on Water Conditions (page 291 hereof)
7. Soil	
Inputs:	B.I.1. Soil (page 126 hereof)
Outputs:	---
Existing state:	C.II.3. Soil Conditions (page 155 hereof)
Assumed impact:	C.III.6. Impacts on Soil (page 300 hereof)

8. Rock Environment and Natural Resources	
Inputs:	B.I.3. Raw Materials (page 128 hereof)
Outputs:	---
Existing state:	C.II.1. Geomorphological Conditions (page 144 hereof): C.II.1.1. Geomorphological Conditions (page 144 hereof) C.II.2. Geological Conditions (page 145 hereof): C.II.2.1. Geological Conditions (page 145 hereof) C.II.2.2. Hydro-Geological Conditions (page 147 hereof) C.II.2.3. Engineering-Geological Conditions (page 149 hereof) C.II.2.4. Seismicity, Tectonicity a Geodynamic Phenomenon (page 150 hereof) C.II.2.5. Natural Resources (page 154 hereof)
Assumed impact:	C.III.2. Impact on Rock Environment (page 285 hereof): C.III.2.1. Impact on Rock Environment (page 285 hereof) C.III.2.2. Impact on Raw Materials (page 286 hereof) C.III.2.3. Impacts on Geodynamic Phenomenon and Geomorphological Conditions (page 286 hereof)
9. Fauna, Flora and Ecosystems	
Inputs:	---
Outputs:	---
Existing state:	C.II.7. Fauna and Flora (page 177 hereof) C.II.9. Protected Area (page 188 hereof) C.II.10. Territorial System of Ecological Stability (page 192 hereof)
Assumed impact:	C.III.7. Impacts on Fauna, Flora and their Biotopes (page 301 hereof) C.III.9. Impacts on Protected Areas (page 312 hereof hereof) C.III.10. Impacts on Territorial System of Ecological Stability (page 315 hereof)
10. Landspace	
Inputs:	---
Outputs:	---
Existing state:	C.II.8. Landscape (page 186 hereof)
Assumed impact:	C.III.8. Impacts on Landscape (page 305 hereof)
11. Tangible Property and Cultural Monuments	
Inputs:	---
Outputs:	---
Existing state:	C.II.12. Cultural and Historical Monuments (page 226 hereof): C.II.12.1. Cultural and Historical Monuments (page 226 hereof) C.II.12.2. Tangible Property (page 226 hereof) C.II.13. Archaeological Excavations (page 226 hereof)
Assumed impact:	C.III.12. Impacts on Cultural and Historical Monuments (page 317 hereof): C.III.12.1. Impacts on Cultural and Historical Monuments (page 317 hereof) C.III.12.2. Impacts on Tangible Property (page 317 hereof) C.III.13. Impacts on Archaeological Excavations (page 318 hereof) C.III.15. Impacts on Cultural Values of intangible nature (page 318 hereof)
12. Traffic and Other Infrastructure	
Inputs:	B.I.5. Requirements on Traffic and Other Infrastructure (page 129 hereof)
Outputs:	---
Existing state:	C.II.11. Population (page 195 hereof): C.II.11.5. Infrastructure (page 220 hereof)
Assumed impact:	C.III.1. Impacts on Population (page 266 hereof): C.III.1.4. Impacts on Infrastructure (page 280 hereof)

Formal requirements of the Annex No. 15 of the Act:

The Report contains the elaboration of all points of the Annex No. 15 of the Act (Content of Assessment Documentation on Proposed Activities Impacts Exceeding State boundaries). The following table presents the outline of the Report chapters where the concerned data are included:

Tab. 0.2: The outline of incorporated data of the Annex No. 15 of the Act into the Report structure

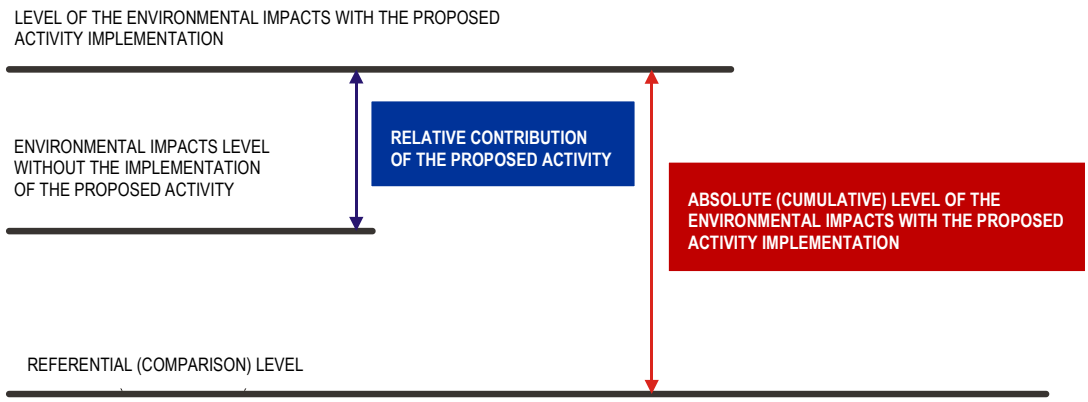
1. Description of the Proposed Activities and their Objectives
A.II. Essential Data about the Proposed Activity (page 18 hereof)
2. Description of Reasonable Alternatives of the Proposed Activity, if needed (e.g. in case of Siting or Technologies) and also an Alternative of Non-Realisation of this Activity
A.II.9. Alternatives of the Proposed Activity (page 117 hereof) C.V. Comparison of Alternatives (page 415 hereof)
3. Description of Environmental Components and Elements, which can be Possibly Severely Affected by the Proposed Activity or by its Alternatives
C.II. Characteristics of Current Environmental State (page 144 hereof)
4. Description of Possible Impacts of the Proposed Activity or its Alternatives and Assessment of their Severity
C.III. Environmental Impact Assessment including Health (page 266 hereof)
5. Description of Measures Reducing Severe Environmental Impact to Minimum
C.IV. Measures to Reduce Impacts (page 409 hereof)
6. Presentation of Applied Specific Methods of Forecasts and Starting Presumptions on which they are based on, as well as Applied Environmental Data
C.VII. Assessment Methods and Data Sources (page 418 hereof)
7. Identification of Deficiencies of Knowledge and Uncertainties Identified during Collection of Required Information
C.VIII. Deficiencies and Uncertainties of Knowledge (page 423 hereof)
8. Proposal of Monitoring and Managerial Programmes and Other Project Analysis Plans, if Necessary
C.VI. Proposal of Monitoring and Post-Project Analysis (page 416 hereof)
9. Conclusion of Non-Technical Information including Appropriate Visual Presentation (Maps, Graphs, etc.)
C.X. Non-Technical Comprehensible Final Summary (page 425 hereof)

Factual Content of the Report

The formal content of the Report is, in line with the statutory requirements, devoted to all relevant environmental components including the public health. It takes into account the character of the proposed activity (that is electricity generation via nuclear facility), particularities of the site (where other nuclear facilities are located) and the requirements of the Scope of Assessment (specifying a range of general and specific conditions for the Report elaboration). From this perspective, special attention within the Report is paid to the problem of impacts on the public and public health (particularly in the area of ionizing radiation impacts), including relevant co-affecting (cumulative and synergic) impacts of the proposed activity along with other existing or upcoming activities at the site.

Thus, the Report takes into consideration not only a relative contribution of the proposed activity, but (mainly) the total cumulative effect of the proposed activity along with other activities at the site and its environmental consequence. It is obvious from the following figure:

Figure 0.1: Assessment Aspects



The Report is a document elaborated in line with the Act on Environmental Impact Assessment. Thus, it is not a safety documentation in line with the Atomic Act. Although it is not possible to avoid completely the interference of both environmental issues and nuclear-safety issues in the Report, the content of the Report is focused predominantly on its primary objective – assessment of the environmental impact of the proposed activity. Therefore, the used terminology is adequate and drawn mainly from customs in the field of environmental impact assessment.

If the Report presents ways of nuclear safety provision, radiation protection, physical protection and emergency planning, they are presented in relation to the environmental perspective (i.e. perspective of environmental impacts). The Report does not discuss technical or organisational aspect of these issues (i.e. design, construction and/or operational perspective). These data represent the input data for the Report elaboration, not its object; they are described but not evaluated. When assessing environmental impacts, it is reasonably assumed that all the statutory requirements of other than environmental relevance will be fulfilled during preparation, operation or termination of operation of the proposed activity.

Methodological Elaboration of the Report

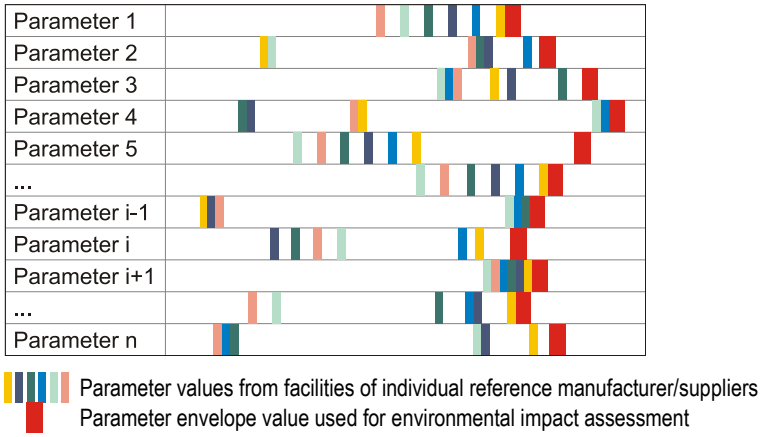
One of the basic methodological approaches in the field of environmental impact assessment and in the field of nuclear power industry is the focus on the safety of the assessment. The Report elaboration is thus consistently subjected to the conservative approach. This is based on the fact that all data considered for the assessment are less favourable from the environmental perspective. Only in such case it is guaranteed that the assessment processes will cover all impacts of the proposed activity at their potential maximum.

One of the applications of such conservative approach is also selection of unit parameters of possible power plant suppliers used for the impact assessment. In this procedure, those least favourable parameters are selected from all environmental parameters of the facilities of all potential suppliers (e.g. the largest water extraction, the highest radioactive discharges, the biggest scope for the impact assessments on landscape, etc.) and, in lots of cases, these are further rounded up conservatively. Such "Plant Parameters Envelope" is applied at impact assessment. The facility parameters of the subsequently chosen supplier will be better (or at least the same) in all indicators than (as) the parameters applied for the environmental impacts assessment. Thus, the results of the assessment will cover all facilities of the potential contractors[3] with a reserve. Such an "Envelope Method" is used for the impact assessment of nuclear power plants worldwide (recently e.g. in Canada, Finland, the USA and the Czech Republic) and is also accepted by the regulator bodies. Nowadays, the application of the marginal parameter envelope is assumed within the Scope of Assessment of the proposed activity issued by the Ministry of Environment.

[3] To avoid any doubts, there is also a descritpion of the technical solution of all individual potential suppliers within the Report. However, it is generally applicable that a power plant supplier may be any manufacturer, whose project meets the envelope parameters used for the environmental impact assessment (of course, also conforming to all other statutory requirements).

The principle of environmental Parameters Envelope creation is presented in the following picture.

Figure 0.2: The Principle of Environmental Parameters Envelope Creation



It is obvious that such a method of selection of parameters for assessment is very conservative and leads to the environmental impact assessment at its potential maximum (worst case scenario). The aim is to reach the possibility to evaluate the results of the environmental assessment with the knowledge that the actual impact of a selected performance would be lower than a forecasted one. So that such a situation will not occur, where the subsequent selection of technical design (manufacturer/supplier of units) would affect environmental and public health protection unfavourably.

A. BASIC DATA

A. BASIC DATA

A.I. Basic Data on the Customer

I. Basic Data on the Customer

A.I.1. Name

1. Name.

Jadrová energetická spoločnosť Slovenska, a. s.

A.I.2. Identification Number

2. Identification number

45 337 241

A.I.3. Registered Office

3. Registered Office.

Tomášikova 22
821 02 Bratislava
Slovak Republic

A.I.4. Customer's Authorized Representative

4. Name, surname, address, and phone number and other contact data about Customer's authorised representative.

Ing. Ján Červenák
Chairman of the Board of Directors, Director General

Jadrová energetická spoločnosť Slovenska, a. s.
Tomášikova 22
821 02 Bratislava
Slovak Republic

tel.: +421/2/482 62 278
e-mail: cervenak.jan@jess.sk

A.I.5. Other Contact Data

5. Name, surname, address, phone number and other contact data about a contact person whom it is possible to gain relevant information on the proposed activity and a place for consultation from.

Ing. Tomáš Vavruška
Member of the Board of Directors, Head of the Safety and Quality Section

Jadrová energetická spoločnosť Slovenska, a. s.
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phone: +421 910 834 395
e-mail: vavruska.tomas@jess.sk

A.II. Basic Data on the Proposed Activity

II. Basic Data on the Proposed Activity

A.II.1. Name

1. Name.

A.II.1.1. Name

NJZ at the Jaslovské Bohunice site.

A.II.1.2. Character

New activity.

A.II.1.3. Classification

In accordance with the Annex No. 8 of the Act, the activity is classified as follows:

Section:	2. Energy industry
Departmental body:	Ministry of Economy of the Slovak Republic
Item:	4. Nuclear power plants and other facilities with nuclear reactors (excluding research facilities for the production and conversion of fission and enriched materials with a maximum thermal output not exceeding 1 kW of continuous thermal output) including their decommissioning and treatment. Nuclear power plants and nuclear reactors stop being such facility if nuclear fuel and other radioactive contaminated components are permanently removed from their sites.
Maximum values:	Part A (obligatory assessment) - without limitation

A.II.2. Purpose

2. Purpose.

Electricity generation.

A.II.3. User

3. User.

Jadrová energetická spoločnosť Slovenska, a. s.

A.II.4. Siting

4. Siting (cadastral area, land parcel number).

The proposed activity is situated in the western region of the Slovak Republic. It is located in the area of the following territorial entities:

Region	*District*	*Municipality*	*Cadastral area*
Trnava	Trnava	Jaslovské Bohunice	Cadastral area Jaslovce Cadastral area Bohunice
		Radošovce	Cadastral area Radošovce
	Hlohovec	Ratkovce	Cadastral area. Ratkovce
		Červeník	Cadastral area. Červeník
		Madunice	Cadastral area Madunice
	Piešťany	Pečeňady	Cadastral area Pečeňady
		Veľké Kostoľany	Cadastral area Veľké Kostoľany Cadastral area Zákostoľany
		Dubovany	Cadastral area Dolné Dubovany
		Drahovce	Cadastral area Drahovce
		Piešťany	Cadastral area Piešťany

The stated list presents the territorial entities where all part of the proposed activity will be sited (thus, the area for the siting and construction of the new NPP and also the corridors of the related infrastructure). Although the extent of areas for sitting all parts of the proposed activity is set out conservatively (by its maximum possible extent), its actual extent will be smaller. Consequently, no land parcel numbers of the land concerned are presented (due to large number of them).

A.II.5. Siting Situation Overview

5. Siting situation overview (scale 1: 50 000).

The siting situation overview of the proposed activity within the scale of 1: 50 000 is attached in the Annex No. 1 hereof.

A.II.6. Justification for the Siting in the Particular Area

6. Reason of siting in the given locality.

A.II.6.1. General Data

The following is written in Energy 2020, which is the European Commission document determining the strategy for competitive, sustainable and secure energy: *"the affluence and prosperity of society, industry and economy depends on a safe, secure, sustainable and affordable energy".* As such, the need for the proposed activity emerges from the need for ensuring energy security of the Slovak Republic, especially in this very important area – electricity generation.

In its nature, the electric power represents a decentralized source of energy (it is generated via co-operation of lots of sources, it is consumed at different place as it is produced and it is possible to consume it in a relatively wide spectrum of operations everywhere a distribution network is accessible). It is ecologically pure at the final consumption point (its use does not generate any harmful pollutants) and it can be used universally (it is transformable into other forms of energy).

Functioning of all economic spheres and life conditions of inhabitants depend on the availability of electricity. The public interest in a reliable electricity supply is hence generally recognized; any potential deficiencies or failures in the electricity supply would affect the whole society.

But the electricity is not the primary source of energy. It has to be generated and transported to the final consumption point. Therefore, the proposed activity represents electricity generation that:

- respects the relevant international commitments of the Slovak Republic,
- respects al the energetic needs of the Slovak Republic set by the relevant state concepts,
- respects and effectively uses the accessible infrastructure of the Jaslovské Bohunice site,
- respects the expected development of consumption and electricity generation in the Slovak Republic.

As such, the proposed activity forms a part of the conception of multi-source energetic mix and energy saving. Thus, it forms one of the power grid components of the Slovak Republic – hence not a direct excluding alternative to other electricity sources. Those are and will be solved in particular consequences.

More detailed information concerning these facts are provided in the following subchapters.

A.II.6.2. Justification of the Need in Relation to the International Commitments of the Slovak Republic

The EU's energy policy is determined by the following essential documents:

The Energy Policy for Europe (2007) is a self-contained strategic analysis of energy situation in Europe. It defines three pillars of EU's energy policy:

- sustainability,
- energy security and
- competitiveness.

Its purpose is to achieve the state of economy with high energy efficiency and low CO_2 emissions that will be in line with the anti-climate change policy, reduction of external vulnerability of the EU through import of hydrocarbons and support of growth and employment. For such purpose, the EU has set several main energy goals:

- to establish an effective internal electricity market,
- to ensure security of electricity supply,
- to reduce greenhouse gas emissions,
- to improve energy efficiency,
- to increase the share of renewable energy resource in the energetic mix,
- to develop low-carbon energy technologies,
- to keep decision-making on nuclear energy use to every member state,
- to promote common international energy policy.

The Treaty of Lisbon amending the Treaty on the European Union and the Treaty establishing the European Community (2009) contains a separate article devoted to power industry. This article states that in the name of solidarity among the member states, concerning the establishment and functioning of internal market and with respect to the need to preserve and improve the environment, the EU's politics in the sphere of power industry follows these objectives:

- to ensure market functioning in the sphere of power industry
- to ensure security in energy supply in the Union
- o promote energy efficiency, saving and development of new and renewable energy resources
- to support cross connection of power grids.

Next, the article states that some areas of power industry shall be the mater of common responsibility, however, each state keeps its sovereignty in decision-making about composition of its energetic mix and in ensuring its energy security.

Other documents. : The first essential document for the legislative framework development for the period after the above mentioned *Energy Policy for Europe (2007),* was the *Energy Action Plan for the Years 2007 – 2010, approved in 2007.* Consequent documents covering its individual spheres are the *Strategy Plan for Energy Technologies (2007)* which contains measures related to planning, realisation, resources and international cooperation in the field of energy technologies, the *Third Liberalisation Package (2007)* devoted to the problem of energy market liberalisation, the *Climate and Energy Package (2008)* dealing with greenhouse gas emission reduction and the raise of OZE and the *Energy Efficiency Action Plan (2006)* having the objective to reduce the demand for energy. The *Second Strategic Energy Review: an EU Energy Security and Solidarity Action Plan (2008)* focused on energy security and *European Economic Recovery Plan (2008) focused on* electric power infrastructure.

Subsequently, in 2009 the Lisbon Treaty was accepted; whose part relating to power industry is described above. The strategy *Europe 2020* as of 2010 determined five main objectives of the EU, one of them relating to climate change and energy. Energy objectives were further elaborated in the document *Energy 2020: a Strategy for Competitive, Sustainable and Secure Energy (2010)*. The essential priorities of energy are effective use of energy resources, finishing establishment of European integrated energy market by 2015, widening consumers' rights and increasing security level, preservance of the EU's leading role in the sphere of energy technologies and stimulation of the outer dimension of the European energy market.

The statements within the *Energy Infrastructure Priorities for 2020 and beyond (2010)* identified basic tasks regarding energy infrastructure development (petroleum, gas, electricity) and priorities of European infrastructure necessary for finishing the establishment of internal market connections. The projects that concern the Slovak Republic include the South Gas Corridor, the South-North gas corridor and petroleum connection and electricity connection in the middle and south Europe. The *Commission's Energy Infrastructure Package (2010*) further elaborated the following projects:

Plan for transformation to a competitive low-carbon economy in 2050 as of 2011 analysed consequences of the commitment to reduce greenhouse gas emissions by 80 to 95% in comparison to the year1990 and indicated the scope of emission reduction within key branches for the years 2030 and 2050. The Energy Roadmap 2050 effective as of 2011 presented the analyses of various scenarios of European energy system decarbonisation and methods of providing the electricity supply by 2050 and its objective was to provide long term technologically neutral European framework for energy policies of the Member States and thus achieve the necessary security and stability in investment to the electricity power sector. Based on this plan, the nuclear energy will be a significant contribution to the energy transformation process in the member states where it exists. From the effectiveness perspective, the least expensive scenarios actually include the ones with the highest share of nuclear energy.

In 2012, the *Directive 2012/27/EU on Energy Efficiency* was accepted to implement new measures to achieve power consumption reduction. Based on the Directive, the Slovak Republic is to reduce by 2020 the final power consumption by 11% compared to the average amount in the years of 2001 and 2005. During the first stage of monitoring (2011 – 2013), 60% of the achieved savings were related to the sphere of buildings, where the energy savings were achieved especially by measures improving the heat and technical characteristics of the buildings providing housing.

These savings were achieved especially from the saving of the heat for heating blocks of flats which is usually provided by other sources than electricity. It can be assumed in the future, that the Directive on energy efficiency will bring the savings predominantly for the consumption from other energy sources and that it will not significantly affect the development of the electricity consumption in the Slovak Republic.

In 2012, the European Commission published the Report *Renewable energy: a major player in the European energy market to* ensure the sustainable development and use of renewable energy resources also after 2020. The *Green Paper: 2030 Framework for climate and energy policies* was

issued in the following year 2013. In the statements from the Report *on making the internal energy market work*, the European Commission repeatedly presents the advantages of European integrated markets and proposes a plan to ensure completion of the establishment of the energy internal market in the EU as quickly as possible.

Based on the perspective of the European energy policy having the aim to reduce greenhouse gas emissions by the year of 2050 by 80 - 90% in comparison to the year of 1990, the electricity is expected to have a key role in low-carbon economy. By 2050, it could contribute to the almost total elimination of CO_2 emissions and it could possibly partially replace fossil fuels in transportation and heating/cooling. Due to the European plans to move to the competitive low-carbon economy in 2050, it will be necessary to ensure almost total elimination of CO_2 emissions in power industry.

In general, renewable energy resources (OZE) are considered the most appropriate for low-carbon electricity generation. However, despite the increase of their use, they can be considered only the supplementary resources in Slovak conditions (with the exception of hydro-electric power plants) which due to their operational and also very costly characteristics can not present an alternative to traditional methods of electricity generation.

As the European Union is not able to guarantee the energy security of the Member States (as it was obvious during the gas crisis in 2009 or during the restriction of supply from the Russian Federation in autumn 2014), it gives them the right to determine energy policy and mainly the energetic mix for the provision of their own electricity needs. Thus from this perspective, there are no restrictions for the Slovak Republic in the utilization of nuclear energy as driving force for the low-carbon growth.

Out of 78% of the low-carbon electricity produced in the year 2013 in Slovakia, more than 66% was generated by nuclear power plants. If the Slovak Republic aims to achieve the low-carbon economy defined in the above-mentioned plan, it does not have any other alternative than nuclear energy, which is a non-carbon electricity resource in the same sense as are the renewable energy resources, but due to its characteristics, it is completely appropriate for covering the consumption in the basic zone and for stabilization of the SR power grid.

Consequently, the proposed NJZ at the Jaslovské Bohunice site is in accordance with all the relevant documents and directives of the European Union as well as with all the commitments resulting from the documents concerned.

A.II.6.3. Justification of the Need in Relation to the Energy Policy of the Slovak Republic

The energy policy of the Slovak Republic is determined by the following essential documents:

Energy Security Strategy of the SR (SEB) (2008) having the aim to attain competitive power industry ensuring safe, reliable and effective supply of all energy forms for reasonable prices with respect to the protection of a customer, environmental protection, sustainable development, supply safety and technical safety.

By 2030, the Strategy is supposed to, among the others, ensure self-sufficiency in electricity production, optimal price policy, pro-export ability of the SR and strengthening its role of transit country in energy market. The document further presents that nuclear power plants will continue to form the basis in electricity production being a significant component of electricity supply security and sustainable development. The construction of a NJZ having the capacity of 1200 MW is considered therein as a potential replacement for the decommissioned JE V2. The new NJZ is also included in a recommended programme of the power plant construction by 2030, where its commissioning is expected approximately between the years of 2024 and 2025.

The strategic priorities in the sphere of electricity supply in the period between 2013 and 2030 include the following priorities, that support the intention to construct the NJZ either explicitly or implicitly:

- to direct the generation station development moving to the stable balance between the consumption and its sources from national resources with approximately 20% power reserve.
- to preserve a current optimal structure of the generation station having balanced distribution of the output among nuclear power plants, thermal power plants and renewable energy resources including hydro-electric power plants of higher output and to cover the electricity consumption with approximately 50% share of generation from the nuclear power plants.

- to direct the development to use all the available low-carbon production technologies (nuclear power plants, thermal power plants, renewable energy resources) having high efficiency in conversion of primary energy sources
- to ensure the construction of the NJZ having the capacity of 1200 MW until 2025, as a replacement for the decommissioned JE V2.

A Decree No. 948/2008 of the Government of the SR effective as of *17 December 2008 (*and its accompanying material) concludes that the only way to deal with the negative energetic balance affecting Slovak energy security is the energy policy and the national economic strategy focused on the promotion of the construction of new electricity generation sources.

Based on comparative analyses of costs for the construction and operation of the alternative sources for electricity generation and after considering all relevant legal, technical and regulatory factors, the Government definitely confirmed the rightness of the decision on the planned new NPP at the Jaslovské Bohunice site. The individual conclusions of selected document parts are defined briefly as follows:

The analysis of the macro-economic environment reached the conclusion that, despite the slow growth of the world (and also of Slovak) economy, there are preconditions for the sustainable development of the Slovak economy. The political and monetary stability contributes to the emergence of the environment appropriate for the realization of the long term and financially demanding projects, the new NJZ being one of them.

The construction of the new NJZ would contribute to the levelling of the electricity generation and consumption balance and to higher competitiveness in the area of its generation; by means of the diversification of entities generating electricity in Slovakia, the possibility of price reduction for final customers could appear.

Individual types of electricity production sources were analysed and compared within the document (whereas the comparison took into account not only the cost of the construction of the plant but also socio-economic and environmental damages). Concerning nuclear power plants, the nuclear reactors of PWR type having electric capacity up to 1750 MW were analysed. The conclusion of the analysis was that in Slovak conditions, the nuclear power plants belong to the least expensive sources of electricity generation and that competitiveness of the electricity generation from nuclear sources was confirmed also by several studies from the European Union and other developed countries of the world.

A Certificate of Compliance by Ministry of the Economy of the SR (2014). On 31 July 2014, Jadrová energetická spoločnosť Slovenska, a. s. submitted to the Ministry of the Economy of the SR an application for the issuance of a Certificate of Compliance for the construction of the NJZ at the Jaslovské Bohunice site. Subsequently, the Ministry of the Economy of the SR certified the request with the decision No. 22613/2014 as of 30 September 2014. Justification of the decision states that the Certificate is in compliance with the energy policy and meets all the requirement of the Act No. 251/2012 Coll. on Energy Sector based on which it was issued.

Manifesto of the Slovak Government for the period of 2012-2016 (2012) asserts that the government will follow the Energy Security Strategy from the year 2008. It is a key factor affecting all spheres of the national economy and the whole society. Energy security is an indispensable part of the strategic security. The government considers sufficient insurance of energy important for the economy and normal life of households to be one of the decisive components of the state security. For that reason, it will support the construction of the new energy architecture based on the cohesive energy policy of the EU. The government will create conditions for the self-sufficiency and pro-export ability in electricity generation, optimal and balanced energetic mix with the emphasis put on low-carbon technologies and the growth of energy efficiency. The government will accelerate the readiness for the new nuclear power plant construction at the Jaslovské Bohunice site and will take advantage of all opportunities to accelerate the construction of the unit 3 and unit 4 of the Mochovce nuclear power plant. When utilizing nuclear energy, the high level of security for all nuclear facilities will be the

main priority for the Government. Concerning the utilization of renewable energy resources, the Government will ensure optimization of the energetic mix and a higher extent of the utilization of a national energy potential including construction of hydro-electric power plants, biomass power plants in a way that new work opportunities would be created and positive synergic effects in the area of regional development, agriculture, energy safety and environmental impacts would be reached. When using renewable energy resources, the government will take into consideration their impact on the final price of electricity and the safety and stability of the power grid. Finally, the Government will create a motivating environment with the aim to reach energy savings.

Strategy for the Final Phase in the Peaceful Use of Nuclear Energy in the Slovak Republic (2014) was updated by National Nuclear Fund in October 2013 and approved by the Government of the SR in January 2014. The main aim of the strategy is the environmental protection against long term consequences of the use of nuclear energy in electricity generation and consequences of the other spheres of its peaceful use. The strategy describes the method of financial resources selection that are necessary for covering historical financial deficits relating to the final part of nuclear energy sector that emerged via non-existence of such conception by 2006. Updating of the document from 2008 was performed due to several reasons, whereas one of them was also the intention to construct NJZ in the Jaslovské Bohunice site. Along with setting the direction of the development in the sphere of final part of nuclear energy use, decommissioning of nuclear power plants and treatment of burnt nuclear fuel and radioactive waste, the funding of individual projects and activities concerned will follow the priorities set in this Strategy. Today, it is possible to state that the Slovak Republic has got functioning system of treatment of burnt nuclear fuel and radioactive waste with clearly defined duties and funding of individual activities.

Intrastate policy and Intrastate program of treatment of spent nuclear fuel and radioactive waste in the SR as update of the Strategy document Strategy for the Final Phase in the Peaceful Use of Nuclear Energy in the Slovak Republic. National Nuclear Fund, Bratislava (in legislative procedure, departmental body is the Ministry of the Economy of the SR, implementation deadline is august 2015) implements the requirements of the Regulation 2011/70/Euratom of the EU as of 19 July 2011 that establishes the Community framework for the responsible and safe treatment with spent fuel and radioactive waste. The Regulation requires that each EU state having a nuclear programme would have cohesive plans and ideas concerning implementation of deposit of all kinds of RAO and VJP which are produced in a particular state, including creation of resources for implementation.

The Document is based on an intrastate policy proposal for VJP and RAO treatment, on the Strategy for the Final Phase in the Peaceful Use of Nuclear Energy in the Slovak Republic and on the documents submitted by holders of permits for VJP and RAO treatment and for decommissioning of JE. It defines programme steps to achieve the following goals: safe and reliable decommissioning of nuclear facilities, minimizing a radioactive waste production, provision of appropriate fuel cycle selection, safe storing of RAO and VJP, provision of a chain of RAO and VJP treatment, provision of nuclear safety, principles of application of graded approach, application of the principle "a polluter pays", provision of objective decision-making procedures, application of the responsibility principle. The Intrastate programme also includes the ongoing preparation of the NJZ within its statements of specification of objectives.

The document involves detailed balance of production of RAO and VJP from all nuclear power facilities in Slovakia including the decommissioned JE V1 and JE A1 and the MO3,4 under construction. Next, it provides the outline of assumed expenditures for radioactive waste and spent nuclear waste treatment, the outline of assumed expenditures for decommissioning of individual power plants and for disposal of RAO and VJP, balance of revenues of National Nuclear Fund (NJF), balance of the RAO storage capacity and needs to expand them, a strategy for preparation of deep geological repository for VJP and high-level RAO. Even though the NJZ is stated in the within the statements of policy and programme, the production of RAO_ and VJP from the NJZ is not taken into consideration within specific balance of the intrastate programme.

Energy Policy of the SR (2014) effective as of 5 November 2014 has become a strategic document determining basic objectives and frameworks of the energy sector development in Slovak Republic, up to the year 2035. Since the provision of the sustainable economic development and competitiveness is conditioned by the reliable energy supply, the document should become a component of the National Economic Strategy of the SR.

In favour of stability, economic development and consumer protection, the energy policy supports (due to the fact that the Slovak Republic belongs to vulnerable countries as regards to energy security) such energetic architecture that "will create conditions for an increase of energy sufficiency, pro-export ability in electricity, transparency and optimal energetic mix with low-carbon technologies, or an increase of energy effectiveness“. The emphasis is put on the optimal use of national energy sources and low-carbon technologies, nuclear and renewable energy resources being one of them.

The construction of the NJZ at the Jaslovské Bohunice site is in the energy policy mentioned within the measures aiming to increase energy security explicitly, with the proposed installed capacity of the plant to be 1200 MW resp. 1700 MW.

Further, the energy policy presents scenarios of the development of the energy economy of the Slovak Republic. They are stated later in the chapter A.II.6.5. Justification of the Need in Relation to the Development of Electricity Production and Consumption.

Assessment Report on the Strategic Document – the draft *Energy Policy of the SR (2013)* was elaborated pursuant to the Act. No. 24/2006 Coll. on Environmental Impact Assessment as amended, in September 2013. It assessed the draft of the Energy Policy of the SR from the perspective of its assumed environmental impacts. The Report concluded that "the impacts of the strategic document that were possible to be assumed within its assessment are not of such nature that would cause a severe impact on the environment of the area concerned". Next, it is stated in the Report that "by implementation of Energy policy of the SR after taking into consideration requirement following environmental policy objectives at national and European level and after elimination of the assumed environmental impacts, the decrease of unfavourable environmental impact of the energy sector is anticipated, especially by means of promotion of programmes allowing to increase the share of environmentally friendly energy systems and by promotion of more effective and less polluting methods of conversion, transmission, distribution and use of energy in line with fare and adequate energy supply in present an in future.”

As the construction of the NJZ was a part of the assessed draft of the Energy policy of the SR, the stated conclusions relate also to the power plant in preparation.

SR Land Development Conception (updated 2011) is a document that is a starting point for national land-planning policy of the SR. In 2011 the edition from 2001 was updated whereas the following provision was added to a binding section: "to provide the land conditions for construction of new electricity and heat generation facilities and the related buildings including the provision for land preparation, the construction and completion of intrastate power grids and facilities serving for electricity transmission, construction of other international connections in relation to energy sector liberalization and opening of energy markets in line with the Strategy of energy security of the SR". That relates also the project of the NPP construction because it is one of the priorities of the Strategy of energy security of the SR as stated above. The land conditions for its construction and construction of related buildings were created within the preparation of the land use plan of the Trnava Self-Governing Region.

Land Use Plan of Trnava Self-Governing Region (accepted in December 2014) is a document determining direction of the region from the viewpoint of a planned construction activity. The construction of the new NPP is included in this plan for the period from 2015 to 2035 in the north-west part of the existing Jaslovské Bohunice power plant site, having a total power capacity up to 2400 MW (1 or 2 units). For this purpose, the land use plan also defines the site for the sitting of the new NPP, construction equipment and connection to the infrastructure. Within the regional land use plan, the creation of

land-planning conditions for the realization of the new NPP and the buildings related to its operation in the Jaslovské Bohunice site belongs between important areas for development, areas of special interests of regional importance determining a framework of components for lower levels of land-plan documentations.

Ten-year Plan of Electric Grid Development for the period of 2014-2023 (June 2014) is a strategic document that is elaborated obligatorily every year by an operator of transmission grid (SEPS) in compliance with the Act on Energy. This ten-year plan is based on a current and assumed state of supply and demand for the grid capacity, on adequate anticipation of generation, supply and consumption of electricity and its cross-border exchange and at the same time, it takes into consideration the plan of the grid development for the whole EU and regional investment plans. It is also stated in the document that with respect to a structure of generation base and well-built transmission grid, the electricity supply for Slovakia is reliable having minimum occurrence of power failures threatening security of electricity supply while all key criteria and recommendations of ENTSO-E in primary and secondary regulation of power capacity and frequency, in regulation of voltage are fulfilled. In line with the development plan and from the perspective of provision of increase of consumption and replacement of lingered capacities, it should be solved in a way that adequate and balanced development of generation base mix would be achieved. Without a comprehensive solution of their impact, the construction of wind and photovoltaic sources could cause problems with regulation of power grid due to the high fluctuation of their electricity generation depending on weather.

The new NPP is not discussed in more detail in the development programme because commissioning of the NJZ is assumed to happen not earlier than after 2025 and the development plan is planned only for the period by the year 2023. However, in case of its construction, the necessary transmission capacities being under planning or construction will be available already in that period.

As it is evident from the stated data, the NJZ at the Jaslovské Bohunice site is completely in accordance with the key relevant energy sector document of the Slovak Republic. It may be referred to as a project which will significantly contribute to the progress of the Slovak energy sector towards the objective to achieve energy security and competitive, low-carbon and sustainable development. The need is given mainly by:

- necessity of substituting the capacities of the power plants in Slovakia which are currently ending their lifetime by a more modern sources;
- anticipated increase in power consumption (despite the economic measures);
- need of stable low-carbon sources in the production mix;
- anticipated decrease in fossil fuel power plants utilization as a result of their environmental unfriendliness and of the decreasing domestic coal reserves;
- unrealistic nature of securing a sufficient and reliable power supply from the renewable sources and
- need to increase the energy security of the Slovak Republic.

A.II.6.4. Justification of Siting at the Jaslovské Bohunice Site

The Jaslovské Bohunice Site has been used for the electricity generation in nuclear power plants and for the construction and operation of the other nuclear facilities in the long term and all the necessary areas and infrastructure are accessible within it, including the source of raw water, electric power grid of the Slovak Republic and radioactive waste treatment systems. The choice of this site thus represents an effective use of the accessible resources from the environmental perspective.

It is necessary to emphasize the existence of over 55 years of actual experience of the population with the construction and operation of the nuclear power plants and that the local citizens support the use of the nuclear energy. From the technical perspective, the region features a sufficiently developed infrastructure, both transportation and technical, and qualified labour force. In comparison with any other potential locations (another region), the Jaslovské Bohunice site has an advantage in the form of lower occupation of land, whereas the site of the decommissioned A1 and V1 being currently in decommissioning can be partially used and the part of building complexes and engineering networks located at the site can be used for the construction site equipment.

For these reasons, the construction of the NJZ will bring various advantages which will hence contribute to the acceleration of construction as well as decrease in costs of the construction and this should be finally reflected in the lower electricity generation prices.

The location of the NJZ at the Jaslovské Bohunice site is explicitly anticipated by the above mentioned *Government Ordinance No. 948/2008* and also the draft *Energy Policy of the SR.*

Within the accepted Land Use Plan of the Trnava Self-Governing Region (2012), the proposed activity is located at the EBO site and in its nearby vicinity, whereas for its siting and construction the accessible premises of the existing EBO site are used.

A.II.6.5. Justification of the Need in Relation to the Electricity Generation and Consumption

Even after including the impact of Directive 2012/27/EU on energy efficiency, the Energy Policy of SR (2014) considers the increase in electricity consumption in all analyzed scenarios, within the entire period until 2035. Expected development of the energy balance of the Slovak Republic is based on subsequent analyses carried out within the Energy Policy of SR (2014).

A.II.6.5.1. Gross Domestic Consumption

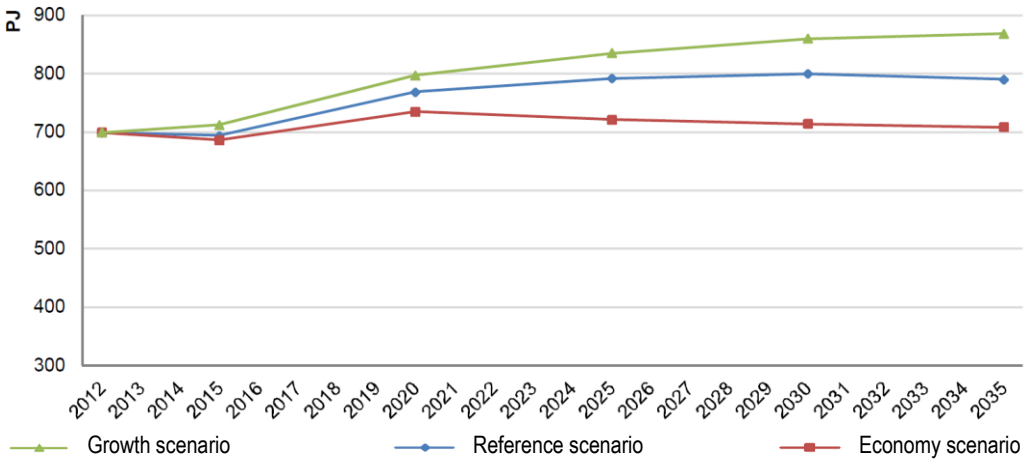
Within energy policy, three scenarios were analysed concerning Gross Domestic Consumption (HDS) based on anticipations of total economic development in Slovakia and Europe.

Scenarios of the Gross Domestic Consumption development in the SR are obvious from the following data.

Tab. A.II.1: Forecast of the gross electricity consumption development pursuant to scenarios of Energy Policy of SR

Scenario	Annual rate of change	Gross Domestic Consumption [PJ]							
		2000	2005	2010	2015	2020	2025	2030	2035
growth	+0,62 %	778	803	743	712	797	835	860	868
referential	+0,25 %	778	803	743	694	769	792	800	790
economy	-0,19 %	778	803	743	686	735	721	714	708

Figure A.II. 1: Forecast of the gross electricity consumption development pursuant to scenarios of Energy Policy of SR



Referential scenario is a basic scenario with the anticipation of the growth of the Gross Domestic Consumption up to the level 790 PJ in 2035. The average rate of intra-annual growth in the period of 2010 to 2035 is about 0,25%. As regards primary resources, the category of nuclear fuel that involves the total produced volume of heat for electricity generation (including electricity to export) and output reserve heat are anticipated to increase the most. The increase of the nuclear fuel consumption will be caused by commissioning of NPP Mochovce 3, 4 after 2015 and by the planned commissioning of the NJZ

after 2025. Within this scenario, the JE V2 will be gradually replaced by the NJZ with the installed capacity 1200 MW, or 1700 MW by 2030.

In line with the SR and EU objectives in the sphere of moving towards the low-carbon economy, it is anticipated that there will be digression in the fossil fuel consumption. The coal consumption will decrease the most, where in 2035, the anticipated value will be by 51% lower than in 2010 what will be caused by the decrease in the coal consumption for electricity generation and by the move to other fuels for heating in heating sector. Also natural gas consumption is probable to decrease, due to its lower utilization in heating sector for the reason of better energy characteristics of buildings (external thermal isolation and construction of low energy and passive buildings) and the transition to other fuels like biomass, for instance. However, this process will be directed to a certain extent by its increased utilization in electricity generation where in future, it could replace coal due to its low emission production and gain a role of a reserve in relation to the expected growth of renewable energy resources. Vice versa petroleum consumption should continue to grow, what is in line with the anticipation of transportation sector growth and neither planned adding of bio components into motor fuels should have significant decelerating effect (except for that, the amount of bio components in motor fuels is to be reduced into the maximum of 7% in accordance with the latest decision of the European Parliament form April 2015).

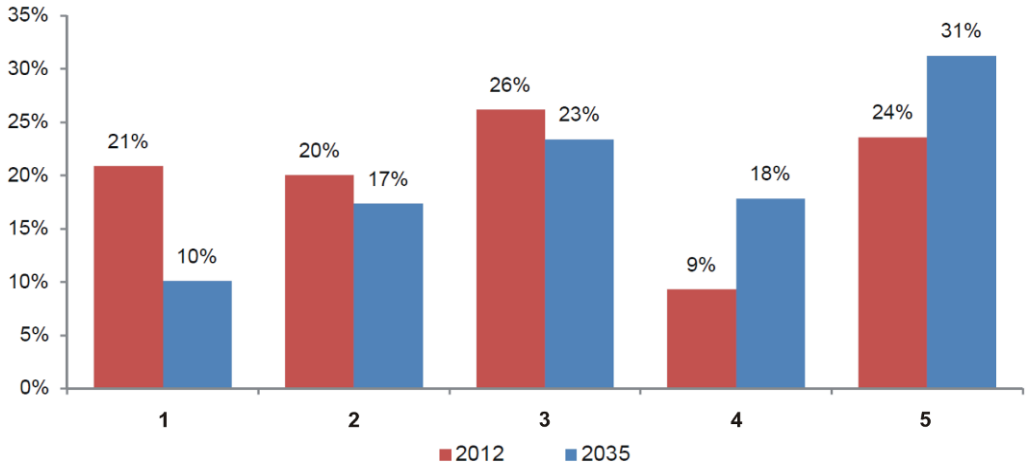
A category of renewable energy resources including also hydroelectric power plants is anticipated to grow due to the expected increase in construction of small hydroelectric power plants and planned increase in utilization of renewable energy resources in electricity supply as well as in heating industry what is still more and more becoming a priority of energy sector in Slovakia and Europe.

Economy scenario — expects that the consumption of primary energy resources and thus gross domestic power consumption will decrease. The main anticipations of this scenarios are the growth of HDP up to 3% a year and the increase of austerity measures realization in all sectors of the economy by means of reducing energy demand significantly. It is expected that this trend will be supported significantly by the Directive 2012/27/EÚ having the objective to decrease gross domestic consumption of the EU. The assumed average rate of decrease is about 0,19% a year from 2010 to 2035.

Growth scenario — is based on the anticipation of a significant HDP growth which should lead to the increase of the consumption of the primary energy resources in the period between 2010 to 2035 at an average level of about 0,62% a year.

In case of the reference scenario, the energetic mix of the SR would be significantly different from the current one (2012). Nuclear fuel will form the most substantial share (increase from 24% to 31% of gross domestic consumption). The share of OZE should double (increase from 9% to 18%), whereas solid fuels are expected to decrease (from 21%to 10%) as well as natural gas (from 26% to 23%) and oil and oil products (from 20% to 17%).

Figure A.II.2: The change in energetic mix by 2035 under the reference scenario of gross domestic consumption of Energy policy of SR



1 Solid fuel
2 Oil and oil products
3 Natural gas
4 Renewable energy resources
5 Nuclear

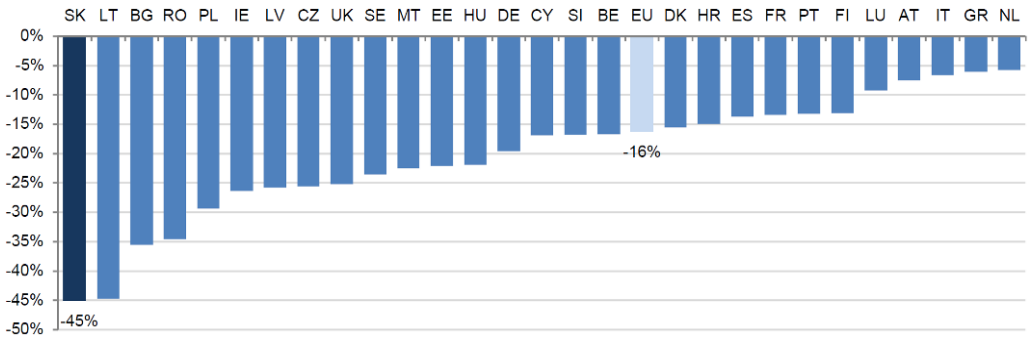
A.II.6.5.2. Final Power Consumption

Final power consumption (KES) is a subset of gross domestic consumption (HDS). Whereas HDS specifies value of energy of primary energy sources, KES specifies the amount of the energy generated via conversion of primary energy sources and consumed by final consumers. Thus, it is the energy that enters into the electric appliances for final utility effect (not for generation of other form of energy).

The ratio between HDS and KES represents *energy conversion efficiency*. In future, it is anticipated that energy conversion efficiency will grow due to improvement of efficiency of facilities generating electricity and heat, what practically means that it would be possible to gain the higher amount of energy from the same amount of primary sources. The efficiency improvement is one of the main objectives of the Directive 2012/27/EÚ on Energy Efficiency.

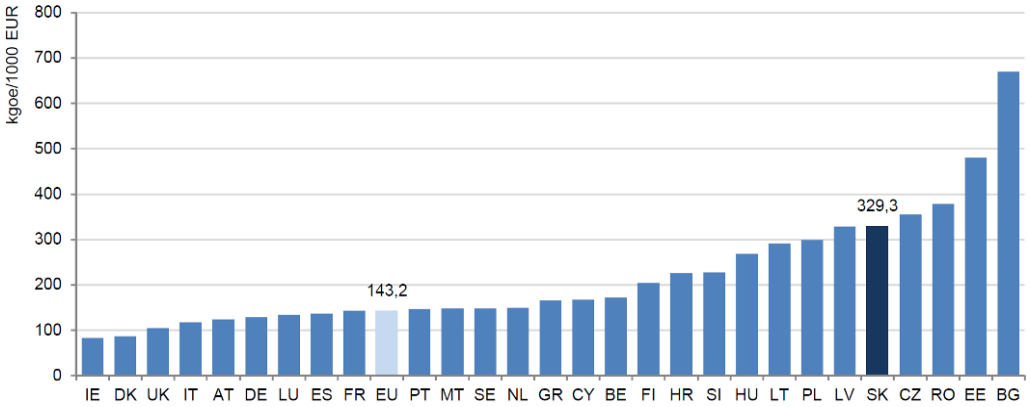
An indicator that interprets the power consumption into a unit of production is represented by *energy intensity*. It is determined as a ration of gross domestic consumption (HDS) and gross national product (HDP). In Slovakia, energy demand has been decreasing for a long time which was caused by the decreasing HDS and simultaneously growing HDP. Between 2001 and 2012, energy demand decreased by 45%, what was the highest decrease among Member States in the EU. Regardless the most rapid decrease among the EU Member States, Slovakia still has got fifth highest energy demand what is more than twice the European average. The reasons are a continuing high share of energetically intense industry sectors (e.g. metallurgical) in HDP, lower productivity of work and small industry restructuralisation towards sectors with a higher added value. It is presented by the following data.

Figure A.II.3: The change of energy demand of the EU countries in the period 2001 - 2012



Source: Eurostat

Figure A.II.4: Energy demand of the EU countries in 2012



Source: Eurostat

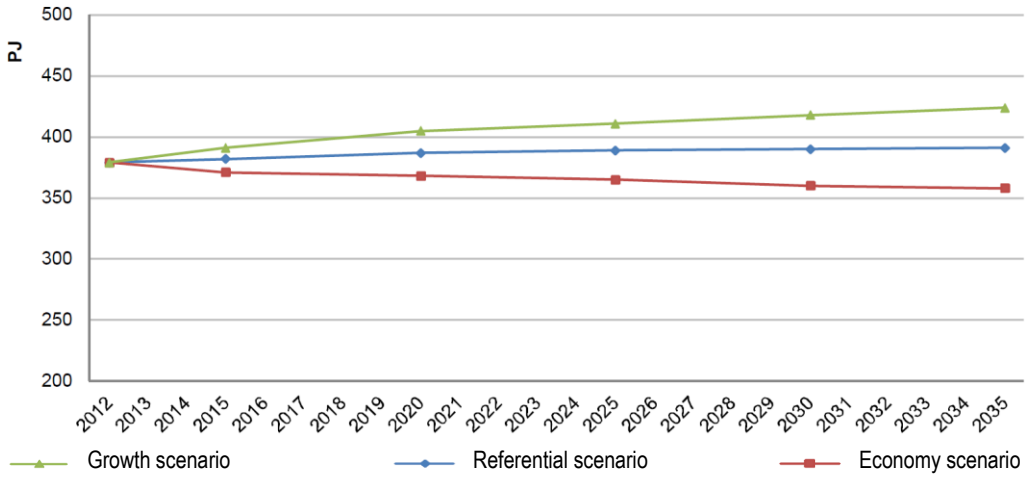
Reduction of energy demand in the economy is one of the main priorities of the Energy policy of the SR, in accordance with the Directive 2012/27/EÚ on Energy Efficiency. The Directive imposes on each Member state the obligation to set a so-called indicative national objective of energy efficiency. Pursuant to the Directive, the Slovak Republic is thus under obligation to reduce the final power consumption by 11% in comparison to the average level in the period from 2001 to 2005 by the year of 2020.

Thanks to the energy efficiency improvement of primary sources conversion and current reduction of energy demand of the economy under referential and growth scenario, only a moderate increase of final power consumption (referential and growth scenario) respectively its gradual decrease (economy scenario) is expected. The scenarios of final power consumption development in the SR are presented by the following data.

Tab. A.II.2: Forecast of the final power consumption development pursuant to the scenarios of Energy Policy of SR

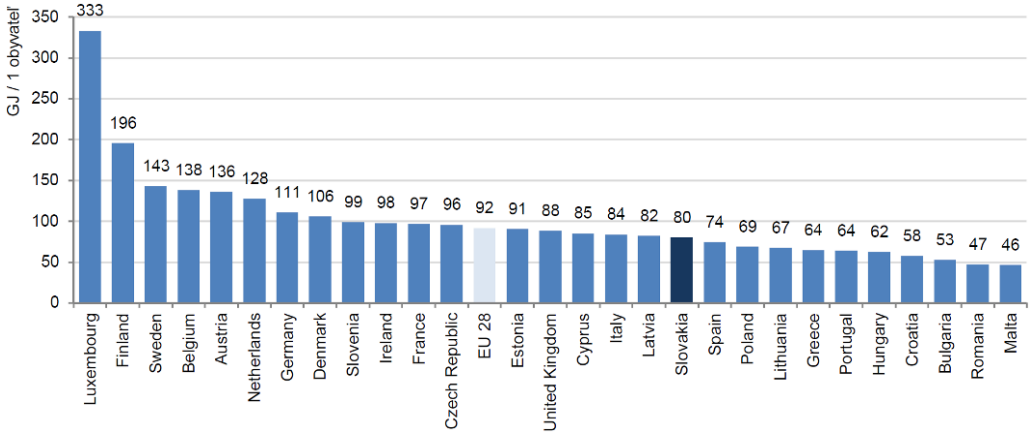
Scenario	Final power consumption [PJ]					
	2012	2015	2020	2025	2030	2035
Growth	379	391	405	411	418	424
Referential	379	382	387	389	390	391
Economy	379	371	368	365	360	358

Figure A.II.5: Forecast of final power consumption development pursuant to scenarios of Energy Policy of SR



As a comparison, the following picture shows final power consumption of the EU state per one inhabitant. It is evident that annually, an average Slovak inhabitant consumes less energy than an average EU inhabitant by about 12 GJ less, while his consumption is significantly lower than in a majority of developed EU countries, e.g. in comparison with Germany 72% (by 31 GJ per year less) and neighbouring Austria 59% (by 56 GJ per year less).

Figure A.II.6: Final power consumption of the EU countries per 1 inhabitant in 2012



Source: Eurostat

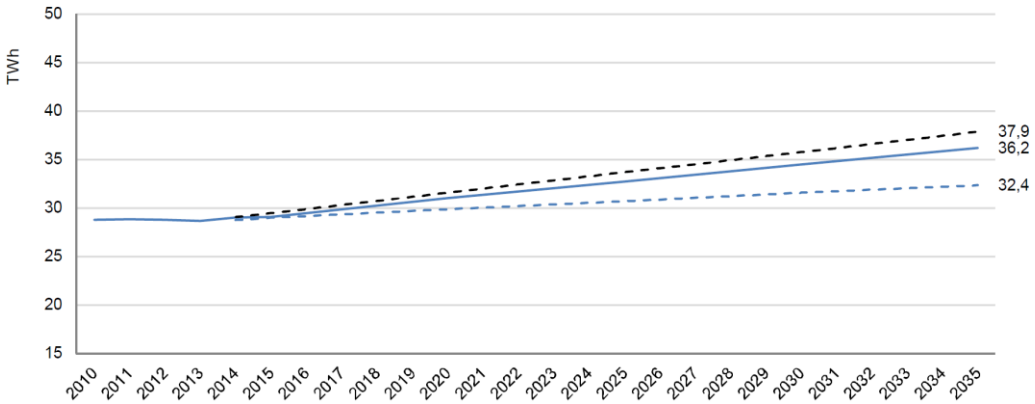
A.II.6.5.3. Electricity Consumption

Within the Energy Policy of the SR, the development of electricity consumption is equally analysed in three scenarios that differ especially in an anticipations about an economical growth. Whereas low scenario anticipates substantial deceleration of the economic growth and HDP growth, referential and high scenario expect an increase of dynamics of the economy and acceleration of an economic development. All scenarios count with a decreasing energy demand and with natural power savings resulting from the competitive market environment and no extraordinary situations are expected which would significantly decrease the consumption (such as termination of operation by one of significant consumers). Because the industry is the largest electricity consumer, its structure will significantly influence the power consumption trend in Slovakia. No significant deviation from the energy intense sectors can be assumed for the future. The course of the consumption scenarios are presented in the following chart.

Tab. A.II.3: Forecast of total electricity consumption development pursuant to scenarios of Energy policy of SR

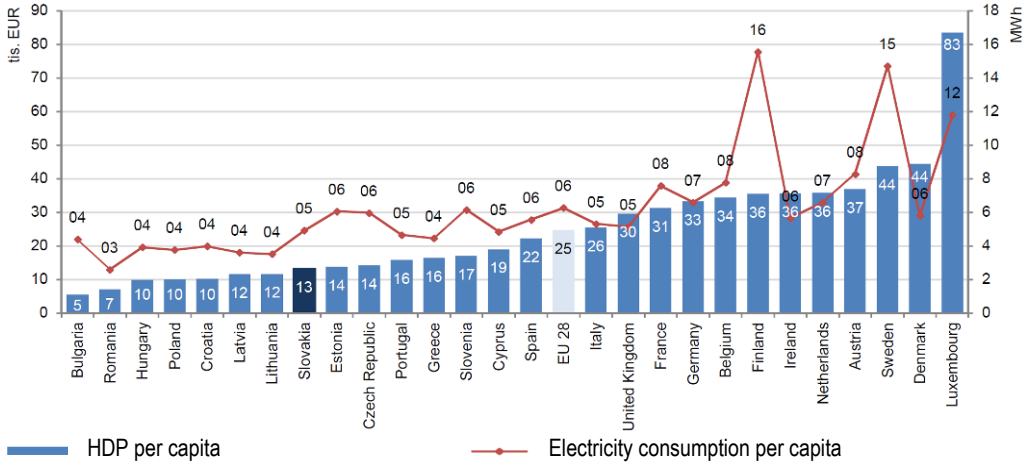
Scenario	Annual rate of change	Electricity Consumption [TWh]									
		2010	2011	2012	2013	2014	2015	2020	2025	2030	2035
High	+1,4 %					29,1	29,5	31,6	33,7	35,8	37,9
Referential	+1,2 %	28,8	28,9	28,8	28,7	29,0	29,1	31,0	32,7	34,5	36,2
Low	+0,6 %					28,8	29,0	29,9	30,7	31,6	32,4

Figure A.II.7: Forecast of total electricity consumption development pursuant to scenarios of Energy policy of SR



These expectations conform to a situation in other EU states where electricity consumption depends on a level of HDP considerably. The following picture presents a ratio between HPD and power consumption per capita.

Figure A.II.8: Electricity consumption per capita in EU states (2013)



Not.: EU 28 except Malta
Source: ENTSO-E, Eurostat

Thus, it is possible to anticipate that electricity consumption will increase due to the effort to converge the SR economy towards the EU average, what confirms the projection of electricity consumption growth in all the projection scenarios of the Energy Policy of the SR.

As all the scenarios expect the growth of the consumption by 2035 within the extent between +13% with the low scenario up to +32% with the high scenario (compared to the year 2013), it will be necessary to ensure sufficient new energy resources in future, not only to cover such a growth but also as a replacement of decommissioned plants. In the Slovak Republic in 2013, the total installed capacity reached 8074 MW_e what represented the decrease by 357 MW_e compared to a previous year.

The thermal power plants (35%) had the highest installed capacity; they utilized the following types of fuel: brown coal (20% of the installed capacity of thermal power plants), black coal (16%), natural gas (39%), fuel oil (10%) and a mix of several fuels (15%). The nuclear power plants disposed of the installed capacity share of 24% and hydro-electric power plants the share of 31%. The other power plants disposed of the share of 10%, the other power plants being enterprise power plants and power plants using renewable energy resources: photovoltaic (67% of the installed capacity of the other power plants), plants using biomass (22%), plants using biogas (9%), wind mill power plants (0,4%) and other resources (1,6%).

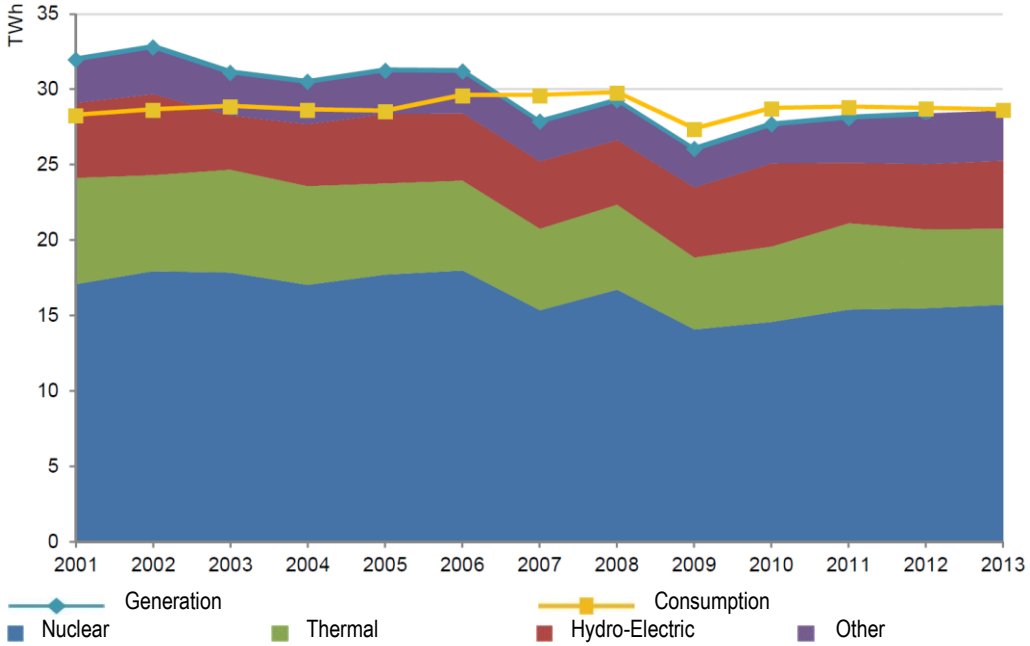
What is an important parameter in analysis of generation capacity of energy resources is a factor of installed capacity utilization that shows disponibility of a resource (thus, how many percent of maximum generation capacity is actually used). Whereas according to the American agency Energy Information Administration that analysed power plants located in the USA in 2009 the average utilizability of nuclear power plants was 90,3%, the utilizability of other resources was substantially lower: with coal power plants, it was 63,8%, with hydro-electric plants 39,8%, plants spending natural gas 42,2% and with renewable energy resources (except water) it was just 33,9%. There is no reason to anticipate significantly different utilizability concerning power plant in Slovakia (e.g. nuclear power plants of company SE had 93,95% utilizability in 2013 being one of the highest in Europe).

That considerable advantage allows a nuclear power plant to generate electricity at a stable level only with breaks necessary for fuel replacement what resulted in the nuclear power plants share in electricity generation having been up to 55% in 2013 (with the share of total installed capacity 24%). Regardless the highest installed capacity, the thermal power plants generated only 15,7% in 2013, hydro-electric power plants 17,7% and the other power plants 11,6%. On the other hand, thermal and hydro-electric power plants are utilized to cover top load that nuclear power plants are not fully utilizable to cover it (in case of NJZs, such deficiency is going to be eliminated partially).

Considering long term electricity generation development in Slovakia, after a significant increase induced by commissioning of the first two units of Mochovce power plants at the end of the nineties it is possible to observe the gradual decrease of generation caused mainly by decommissioning of NPP Bohunice 1,2 (V1). However, during the last three years, generation has slightly increased especially thanks to modernization and increase of nuclear power plants capacity and to increase of

renewable energy resources capacity (predominantly of photovoltaic power plants). In spite of that, the current generation of 28,4 TWh is still lower by approximately 12,8 % than the maximum value of 32,8 TWh reached in 2002.

Figure A.II.9: Balance of total electricity generation and consumption in SR in the recent period according to resources

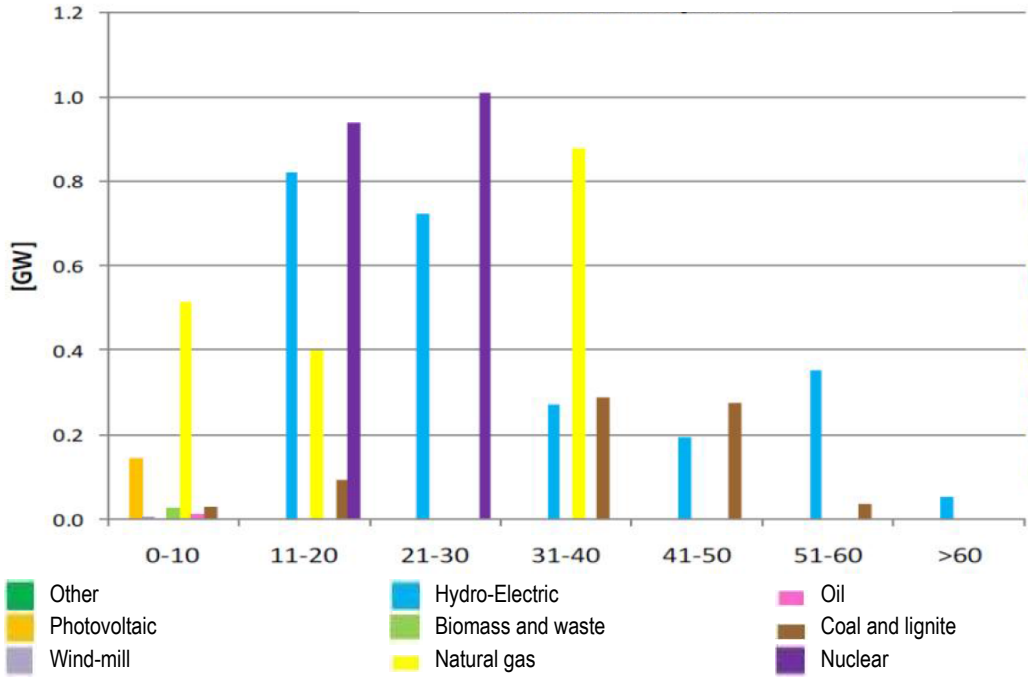


Source: Slovak Energy Dispatching

The majority of coal power plants and substantial amount of natural gas capacities in the SR is coming near to the end of their lifetime period. By 2020, it is anticipated that 44% of generation capacity of power plants will be decommissioned in the SR (compared to 2010) due to the end of their lifetime period[4]. It is evident from the following picture.

[4] It is important to note, that ageing of the electricity generation basis is not only a problem in the Slovak Republic, but in the European Union as such. It is presumed that by 2025, the EU will necessarily have to substitue up to 267 GW of capacity, wheras the required investment in the power generation basis should reach up to EUR 750 billion by 2020. As a result of the ongoing financial and economic crisis in Europe, such investments are currently not made (with the excepton of granted facilities sucha s the renewable source of energy) and the risk of problems with safequarding the electricity supply is increasing for the future. It is expected that by 2023, the EU will have almost one third of the current installed capacity of fossil fuel power plants, what could mean considerable problems for the EU power grid, both fromt he electricity geneation perspective and from the prerspective of providing back-up capacity fro balancing the deviations in the produciton of unstable sources of electricity, sucha s the renewable sources of energy.

Figure A.II.10: Age structure of power plants in SR



Source: Study on Incentives to Build Power Generation Capacities Outside the EU for Electricity Supply of the EU (Fichtner for the European Commission, 2012)

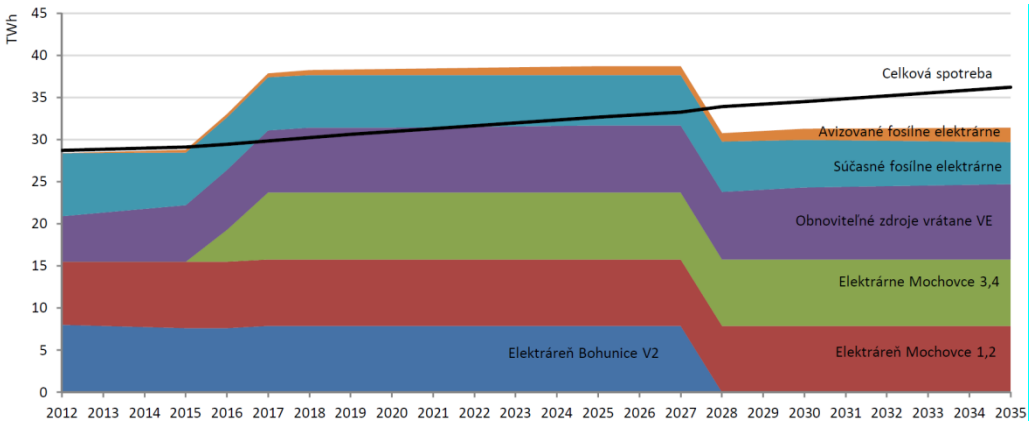
According to the Energy Policy of the SR (October 2014) dealing with the anticipation of electricity generation in Slovak power plants, there are two possible scenarios that discuss about the extension or non-extension of the JE V2 in EBO site operation after the year 2028. Currently, JE V2 is awarded a permit for operation that is valid without time limit on condition that the periodic safety review shall be performed by 2018. With respect to the updates performed on this power plant focused on the increase of nuclear safety based on requirements of the UJD SR, IAEA and EU bodies, it is possible to anticipate reasonably the fulfilment of the current nuclear safety requirements and thus the extension of its operation by 10 years at least. With respect to the fact that nowadays it is not possible to anticipate more exactly the development after 2028 and the preparation and construction of nuclear power plant is very demanding from the financial and time perspective, due to preservation of the continuity of electricity generation by nuclear power plants, it will be necessary to make a decision on the new NJZ power plant before the definite term of the JE V2 decommissioning is known. Thus, it is necessary to reckon with simultaneous operation of the new NJZ and the JE V2.

Concerning anticipation of the capacity development of other nuclear power plants, currently it is not assumed that it would increase and thus replace the decommissioned JE V2. Concerning thermal power plants, it is assumed that their share on electricity generation will decrease in Slovakia what will be caused by decommissioning of old plants and by limited construction of new fossil facilities as a low-carbon electricity generation is preferred.

Regarding renewable energy resources, it is possible to reckon with the increase of their share on the total electricity generation. Especially in case of hydro-electric power plants, there is a significant possibility for their development in the future, since the hydro energetic potential of the Slovak rivers is used at 60-70%. However, these power plants are not ideal for covering the basic demand due to the character of production and also after the planned hydro-electric power plants are constructed, they are intended to be used for regulation services. As regards the development forecast of electricity generation from other OZE, the National Action Plan for Energy from the Renewable Energy Resources anticipates the increase of the share of renewable energy resources (including water) on electricity generation from the current 19% to 24% by 2020. After the hydro-electric power plants, the highest potential is identified mainly with combined heat and power production (KVET) from the biomass and the utilization of biogas because the photovoltaic and wind mill power plants are considered to be unstable with high fluctuation of production and since 2009, their construction has been stopped in Slovakia by SEPS that has stopped issuing the positive statement for obtaining a licence on the power plant construction from the Ministry of Economics of the SR. As it is obvious from the following picture, in future, it is not possible to reckon

with the idea that the electricity generation from the renewable energy resources could replace the electricity generation from much more stable and predictable resources, like nuclear power.

Figure A.II.11: Forecast of balance of electricity consumption and production without realisation of the NJZ and without the extension of the JE V2 operation after 2028 pursuant to Energy Policy of SR



Explanation (Figure A.II.11):

Celková spotreba (SK)	= Total consumption (EN)
Avizované fosílne elektrárne (SK)	= Appraised fossil power plants (EN)
Súčasné fosílne elektrárne (SK)	= Current fossil power plants (EN)
Obnoviteľné zdroje vrátane VE (SK)	= Renewable energy resources including wind energy (EN)
Elektrárne Mochove (SK)	= NPP Mochovce 3,4 (EN)
Elektrárne Mochove (SK)	= NPP Mochovce 1,2 (EN)
Elektráreň Bohunice V2 (SK)	= NPP Bohunice 3,4 (V2) (EN)

Thus, if the NJZ construction would not be implemented, then according to the forecast by the Ministry of Economics of the SR presented in the Energy Policy of the SR (October 2014), after the JE V2 decommissioning, the Slovak Republic would be endangered by a lack of production capacities of electricity, the generation of which it is not possible to replace by low-carbon sources in close future. With respect to the new Ordinance of the European Council 2014/87/Euratom as of 8 July 2014, it will be necessary to put the EU nuclear power plants through partner safety assessments of the state of their nuclear safety periodically, with the participation of the international group ENSREG representing individual national authorities.

Within these partner assessments, it will be needed to meet the tentatively developing safety referential level according to WENRA. It brings a certain amount of uncertainty into the anticipation of future long-term operation of all the older nuclear plant units.

A.II.6.5.4. Conclusion

Within measures focused on increase of energy security of the Slovak Republic, the Energy Policy of the SR (2014) indicated explicitly also the construction of the NJZ in the Jaslovské Bohunice site having the installed power capacity of 1200 or 1700 MW. The NJZ contributes to the fulfilment of numerous energy policy priorities (especially reduction of dependence on fossil fuels import, an increase of a share of low-carbon and non-carbon electricity generation and of the nuclear energetics utilization as the main non-carbon source of electricity) and its objectives in the share of power engineering (predominantly the self-sufficiency and adequate pro-export capability as regards electricity and a flexible, low-carbon and sustainable structure of the source base, preservation and other optimization of the electricity generation sources structure from the perspective of economic and environmental sustainability and security of power grid and finally strengthening of energy security by supporting the construction of sources able to stabilize the power grid).

However, the NJZ is only one part of that diversified fuel mix being an alternative not excluding the other resources. The following overview describes the characteristics of potential referential alternatives.

Without the NJZ: Should the NJZ not to be build, the Slovak energy sector could have a limited ability to meet the objectives of the Energy Policy of the SR (2014) and the Energetic Security Strategy (2008), such as self-sufficiency, low carbon economy or the export-oriented balance in electricity generation and consumption. In case of not extending the operational lifetime of the JE V2 it would come to a serious situation.

Coal power plants: The domestic brown coal reserves are markedly limited and its mining is uneconomical, therefore it would need state support. The Energy Policy of the SR (2014), not only does not count with the construction of new coal sources of electric power, but the facilities in this category will also be substituted by other low carbon sources.

Natural gas power plants: Because of the high natural gas prices and low electricity prices, the gas power plants became uneconomical. Some facilities in the SR were actually forced to interrupt their operation and for the future, the Energy Policy of the SR (2014) counts only with the construction of smaller sources based on a combined heat and power production (KVET) because of the protection of the environment and because low carbon production is preferred. These facilities should be mainly important for the provision of support services.

Hydroelectric power plants: It is impossible to build hydroelectric power plants in such an extent in the Slovak conditions, which would substitute an amount of generated power comparable to the planned NJZ, because the total exploitable hydro-energetic potential of the Slovak water courses reaches only at around 6,700 GWh a year, whereas already more than 70 % of it is already utilized nowadays. The hydroelectric power plants of larger installed capacities furthermore lead to significant negative impacts on the environment.

Solar power plants: Because the photovoltaic power plants belong to the unpredictable sources of electricity and because they severely endanger the safety of the transmission grid (which due to their limited regulation of construction can, according to the company SEPS, endanger the safety of Slovak transmission grid), their construction in Slovakia was limited by the legislation to small, decentralized sources and the Energy Policy of the SR does not count with a more significant increase in their production in the future. Currently, the installed capacity of photovoltaic power plants in Slovakia is about 537 MW. The total technically usable potential of solar energy to generate electricity in Slovakia is estimated at only 1,540 GWh per year.

Wind power plants: The wind power plants are also an unpredictable source of electricity and its utilization is therefore limited by the possibilities of the transmission grid. Moreover, the exploitable potential of the wind power in Slovakia was estimated to amount to 600 GWh annually only (or 1,135 GWh in a more optimistic estimation) and this predetermines the wind power plants in the Slovak energy sector only to the role of an additional source.

Geothermal power plants: Despite the fact that the electricity generation from the geothermal energy is more reliable and stable than the solar or wind power plants, its exploitable potential (6,300 GWh) is suitable in the conditions of the SR for heating purposes only. The chemical composition of the geothermal water also represents technical problems. That is why it is not anticipated that this form of energy would play a more significant role in the electric power industry.

Biomass power plants: Using biomass has the greatest potential among the renewable sources of energy in the Slovak energy sector (at the value around 40,800 GWh per year - this figure, however, includes in particular the potential heat in heating systems; the potential for electricity generation is about 1300 GWh per year). However, it is needed to take into the account that there would be several essential disadvantages to resolve. These include mainly the increase in local air pollution, waste production in form of ash and the need to transport large volumes of fuel into the place of its combustion, (increase of transportation on the transport routes, greenhouse emissions). Last but not least, the increase in soil utilization for growing energy crops instead of producing foodstuffs could have an impact on the food security of the state. Electricity generation from biomass in similar in extent to the one of the NJZ is therefore in the conditions of the SR unrealistic.

The above-stated information imply that concerning electricity generation, the Slovak Republic considers not only mix of energetic resources that takes into consideration their electric energetic potential and predictability, but also the electricity price and the environmental parameters of the resources.

A.II.7. Deadline for commissioning and termination of construction and operation

7. Deadline for commissioning and termination of construction and operation of the proposed activity.

The anticipated deadlines are:

Deadline for the start of construction:	2021
Deadline for test commissioning:	2027
Deadline for operation:	2029

A.II.8. Brief Description of the Technical and Technological Solution

8. Brief description of the technical and technological solution

A.II.8.1. Scope of the Activity

The proposed activity is a NJZ at the Jaslovské Bohunice site including all related areas, construction sites and technological facilities for the operation and construction of the power plant.

The following components are a part of the activity:

Power plant units:	type:	pressurized water reactor (PWR)
	generation:	III+
	net installed electric capacity[5]:	up to 1700 MW_e
	number of units:	1
	operation period:	60 years

There will be commercially accessible contractors' units used, whereas the list of their references is stated below in chapter A.II.8.3. The specific data on the NJZ (page 61 hereof and the following pages) while other contractors' projects are not excluded that are in compliance with the Envelope of parameters used to environmental impact assessment. Such a reactor type will be used that currently represents the best available technology and that had been tested and safely operated in other nuclear-developed country in time before commissioning of the NJZ. The contractor will be subsequently selected at other stages of the project preparation, the choice of the contractor is not a subject of this the environmental impact assessment. The parameters used for their impact assessment conservatively covers (or will cover) facilities of all the considered contractors.

The components of the units are composed of all necessary building structures and technological facilities of the primary circuit, secondary circuit, cooling circuit, auxiliary structures and operations, including all related and induced investments (communications infrastructure, parking lots, pavements, vegetation adjustments and the like).

The area for unit siting and construction including the related structures and operations is a part of the area for siting and construction of NJZ which is marked in Annex No. 1 hereof.

Electrical connections:	electrical power outlet:	overhead electric line of 400 kV
	Back-up power supply for own consumption:	overhead/underground transmission of 110 kV

The electric power of the units will be transmitted outwards via a 400 kV overhead electric line to the new Jaslovské Bohunice electric distribution station. This station will be a part of the transmission grid of the Slovak Republic which is administered by SEPS, a.s. Hence, it is not a subject to the proposed activity.

[5] The term "net installed electric capacity" is based on the Scope of Assessment. The term refers to the output delivered to the transmission grid of the Slovak Republic (thus net electric output of the new nuclear power plant or of the individual referential projects).

The back-up power supply of own consumption will be designed via a 110 kV overhead electric line for the same electric power station. The back-up power supply for own consumption will be solved via a 100 kV underground or overhead electric lines.

All the components necessary for the connection of the power plant units to the power grid of the Slovak Republic are a part of the electrical connection.

The corridor for the electrical connection siting is marked in Annex No. 1 hereof.

Water management connections:

water supply: underground piping, the existing infrastructure
waste water and precipitation water drainage: underground piping

The supply of raw water will be through a new underground pipeline from the water source (Sĺňava dam water reservoir).

The supply of drinking water will be carried out via connection to the existing infrastructure at the site.

The waste water drainage will be done via a new waste water collector to the recipient (the Váh River or the Drahovský kanál).

The precipitation water drainage will be carried out by means of a new precipitation water collector to the recipient (the Dudváh River).

All components necessary for the supply of the power plant with raw and drinking water and the drainage of waste technological, sink and precipitation waters will constitute a part of the water management connection.

The corridors for the water management connection siting is marked in Annex No. 1 hereof.

Furthermore, a part of the proposed activity are areas and equipment for the construction (construction equipment site), including all the elements necessary for building supplier during the construction resp. construction activity. Site equipment will be implemented in areas immediately downstream the area of construction of the facilities. Area for the location of construction equipment is part of the area for the location and construction of NJZ, which is indicated in Annex 1 to this report.

For completeness, the operation termination (decommissioning)[6] of the proposed activity has to be mentioned. It can be expected that at this stage, no additional need for the land occupation and construction of new objects or technological facilities outside the area for the siting and construction of the NJZ will occur.

A.II.8.2. General Data

This chapter describes the generally applicable data and requirements relating to the nuclear energy industry and nuclear power plants with a PWR reactor type.

A.II.8.2.1. Basic Data on Nuclear Power Plants with a PWR Reactor Type

A.II.8.2.1.1. Physical Principle of a Nuclear Power Plant with a PWR Reactor Type

Energy is a capability of mater (substance or field) to perform an action. Electric energy is used significantly for performance of action. In its nature, it represents decentralized energy source (it is generated via coaction of numerous sources; it is consumed at different place then generated and it is possible to consume it in a relatively wide spectrum of performance everywhere an electrical grid is available). In a final place of consumption, electricity is ecologically pure (no pollutants are produced by its consumption) and it is of universal application (it is transformable into other form of energy). Functions of all shares of economy and inhabitant's life conditions depend on its availability; potential shortage or malfunction in electricity supply affect the whole society and can result in fatal consequences.

[6] The operation termination (decommissioning) is not subject to the proposed activity. Pursuant to Act No. 246/2006 Coll. on the Environmental Impact Assessment as amended, decommissioning is an individual activity subject to review. It will thus be at the relevant time subject to an individual EIA process. The operation termination (decommissioning) is hence solved only on an informative and general, conceptual level.

However, electricity is not a primary energy resource and in its usable form, it is not generated by itself. It has to be produced, transmitted to the place of the final consumption and consumed at the same time. Thus, in its nature, electricity serves as transfer medium transmitting energy between a place of its generation and a place of its consumption.

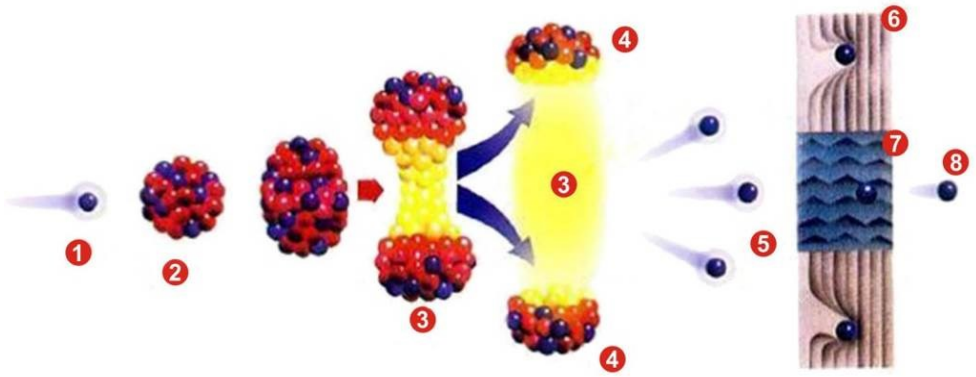
In most cases, electricity is generated by means of electric generators that transform mechanic energy into electric energy (via exciting with the application of electro-magnetic induction principle). A turbine driven by various medium (pressurized steam with thermal power plants, water with water power plants, wind with wind-mill power plants) is a usually source of mechanic energy. The pressurized steam for the turbine is prepared with thermal energy of primary energy resources (coal, gas, nuclear fuel, etc.)

The principle of electricity generation in a nuclear power plant corresponds the principle of any other thermal power plant. It may be described in a simplified way by means of this chain (the components of the nuclear power plant are marked in *italics)*:

- the primary source of energy - fuel (e.g. coal, oil, gas, *nuclear fuel,* geothermal energy etc.),
- use of fuel for the production of thermal energy (coil boiler, burners, *nuclear reactor* etc.),
- use of thermal energy for the generation of steam (boiler, *steam generator* etc.),
- use of steam for the generation of kinetic energy (*turbine*),
- use of kinetic energy for the electricity generation (*turbo generator*).

The basic element of nuclear power plants is the *nuclear reactor* where a nuclear reaction takes place using energy contained in a *nuclear fuel* creating heat. The heat is subsequently used to generate vapour. Nuclear reactors, which are currently used worldwide, use the heat generated exclusively via fission nuclear reaction (the use of fusion nuclear reaction is still subject to research). The principle of fission nuclear reaction is illustrated in the following figure.

Figure A.II.12: Schematic illustration of fission reaction



1	Slow neutron	**5**	Fast neutrons
2	Uranium U-235 nucleus	**6**	Absorber
3	Fission generating heat	**7**	Moderator
4	Fission products	**8**	Slow neutron

The essence of fission nuclear reaction is that the atom nucleus (typically a uranium U-235) is split by a slow neutron. Through this fission, the original nucleus is usually divided into two fragments, whereby a part of the binding energy is released in the form of heat (which is further on used for the steam generation) and at the same time, other two or three fast neutrons are released. The released neutrons may potentially split other nuclei, and therefore the reaction is called the chain reaction. This process is controlled in the nuclear energy utilization in such manner, so that each neutron released in the fission would be slowed down and would hence induce the next fission reaction. This way, the fission reaction follows continuously as the number of fissions in a unit of time does neither rise, nor fall. The other neutrons, which are released in the fission, are captured in the materials of the reactor core. By changing the position of individual active components of the reactor core (of regulation elements) where the neutrons are captured as well as by changing the concentration of absorber in a coolant, it is possible to reach a change of the fission reaction intensity, this is utilized when the reactor capacity is changed or when it is shut down.

The substance used for fission is called *the nuclear fuel*, the substance, which slows the fast neutrons down, is called *moderator*, the substance, which captures neutrons is called *absorber* and the heat transferring medium letting the heat out

of the reactor is called *coolant*. The cluster of fuel assemblies in a reactor container where fission nuclear reaction takes place is called *core*.

The nuclear power plants with a PWR reactor type (Pressurized Water Reactor) utilize uranium as the nuclear fuel, whereby there is an increased concentration of the uranium isotope U-235 to a level of up to approximately 5% U-235 by means of its enrichment. A fuel rod is the basic element, where the heat is released in the reactor. It consists of uranium dioxide pellets (UO_2), which are sealed in a zirconium tube. The fuel rods are arranged in the fuel assemblies, which are laid in the reactor's core.

In the PWRs, a demineralised water (H_2O) with regulated chemical regime is utilized as the coolant and it also serves as a moderator and as the absorber carrier (whereas the absorber is an additive of hypo boric acid). The water heats up during its flow through the reactor, it enters several pressure cooling loops where the coolant circulates with the help of circulation pumps, it enters the primary side of steam generators where it transfers a part of its thermal energy to a secondary side through the heat transfer surface area and finally it returns back to the reactor. This coolant circuit is called *primary circuit*. In this circuit, the cooling water is kept under high pressure (so that it would stay in a liquid stage at temperatures above 300°C, this is why it is called a pressurized water reactor).

In the steam generators (which work as heat exchangers between the primary and secondary circuit), the heat from the primary circuit is utilized for heating up water in the secondary circuit. In the secondary circuit, he water is exposed to the adequately lower pressure (compared to the primary circuit) so that it can change into pressurized steam via heating. The pressurized steam is further on transmitted to the turbine, which it sets into movement. After the energy transfer, the steam condensates to water and the condensate is once again pumped into the steam generator.

The turbine kinetic energy is utilized as a drive mechanism of the *electric generator (turbo generator)* and the generated electricity is let out to the power grid.

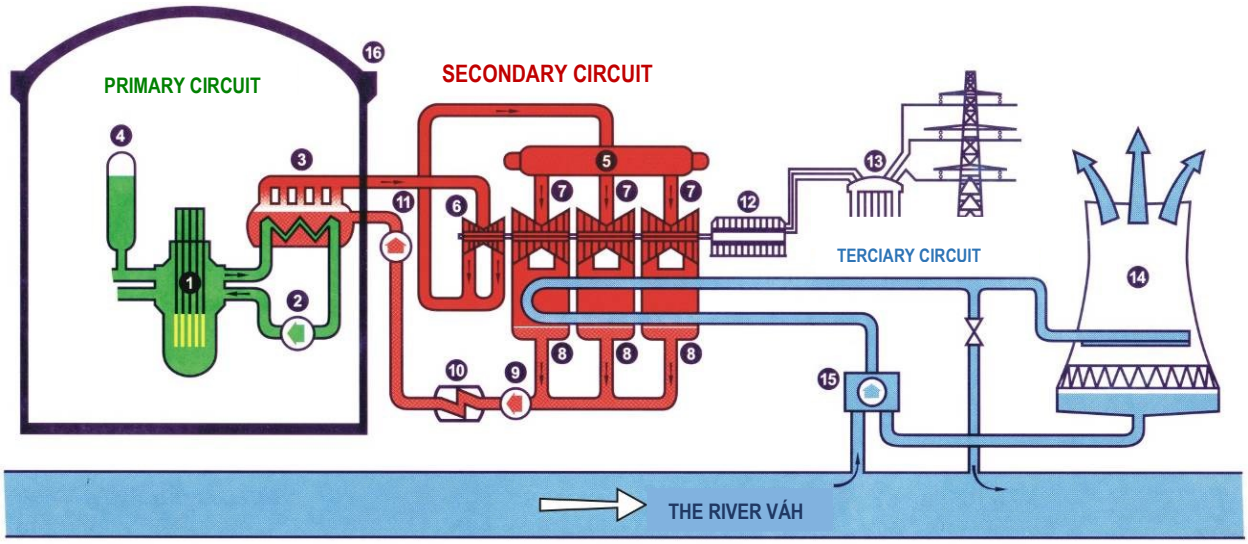
For the purpose of steam condensation in the condenser of the secondary circuit, the tertiary coolant circuit is used where the cooling water circulates through the cooling towers in which the low-energy heat is transferred to the atmosphere by means of vaporization[7]. Any decrease (mainly water vapour) of the tertiary water is supplemented by treated raw water from a suitable source (in the case of the Jaslovské Bohunice site, from the Váh River – Sĺňava dam water reservoir).

With regard to the safety requirements on nuclear power plants, the facilities of the reactor and of the primary circuit (so called nuclear island) are located in a containment, its purpose is to prevent a leakage of radioactive substances into the environment in case of fuel and primary circuit disruption. The containment quality requirements in the generation III and III+ reactors technology are very high and apart from the protection against internal risks (resulting from own technology failures), the containment provides also for the protection against external risks (e.g. extreme weather conditions or human activity impacts – blast wave, aeroplane crash etc.).

The principal diagram of a PWR nuclear power plant, is shown in the following figure:

[7] Alternatively, river (or sea) water can be used for condenser cooling in the tertiary circuit directly, without using the cooling towers. The low-energy heat is in such case transferred to these waters directly. This, however, is not feasible at the Jaslovské Bohunice site because the Váh river is not (because of its hydrological conditions – flow rate) a suitable heat recipient and it could be disproportionately heated up. On the other hand, nuclear power plants at the Danube river (Paks, Kozloduy, Cernavoda), which have a sufficient flow rate, are cooled directly from the river.

Figure A.II.13: Principal diagram of NPP with pressurized water reactor



PRIMARY CIRCUIT

1 Reactor
2 Cooling loop, circulating pump
3 Steam generator
4 Pressurizer
16 Containment

SECONDARY CIRCUIT

5 Separator, pre-heating equipment
6 High-pressure part of the turbine
7 Low-pressure part of the turbine
8 Condenser
9 Condensate pump
10 Heat regeneration
11 Feeding pump
12 Electric generation
13 Transformer, electric power outlet

TERCIARY CIRCUIT

14 Cooling water
15 Pumping station

A.II.8.2.1.2. Statistical Data on Nuclear Power Plants Worldwide

At present (according to World Nuclear Association data, June 2015), there are 437 nuclear power units in operation or operable in 31 countries of the world, with the total installed electric power of more than 380 GW_e. In 2014, nuclear power plants generated approximately 2,411 TWh of electricity representing around 11.5% of the worldwide electricity generation.

Totally, 66 another units are under construction. A vast majority (approximately 85%) of NJZs under construction is represented by PWR type reactors, what is given mainly by their safety and economic advantages.

A.II.8.2.1.3. Development Generations of Nuclear Reactor Technologies

The electricity generation from the energy released from the uranium fission has an over sixty-year long history, since the launch of the demonstrable nuclear power plants. The nuclear reactors' technology of the commercial nuclear power plants is according to the grade of their technical development divided into categories called generations. The characteristics of the individual generations is as follows:

Generation I: Generation I includes reactors, which were designed in the 1950's – 1960's. This generation also involved the A1 NPP at the Jaslovské Bohunice site. The last reactor of this generation to be still operated is unit 1 of the Wylfa nuclear power plant in Great Britain (with the planned decommissioning at the end of 2015)

Generation II: The design and construction of nuclear power plants with reactors of Generation II started in the 1970s. Power plants with Generation II reactors currently have the most significant share in the electricity generation within the nuclear power plants. More than a half of these nuclear power plants is made of PWR type pressurized water reactors. This generation also involves PWR reactors constructed and operated in the former Czechoslovakia (the succession states are SR and CR).

The safety level of the nuclear power plants with Generation II reactors, compared to Generation I reactors, is markedly higher, mainly when it comes to the reliability of the safety systems. Also the technical-economic parameters of the power plants with these reactors are more favourable.

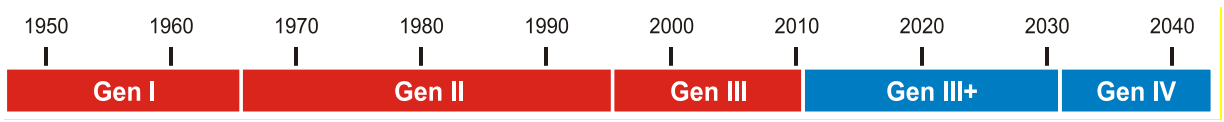
Generation III: Generation III encompasses reactors designed in the 1990s. In those projects, which stem from the best practice obtained from the construction and operation of the Generation II reactors, the following improvements are included: more efficient utilization of the nuclear fuel; on achieving higher heat efficiency and on the utilization of standardized projects aimed at lowering the requirements for the time of construction as well as on lowering the requirements for servicing and maintenance during the operation. The increase in safety of the Generation III reactors (as compared to the Generation II reactors) is achieved e.g. by a more extensive utilization of passive elements in the design of the protection systems, by means of a robust double containment with a higher resistance against external risks and by means of utilizing specific systems designated in the project for managing severe accidents.

Generation III+: Generation III+ immediately follows the Generation III reactor in its development. The projects of this generation reactors currently represent the best available techniques and will be put into operation in the upcoming period. They offer an improvement in economic indicators (a simplified standard project, which will lead to shortening the licensing period and to lowering costs for construction and operation) as well as other significant benefits for safety (higher level of inherent safety, higher utilization of passive safety, containment resistance against a large aeroplane crash, prolonged period without the necessity of intervention by the operators in the event of failures and design based accidents, higher seismic resistance, which results in lowering the risk of accidents) and also optimization of radioactive waste production (with respect their minimization and treatment, phase of decommissioning in a power plant project). This generation also covers the reactor (i.e. the power plant) subject to the proposed activity.

Generation IV: Generation IV projects are still only subject to concepts and development. The Generation involves mainly reactors operating with fast neutrons and closed fuel cycle that allow to use nuclear fuel more effectively and to reduction the amount of produced radioactive waste at the same time. It includes also some technologies that operates with thermal neutrons and open fuel cycle. According to their development state, their decommissioning is expected to take place between the years 2030 – 2040.

The following figure illustrates the gradual development of the nuclear reactor technology.

Figure A.II.14: Development generations of nuclear power plant technology



A.II.8.2.1.4. Safety and Economic Characteristics of Generation III+ PWR reactors

Nowadays, Generation III+ projects utilize the best accessible technologies based on the proved Generation II reactor types. The main differences from Generation II are:

- A standardized design, lowering the necessary licensing period of individual power plants and the necessary investment costs and construction period.
- The simplified (but concurrently more robust) design enabling easier servicing and higher operational reserves.
- Higher operational availability (90% and more), higher net efficiency (of up to 37%) and longer lifetime (a min. of 60 years).
- Lower accident risk with a severe damage of the core (below 10^{-5}/year).
- Higher resistance against external events.
- Facilitating the power plants with specific systems for the prevention and consequences mitigation of severe accidents.

- Providing for higher fuel utilization (higher consumption of up to 70 GWd/tU) and lowering the amount of the produced radioactive waste.
- Lengthening the periods between outages for reloading and replacing fuel by using combustible absorbers (of up to 24 months).
- An improved operation economy.

Concurrently, generation III+ projects have the general advantages of PWR type nuclear reactors:

- Stability as a result of the existence of a negative feedback (the increase in temperature works against power increase).
- Passive system of emergency shut-down. The control rods are held in the upper position by electromagnets and when necessary, they are inserted to the reactor's core by means of its own weight. After their insertion, the nuclear reaction is safely stopped.
- Primary and secondary circuit separation. The secondary circuit is separated from the primary circuit (by the steam generator), hence the water in the secondary circuit practically does not involve radioactive substances, which restricts the leakage of radionuclides to the environment.
- Possibility to utilize a fuel on the basis of UO_2, as well as the fuel of MOX type.

A.II.8.2.2.Basic Legislative Requirements on Nuclear Power Plants

The basic legislative regulations, which set forth the conditions for nuclear power utilization, are Act No. 54/2004 Coll. on the Peaceful Use of Nuclear Energy (the Atomic Act) on the amendment of certain Acts and Act No. 355/2007 Coll. on Protection, Support and Development of Public Health on the amendment of certain Acts. Pursuant to these acts and the related regulations, all the requirements have to be met in nuclear energy utilization, mainly the requirements for:

- nuclear safety,
- radiation protection,
- physical protection and
- emergency planning.

The basic data on these requirements are stated in the following text.

A.II.8.2.2.1. Nuclear Safety Requirements

In accordance with Act No. 541/2004 Coll. on the Peaceful Use of Nuclear Energy (the Atomic Act) nuclear safety means "*technical condition and capability of a nuclear facility or transport facility as well as the ability of their operator to prevent the prohibited leakage of radioactive substances or ionising radiation into the working environment or environment and the ability to prevent events and to mitigate consequences in nuclear facilities or during the transport of radioactive materials".*

The basic principles for safe use of nuclear energy are with the cooperation of international experts summarized in the IAEA document Fundamental Safety Principles (SF-1) and are elaborated to a one complete system of internationally accepted requirements and instructions aimed at safe use of nuclear energy which are published and kept by IAEA in a series of documents called the IAEA Safety Standards.

The conditions for a peaceful use of nuclear energy in the Slovak Republic are specified by the above mentioned Atomic Act defining the conditions and obligations subject to which legal entities and business entities may use nuclear energy and introducing the obligation to perform supervision over nuclear safety. This supervision is carried out by the Nuclear Regulatory Authority of the Slovak Republic (UJD SR).

Specific requirements on nuclear facilities safety in the territory of the SR are defined by the UJD SR Regulation No. 430/2011 Coll. on Nuclear Safety Requirements for Nuclear Facilities. Specifically for siting, construction, commissioning, and operation of a NPP but also for its decommissioning, the future operator of the nuclear power plant has to obtain a permit. The content and purpose of the documentation for the license system assessed in the process of issuing the permit are defined in Annex to the quoted Atomic Act and in the follow-up regulations of the UJD SR. At each assessment stage before issuing the relevant permit (licensing), the operator has to submit documentation involving detail safety evaluation, corresponding the level of the NPP project preparation status.

Detailed requirements concerning the nuclear safety, the fulfilment of which has to be documented and controlled when being licensed, are specified in the binding regulations issued by the UJD SR. The UJD SR regulations are systematically updated and with each innovation, they are harmonised with the safety recommendations of the Western European Nuclear Regulators Association (WENRA), with the requirements for nuclear safety issued by the IAEA in the series of its safety standards and finally, before these regulations are issued, they are provided to the EU Member States for opinion pursuant to the rules of the European Commission.

Next to the directives, the UJD SR also issues safety guides (series of documents labelled BNS), which include recommendations on how to meet the requirements correctly. When elaborating the BNS guides, the relevant guides issued by the IAEA (Safety Guides) are used but also the best practices from approaches of prominent countries, which utilize the nuclear energy in the long-term (e.g. US NRC guides, guides of the Finland's Radiation and Nuclear Safety Authority guides, etc.).

A.II.8.2.2.2. Radiation Protection Requirements

Radiation protection, for the purpose of the Government Order No. 345/2006 Coll. on Basic Safety Requirements for Protection of Health of Workers and the Population from Ionizing Radiation, means *"the protection of people and environment from radiation and its effects including measures for its achievement".*

Radiation (radiological) protection system, with the planned activities pursuant to the valid legislative regulations of the SR, is based on the following general principles:

1. The justification principle: Each practical activity involving radiation exposure should create a sufficient benefit to the radiated persons or society, which would balance the harm caused by radiation (justification of the practical activity).
2. The optimization principle: Exposure of people to radiation from any individual source should be maintained as low as reasonably achievable (ALARA principle), whereas the technical, economic and social factors are taken into account.
3. The not-exceeding-the-limits principle: Exposure of individuals to radiation resulting from a combination of all relevant sources of radiation shall not, under normal conditions, exceed the set limits for individual amount and risk.

The project of the NJZ will hence be solved in such manner, that all exposures will be maintained on a minimum reasonably achievable level after taking the economic and social aspects into account. The relevant exposure limits set by the relevant regulatory bodies will be respected.

The protection optimization process will be applied at the stage of project proposal and construction of the NJZ. The next protection optimization will be secured at the stage of the NJZ operation.

Experiences gained from exercising general principles of radiation (radiological) protection show that if activity justification and protection optimization are implemented effectively, cases of need for individual dose limits application are only rare. Limits of professional and non-professional radiation exposure are determined in a way that in case of life exposure:

- they would exclude a possibility of deterministic health damages,
- they would keep expected occurrence of stochastic damages at generally acceptable low level.

Work and life conditions which are considered as generally acceptable are those with which the life exposure is substantially lower than a limit. Neither small surpassing (life) limit values can be neither justified nor accepted. Exposure slightly below the limit is acceptable, but only in a rare and justified cases.

Exposure limit for the population is set by the SR Government's Order No. 345/2006 Coll. on Basic Safety Requirements for the Protection of Health of Workers and Population from Ionizing Radiation that establishes the value of 1 mSv/year as a limit of effective dose in every calendar year. Pursuant to the quoted Order of the Government it is possible to discharge radioactive substances into the air and surface water from operational nuclear facilities if it is ensured that the highest individual effective doses for inhabitants living in the nuclear facility surrounding will not exceed 0,25 mSv/year (250 μSv/year) as a result of such a discharge. This value is considered to be a limit dose for nuclear facilities planning and

construction.[8] If there are more nuclear facilities affecting doses to inhabitants, this limit dose applies to a total exposure by all nuclear facilities in a site or region.

A.II.8.2.2.3. Physical Protection Requirements

Physical protection, under the Act No. 541/2004 Coll. on Peaceful Use of Nuclear Energy (the Atomic Act), means *"a set of technical, regime or organizational measures necessary for the prevention of and detection of unauthorized activities with nuclear facilities, nuclear materials, special materials and facilities; during the manipulation of radioactive wastes, spent nuclear fuel; during the transport of radioactive materials, as well as during unauthorized entry to the nuclear facility and sabotage".*

It deals with a set of technical resource systems and a set of measures including administrative measures which are designed so that they would provide protection of assets and protection of nuclear power facility containing nuclear material. The purpose of the physical protection system is to provide:

- access to guarded space, protected space and inner space only to persons or vehicles with an issued entry or drive-in permission to the defined space,
- so that the authorized persons entering the guarded space, protected space and inner space would not abuse this permission for an unauthorized activity;
- an early detection of an intruder and slowing their progress down, thus to allow the emergency squad to stop them before an unauthorized activity is performed by means of combining the electronic safety system with mechanical preventive resources.

The physical protection is a specific activity, where the selected areas are subject to classified facts and control of access to information classified pursuant to the legislative regulations defining the manner of providing physical protection as well as pursuant to the Act No. 215/2004 Coll. on the Protection of Classified Information, as amended and the Order of the SR Government No. 216/2004 Coll. which establishes areas of classified information.

The physical protection system of the NJZ will be globally included under the physical protection of state provided for the Slovak Republic on the highest level by the safety and armed forces and it will consist of mechanical preventive resources, technical systems, emergency protection, administrative measures, operational regulations and of an agreement with the police force on providing emergency protection.

Under the respective provisions of the Act No. 541/2004 Coll., the Atomic Act, as amended, in case of submission of the application for issuance of nuclear facility construction permit, a holder of a license is obliged to submit at UJD SR a Preliminary Site Security Plan (PPFO) and Site Security Plan (PFO) in case of submission of the application for issuance of nuclear facility commissioning permit. The objective of these plans is specified in more detail in the UJD SR BNS Safety Guideline 1.8.1/2005. Pursuant to the provisions of the UJD SR Ordinance No. 51/2006 Coll. the Preliminary Site Security Plan involves the following information:

a) set of data characterizing a possible threat to nuclear facilities, nuclear materials or radioactive waste at a stage of preparation of Security Plan project with respect to possible aggravation of security situation during anticipated nuclear facility operation, namely a number of violators, their weaponry, training, used means of transport and motivation
b) assessment of the construction locality and local conditions from the viewpoint of physical protection
c) preliminary assessment of risks stemming from unlawful activities
d) analysis of possibilities of unlawful activates and evaluation of their consequences,
e) classification of nuclear facility and nuclear materials into particular categories,
f) documentation on quality assurance, design and implementation of physical protection,
g) analysis of a function of physical protection during construction, commissioning, operation and decommissioning of nuclear facility and possible operational events,

[8] However, a respective authority can set a limit that is lower. The total limit (the total limit for all the nuclear power plants in the area together) set for the nuclear facilities in the site of Jaslovské Bohunice Nuclear Power Plant is 0,082 mSv/year (82 µSv/year). For more details, see chapter C.II.15.3.2. Radiation State of the Site Concerned (page 232 hereof).

h) description of site security measures in the course of nuclear facility construction.

Site Security Plan is elaborated as a separate document constituting a supplement to the application for nuclear facility commissioning permit. The Physical Protection Plan deal with comprehensive provision of nuclear facility site security and contains the following items:

a) Changes to an original construction solution of the preliminary site security plan with an evidence that such changes will not reduce a level of site security,
b) assessment of results of site security testing,
c) system measures,
d) manner of protection, control and entry of means of transport,
e) description of maintenance and operational controls,
f) measure relating to the restriction of nuclear facility operation at an attempt of unlawful action or at the breach of site security,
g) limits and conditions of site security system.

Within the meaning of the above mentioned legislation concerning nuclear facility and material site security, premises of nuclear facilities have to be divided into:

- guarded premises, i.e. the premises that are bounded by mechanic barrier means (double fencing) and that are secured with electronic security technology;
- protected premises, i.e. the premises inside the guarded premises that are bounded with mechanic barrier means (simple fencing) and that are secured with electronic security technology;
- inside premises, i.e. premises inside the protected premises the wall of which are formed by mechanic barrier means secured with electronic security technology.

The above-mentioned zones (premises) are secured with physical barriers and means of electronic security and detection system. The barriers have entrances for ordinary entry of persons, material and vehicles that are controlled by components of an entry control. The proposed system excludes uncontrolled entry of persons who are not holders of a relevant authorisation into the guarded object or protected object and buildings.

For the purpose of providing the site security of the NJZ, the operator will use a Site Security System Hardware being a technical successor of Automated Nuclear Power Plant Security Complex that is used in Slovak nuclear power plants standardly nowadays.

A.II.8.2.2.4. Requirements on Emergency Preparedness

Emergency preparedness, under the Act No. 541/2004 Coll. on Peaceful Use of Nuclear Energy (the Atomic Act), means *"the ability to develop and perform an activity and measures, which lead to the identification and management of incidents and accidents at nuclear facilities or during the transport of radioactive materials and to mitigate the possibilities of endangering the life, health or property of population and the environment, whereas such an ability has to be documented in an emergency plan"*.

It covers the organization of emergency planning in the areas of staff on-the-job-training, organizational and material-technical provision, with the aim to reach preparedness for accepting preventive measures focused on decreasing radiation consequences of incidents or accidents, which might occur during the implementation, operation or operation termination of the nuclear facility.

Emergency preparedness is implemented by means of emergency plans. The emergency plans, within the scope of the future NJZ construction and operation, are divided into:

- Preliminary internal emergency plan containing planned measures at the nuclear facility site during its construction,
- Inner emergency plan including planned measures at the nuclear facility site from the beginning of stage of nuclear plant commissioning and a relation to a plan of population protection
- Public emergency plan (external emergency plan), which contains measures to protect the population in the endangered area during the release of radioactive substances into the environment, as well as links to the internal emergency plan.

Persuan to the Ordinance of the UJD SR No. 55/2006 Coll. on Details concerning Emergency Planning in case of an Incident or Accident, for the purposes of emergency preparedness, emergency situations are classified into the following levels according to a degree of gravity.

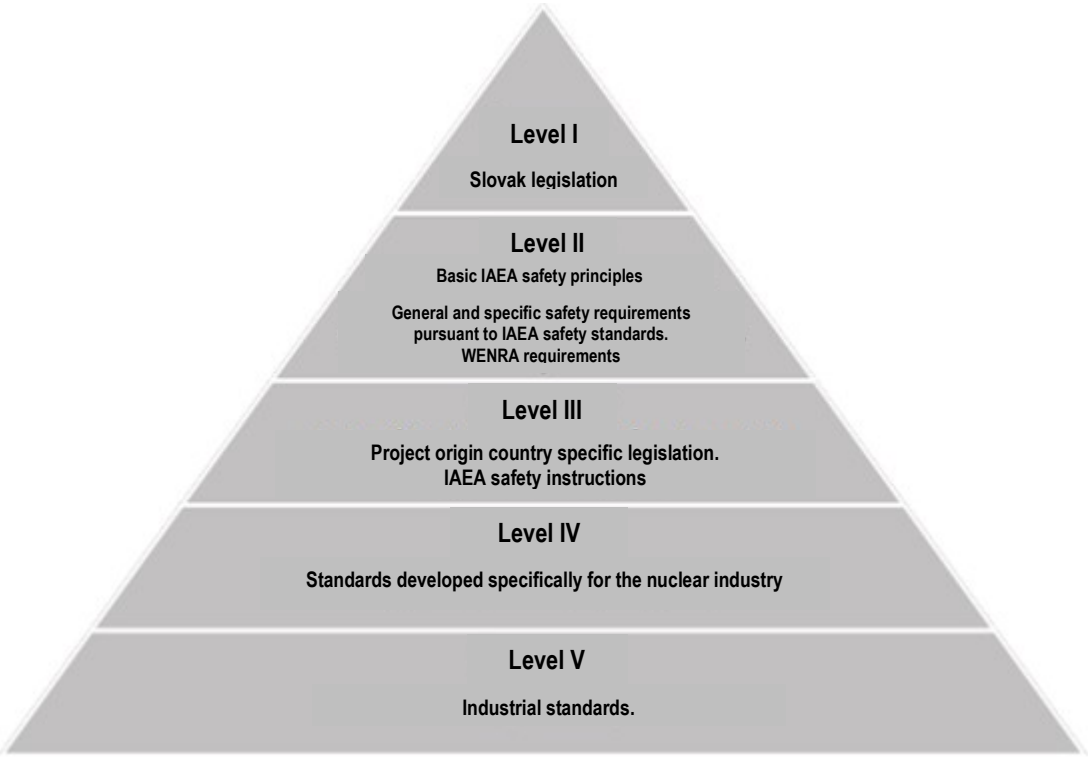
1. level (emergency) when the fulfilment of security function is jeopardised or violated, security barriers are violated or not working, there is a threat of radioactive waste leakage or radioactive substances have leaked what can lead to or leads to forbidden exposure of people in a construction site of nuclear facility and in case of unfavourable development of events, there is a threat of leakage of radioactive substances outside nuclear facility construction site.
2. level (emergency at nuclear facility site) that can lead to or leads to the leakage of radioactive substances outside nuclear facility construction sites and at nuclear facility site.
3. level (emergency in nuclear facility surroundings) that can lead to or leads to severe leakage of radioactive substances into nuclear facility surroundings.

The emergency plan for the NJZ will be set independently on the emergency plans of the existing nuclear facilities at the Jaslovské Bohunice site while the requirements specified in Annex 5 of the Ordinance of the UJD SR No. 55/2006 Coll. and as well the relevant requirements and recommendations stated in the Safety Guides of IAEA and WENRA will be respected.

A.II.8.2.2.5. Hierarchy of the Legislative Requirements on the NJZ

Hierarchy of the Legislative Requirements that the NJZ has to fulfil are presented in the following picture.

Figure A.II.15: Hierarchy of regulations and standards valid for preparation, construction and operation of nuclear power plants in SR



Level I (Slovak legislation[9]): The first and most important level involves requirements resulting from statutes (mainly the Atomic Act), ordinances (mainly the ordinances of the Nuclear Regulatory Authority of the SR) and government orders, which refer to the activities relating to the nuclear energy utilization, i.e. also to

[9] The Slovak Republic is a member of the EU, thus the Slovak legislation is harmonized with regulations of the EU.

siting, construction, commissioning and operation of a nuclear power plant (further also to its operation termination and decommissioning).

This level includes also legislative requirements relating to the use of nuclear energy defined by the Regulation of the European Council (2009/71/EURATOM) that established Community framework for nuclear safety of nuclear facilities. The requirements of this EU Regulation are reflected in the national legislation and its amendment from 2014 (Regulation of the European Council 2014/87/Euratom as of 8 July 2014).

Level II (WENRA requirements on new nuclear reactors, guidelines of the UJD SR issued in a series of BNS, general and specific safety requirements pursuant to the IAEA safety standards): The second level includes the generally recognized international documents where the basic requirements for safety are defined:

- the document IAEA SF-1 Fundamental Safety Principles (2006) defines the basic safety target of nuclear energy utilization like the protection of the public and environment from harmful effects of ionising radiation and it develops it further to more detailed objectives and principles of providing nuclear safety.
- The documents IAEA General Safety Requirements directly link to the above mentioned document and it defines the above mentioned targets and principles in more detail for the areas of legislation and supervising, safety control, radiation protection, safety assessment and radioactive waste management.
- The documents IAEA Specific Safety Requirements involve specific requirements for the assessment of the NPP site, requirements for the project and operation of the NPP with nuclear fuel and for the transport of radioactive materials.
- The WENRA documents involve recommendations of priorities when providing nuclear safety of both the operated NPPs and the NPPs under preparation in the WENRA member states (the Slovak Republic is a member of WENRA via UJD SR)

Level III (legislation of the country of the project origin and IAEA Safety Guides): The third level of requirements for nuclear safety includes requirements for nuclear safety valid in the country of the project origin and potentially also requirements for safety valid in some of the EU countries, where the JE project was licensed (or where the licensing process of the particular project is ongoing). These requirements for the JE nuclear safety will become binding for the NJZ project if reflected to the nuclear facility's quality requirements accepted (approved) by the UJD SR. This level also includes IAEA recommendations published in the series of IAEA safety guides (IAEA Safety Standards – Specific Safety Guides), which involve detailed international recommendations for providing nuclear safety of JE systems, constructions and components.

Level IV (standards developed specially for the nuclear industry): The fourth level of requirements is composed of regulations and standards valid for the nuclear industry (national standards and standards used in the licensing process in the country of the nuclear technology; internationally recognized standards and standards for the nuclear area) e.g.: ISO, EN, IEC, IEEC.

Level V (industrial standards): The fifth level is made up of valid industry standards, mainly standards harmonised in Europe (the Euro Norms). They will be applied mainly in the secondary part of the NPP project and in the project of the follow-up systems.

The above mentioned requirements refer not only to the currently valid regulations in the period of preparation, design and construction of the power plant but also to potential new requirements for nuclear safety, for the design of the power plant at any stage of its life cycle. The current state of technical standards is hence continuously applied in line with the development of the best available technology including the lessons learnt from the potential non-standard or accident events at the nuclear facilities worldwide.

A.II.8.2.3. Safety Objectives of the NJZ Project

A.II.8.2.3.1. Basic Safety Objective

Concerning nuclear energy utilization and operation, under the Atomic Act and basic Safety Guide IAEA SF-1 Fundamental Safety Principles (2006), an essential safety objective is defined as follows: to protect people and the environment against harmful effects of ionizing radiation. The essential safety target and total of ten fundamental safety principles for nuclear facilities defined in the document IAEA SF-1 form the base of requirements on nuclear facility safety.

Compliance with the basic safety target will be considered at all stages of the NJZ life cycle, i.e. planning, siting, designing, manufacturing, constructing, commissioning, operating and decommissioning. It also includes the transport of the radioactive material and radioactive waste management.

To secure the basic safety target during NJZ design, the following basic safety requirements need to be fulfilled:

- to prevent the uncontrolled exposure of public and release of radioactive substances to the environment during all operational states,
- to minimise the probability of occurrence of events, which might lead to the loss of control over the reactor core of the reactor, over the fission chain reaction, radioactive source or over any other source of radiation,
- in case of such events, to manage them in a manner that would minimise their consequences,
- to ensure strict technical and administrative control of all radioactive sources.

A fundamental safety objective and essential safety requirements are reflected in specific requirements on nuclear safety of nuclear power plants that were elaborated in the following spheres:

- concept of protection in depth,
- safety of the project,
- safety assessments and maintaining the integrity of the project throughout the lifetime of the NJZ,
- radiation protection.

A.II.8.2.3.2. Requirements for protection in depth

The primary measure for the prevention of the special situation emergence (breakdowns, incidents and accidents) and of mitigation of their consequences is the in-depth protection concept. The concept will be applied to all activities important for safety, i.t. to organisational activities, design, operational management at all output levels including decommissioned state. The in-depth protection concept is based on the fact that the performance of all activities important for safety is divided into several levels so that in case of occurrence of the special situation, the special situation is identified and compensated via technical and/or organisational measures at such level of protection at what it emerged or its remedy will be secured with adequate technical and/or organizational measures at a higher level of in-depth protection.

In nuclear power plant projects, this in-depth protection concept is applied and as an important safety principle elaborated in detail, whereas the efficiency of this principle is constantly verified and assessed. The principle of the in-depth protection within the nuclear power plant projects depends on the utilization of multiple physical barriers, which restrict the radioactive substance leakage and on protecting the integrity of all these barrier systems of technical and organizational measures, which are designed on five levels.

The organizational measures and physical barriers are provided so that in case of failure of technical measures or physical barriers on a lower level, technical measures and physical barriers on higher levels are applied. The application of the in-depth protection principle in a nuclear power plant project ensure that in case of a multiple failure of the facility or staff – even on a number of levels – the population and environment are not endangered.

The technical and organizational protection levels in the nuclear power plant project are as follows:

First level of protection: The aim of the first level of protection is to prevent deviations from standard operation and system and equipment failures. The fulfilment of this aim leads to the requirement of a sensibly and

conservatively designed, constructed, maintained and operated power plant, in line with the relevant requirements for reliability and quality in accordance with good technical practice.

Second level of protection: The aim is to recognize and manage deviations from standard operation (abnormal operation and failures) so that escalation of the anticipated operational events (abnormal operation and failures) into an accident is prevented. In order to prevent such operational events or in order to minimise their consequences with the aim to renew a safe condition of the facility, it is required that specific management and limitation systems and elaboration of complex operational regulations are implemented.

Third level of protection: It is made up of measures for managing design bases accidents (DBA) and multiple accidents in the extended condition of the project (DEC). In the nuclear power plant design, the occurrence of design incidents is postulated and it is required to secure:

- such measures (inherent safety characteristics and/or protection systems and regulations), which, during an individual occurrence in the project of postulated incidents, enable the prevention of damage on the core and avert the radioactivity leakages to external environment above the permitted limit and enable setting the unit into safe condition;
- additional measures (safety technical systems and regulations), which, on the occurrence of the postulated multiple failures, enable to avert such development of incidents which would lead to the damage on the core.

Fourth level of protection: The aim is to mitigate consequences of severe accidents which result from a failure on the third level of protection. The most important role on this level is trapping the radioactive materials inside a protection enclosure (containment). The fourth level of protection involves measures for managing severe accidents in Design Extension Conditions (DEC), i.e. accidents with sever disruption of fuel system, and focuses on maintaining the containment integrity.

Fifth level of protection: The aim of fifth and last level of protection is to mitigate radiological consequences from significant radioactive material leakages, which may occur within the accident conditions in case of a failure of all the previous levels of protection. In fact, the incidents of this type have to be excluded in the NJZ project. The measures on this level represent emergency plans and providing an adequately equipped emergency control centre.

Systems, equipment and components designed for the preventive and protection activities at the first to fourth protection level are designed and implemented as systems that are significant for nuclear safety with requirements on reliability and that are graded according to function importance for the security fulfilled by systems, equipment and components. The requirements on reliability of these equipment are projected into requirements on qualification for environmental conditions where the facility is going to operate (within the conditions of normal operation and within the conditions of anticipated accidents), into requirements on provision of quality during generation, construction, commissioning and operation.

It is required within the design of the power plant that facilities important for safety would be designed so that during their normal operation, it would be possible to control and test them without mitigation of nuclear safety level

The following table shows the characterisation of the mentioned five levels of protection in line with WENRA (WENRA Report Safety of the new NPP designs, Study by Reactor Harmonization Working Group RHWG, March 2013).

Tab. A.II.4: Characterisation of levels of protection pursuant to WENRA

In-depth protection level	Target	The means for managing	Radiation consequences	Associated states of power plants
Level 1	Prevention of failures and abnormal operation	Conservative project, high quality of construction and operation and maintenance of essential operational parameters of power plant within established limits	Without radiation effects on external environment (restriction by the leakage during the operation)	Normal operation
Level 2	Abnormal operation and failure management	Managing and limiting systems and other monitoring systems		Abnormal operation
Level 3a	Management of incidents with the aim to reduce radiation leakage and prevent sever accident occurrence	Protection system of reactor, safety systems, regulations on incident management	Without radiation effects or only negligible radiation consequences in external environment	Design Basis Accident (DBA)
Level 3b		Additional safety measures, regulations on incident management		Multiple Failure within Design Extension Conditions (DEC)
Level 4	Management of severe accidents with the aim to prevent leakage into the external environment	Additional safety equipment for mitigation of consequences of reactor core melting, severe accident management	Radiation effects in external environment of a nuclear power plant can lead to announcement of protection measures in a restricted area and time	Sever accident within Design Extension Conditions (DEC)
Level 5	Mitigation of radiation consequences caused by significant leakage of radioactive substances	Organisation of accident response, intervention levels	Radiation consequences in external environment requiring implementation of protection measures	-

The levels of physical barriers in the PWR reactor type project, which prevent the radioactive substances leakage to the external environment, are (except for a structure of nuclear fuel material having high chemical stability and retention ability to impede fissile products release) as follows:

The first barrier: Fuel rods cladding.

The second barrier: Reactor coolant pressure boundary.

The third barrier: Containment (composed of an inner and outer safety enclosure).

The first barrier is designed for the conditions of mechanic, the thermo- hydraulic and cyclic load of materials and fuel rods construction for the period of several years, according to the assumed maximum fuel consumption. The first barrier is designed in a way that its integrity is preserved during a normal and abnormal operation and at the same time, its damage during accident conditions was minimized.

During transport operations and during spent fuel depositing when the load put on these barriers is reduced substantially, the lifetime of these barriers is required to last for the whole time of burnt fuel depositing (usually for the period of 40-60 years assuming that depositing is performed according conditions of cooling and corrosive characteristics of the environment set and checked by a fuel contractor).

The second and the third barrier is designed for the conditions of normal, abnormal operation as well as for accident conditions for the whole lifetime of the power plant. These barriers are designed in a manner that:

- barrier integrity is preserved during normal and abnormal operation
- integrity of at least one barrier is preserved also during accident conditions.

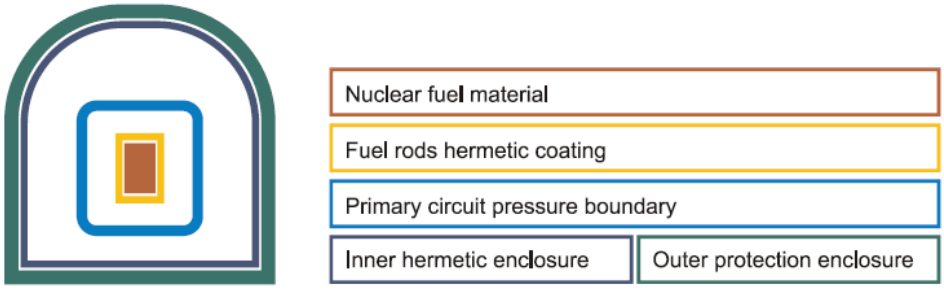
Integrity of the first physical barrier will be checked with analyses of a radioactive fissile products content in the coolant of the primary circuit because in case of possible damage to cladding, it is possible to detect reliably the leakage of gas radioactive fissile products into coolant from the space between the fuel and cladding.

The second barrier tightness will be detected by the diagnostic systems (for instance, systems based on measuring sound effect, measuring the presence of steam, water or radioactivity in technological premises where the primary circuit facility is situated, or by methods based on measuring of radioactivity in water at a secondary side of steam generators).

The third barrier tightness will be checked by tests (by strength and tightness test performed before commissioning and by periodic tests during operation).

The schematic illustration of the physical barriers in the PWR reactor type nuclear power plant project is illustrated in the following picture:

Figure A.II.16: Schematic illustration of physical barriers in the project of a PWR type power plant



The purpose of these physical barriers is to impede the penetration of radioactive substances from the place of emergence (nuclear fuel material) gradually up into the external environment. Each physical barrier is designed conservatively (with substantial projects reserves in relation to damage) and its state is monitored during operation in advance.

A.II.8.2.3.3. Requirements on the NJZ Project Safety

Keeping the barrier functionality regarding the leakage of radioactive substances within the NJZ will be secured with conforming to the following fundamental safety functions:

- it will be possible to manage reactivity, to shut down the reactor safely and keep it in the shut down and subcritical state at all circumstances,
- it will be possible to remove the heat from the nuclear fuel away for a sufficiently long period in all circumstances,
- It will be possible to keep the integrity of at least one barrier for impeding of radioactive substances inside the nuclear facility in all circumstances,
- Regulation and restriction of the amount and type of radioactive substances discharged into the environment will be ensured in all circumstances.

The fulfilment of the fundamental safety functions will be secured by means of the implementations of mutually supplementing technical and organisational measures at the individual levels of in-depth protection.

The safety systems securing the fulfilment of the fundamental safety functions of the NJZ during design basis accidents will be backed-up several times (the principle of redundancy) to ensure the reliability of functioning and at the same time, the protection against a failure by common cause will be applied.

The failure by common cause, i.e. non-availability of several divisions or systems due to one reason, will be limited by means of the variety of project solution of the individual divisions or systems (the diversity principle), by space division (the principle of physical separation) and by restriction of mutual connection of individual systems (the principle of functional isolation). Regarding these systems, the sufficient self-sufficiency will be secured also from the perspective of energy supply (pressure air, electricity, ...) and operational mediums (water, air,...).

A.II.8.2.3.4. Safety Assessment and Keeping of Project Integrity for the NJZ lifetime

A.II.8.2.3.4.1. Initial Project Safety Assessment

To prove the achievement of the basic safety objective, a complex assessment of the NJZ project safety will be performed in a form of the elaboration of a Preliminary and Pre-Operation Safety Report. The safety assessment is required for a normal operation of the power plant, for expected operation situations and for accident circumstances. The aim of these analysis will be also to prove the capability of the designed facility and the effectiveness of systems and components important to safety, to deal with the postulated initiation situations and design accidents.

The safety assessment is performed based on the deterministic analyses of safety according to the methodology of combined approach with analyses (i.e. the employment of a realistic computing programme and the conservative initial and marginal conditions), or based on the realistic approach (i.e. the employment of a realistic computing programme, the realistic initial and marginal conditions and appraisal of uncertainty) and also based on probabilistic analysis of safety that will be supplemented with the analyses of uncertainty and analyses of sensitivity.

Concerning a wide spectrum of initiation situations (including internal situation and external affects), the fulfilment of the safety functions are proved by deterministic analysis and thus also by preserving of sufficient function of physical barriers. The methodology of safety analyses is applied also to anticipate the effect of the current loss of normal and emergency power supply and the exercise of the principle of an additional independent simple failure (a requirement on the application of simple failure assumption is not applicable in case of very improbable initiation situations and situations in design extension conditions (DEC)).

The probabilistic analyses will be focused on the probability assessment of the reactor core severe damage risk and on the probability assessment of the early or large radioactivity discharge occurrence. The acceptable level of risk for NJZs is set in the IAEA documents (occurrence probability of the large core damage has to be ≤1E−5/year, the occurrence probability of the early or large radioactivity release has to be ≤1E-6/year).

The verification of balance of safety measures for solution of individual initiation situation will be a part of the probabilistic analyses, i.e. in order to exclude existence of any dominant risk in the NJZ project.

Sufficiency of fire protection will be assessed based on a fire risk analysis.

A.II.8.2.3.4.2. Regular Safety Assessment

For the period of the NJZ operation the safety assessment performed at the stage of the detailed design, power plant commissioning and permitting of the operation, will be updated regularly. At present, a periodic nuclear facility safety review is a standard practice internationally. A periodic nuclear facility safety review is performed at least once per ten years.

Within the legislative framework of the Slovak Republic, a comprehensive periodic nuclear safety review is defined by the Atomic Act and the relating Ordinance of the UJD SR No. 33/2012 Coll. on regular, comprehensive and systematic evaluation of the nuclear safety nuclear facilities. In compliance with the quoted legislative documents, the objectives of the periodic NJZ safety review will be focused on:

- Comparison of the attained state of nuclear safety of the nuclear facility with the current requirements on nuclear safety and comparison with a good practice,
- Assessment of cumulative effects of nuclear facility ageing, for the assessment of effect of performed and considered changes to the nuclear facility and for the assessment of operation experiences,
- Specification of justified changes to the nuclear facility with the aim to keep the required high level of nuclear safety or to increase it up to the level nearing to world modern nuclear facilities,
- A proof that the required nuclear safety level is secured by the next periodic review or by the termination of the permit validity.

Pursuant to the above-stated legislation, the areas of the periodic safety review are as follows:

- nuclear facility project,
- current nuclear facility state,
- qualification of facilities,
- ageing management,
- safety analyses and their utilization,
- operational safety of the nuclear facility,
- application of experiences from other nuclear facilities and research results,
- organisational and administrative management,
- quality management system,
- operational procedures and regulations,
- human factor,
- emergency planning,

- radiological impact on the environment,
- nuclear facility operation after the end of the designed considered lifetime.

Based on the performed periodic review, the operator of the nuclear facility submits to the UJD SR a report on the results of the assessment of nuclear safety concerning individual areas, identifies and evaluates safety significance of identified deviation from the applicable current safety requirements of national and international practice.

An integrated plan for realisation of the proposed measures on the nuclear facility is a part of the documentation about the results of the periodic review submitted to the supervisory body.

More detailed amendments on a manner of performance of the periodic Slovak nuclear plants assessment are stated in the safety guideline of the UJD SR – BNS I.7.4 (Comprehensive Periodic Nuclear Safety Review).

Operator's duty to inform the public about the facility state and its environmental impact (i.e. also on results of monitoring) regularly is established by the Atomic Act (Section 10, subsection 1, paragraph l) as follows: "Within the scope of the permission of the authorisation, the authorisation holder is obliged to inform the public, through its web site, press or by other publicly available means always by 30 April, on the status of nuclear safety of nuclear facilities for the last calendar year".

A.II.8.2.3.5. Radiation Protection Requirements.

There will be an effective radiation protection system provided for the NJZ, not only at the nuclear power plant site but also in its surroundings.

Along with fundamental requirements on radiation protection (specified above in the part A.II.8.2.2.2.), the following will be applied to the nuclear facility project under the IAEA standard SSR 2/1 - Safety of nuclear power plants - Design (2012):

- To ensure for all states of normal operation that radiation exposure doses in the power plant premises or exposure as a result of all the planned radiation discharges from the power plant will be kept under the accepted dose limits and at the same time will be kept as low as reasonably achievable (ALARA)
- To ensure that radiation consequences for all the accidents considered in the power plant project will be kept under respective dose limits and at the same time will be kept as low as reasonably achievable (ALARA)
- To ensure that the probability of accidents with extensive leakage of radioactive substances or severe radiation consequences will be minimized to an extremely low level, by means of the NJZ project design. To ensure that situations with substantial probability leading to the stated consequences will be practically eliminated.
- To identify possible sources of radiation in the NJZ in all the operational states (normal operation, commissioning, refuelling, radioactive waste management) and in emergency situations and anticipated exposition and radiation risks caused by them,
- To ensure the control of fuel cladding tightness and to limit the activity of primary coolant and production of corrosive and activation products in the primary circuit coolant via proposal of materials, purification station design and chemical regime. At production of constructions, systems and components to use such construction materials with which their activation by radioactive substances is minimized.
- To apply the regulations on prevention of leakage or dispersion of radioactive substances and of contamination in the power plant premises.
- In a proposal of liquid and gas waste purification stations, exercise technical solutions effectively minimizing activity of the discharge and their composition from the perspective of environmental impact and exposure of population.
- To propose such arrangement of facilities that the entry of the staff to places of increased radiation risk and places of possible contamination of persons will be controlled and exposure or contamination of the staff excluded or reduced effectively.
- To divide the power plant premises into zones according to the degree of radiation risk in compliance with the specifying requirements of the national legislation.
- To apply the measures on the exclusion of unauthorised or uncontrolled movement of persons and material through the individual zones.
- To use the design of shielding and air-condition systems in a way that the doses for the staff will be minimized during normal operation and maintenance of facilities as well as during emergency situations.

- To propose the design of facility maintenance, fuel and radioactive and waste manipulation in a manner that the doses for the staff will be minimized.
- To ensure that in the premises with frequent maintenance or hand manipulation the radiation exposure of the staff will be minimized.
- To ensure sufficient means of decontamination of persons and facilities.

In the NJZ, the system of management, verification and assessment of radiation protection, control of the fulfilment of the radiation protection requirements including monitoring and documentation of the radiation protection state will be established. The scope of the radiation protection will conform at least to the level of the radiation protection system in the current operated nuclear power plants. The radiation monitoring applied in the NJZ project will ensure the fulfilment of the following functions effectively:

- monitoring of persons – personal dosimetry control,
- monitoring of a workplace – continuous and periodic control of the work environment, power plant premises, technological facilities and mediums,
- monitoring of discharges – continuous control of activity of discharges into the air and watercourses
- monitoring of surroundings – continuous and periodic control of radiation situation in the power plant surroundings,
- connection to the radiation monitoring at national level and cross-frontier warning.

Radiation monitoring will be proposed in such a way that it will ensure the stated functions in all the operational states and emergency situations.

A.II.8.2.4. Requirements on the Selection of the NJZ Site

The siting of the NJZ at the site, where the nuclear facilities are already situated, takes place pursuant to the same rules and requirements as for siting of nuclear facility at a new site. An undeniable advantage of the existing site is that, relating to the existing site, there is a set of climatic, seismological and geotechnical data that makes it easier to assess the site of NJZ siting but next to that, it also allows to gain more realistic outputs from the assessment – and that exactly on the basis of experience from the use of the site for nuclear facility operation. The assessment of the Jaslovské Bohunice site for the siting of the NJZ has to respect also new standards and ordinances and also new methodologies of an external risk assessment have to be taken into consideration.

The requirements on the nuclear safety of the nuclear facilities concerning their siting are defined by the Ordinance of UJD SR No. 430/2011 Coll. on Requirements on Nuclear Safety requiring the assessment and evaluation of the following items before submission of the application on nuclear facility siting:

(1) When siting nuclear facility, the assessment of the geological and seismic load of the chosen site has to be elaborated including:

a) probabilistic analysis of a seismic threat to the site,

b) assessment of seismological and geological conditions at the site and of engineering and geological aspects and geotechnical aspects of the proposed site,

c) determination of a threat related to an earthquake via seismic-tectonic assessment of the site with the use of the biggest possible scope of acquired information,

d) assessment of a threat as a result of movements caused by earthquake whereas a seismic-tectonic characteristic of the site and specific conditions of the site will be taken into consideration,

e) analysis of uncertainty as a part of a seismic threat assessment,

f) assessment of the impact of potential surface fracture movement on the site,

g) examination of geological, geophysical and seismological characteristics of the region irrespective of state frontiers and geotechnological characteristics of the site in accordance with the international practice performed in a way that an acquired database of date is homogenous for the whole area or at least allows the sufficient characteristics of seismic-tectonic structures of the site and size of the region examined; a type of information that has been acquired and a scope and details of examination are defined according to the character and complexity of seismic-tectonic conditions.

h) a proof of sufficient scope and detailed nature of acquired information and of research conducted to determine a threat as a result of seismic movements and movement on the earth fracture.

(2) Irrespective of the results of the analyses performed under the previous article, a minimum level of the seismic load of the site determined for the nuclear facility siting has to be represented by a standardized horizontal spectrum of response at a level of free field conforming to the peak value of acceleration equalling to 0,1 g

(3) The requirements of the nuclear facility safety at the stage of its siting are also characterised by locality characteristics that exclude the nuclear facility siting at this site and they are stated by Annex No. 2 of the Ordinance of the UJD SR No. 430/2011 Coll. Pursuant to the quoted ordinance, the following locality characteristics preclude the use of the locality for siting nuclear facilities:

a) in the conditions of operation, abnormal operation or in case of emergency situation, it is not possible to ensure at the site:
   1. keeping of established doses of population exposure and of established noise level and vibrations affecting people and also surrounding land and constructions,
   2. protection of life, health and property against consequences of emergency situations,
   3. protection against harmful impact of extreme meteorological effects and floods on nuclear facility

b) there is a threat of landslide or collapsing of the terrain at the site, a threat of flooding by mine waters or other strong tremors as a result of mine activity, gas or oil mining and there are underground water reserves at the site.

c) there are geodynamic and karst phenomenon endangering stability of rock massive in the area, like landslides, motion and seismically active zones, liquefaction of soil, tectonic activities or other phenomenon that can change the angle of the surface above established technological requirements,

d) protected zones of natural curative sources and natural mineral sources, areas with climatic conditions suitable for healing, a spa or a spa area stretch over the area,

e) there are declared mining premises with mining of raw materials in the area,

f) protected zones of industrial or other economic objects with which unfavourable operational collisions could emerge stretch over the area

g) density and dispersion of population do not allow the application of emergency preparedness measures in the area,

h) it is not possible to provide a sufficiently safe and reliable electrical power outlet of the planned installed capacity in the area,

i) if it regards a storage site, the existing huge or possibly not easily predictable risk arising from external events and events induced by a human activity, or if it is not possible to anticipate development of these events reliably during the project lifetime.

A preliminary assessment of the preclusive criteria was performed at the stage of the study of the NJZ feasibility and it proved that the site for the NJZ is convenient (see the following table). A detailed assessment of the preclusive criteria will be performed at the stage of preparation of the application for the NJZ siting permit. The results of the detailed assessment will be a part of a contractual safety report that will be submitted to the UJD SR as a part of the documentation of future operator's application for the NJZ siting within the scope of the Atomic Act.

Tab. A.II.5: Preliminary assessment of preclusive criteria

Preclusive criteria		Assessment	Comment
a)	Within the conditions of operation, abnormal operation or in case of emergency situation, it is possible to ensure:		
	- keeping of established doses of population exposure	Satisfied	The current experience with licencing procedures for generation III reactors proves that radiation consequences on population in operational and also in emergency regimes are very low. These characteristics of the NJZ will be proved by a standard way when permitting the construction.
	- noise	Satisfied	The NJZ is not a substantial source neither of noise nor vibrations as well as other nuclear facilities at the site. The detailed assessment has been performed in a separate acoustic study in EIA procedure; next, noise and vibration measurement will be performed before and after the launch of the construction.
	- vibrations	Satisfied	
	- protection against harmful effects of extreme meteorological impacts	Satisfied	An overall report of the Slovak Hydrometeorological Institute for the Jaslovské Bohunice site 2012 confirms, that there are no extreme meteorological conditions there that would potentially endanger population and external environment. The parameters of extreme meteorological phenomenon including rare dangerous meteorological phenomenon will be used as a base for the NJZ, so potential occurrence of extreme meteorological phenomena cannot endanger the NJZ safety.
	- protection against harmful effects of extreme floods	Satisfied	Concerning floods, the NJZ site was also evaluated by stress tests under ENSREG programme (Final Report from Stress Tests EBO 3,4) according to which it is possible to exclude the risk of floods from surface and underground waters. For exclusion of the possibility of floods caused by heavy rains, there have been the requirements accepted that the locality of the NJZ siting shall not be prone to accumulation or retention of precipitation waters and that the outlet of precipitation waters from the site shall be secured.
b)	The area is endangered by landslides or terrain collapses, flooding by mine waters, or strong vibrations resulting from mining, gas and oil extraction or there are underground water reserves in the area.	Satisfied	There is no mining in the area as well as no gas or oil extraction, nor there are any underground water reserves. The landslides, collapse of the terrain, flooding by mine waters or strong vibrations resulting from mining are not possible due to the complete absence of mining or other extraction activities in the NJZ site or in close surroundings.
c)	Occurrence of geodynamic and karst phenomenon endangering stability of rock massif		
	- landslides	Satisfied	The assessed construction site of the NJZ is currently stable and within common construction procedures, there is no anticipation of landslides or other manifestations of instability. According to the study Assessment of seismicity and geological conditions for the NJZ project, a risk of slope deformations is excluded in the NJZ surroundings.
	- tectonic activities, motion and seismically active zones	Satisfied	The area Dobrá Voda, that is 12 km far from the NJZ, belongs to the active seismic zones in Slovakia, and thus important NJZ facilities has to conform to the local seismic characteristics set with a probability of occurrence of at least 1E-04 per year. The criteria for NPP siting require 8 km distance from the active earth fracture. In the study Assessment of seismicity and geological conditions for the NJZ project, it is stated that the fracture lines close to the NJZ site (as well as in the Slovak territory) could have been active in the period before 780 thousand years ago.
	- liquefaction of soil	Satisfied	The preliminary assessment according to the results of the stage of indicative engineering-geological research has not proven any presence of such soil that could be liquefied. The perspective base soil for difficult constructions of a given profile is represented by fluvial gravel. The soil of gravel sand layers in the NJZ area are not prone to liquefaction.
d)	Protected zones of natural healing resources and natural mineral resources, areas with climatic conditions suitable for healing, a spa or a spa area,	Satisfied	The NJZ location does not interfere with any protected zone of underground waters, i.e. No protected zones of natural curative sources and natural mineral sources, areas with climatic conditions suitable for healing, a spa or a spa area stretch over the area intended for the NJZ siting.
e)	There are declared mining premises with mining of raw materials in the area,	Satisfied	There are no mining premises with raw materials mining at the NJZ site. In the surroundings of the NJZ site, there are no economically more important fields of raw materials. Thus, no registered or potential raw material sources will be affected.

Preclusive criteria		Assessment	Comment
f)	The area interferes with protected zones of industrial or other economic objects with which unfavourable operational collisions could emerge	Satisfied	The NJZ site does not interfere with any protected zones of industrial or other economic objects. In the surroundings, there are no facilities that could endanger the NJZ. The re-assessment of risk regarding NPP by external causes performed for the existing JE V2 within the PSR process has proved that the external activities performed in the surroundings of the Bohunice site will not endanger nuclear facility safety at the site.
g)	The density and dispersion of population does not allow the application of emergency measures in the area.	Satisfied	The extent of emergency zone of the NJZ will not be larger compared to the existing nuclear facilities situated at the site. The plan of population protection approved by relevant state organs that is elaborated for the operated NPPs at the site proves, that also in case of the NJZ it will be possible to elaborate an effective plan for population protection. An Internal Emergency Plan will be elaborated for the NJZ followed by External Emergency Plans elaborated for the population protection in case of accident state at the NPP. As these External Emergency Plans are currently elaborated and adopted in relation to the operation of the JE V2, we expect their update in relation to the NJZ.
h)	It is not possible to provide safe and reliable electric power outlet.	Satisfied	The equipment for electric power outlet of the NJZ will comply with the Ordinance of UJD SR No. 430/2011 Coll., Annex No. 3, Part B, II. Specific requirements on a design of nuclear facility with nuclear reactor, Part J. - Electricity supply system.

In line with IAEA recommendations and good international practice, the so-called underlying criteria for the selection of the NJZ siting has been included into the assessment of the Jaslovské Bohunice site suitability for the NJZ siting, by the choice of suitable and relevant criteria for the Jaslovské Bohunice Nuclear Power Plant site pursuant to the IAEA safety standards and state requirements of some neighbouring countries having determining criteria incorporated in their regulations.

In case of non-compliance with the criteria of this category, it is possible to situate the nuclear facility at the site only under the condition that there are engineering protection solutions for unfavourable conditions elimination at the site.

The category of the underlying criteria includes:

a) Insufficient bearing capacity of foundation soil for the construction siting and inappropriate geotechnical parameters of underlying layers of foundation soil.

b) Occurrence of underground waters or occurrence of well permeable soil in the depth smaller than 2 metres below the considered level of the rough grading of the surface selected for siting.

c) Probability of the airplane crash with effects surpassing the resistance of the nuclear facility construction is higher than 1E-07/year.

d) Sufficiency of source suitable for cooling. Securing appropriate sources at the minimum level of 97% will be required for the cooling in the NJZ relating to the electricity generation processes.

e) In case of the loss of a main route for residual heat removal from the unit into the external reservoir, the NJZ design has to provide an alternative route for residual heat removal from the unit. The capacity of the alternative route has to be separately sufficient for safe keeping of nuclear facility in a decommissioned state for the period of at least 30 days.

f) Resistance against dangerous explosions in the proximity of the nuclear facility. Whereas parameters of explosions having the worst effects on the NJZ (pressure wave, flying objects, etc. of technological origin from accidents within facilities in the NJZ proximity) will be specified as requirements on the NJZ project.

A preliminary assessment of the underlying criteria was performed at the stage of NJZ feasibility study and proved that the site is convenient for the NJZ siting (see the following table). The detailed assessment will be performed at the stage of preparation of application on the NJZ siting permit. The results of the detailed assessment of underlying criteria will be included in a contractual safety report that will be submitted to the UJD SR as a part of the documentation of future contractor's application for the NJZ siting in the scope pursuant to the Atomic Act.

Tab. A.II.6: Preliminary assessment of underlying criteria

Underlying criteria		assessment	Comment
a)	Bearing capacity for foundation soil for the construction siting	Conditionally convenient	The prospective foundation soil for the main generation unit of the NJZ is represented by fluvial gravel having appropriate geotechnical parameters for bearing depth foundations. Such fluvial gravel can be reached by standard piling technologies. The alternatives also allow improvement of the subsoil, or its exchange to the level of fluvial sediments (up to the depth of 20 m). The research of geological structure of subsoil has not identified any anomalies and other facts precluding or substantially complicating the NJZ realization. The previous use of the site does not include such processes that could change characteristics of foundation soil or create anomalies in geological construction.
b)	Occurrence of underground water under the considered level of rough terrain grading	Conditionally convenient	Construction: Within the existing knowledge of the NJZ project, there are two alternatives of possible foundation of the main generation unit construction. Alternative No.1: surface foundation, however, on the subsoil improved by appropriate technologies: the improvement of the subsoil by gravel-sand pillow through which a part of soil having less favourable characteristics (loess) is replaced with gravel-sand; this alternative keeps a part of loess as an isolator what is favourable from the perspective of underground water quality protection – from that implies minimum or no impact in the course of construction. Alternative No. 2: improvement of the subsoil by piles bearing into a layer of gravel that are connected by reinforced concrete desk in the upper part. Bearing of piles does not require special intervention into saturated layer or pumping of underground water. Other NJZ objects will be constructed in the environment of non-saturated loess geological layer, i.e. above the level of underground water with keeping a part of loess as an isolator.
c)	Probability of the airplane crash with effects surpassing the resistance of the construction	Convenient	Probability of accidental airplane crash is lower than 1E-07/year for the NJZ site. The NJZ will be required to prove its resistance against airplane crash within the conditions defined in contractor's assignment.
d)	At least 97% sufficiency of sources convenient for cooling in the NJZ related to processes focused on electricity generation	Convenient	The hydrologic study proves the sufficient water flow in the River Vah even at one hundred year minimum.
e)	An alternative route for residual heat removal for the unit (for the period of 30 days in decommissioned state of the NJZ)	Conditionally convenient	A separate reservoir is planned for the NJZ with the 30 day capacity for a decommissioned reactor. Next, what is planned involves also substitute raw water off-take from the Drahovce dam (in case of failures, a possibility of water off-take from Sĺňava water reservoir). An investor will include this requirement on the construction contractor.
f)	Resistance against dangerous explosions in the proximity of the NJZ	Conditionally convenient	A preliminary assessment has not identified any significant source of explosion risks. An investor will include this requirement on the supplier of the construction.

A.II.8.2.5. Requirements on Safety Categorisation of the NJZ Facilities

Constructions, systems and components of the NJZ important for ensuring nuclear safety (the so-called selected facilities) will be categorized into safety classes according to the valid legal provisions, which are in the sphere of nuclear safety ensuring defined by the Ordinance of UJD SR No. 430/2011 Coll. on Requirements on Nuclear Safety., IAEA and WENRA requirements defined by the documents SSR-2/1, WENRA Safety Reference Levels for Existing Reactors (2014) and WENRA Report Safety of the NJZ designs (2013), the relevant requirements of EUR and IAEA requirements pursuant to the document SSG 30 will be respected during the categorisation of systems, facilities and components of the NJZ into safety classes. Also categorisation used by a selected contractor of the NJZ will be adequately taken into account.

Safety categorisation for the NJZ will be performed in line with the following conditions:

- Definition of safety functions needed to prevent emergency situation formation and to mitigate consequences of emergency situation considered in the project (Design Basis Accident) including emergency design extension conditions.
- Identification of systems and facilities needed to fulfil individual safety functions,
- Consequences of a failure to fulfil relevant safety function by specific systems and facilities,

- Frequency with which it is possible to expect formation of requirement on the fulfilment of a safety function by a specific item of systems and facilities
- After the formation of initiation situation, a period during which the fulfilment of the safety function will be required and for what period in the course of initiation situation the fulfilment of the safety function will be required
- Categorization of each item of system into a safety class generally according to the highest level of safety function that a given facility has to perform.

When designing a principle will be observed, that as long as an executive safety system is intended to fulfil the safety function and functionality of a support system is required for its fulfilment (e.g. supply of energy, mediums, greasing, etc.), then the support system important to safety will be classified into the same safety category as a respective executive safety system which it supports.

Reliability of safety systems and their equipment, systems and components will be in the NJZ design secured by requirements on the resistance to a simple failure, resistance to failures with common cause, by diversity, functional independency, separation of redundant subsystems, qualification according to environmental conditions during the operation and emergency situations, seismic categorisation, the exercise of a safe failure principle, exercise of in-depth protection principle in such a way that tools providing in-depth protection at various levels of protection be independent via achievable manner.

The requirements on the safety categorisation of systems, facilities and components specifically determined for emergency management will be defined separately with respect to the assessment of the analyses and need of facilities to management and mitigation of emergency consequences.

A.II.8.2.6. Main Stages of the NJZ Licencing Process

For siting, construction, commissioning, and operation of a NPP but also for its decommissioning, the operator of the nuclear power plant has to submit documentation involving detail safety evaluation corresponding the level of the NPP project preparation status in line with the provisions of the valid legislation on safety assessment before the issuance of a respective permit.

The content and purpose of the documentation for the license system are defined in valid nuclear legislation – in the respective Acts or implementing Ordinances. The detailed requirements concerning nuclear safety, the fulfilment of which will be documented and controlled when licencing the NJZ, are defined in the binding Ordinances and guidelines issued by the UJD SR.

The first step of the licensing process is the *nuclear power plant siting permit.* The future operator submits at this stage a documentation, a part whereof is the *Final Statement from the Proposed Activity Assessment* (pursuant to Act on Environmental Impact Assessment) and the *Initial Safety Analysis Report* (involving the information on the evaluation of siting suitability of the NPP). The submitted documentation includes an overview of nuclear safety requirements that the design has to meet and also the main technical parameters of the power plant. Based on the assessment of the Safety Report and a set of other documentation submitted by an applicant pursuant to the Atomic Act, the UJD SR decides on the issuance of the *approval for nuclear facility construction siting*.

Another licensing step is *the nuclear power plant construction permit*. This stage is based on the fact that there are the basic technical documents on the project of a nuclear power plant available. The basic documents on ensuring nuclear safety in the nuclear power plant project create the basis for elaborating the *Preliminary Safety Report*, where the future operator proves the fulfilment of all requirements for nuclear safety as well as the fulfilment of all safety objectives. Based on a positive assessment of the safety report and the set of other documentation, which the applicant submits in line with the Atomic Act and based on statements of the public bodies concerned pursuant to the Construction Act, the UJD SR issues a *permit for NPP construction*.

The following significant licensing step represents the *Nuclear Power Plant Commissioning and Operation Permit*, which the UJD SR issues pursuant to assessing the Operational Safety Report and other documentation submitted by the applicant in compliance with the Atomic Act. This involves the safety assessments of the actual and already constructed facility, which is ready for future operation hence based on the entry data from the operational project. This safety report involves also the quality assessment of the project implementation and the assessment of potential changes to the project as compared to the state assessed in the Preliminary Safety Report. Pursuant to assessing the safety report and the set of other documentation,

the UJD SR will decide on issuance of *Nuclear Power Plant Commissioning Permit* and after the assessment of the commissioning stage and trial operation of the NJZ, also on issuance of *Nuclear Power Plant Operation Permit.*

Similar licensing steps are carried out before and during the operation termination stage, when the permit for activities related to decommissioning is issued.

During the tender, the potential supplier offers his typical project, which has normally been already licensed in the country of project origin or in some other EU country (in case of other nuclear-developed country), thus there will be performed only such changes to the project as required by the Slovak legislation, and changes necessary for incorporating the project at the Bohunice power plant site.

A.II.8.3. Specific Data on the NJZ

This chapter describes specific data and requirements related to the NJZ at the Jaslovské Bohunice site.

A.II.8.3.1. Technical data

A.II.8.3.1.1. Basic Technical preconditions

The basic technical data of the NJZ are summarised in the following points:

- The total installed power of up to 1700 MW,
- Minimum 60 years lifetime.
- An existing project licenced in the country of origin, in some other EU country or other nuclear-developed country (USA, Russia, Japan, the South Korea, China, etc.) at the time of contractor selection at least at the advanced stage of construction at the other site
- A turnkey contract or supply of technological islands with coordination function of the contractor of the nuclear island.
- Supply of technology together with nuclear fuel supply with the consideration of the nuclear fuel contractor diversification.
- Ensuring the licensing process will be in line with the legislative regulations of the Slovak Republic and utilizing experience and recommendations of international institutions.
- The power plant will work on the basic part of the daily load diagram and it will be authorized to provide the contractor of the superior transmission grid with support services corresponding the primary, secondary and tertiary active power regulation.
- The unit will be able to work long-term at a capacity varying from 50 to 100% of the rated output and will be able to meet the required technical conditions of inlet and connection of a facility for electricity generation.
- The unit capability factor for a 12-month period will be higher than 0.9 (period throughout which the unit is able to be in service divided by a whole calendar year).

A.II.8.3.1.2. Fundamental Safety Data

A.II.8.3.1.2.1. Fundamental Safety Objectives

The NJZ project will be designed in a manner that the fulfilment of all fundamental safety objectives will be secured in accordance with provisions and requirements of the UJD SR, IAEA a WENRA for NJZs.

The basic safety target is to protect persons, society and environment from an unfavourable impacts of ionizing radiation. In order to achieve the highest reasonably accessible level of safety during the operation of nuclear facilities, to the following needs to be obeyed:

- prevent the uncontrolled exposure of persons and releases of radioactive substances to the environment
- minimise the probability of events, which might lead to the loss of control over the reactor core of the reactor, over the fission chain reaction, radioactive sources or over any other source of radiation.
- In case of such events, to manage them in a manner that would minimise their consequences.

- Secure strict technical and administrative control of all the radioactive sources

Compliance with the basic safety target will be respected at all stages of the nuclear facility's life cycle, i.e. planning, siting, designing, manufacturing, constructing, commissioning, operating and decommissioning. It also includes the transport of the radioactive material and radioactive waste management.

A.II.8.3.1.2.2. Probabilistic Safety Characteristics

All referential nuclear units considered for the NJZ are designed with regard to the requirements for Generation III+ sources and in line with the IAEA and WENRA requirements for new power plants.

It is required for the NJZ that the core damage frequency (probability of its occurrence), while considering all possible scenarios of failures and their combinations, would be lower than 10-5/year and at the same time, that it would be almost excluded that the core damage might be followed by a significant and early leakage of radionuclides from the containment and from the facility for fuel storage (if a storage pool of spent fuel is not a part of the containment). At the same time, the frequency of such an event would in any case be lower than 10-6/year.

A.II.8.3.1.2.3. Fundamental Requirements on Resistance against Risks and Failures of the NJZ

Internal risks

In compliance with the requirements of the Ordinance of the UJD SR No. 430/2011 Coll. on Requirements on Nuclear Safety, the NJZ project will take into consideration a potential possibility of occurrence of failures that could endanger the nuclear facility operation. The respective ordinance establishes an obligation to perform analyses of the designed facility with the aim to identify all the internal situations possibly affecting nuclear safety.

The following types of potentially possible internal situations connected with a risk (stated in the IAEA requirements on a project of nuclear power plants of SSR 2/1 standard - - Safety of nuclear power plants - Design, 2012) will be analysed in the NJZ design:

- Internal fires and explosions,
- internal floods,
- flying objects internally generated
- collapse of constructions,
- fails of a weight,
- swings of pipelines
- impacts of a spouting medium from the damaged systems
- electromagnetic interference

Based on the results of the analyses of the internal risk, the following measures will be adopted in the NJZ design – measures on prevention, or mitigation of consequences of internal situations in a way that safety of nuclear power plant be not endangered.

External risks

The NJZ design will take into consideration the external situations of natural origin and the external impacts caused by a human activity that have been identified in the process of the NJZ site assessment for construction.

A general list of the external situations is identified in the IAEA requirements for a project of nuclear power plants SSR 2/1 Safety of nuclear power plants - Design (2012) and refined in the guideline IAEA NS-G-1.5 External events excluding earthquakes in the design of nuclear power plants (2003), and WENRA Report Safety of the NJZ designs (2013).

A list of the external situations which will be taken into the account in the NJZ design will be specified for the conditions of the Slovak Republic and the Jaslovské Bohunice site. Requirements for considering the external situations in a nuclear power plants project are set by the Ordinance of the UJD SR No. 430/2011 Coll. on Requirements on Nuclear Safety where also a minimum scope of external situations required for analyses is specified.

With respect to the above quoted sources, the NJZ design will take into consideration the following types of external situations:

a) Seismic threat.

b) Extreme meteorological and hydrological conditions
- extreme load caused by wind, including flying objects generated by wind,
- extreme temperatures of the outer atmosphere,
- extreme precipitation (water, snow) and local floods,
- extreme temperatures of cooling water,
- extreme hoarfrost,
- extreme discharge of atmospheric electricity
- external floods

c) The impact of human activity in industrial, transportation and military objects in the proximity of the nuclear facility, including explosions in the proximity of the nuclear facility:
- explosion connected with a pressure wave and flying objects,
- fires,
- leakage of explosive or toxic gases,
- contamination by harmful fluids,
- accidental airplane crash,
- sabotage.

d) The crash of a commercial airplane (intentional crash of the commercial airplane is included in the WENRA requirements-Report on Safety of the NJZ Designs 2013). For the purpose of the assessment of the NJZ safety in relation to the crash of a commercial plane, the criteria stated by US NRC set in 10 CFR part 50.150 will be applied and they require: continuity for the reactor core cooling (or for the conservation of containment integrity) and continuation for the spent fuel cooling (or for the spent fuel pool integrity to be secured)

The facilities and constructions of the NJZ important for safety will be designed and situated in a way that the external situations impact on the power plant safety would be minimized.

A.II.8.3.1.2.4. Seismic Resistance

All referential nuclear units considered for the NJZ are designed with regard to the seismic effects and the project will be further adapted to the characteristics of the Jaslovské Bohunice site.

The seismic characteristics of the Jaslovské Bohunice site have been defined pursuant to the IAEA safety standards. Before the commencement of the NJZ designing, they will be specified again pursuant to the latest safety standards of the IAEA for seismic threats. Under provisions of the UJD SR and IAEA recommendations, two design earthquake levels of SL-1 and SL-2 will be set for the NJZ.

The SL-1 level represents a lower seismic load at the occurrence of which it is possible, regarding the local geological and seismic conditions, to consider throughout the designed lifetime of the power plant. After such seismic event, the nuclear facility has to be capable of re-commissioning of operation again (after the respective controls are made). The SL-2 level represents a maximum seismic load, which, according to the analyses and assessment, may theoretically occur at the site and wherein the safely shut down of the nuclear power plant is required. SL-2 level is applied as an assignment for required seismic resistance in a design of nuclear facility constructions, systems and components significant from the safety viewpoint.

The more detailed date concerning seismic characteristics of the site are included in the chapter C.II.2.4. Seismicity, Tectonicity and Geodynamic phenomena (page 150 hereof).

A seismic categorisation of constructions, systems and components will be performed in accordance with legislative provisions of the SR, IAEA standards and requirements of the UJD SR to take into consideration the specific conditions of the site.

A seismic qualification will be set and required for all systems, facilities and constructions important for safety.

A.II.8.3.1.2.5. Extreme Meteorological and Hydrological Conditions in the NJZ Project

All referential nuclear units considered for the NJZ are designed with regard to the load of extreme climatic conditions and the project will be further adapted to the characteristics of the Jaslovské Bohunice site.

These extremes involve maximum and minimum temperatures of atmosphere and cooling water, wind speed (including tornados), torrential rains and snow cover load. Furthermore, the design values for extreme discharge of atmospheric electricity and hoarfrost will be set for the NJZ project. Apart from extreme intensity of torrential rains at the site, also extreme level and flow rate on the nearby watercourses (including the maximum water level in an event of dam breaks or watercourse obstruction through ice and thus induced floods) is set and assessed with floods.

For the NJZ site, there is a detailed assessment of meteorological and hydrological conditions available, including the derivation of design values relating to climatic extremes. For the statistic processing of the individual meteorological characteristics, there are data from the monitoring station networks of the Slovak Hydrometeorological Institute (SHMÚ) available. The methods of statistical processing are based on the valid IAEA standards for meteorological and hydrological risk assessment (SSG-18 Meteorological and Hydrological Hazards in Site Evaluation for Nuclear facilities, 2011) and they are based on statistical elaboration of more than 30 year database of hydrometeorological measures conducted in advance at the Jaslovské Bohunice site and on a more than 60 year database of meteorological data from the surrounding stations of SHMÚ (towns Hurbanovo and Piešťany).

In line with the IAEA standards and the common international practice, the effects of climatic impacts are set for two of the proposed levels. This is the so called design and extreme load. In case of the design load of climatic impacts, the extreme load for NJZ will be considered set for repeatability of occurrence of climatic impacts once in 100 year period. For buildings and systems important for safety which are directly affected by external environment of the site, the extreme loads for NJZ will be considered set for repeatability of occurrence of climatic impacts once in 10,000 year period.

Extreme climatic conditions were set by the Overall Report of SHMÚ for the Jaslovské Bohunice site (2012) in accordance with UJD SR requirements defined by the Ordinance No. 430/2011 Coll. on Requirements on Nuclear Safety and with IAEA and WENRA recommendations for all relevant meteorological components and phenomena for the site and for the average period of repeatability of 100 years and 10 000 years. The values conform to the Middle European rates.

A 10 000 year maximum and minimum of the immediate air temperature are +44 °C a -45 °C, a maximum wind blow is 53 m/s, daily rainfall 209 mm, 15 minute run-off precipitation 61 mm, a value of the new snow coverage (created within 24 hours) reaches 492 mm. A tornado of F1 category can occur at the site.

The NJZ site has a low risk of a strike of lightening with high intensity. Maximum density of lightening cloud-earth is in the vicinity to 10 km from the NJZ up to 2,5 lightening per km^2 per year. In the area to 50 km from the NJZ, the density is slightly higher to over 2,5 lightening per km^2 per year only in the north-eastern part having higher orography (Strážovské vrchy) and near Senec. Median values of a peak current is between 10 to 13 kA.

For the extreme values, the Slovak Hydrometeorological Office elaborated the analysis of climatic change impact by the year 2100. The anticipated climatic change has only a small impact on a majority of extremes, but for the tornado it was recommended to expect at least F2 category. Also the daily rainfall of the 10 000 year extreme precipitation can be higher than nowadays and it is not possible to exclude extreme precipitation up to 400 mm/24 hours in the south-west Slovakia.

At the territory of the Trnava Self-Governing Region, a flood wave having the height of 2,40 m to 2,80 could emerge in case of simultaneous disturbance of the Liptovska Mara and Oravská priehrada water dams if there would be no regulatory measures applied on the Vážska kaskáda water dam at the same time. Subsequently, there would be disturbance (spill-over) of other water dams along the river Vah.

The flood wave would not reach the NJZ site. However, it could damage objects for the inlet of technological water from Váh (the Sĺňava water dam) for the NJZ. The site of the NJZ will include its own water reservoir that will provide the function of water reserve for long-term cooling (at least 30 days) during emergency situations, for instance during the impossibility to provide water supply from the Váh River or the water dam Sĺňava.

As the protection against floods from the local run-off rainfalls, there is a protection ditch planned around the NJZ site that is intended to catch run-off waters from the surrounding terrain. The aim of the measure is to prevent flooding of the NJZ in case of run-off rainfalls and safely take the caught water away into the canal Manivier.

A.II.8.3.1.2.6. External Influences Resulting from Human Activities

All reference nuclear units considered for NJZ (the NJZ) are designed with regard to load of influences resulting from human activities and will be further project-based adapted to the characteristics of Jaslovské Bohunice area.

The influences have their source in the vicinity of locality of the NJZ and they at the same time include possible sources of danger on the premises of the NJZ. They result mainly from the industrial or agricultural activities in the given region, from transport of harmful substances on the traffic routes near the power plant (roads, railways) and from a danger resulting from air transport (airplane crash). Possible sources of danger inside the premises of power plant include mainly storage and internal transport of toxic, explosive, flammable, oxidizing, choking and radioactive materials which usually include hydrogen, ammonia, diesel, hydrazine, oxygen, nitrogen, other chemicals used in the power plant and transport of radioactive waste and spent fuel. A specific internal source of danger can be accidents on the other nuclear facilities in the area connected with leak of radioactive substances into the environment.

External events (design-based) are defined as events the probability of occurrence of which is 1E-07 per a year or higher and their potential consequences are serious to such an extent that they can influence the nuclear safety of the power plant. A preliminary risk assessment for the NJZ emerging as a result of human activities is located in the chapter C.III.19.1.10. Risks resulting from other human activities in the area (page 400 of the Report).

A danger resulting from intentional attacks (sabotage, terrorist attack) will be dealt with and eliminated by standard means and procedures of physical protection in accordance with international and national legislative regulations. A description of the procedures of risk danger management of the NJZ resulting from intentional attacks is defined in the chapter C.III.19.1.8. A risk of terrorist attack (page 396 of the Report).

A.II.8.3.1.3. Basic Data about Reference Projects

The power plant with PWR units of generation III+ can be delivered by many worldwide prominent producers. The following project solutions are considered to be as referential:

- AP1000,
- EU-APWR,
- MIR-1200,
- EPR,
- ATMEA1,
- APR-1400.

Supplier of the power plant will be selected subsequently in the next stages of project preparation; the selection of the supplier is not a subject of assessment of influence on the environment. The environmental and safety requirements for all types of reactors are identical and their impacts are taken into account in their potential maximum. It means that the parameters used when assessing the impacts conservatively cover the parameters of devices of all the suppliers in question.

Basic date about the reference projects resulting from data presented by their suppliers are mentioned in the following text.

Project AP1000

It involves a project of a company Westinghouse Electric Company LLC, USA. Thermal output of one unit is ca. 3415 MW_t, net electrical capacity is ca.1100 MW_e.

Development of technology of a pressurized water reactor AP1000 has taken more than 15 years and is based on the knowledge and experience from a successful 50 years long operation of more than 100 commercial power plants grounded on the designs of company Westinghouse.

Main design characteristics are briefly summarized in the following items – extended lifetime of the power plant, use of passive technology, simplification of design, increased independence of the power plant from the external sources, multiple safety levels and solutions for severe accidents incorporated into the design.

A reactor cooling system consists of two heat transfer loops. Each loop includes the steam generator, two main circulation pumps, one hot leg and two cold legs for circulation of reactor coolant. Besides of that the cooling system of the reactor consists of pressurizer, cross-tie pipeline, valves and devices for operating management and initiating of safety devices.

Containment AP1000 is of a simply version with an external protective building. Containment consists of a steel tank with wall thickness to 44 mm and provides a high level of tightness. The containment tank is surrounded by a protective building.

The design is based on use of passive safety systems which are designed in such a way that they will work without an operator intervention for 72 hours after the design based accident. The passive safety systems use natural driving forces like compressed gas, gravitational flow, natural circulation flow and convection, they do not use active components (like pumps, fans or diesel generators) and are designed to function without additional active supporting systems. The main safety systems are a passive system of emergency core cooling system, a passive system for residual heat removal from the reactor and a passive containment cooling system.

The passive emergency core cooling system uses 3 sources of water for the core cooling:

- High pressure injection system (2 full-pressure injection tanks);
- System of hydroaccumulators (2 hydroaccumulators with a nitrogen pad);
- Storage tank for refuelling in the containment.

In case of a primary circuit line break is cooling of the core secured at first by water from the high-pressure injection tank and later, after the pressure in the primary circuit is decreased, by water from hydroaccumulators. After emptying of the hydroaccumulators, gravitational feeding follows from a storage tank of the refuelling placed in the upper part of the containment. Heat removal is realized through evaporation and through the containment walls to the outer atmosphere (or more precisely, supported by the external spraying of the containment walls).

In case of an accident without the breach of the primary circuit integrity the pressure decrease in the primary circuit is controlled by a system of automatic depressurization of the primary circuit. A long-term cooling of the reactor is secured by natural water circulation between the reactor and the residual heat removal cooler.

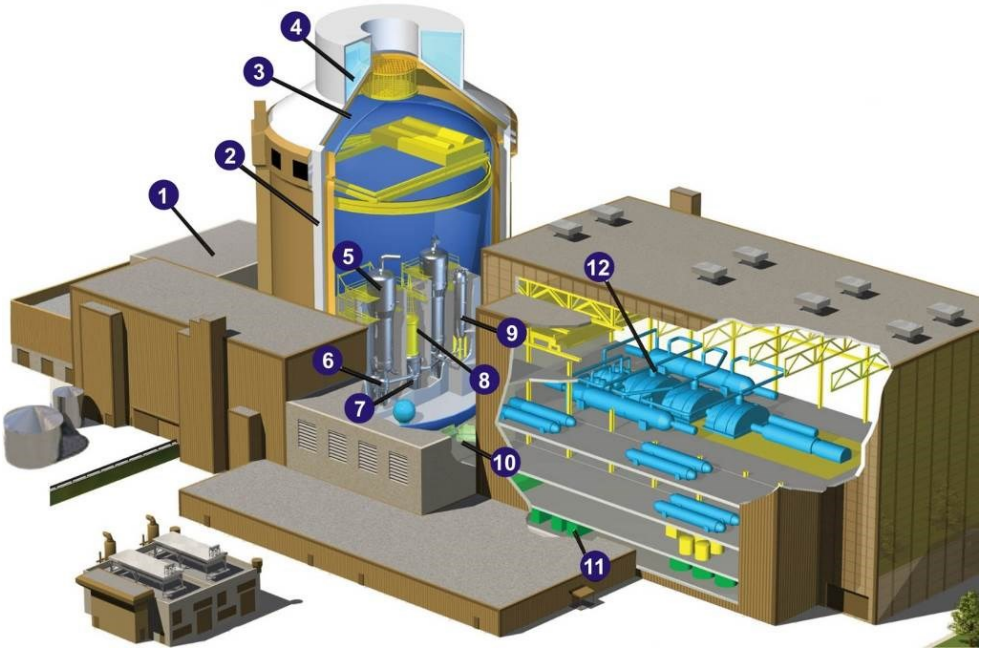
Heat from cooler of residual heat removal is conducted by natural circulation into a refuelling storage tank in the containment which can hold the heat for 1 hour from the start of an accident. After expiry of this time water starts boiling in the tank and the heat from the storage refuelling tank in the containment is conducted by means of vaporization to the containment. The heat is conducted from the containment by passive system of containment cooling.

The passive cooling system of the containment conducts heat from inside the containment to the atmosphere during LOCA or during steam piping break accident or feed water piping break accident. Steam inside the containment condensates on the wall of steel containment which is cooled from the outside by natural circulation of air and by water from the tanks placed in the upper part of the containment. The pressure inside the containment is thus maintained within the permitted limits.

Containment integrity is in case of severe accidents secured by the functions of three systems:

- Hydrogen concentration controlling system which is designed for design based accidents and severe accidents and consists of 3 hydrogen recombiners removal from the section of combustion of hydrogen units;
- Containment passive cooling system (described above);
- Stabilization of core melt in the pressure vessel of the reactor using the passive cooling system of reactor shaft that is flooded to cool it from the tank inside the containment.

Figure A.II.17: Overall cross-section view of unit AP1000



1	Fuel handling building	**7**	Reactor
2	Containment building	**8**	Integrated upper unit of the reactor
3	Containment	**9**	Pressurizer
4	Coolant storage tank of the containment passive cooling system	**10**	Unit control room
5	Steam generators	**11**	Supply pumps
6	Main circulation pumps	**12**	Turbogenerator (turbine and generator)

Power plant consists of five main building structures: nuclear island, turbine halls, auxiliary building, diesel-generators building and building for radioactive waste. Each building construction is built on the independent foundation plates. The nuclear island consists of containment building, protective building and building of auxiliary operations, which are built on the common foundation plate. The devices directly connected with the nuclear safety are located only in the containment building, in the building of auxiliary operations and in the diesel-generators building.

A designer of AP1000 performed a detailed assessment of a crash of a large commercial airplane for the reactor AP1000. The assessment states that, on the basis of the performed realistic calculations, the crash of an airplane would not disrupt the ability of AP1000 core cooling, would not compromise the integrity of containment and would not compromise the integrity of the spent fuel pool.

Project EU-APWR

EU-APWR is a European model of pressurized water reactors of the company Mitsubishi Heavy Industries (MHI), Japan. Thermal output of one unit is ca 4466 MW_t, net electrical capacity is ca. 1600 MW_e.

A project of the APWR reactor comes from a verified project of 4-loop PWR reactors of the company MHI and, moreover, it uses innovative technologies for the purposes of increase of safety, reliability, economy and minimization of environmental impacts. EU-APWR is further modified in order to simplify the meeting of the individual national requirements in case of licensing in European countries.

The primary circuit of the EU-APWR reactor consists of four identical loops for heat transfer connected parallel to the reactor pressure vessel. Each loop is composed of a steam generator, main circulation pump and relevant piping and valves. The primary circuit, in addition, includes pressurizer, pressurizer relief tank, safety valves, connecting piping and instrumentation. All the above mentioned components are located in the containment.

A safety enclosure system consists of a primary and secondary containment. The primary containment is composed of one jacket made of prestressed concrete in a shape of a vertical cylinder ended with a hemispherical cupola. The secondary

containment is a construction overlapping the penetrations of the primary containment. The function of the interspace between the primary and secondary containment is to prevent the direct leakage of containment atmosphere into the surrounding environment through feedthroughs in the primary containment.

Safety systems use a combination of active and passive systems. They consist of an emergency core cooling system, residual heat removal system, system of emergency power supply of steam generators, containment systems, containment spray system and interspace filtration system of the containment enclosure.

The emergency core cooling system includes system of hydroaccumulators, high pressure injection system and emergency depressurization system. The emergency core cooling system is designed with sufficient redundancy (4x50 %) in order to be able to fulfil the specified safety functions in case of an expected individual failure of an active component shortly after the accident or in case of an individual failure of an active or a passive component in a longer time horizon after the accident while in both cases, there is one extra redundant line put out of operation for maintenance.

Improved hydroaccumulators are connected to cold legs of circulation loops and supply water into the primary circuit if the pressure decreases below the operating pressure of hydroaccumulator. They consists of internal passive flow valves, the function of which is to provide the injection of high flow in order to refill the reactor vessel in the first injection phase and subsequently to reduce the flow when the water level in accumulator decreases.

A high-pressure injection system consists of four independent divisions from which each includes a pump and relevant valves and pipings. The pumps draw boric acid solution from a refuelling storage shaft placed in the containment and transfer it to the injection nozzles on the reactor pressure vessel. Two injection divisions are able to fulfil the designed cooling function in case of a large leakage with the expected individual breakdown in one division and with a shutdown of the second division for maintenance.

Containment spraying system consists of four independent divisions. Each division is composed of one pump for containment spraying / residual heat removal, one heat exchanger and relevant valves, pipings and instrumentation. Each division is physically separated. The main devices of the system are installed outside the containment. The containment spraying system secures the cooling of containment internal area and partial collection of radioactive substances in the course of an accident.

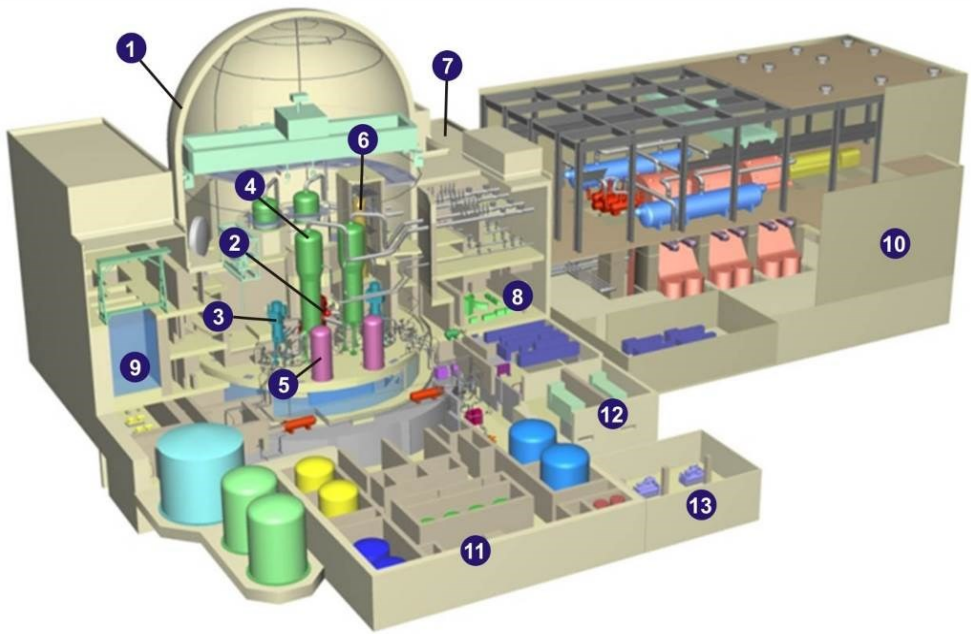
In case of core melting the melt will be collected in the area of reactor shaft. In order to achieve and maintain the heat removal in case of occurrence of the melted core in the reactor shaft, the shaft is flooded with boric acid solution by means of the injection system injecting to the reactor shaft.

In order to provide the sufficient degree of core melt cooling in the flooded reactor shaft, EU-APWR is equipped with a device for dispersion and cooling of core melt. This device consists of special porous grate and it improves the dispersion of the melt layer and remains created by the interaction between the melt and cooling water and at the same time it improves the natural water circulation in the reactor shaft.

The hydrogen concentration controlling system provides elimination of the risk of explosion in the containment in case of a sever accident. Its purpose is to monitor the containment atmosphere, combustion of hydrogen created during a severe accident by a system of hydrogen igniters before it reaches the critical concentration and to reduce the hydrogen concentration using passive autocatalytic recombiners. The hydrogen recombiners and igniters are located inside the containment at the level of the upper parts of steam generators.

A large containment and arrangement of constructions and components inside the containment simplifies the effective mixing of containment atmosphere and supports the hydrogen dispersion during and after accidents connected with hydrogen leakage into the containment.

Figure A.II.18: Overall cross-section view of unit EU-APWR



1	Containment building	**8**	Unit control room
2	Reactor	**9**	Spent nuclear fuel storage pool
3	Main circulation pump	**10**	Turbine hall
4	Steam generators	**11**	Auxiliary operations building
5	Advanced hydroaccumulators	**12**	Emergency generators
6	Pressurizer	**13**	Entrance building
7	Reactor building		

Nuclear island includes the reactor building, containment, emergency generators building (combustion turbines), auxiliary operations building and entrance building.

Containment roofs all the reactor cooling system components and its internal reinforced concrete walls protect the devices against flying fragments and they also provide the biological protection for the maintenance staff. There are safety systems and devices important for safety located in the reactor building. The safety systems are located in four quadrants surrounding the containment construction. Each quadrant is separated by a physical barrier.

The containment and reactor building are located on the common foundation plate and are designed the way so that they withstand a crash of a large commercial or military airplane. Containment, reactor building and emergency generators building are designed as seismically resistant.

Project MIR-1200

It is a project of a company consortium Škoda JS/JSC Atomstroyexport/JSC OKB Gidopress, the Czech Republic/Austria. Thermal output of one unit is ca. 3212 MW_t, net electrical capacity is ca. 1114 MW_e.

Project MIR-1200 is a result of development of technology of a pressurized water reactor VVER-1000 starting with a types V-187 and V-302 followed by a type V-320 (operated e.g. in Temelín, Czech Republic) through a project AES-91 with a reactor VVER-1000/V-428 currently operated in 2 units of a power plant in Tianwan, China, further, a project VVER-91/99 with a reactor VVER-1000/V-446 with extended lifetime up to 60 years, which was intended for the locality in Olkiluoto in Finland, up to the current reactor type AES-2006 with lifetime up to 60 years and higher output, which is similarly to VVER-1200/V-491 (MIR-1200) under construction in Leningrad nuclear power plant 2 and in the version VVER-1200/V-392M under construction in Novovoronezh nuclear power plant 2.

MIR-1200 comes from the verified solutions and puts stress on the increased safety. The design is based on the principle of safety assurance for staff, inhabitants and environment. It uses a combination of the most modern both active and passive safety systems to deal with accidents.

MIR-1200 is a pressurized water reactor with four heat exchange loops, each of them with a horizontal steam generator and main circulation pump. A pressurizer is connected to the hot leg of one circulation loop. The reactor, main components of the primary circuit, passive part of the emergency core cooling system, tanks of passive system of heat removal, refuelling system and fuel storage system are located in a double containment.

The double containment consists of a primary (internal) containment and secondary (external) containment. The primary (internal) containment is a prestressed concrete cylinder with a cupola and forms a supporting frame absorbing the tensile stress caused by the pressure in case of an accident with the coolant loss inside the containment. A steel padding on the inside surface secured the inner tightness. The secondary (external) containment is made of monolithic reinforced concrete and provides protection against the external risks including the resistance against the crash of a large transport plane.

A safety conception of MIR-1200 is grounded on the primary use of active safety systems for handling the design based accidents and on the combination of use of the active and passive safety systems for prevention and handling the sever accidents. Other safety improvements, in comparison with existing power plants, are the higher redundancy of safety systems, protection against the crash of a large plane, higher resistance to earthquakes and other malfunctions with a common cause, realistic evaluation of a human factor and the like.

The emergency core cooling system of MIR-1200 is designed to provide the core cooling in case of an accident with the coolant loos in the primary circuit as a result of the primary circuit integrity break. It consists of four high pressure injection pumps (4x 100 %), four low pressure injection pumps (4x 100 %) and four passive hydroaccumulators (4x 33 %). The suction of the pumps is from the storage tank placed in the containment and they supply water into the circulation loops, hydroaccumulators are connected directly to the reactor pressure vessel.

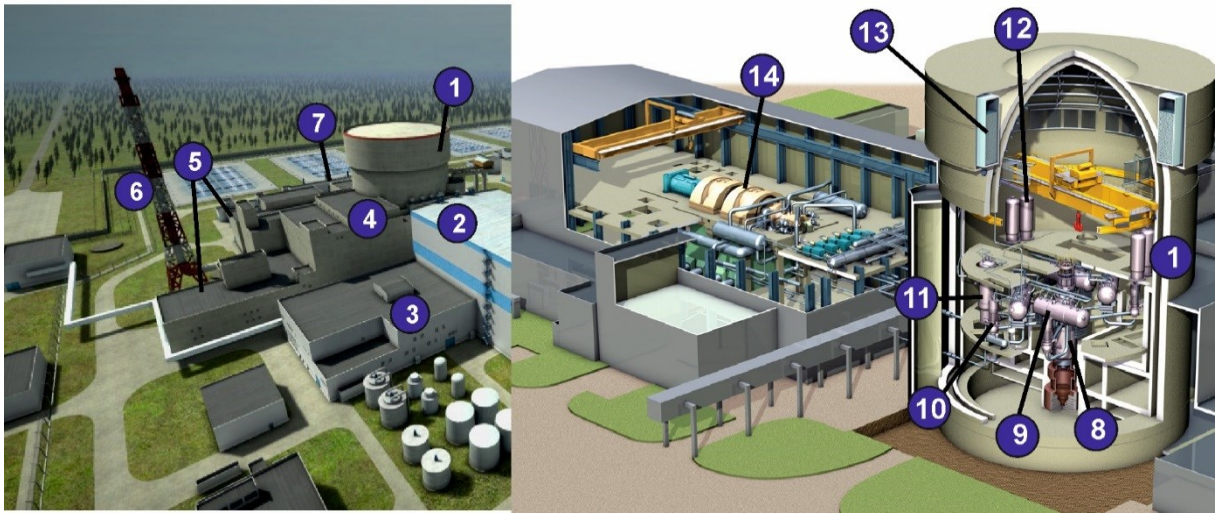
A standard means for heat removal from the containment is a spraying system. Heat can be continually removed from the containment with a passive heat removal system from the containment which does not require any electrical power supply. The system is designed for a continuous operation (at least 24 hours in the continuous mode) and it can work for an unlimited long period provided that a sufficient amount of water for refilling of the passive emergency heat removal tanks is available. The tanks and heat exchangers are located in the upper part of the outside containment.

In order to maintain the containment integrity in case of severe accidents, the project provides special technical equipment for handling an accident and for minimization of radioactive substances leakage. It is primarily a case of hydrogen concentration controlling system in the containment and melted core catcher.

In order to rule out a possibility of hydrogen explosion in case of design based accidents and in case of accidents in the extended project conditions (DEC) (including severe accidents) a hydrogen concentration removal controlling system is available. There are passive catalytic recombiners for hydrogen removal positioned in the containment area.

The melted core catcher is designed to be able to maintain the liquid and solid remnants of damaged fuel (core), pressure reactor tank and inner part of reactor after an accident with core melting and prevent this way the container integrity loss. It is positioned in the reactor shaft under the pressure vessel. Its function is to protect the reactor shaft against heat and mechanical influences of the core melt, to dilute of melt by a material which is specially designated for this purpose with a goal to reduce the specific heat development from the unit of volume, to provide the heat removal from the melt into the cooling water and to provide the below-critical level of the melt. The melt can be maintained and cooled for an unlimited period.

Figure A.II.19: Overall cross-section view of unit MIR-1200



1	Containment building	**8**	Reactor
2	Turbine hall	**9**	Steam generator
3	Water treatment plant	**10**	Main circulation pump
4	Controlling systems building	**11**	Pressurizer
5	Auxiliary operations building	**12**	Hydroaccumulators
6	Ventilation stack	**13**	Passive heat removal tanks
7	Safety systems buildings	**14**	Turbogenerator

Main objects of the project MIR-1200 are a reactor building, containment, turbine hall intermediate building, safety systems building, active auxiliary operations building I and II, controlling systems building, diesel-generator station, fuel management building and turbine hall. The double containment and reactor room are placed on the common foundation plate and they are increasingly resistant to seismic events. Other objects of the nuclear island are constructionally designed on the separated foundation plates and this is the reason why the project differs from the rest reference projects.

Project EPR

It is a project of the company AREVA NP, France. Thermal output of one unit is ca. 4616 MW_t, net electrical capacity is ca.1660 MW_e.

An EPR reactor is a development type of the pressurized water reactor (PWR) designed by the company AREVA NP. The EPR project is based on the use of a combination of the design and operating experience of AREVA NP which is composed of the former companies Framatome and Kraftwerk Union (KWU, Siemens). The EPR reactor meets safety requirements of the French Nuclear Regulatory Authority approved in 2000 with the participation of German experts and known as “Technical instructions for projecting and construction of a new generation nuclear power plants with pressurized water reactors” (Directives techniques pour la conception et la construction de la prochaine génération de réacteurs nucléaires, 2000).

The EPR project can be characterized as an advanced reactor with increased safety and better economic indicators, with particular focus on the active safety systems and with higher redundancy. Project innovations are oriented in two ways: improvement of economic characteristics and increasing of power plant safety. The most important safety innovations are the core melting preventive measures and measures focused on the moderation of consequences, increased resistance to external risks, in particular against a crash of a military aircraft or a large transport plane, and higher level of redundancy in the active safety systems. Each of four divisions of the safety systems is protected against the spreading of internal risks (e.g. fire, high pressure piping break, floods) from one division to the other one. This requirement results in positioning of each division in a certain area and in an independent building, which is separated from the rest of the divisions.

The arrangement of the reactor cooling system consists of four conventional loops. A pressurizer is connected to one hot leg via connecting piping and to two cold legs via injection piping. The volume rate of the reactor pressure vessel, pressurizer

and steam generators to the size of reactor core is higher what inherently extends the time of heat removal from core in case of breakdowns of cooling from the secondary circuit.

EPR containment is made as a double. The primary containment consists of a cylinder with cupola made of prestressed reinforced concrete. The inner surface is covered with airtight steel padding (cylinder, cupola and inner surface of the foundation plate). The secondary containment is a cylindrical reinforced concrete construction with a cupola. It protects the construction of the primary circuit against the external risks and is made to resist the consequences of an impact of military aircraft or a large transport plane.

Subatmospheric pressure is maintained in the interspace between both containments in order to catch the leakage through the construction of the internal containment.

An independent cooling system with two cooling legs is intended for a long time heat removal from the containment, cooling of cooling water storage tank in the containment and cooling of the melt core catcher in case of severe accidents. This system is absolutely independent from four divisions of the cooling system specified for management of design based accidents.

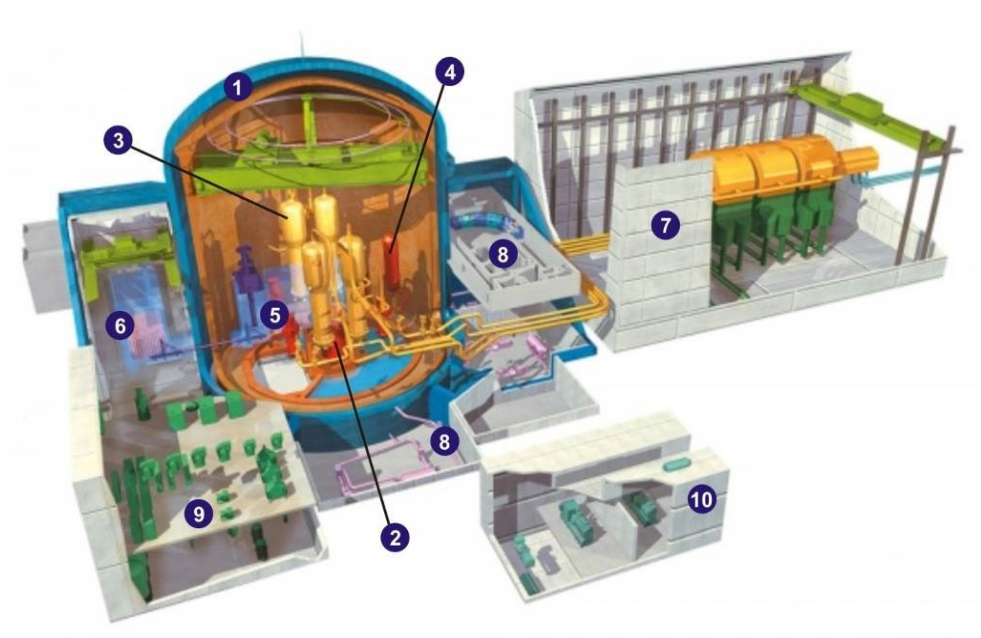
The most important safety innovation is preventive measures against core melt and moderation measures of the potential consequences, higher resistance to external risks, in particular to a crash of a military aircraft and higher level of redundancy in the active safety systems. The emergency injection system for the primary circuit is designed as 4-redundant while each and every redundant division is able to individually manage all safety functions. Moreover, each redundant division of the emergency injection system for the primary circuit consists of one middle-pressure emergency injection pump, one hydroaccumulator and one low-pressure emergency injection pump. The suction of the pumps is from the cooling water storage tank in the containment, which is located in the lower part of the reactor building. Its function is to collect a large amount of boric acid solution with homogenous concentration and temperature suitable for filling up of the refuelling pool, it is also a safety source of water in case of emergency injection of the primary circuit in case of a LOCA and it is a source of water for cooling of the containment and core melt in case of a severe accident.

In order to rule out a risk of hydrogen accumulation in case of a LOCA or in case of severe accidents, a flammable gas control system in the containment is available, which consists of two subsystems:

- Mixing of atmosphere of the containment by means of passively functioning membranes and mixing valves;
- Hydrogen reduction system using passive autocatalytic recombiners.

EPR project deals also with a possibility of an accident with the core melting connected with reactor pressure vessel meltdown. EPR reactor is equipped with a special system for detection of melted core which detects the melted parts of the core and of the reactor pressure vessel. The principle of system function lies in the core melt spilling within a large area and its stabilization by means of cooling from above and below by water from the cooling water storage tank in the containment. When spilt, the ration between the surface and melt volume increases and this causes fast and effective cooling and reduces subsequent radionuclides release into the containment atmosphere.

Figure A.II.20: Overall cross-section view of unit EPR



1	Containment building	**6**	Storage pool for VJP
2	Reactor	**7**	Turbine hall
3	Steam generators	**8**	Safety systems building
4	Pressurizer	**9**	Auxiliary operations building
5	Main circulation pump	**10**	Diesel generators

EPR nuclear island consists of a reactor building, double skin containment, four safety systems buildings and fuel management building which are all located on the common foundation plate. The location of the nuclear island on the common foundation plate can secure that in case of a plane crash or seismic activity the individual construction objects of the nuclear island will not tilt to each other. The auxiliary operations building, two emergency diesel generators building, radioactive waste management building and two feeding objects and essential service water pumps are located on the independent foundation plates as well as two buildings of coolers of essential service water. Turbine hall is constructionally independent from the nuclear island.

Project ATMEA1

It is a project of a joint venture of the companies AREVA NP/Mitsubishi Heavy Industries, France/Japan. Thermal output of one unit is ca. 3150 MW_t, net electrical capacity is ca. 1125 MW_e.

ATMEA1 represents an evolutionary project of a pressurized water reactor with the reference projects of the newest power plants of the company AREVA and Mitsubishi Heavy Industries from which the majority of components and systems used in ATMEA1 were derived.

ATMEA1 is a reactor with a basic set of common project characteristics which are adaptable to specific commercial requirements and requirements of supervisory bodies of each country involved. An important developmental goal was also to provide the electricity production competitiveness in comparison with alternative energy sources.

The cooling system of ATMEA1 reactor consists of three primary cooling loops, each of them with a reactor cooling pump, steam generator, hot led piping and cold leg piping. A pressurizer is connected to the hot leg of one loop of the reactor cooling system.

The containment is composed of a simple containment building made of prestressed concrete the lower cylinder-shaped part of which is surrounded by interspace and by the outer wall made of reinforced concrete. The containment inside is covered with a steel padding which comes out of the foundation plate.

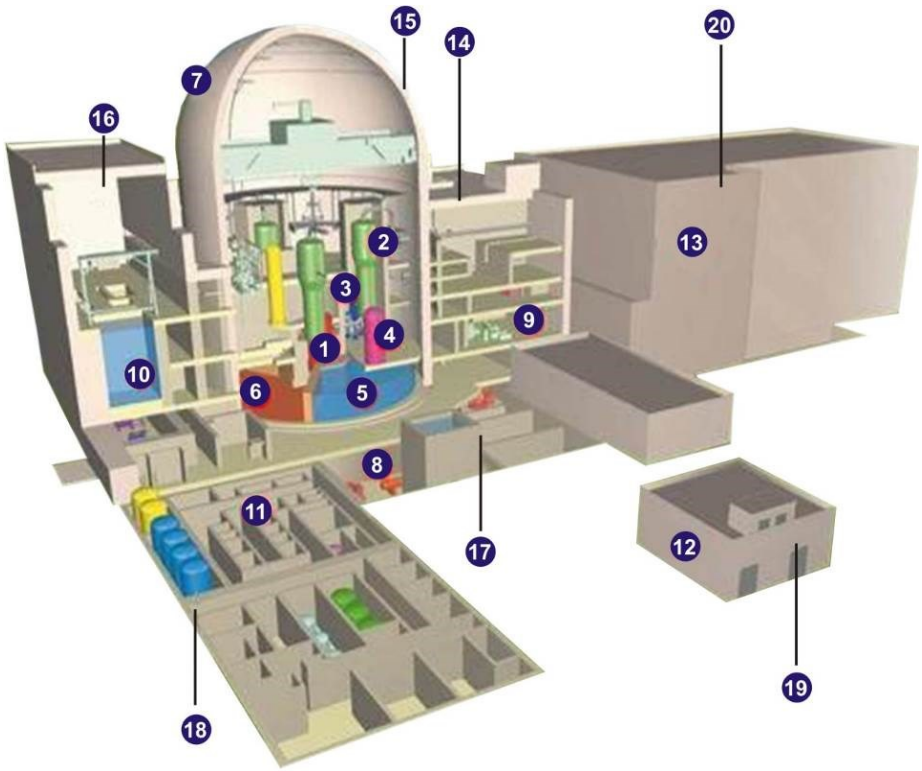
The ATMEA project uses a combination of passive and active safety systems for reduction of consequences of an accident with preference given to the active systems. The passive functions are used only in a case of the verified devices of pressurized water reactors (e.g. use of hydroaccumulators for emergency reactor core cooling). The active safety systems consist of three identical, independent, fully redundant divisions of the emergency injection into the primary circuit. Each division includes a middle-pressure pump of the emergency injection and an improved hydrogen pressured hydroaccumulator. Each division has its own suction connected to the water storage tank placed in the containment and the displacement is connected to the cold leg of the circulation loop. The middle-pressure pumps of the emergency injection are located in the safety systems building. ATMEA1 project includes 100% stand-by division allowing the maintenance of one of three basic divisions in the course of the unit power operation and also allowing the diversity of the project solution of the safety systems.

The improved hydroaccumulator is a passive component of the emergency cooling system. It secures the coolant injection into the cold legs of the circulation loops when the primary circuit pressure decreases under the gas pressure in the hydroaccumulator without a need for a safety signal or operator´s intervention. The hydroaccumulators are located inside the reactor building.

In order to prevent the severe damage of the core or to reduce the impacts of high-pressure core melting of the reactor a reliable depressurization system of the primary circuit.

The passive autocatalytic recombiners are used to maintain the hydrogen concentration in the containment area below the explosive concentration in case of large leakage from the primary circuit or in case of a sever accident

Figure A.II.21: Overall cross-section view of unit ATMEA1



1	Reactor	**11**	Auxiliary operations system and waste storage
2	Steam generators	**12**	Emergency electric generators
3	Main circulation pumps	**13**	Turbogenerator
4	Advanced hydroaccumulators	**14**	Safety systems building
5	Coolant container in the containment	**15**	Reactor building
6	Melt catcher	**16**	Fuel handling building
7	Containment	**17**	Safety systems building
8	Safety systems	**18**	Auxiliary operations building
9	Unit control room	**19**	Emergency power supply building
10	Spent fuel pool	**20**	Turbine hall and engine room

The core melt stabilization system is designed to prevent the containment integrity loss caused by the foundation plate meltdown in case of a severe accident. There is a space (a so-called melt catcher) in the lower part of the containment which is supposed to catch the core melt and to transform it into a coolable configuration, which can be stabilized in the long term. The melt catcher is similar to the one in the EPR project.

A spraying system is used for a long-term heat removal from the containment. Its function is to reduce the pressure and temperature in the containment to an acceptable level in case of an accident with the coolant loss, the long-term cooling of the containment after a coolant loss accident, cooling of the water storage tank in the containment in case of a coolant loss accident and at the same time it represents a reserve in case of the overall breakdown of the middle-pressure emergency injection pumps of the primary circuit.

The nuclear island ATMEA1 consists of:

- Reactor building, safety systems building and fuel building, which are located on the common foundation plate,
- Auxiliary operations building, two emergency power supply buildings, radioactive waste management building and entrance building, which are located on the independent foundation plates.

The reactor building is composed of containment and is located in the middle of the nuclear island. The containment is surrounded by safety systems building and fuel building. There are main components and pipings of the primary circuit, steam production systems and safety systems in the containment. The nuclear island buildings are designed to withstand the internal events as well as the external risks including earthquakes. Moreover, the containment building is designed to withstand a crash of a large transport plane. The common foundation plate of the rector building, safety systems building and fuel building secures that the building will not tilt to each other in case of a seismic activity or in case of a crash of a large transport plane.

Project APR-1400

It is a project of the company Korea Hydro&Nuclear Power (KHNP), South Korea. Thermal output of one unit is ca. 4007 MW_t, net electrical capacity is ca. 1400 MW_e.

The project APR-1400 was developed on the basis of a verified technology and experience resulting from designing, building, operation and maintenance of the reactor OPR1000 (8 of these units is in operation and 4 units are under construction in Korea) and the project 80+, which was certified by the US Nuclear Regulatory Commission in June 1997. In the course of the project development the mainly requirements of the American and Korean authorization holders were taken into consideration.

Reactor APR-1400 consists of numerous project adjustments and improvements in comparison with the previous designs of this producer. The project adjustments were realized to meet the authorization holder´s needs from the point of view of safety, operating characteristics and maintenance, improvement of economic indicators and to meet the requirements of the supervisory bodies and to meet the new permission conditions. Also the requirements to handle the conditions of a severe accident, risk connected with modes of the reactor, which is out of operation, were taken into account in the design. The main design improvements are the increased output, better use of power plant potential, longer interval between refuelling, use of modern materials and increased power plant lifetime. The project APR-1400 also increased the redundancy of safety divisions using a combination of the optimized passive and active safety systems. The coolant storage tank is located in the containment. The seismic resistance was increased in the project, as well as the thermal reserves (increase of the water volume of the steam generator), a time for an operator´s intervention was prolonged and an ability to deal with a total power cut was completed. The result is a decreased possibility of occurrence of severe accidents.

The reactor cooling system consists of two cooling loops. Each loop includes one steam generator, one hot and two cold pipeline legs and two main circulation pumps. A pressurizer is connected to the hot leg of one of the cooling loops.

The containment building is a prestressed concrete construction of a cylindrical shape with a hemispheric cupola placed on the common foundation plate with the auxiliary operations building. The cylindrical part of the construction is additionally prestressed by horizontal and vertical ropes. The inner surface is covered with hermetically tight steel padding providing water tightness. A part of the steel padding which is tight-fitting to the foundation plate is protected by a concrete layer. The prestressed concrete jacket provides a sufficient protection against the external dangers and is dimensioned to withstand a plane impact.

The innovated safety systems for mitigation of effects of the severe accidents are e.g. a large full-pressure containment made of prestressed concrete, reactor shaft flooding system and external cooling of the reactor tank flooding system, hydrogen removal system, a big reactor shaft adjusted to catch and cool the remnants of the melted core, auxiliary emergency system for spraying of the inside containment area.

The emergency injection system contains four independent divisions and a water storage tank in the containment. Each division has 100 % capacity for design based accident management. Four high-pressure pumps of the emergency injection system and four improved passive hydroaccumulators inject the coolant in case of a breakdown of the primary circuit integrity. Pumps displacement is connected directly to the reactor pressure vessel through special nozzles, which are specified for it.

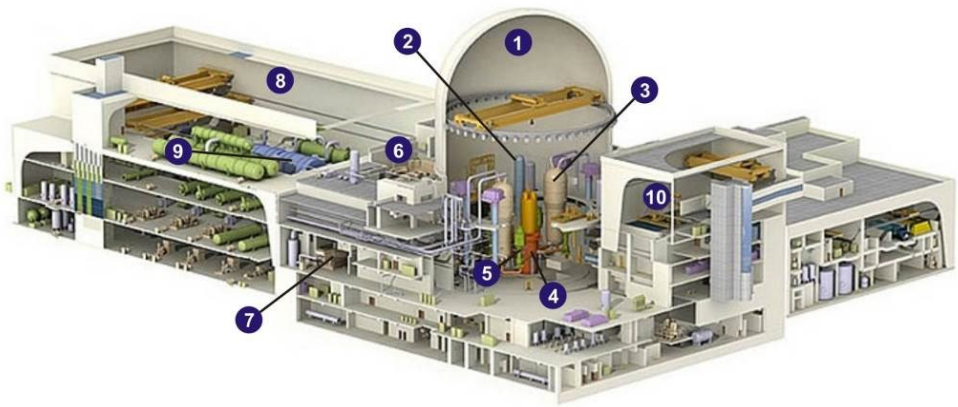
The emergency injection system in cooperation with the safety depressurization system of the primary circuit cools the core in case of an accident in the design extension conditions (DEC) in case when the steam generator for residual heat removal is not available.

The water flow is passively regulated into the primary circuit in case of a major leakage from the primary circuit, without using any action member or without the need of an operator´s intervention, by means of a special device for flow controlling/reducing, which is installed in the improved hydroaccumulators.

The APR-1400 containment spraying system is designed to maintain the pressure and temperature in the containment within the project limits also in the improbable situations with large heat leakage into the inside of the containment. The containment spraying system is composed of two 100% redundancies containing a containment spraying pump, heat exchanger, spraying collectors and fittings. The water source for the system is a water storage tank in the containment. The spraying pumps of the containment can be used as residual heat removal pumps from the reactor the other way round.

Besides the basic containment spraying system, there is also an auxiliary emergency containment spraying system available, which secures the long-term cooling by means of water supply and containment spraying, decreases the temperature and pressure in the containment during a severe accident.

Figure A.II.22: Overall cross-section view of unit APR-1400



1	Containment building	**6**	Unit control room
2	Pressurizer	**7**	Diesel generator
3	Steam generators	**8**	Turbine hall
4	Reactor	**9**	Generator
5	Main circulation pump	**10**	Spent fuel pool

The hydrogen concentration reduction system in the containment consists of passive autocatalytic recombiners and uses also hydrogen igniters. The igniters complement the recombiners in case of rather unlikely accidents with a very quick expected hydrogen release in order to prevent the explosion of hydrogen by means of controlled combustion of hydrogen and to maintain the containment compactness.

A very large internal volume of the containment APR-1400 provides a sufficient free volume for hydrogen production adjustment in case of a severe accident.

In case of an accident with core melting the project APR-1400 tries to maintain the melted core in the reactor pressure vessel by means of the vessel external cooling using the quick reactor shaft flooding with water from the containment storage tank. The version APR-1400, designed for European market, contains also a core melt catcher.

An APR-1400 project layout can be divided into a nuclear island, turbine island and other devices of the power plant. The nuclear island consists of containment, auxiliary operations building and a common object.

All the components of the reactor cooling system are located in the containment. The inner reinforced concrete containment walls protect the devices against flying fragments and they also protect them against radioactive radiation. There is also a cooling water storage tank in the containment. All floors or larger horizontal areas in the containment are located above the containment ground and are designed as individual drainage and all the water, by means of gravity flow, returns to the storage tank.

Safety systems components, e.g. emergency injection system and emergency power supply system are located in the auxiliary operations building. The auxiliary operations building is composed of a unit control room, emergency diesel generators and a separated space for fuel handling. The emergency diesel generators are spatially separated on the opposite sides of the object. The auxiliary operations building and containment as located on the common foundation plate. The containment building is designed with increased resistance to seismic activity and to a plane crash.

The common object consists of an entry check area, radioactive waste management area and active workshops. The turbine island is composed of a turbine hall and substation of station internal power consumption, which are located on the common foundation plate. There is a turbine, generator and other components forming the secondary circuit and producing electricity in the turbine hall.

A.II.8.3.2. Technological Solution

A generalized description of technological devices of the pressurized water reactor unit follows, which sufficiently covers all design basis features of the reference projects.

A.II.8.3.2.1. Primary Part

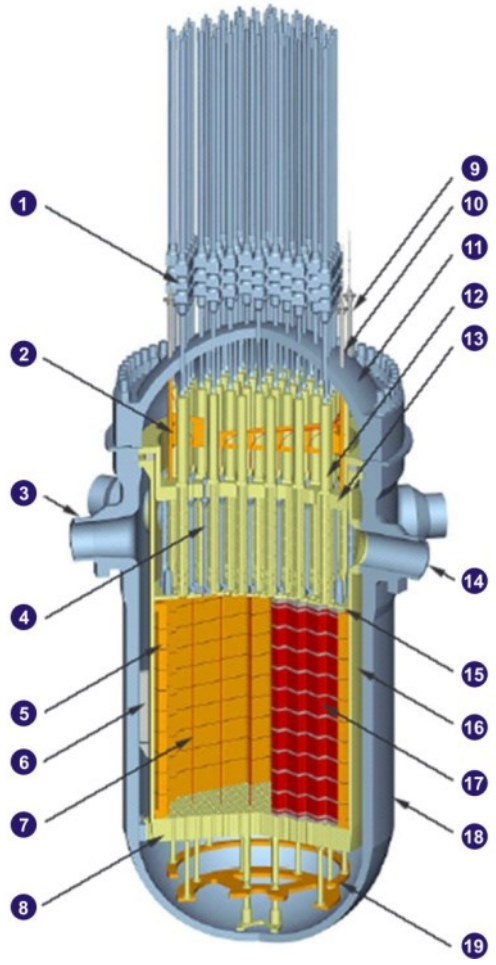
The primary part of the power plant unit consists of a primary circuit, auxiliary systems of the primary circuit, safety systems and protective enclosure system – the containment, which is at the same time a part of the construction part. The main components of the primary circuit are: a pressurized water reactor, steam generators, main circulation pumps, main circulation pipeline and pressurizer. The primary circuit transmits heat, which is generated by the reactor core, into the steam generators by means of forced water circulation under high pressure (using the main circulation pumps). This secures the core cooling and heat removal from the core into the steam generators. The primary circuit systems also control the coolant temperature in the core, coolant pressure in the primary circuit, coolant flow rate through the core, core reactivity, integrity maintenance of the pressure boundary and radioactivity trapping using a physical barrier (pressure boundary of the primary circuit).

Reactor

In the PWR power plant, it is a pressure vessel consisting of a reactor tank and reactor cover, inner built-in structures located in the reactor vessel and control elements drives located on the reactor cover and instrumentation. The main function of the reactor is to store the core (where a nuclear fission reaction is carried out) and to provide the sufficient amount of moderator (used also as coolant) necessary for maintenance of the nuclear fission reaction in the core.

Coolant enters the reactor through inlet nozzles; it circulates through a space between the vessel body and the core shaft and enters the core from the bottom. When flowing through the core, coolant is warmed up by the heat generated by the nuclear fuel fission reaction and flows out of the reactor through the outlet branches. A typical solution of the reactor assembly is depicted on the following picture.

Pict A.II.23: Typical construction design of PWR reactor, example of fuel assembly design

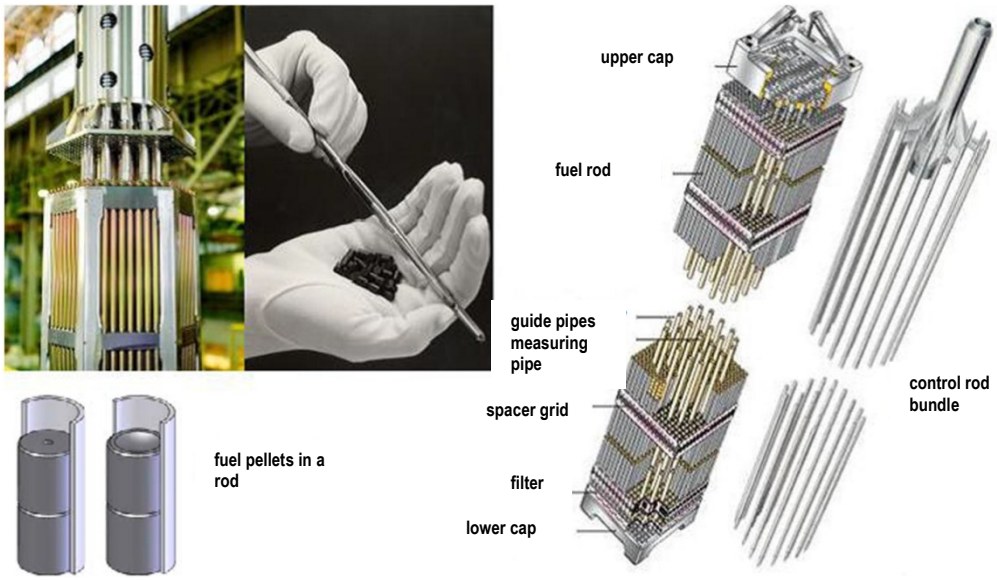


1 Regulatory bodies drives
2 A set of conducting pipes of the in-core reactor measurements
3 Inlet branch
4 Protection pipe block of the core
5 Neutron reflector
6 Place for checking samples of the reactor vessel material
7 In-core measurement pipes
8 Lower supporting core plate
9 Thermocouple nozzle
10 In-core reactor measurement nozzles
11 Reactor cover
12 Conducting pipes
13 Upper supporting core assembly
14 Outlet branch
15 Upper plate of the core
16 Core shaft
17 Fuel assembly
18 Reactor vessel
19 Anti-whirl plate

The controlled nuclear fission reaction and transfer of heat, which was produced during the reaction, to the coolant is carried out in the core. The core consists of fuel assemblies placed mostly in a square-shaped or hexagonal grid. The fuel assembly consists mainly of fuel rods, conducting pipes, distance grids and fastening heads. The fuel rods are composed of fuel pellets, which are hermetically enclosed in the pipes made of special alloy (mostly zirconium based), called cladding. The purpose of the cladding is to maintain the geometry of a fuel rod, allow the heat transfer from the fuel to the coolant and at the same time to maintain the radioactive fission products in the fuel (it forms a physical barrier against the radioactive substances leakage into the outer environment). The conducting pipes form channels for insertion of either regulatory bodies, neutron source or fuel rods with a combustible absorber. The measuring pipe is usually located in a fuel assembly in the central position and consists the channel for insertion of the internal neutron detector.

Fuel is placed and changed in the reactor by means of a fuel charging machine in time of the reactor shutdown.

Figure A.II.24: Illustration of a fuel pellet, fuel rod and fuel assembly



Reactor output is managed by a combination of changes concerning a position of assemblies of the mechanical regulation (clusters) and changes of boric acid concentration in the coolant.

Steam generator

A steam generator is a pressure vessel of a vertical or horizontal shape with a system of distribution line of feedwater and distribution line of emergency feedwater, with a system of heat-exchanging surface (composed of pipes) and with a steam system (composed of a moisture separator and steam header).

The steam generator functions in the nuclear power plant, altogether with the pressurized water reactor, as a heat exchanger between the primary and secondary circuit. The heated coolant flows into a hot steam generator collector from where it is distributed to the heat-exchanging pipe bundle. When flowing through the tube bundle, coolant releases the heat to feedwater of the secondary circuit and after the coolant is cooled down, it flows into a cold collector. Subsequently, it flows into a cold leg of a primary circuit loop and from there it flows through a main circulation pump back to the reactor. Saturated vapour, which is conducted through a moisture separator and steam collector to the turbine, is produced from feedwater on the secondary side of the steam generator

Main circulation pump

A main circulation pump is usually a vertically centrifugal single-stage pump with a shaft seal unit and an asynchronous electromotor. The main circulation pump secures a coolant circulation in the primary circuit in accordance to the heat output of the reactor in various operating modes.

Volume compensation system

A volume compensation system is composed of a pressurizer vessel in which the coolant of the primary circuit is maintained approximately on the saturation threshold and of electric heaters system and injections of the cooler primary coolant from the cool loop and functions for maintenance of the constant operating pressure and reduction of pressure deviations in the primary circuit.

Auxiliary systems of the primary circuit

Auxiliary systems of the primary circuit are composed of:

- Make up system and coolant treatment system of the primary circuit and maintenance of chemical modes,
- Radioactive waste management system (RAO),
- Cooling system and coolant treatment from the spent fuel pool system,

- Air-conditioning systems.

Primary circuit make up and discharge system and coolant chemical mode treatment system are necessary for a long-term controlling of the nuclear fission reaction and maintaining of coolant cleanness. This system uses the discharging or injecting of primary circuit coolant to maintain the necessary coolant balance in all operating modes of the unit, it regulates the boric acid concentration in the coolant, eliminates fission and activation products from the coolant and secures the injection of chemicals to the coolant for the purpose of controlling of the chemical modes (coolant pH, coolant degasification). Regulation of the boric acid concentration in the coolant allows regulation of the inventory of the reactor reactivity what is necessary for a long-term controlling of the fission chain reaction.

RAO management system secures the management of radioactive waste in a gas, liquid or solid form. Major part of the coolant and a part of chemicals is reused after the treatment in the primary circuit. Further information on the RAO management within the NJZ can be found in the chapter A.II.8.3.4.2. Radioactive waste management (page 95 of the Report).

Spent fuel storage pool cooling system secures the heat removal from the spent fuel during its storage in a spent fuel pool (for a period necessary for reduction of the residual power to the level allowing the storage outside the reactor unit in a special warehouse) during the refuelling and also in a case of extraction of the entire core from the reactor. Moreover, the system maintains the sufficient level for a manipulator shielding against the radioactive radiation from the fuel. The cleaning system secures the sufficient quality of cooling water and consists of lines of ion exchangers.

The air-conditioning systems secure the environment parameters which create conditions necessary for the operating personnel and for the correct function of technological device during the operational states and emergency situations.

Safety systems

Safety systems of the primary circuit are composed of the following main systems:

- system of rapid reactor shut-down (scram system),
- Emergency core cooling system,
- Emergency power supply system,
- Residual heat removal system,
- Pressure system of protection of the primary circuit and safety depressurization system,
- System of heat removal from the containment and system of the pressure reduction in the containment,
- System of the combustion of hydrogen in the containment,
- Essential service water system (TVD)
- Safety systems intermediate cooling circuit system,
- Steam generators emergency power supply system,
- Melt stabilization system in case of a severe accident.

The reliability of the mentioned systems has to meet the maximum requirements in the projects of nuclear power plants.

The scram system is able to interrupt the fission chain reaction very quickly. The reactor is equipped with a safety system of protection, which is composed of absorption rods and relevant controlling circuits. The scram system is activated automatically in case of an inadmissible exceeding of the permitted parameters of the operation. The system can be put in commission also by an operator by pushing the relevant button in the emergency or unit control room. Since the absorption rods are maintained, when in operation, by means of electrodrives in the upper positions, in case of a scram they passively (free fall) fall to the core and in a few seconds stop the fission chain reaction.

The emergency cooling system cools the core in case of a breakdown of heat removal from the primary circuit and it also secure the sufficient amount of the coolant for the core cooling in case of accidents with the cooling medium leakage from the primary circuit. The system uses multiply redundant passive systems (hydroaccumulators) and/or active systems (emergency pumps and vessels) and secures the injection of the cooling water and boric acid solution to the reactor core.

The emergency power supply system is composed of diesel generators or combustion turbines and electric batteries. The system powers the safety systems and important controlling systems in case of a cut off of the working and auxiliary power supply.

The residual heat removal system removes heat emerging from the shut down reactor as a result of the continuing radioactive conversions of fission products present in the fuel and it helps to cool the reactor down under normal operational conditions, under abnormal conditions and under accident conditions while the tightness of the primary circuit remains intact.

The pressure protections system of the primary circuit and safety depressurization system reduce the pressure increase in the primary circuit and prevents the pressure increase above the design pressure limits. The system also enables the controlled pressure decrease in the primary circuit, which is necessary for a correct function of the emergency core cooling system in case of accidents when the pressure in the primary circuit does not spontaneously decrease and the function of the emergency cooling is necessary.

The residual heat removal system from the containment and pressure decrease in the containment reduce the pressure and temperature increase in the containment by means of steam condensation in case of the integrity loss of the primary or secondary system in the containment. The system is usually composed of a combination of active and passive systems of spraying of the containment area. The heat from the containment is conducted to the essential service water system or to the reactor environment through the outer passive cooling of the containment walls.

The hydrogen combustion system in the containment reduces the increase of hydrogen concentration in the containment above a secure level. Hydrogen can be discharged into the atmosphere from the reactor shell primarily in emergency conditions connected with fuel element cladding overheating as a result of a reaction of steam with zirconium fuel element cladding. The system is composed of passive catalytic recombiners and/or hydrogen igniters.

The essential service water system (TVD) removes the residual heat from all important unit systems for which a long-term cooling shutdown is not allowed and from the residual heat removal system. In case of emergency situation it removes heat also from active systems of emergency core cooling. Heat is removed from the system into the end heat catcher – mostly special forced draft cooling towers or TVD pools with sprinklers.

The intermediate circuit system for cooling of safety systems is an enclosed cooling system which provides the heat removal from the safety system components, mainly pumps, to the TVD system. The intermediate circuit system for cooling the safety systems forms an additional protective barrier against the penetration of radioactive substances from the primary circuit coolant to the TVD system.

The steam generators emergency feed water supply system secures the water supply for steam generators in case of the lapse of the main and auxiliary steam generator feed water supply systems. It removes the heat from the primary to the secondary circuit in case of accidents without the coolant loss from the primary circuit.

The melt stabilization system in case of a severe accident catches the core melt inside the reactor pressure vessel or catcher the melt outside the pressure vessel so that the containment integrity is not broken. The system solution is based on the outside cooling of the pressure vessel or on the melt cooling outside of the pressure vessel in special containment area which is adapted to intense heat removal from the melt.

Protective enclosure system

Containment (protective enclosure) in the units of the generation III+ consists usually of the internal hermeneutic and external strength protective enclosure. The internal hermeneutic enclosure is composed of the construction itself and hermetization joints (passages, penetrations, closing elements) and there are controlling systems for temperature and pressure of the hermetic enclosure in the inside area (e.g. passive heat removal, spraying, combustion of hydrogen and the like). The inside hermetic enclosure is designed to reduce the leakage of radionuclides into the environment in case of emergency situation (including severe accidents) to minimize the radioactive impacts on the surrounding. The internal (primary) containment is, from the construction point of view, composed of prestressed concrete cylinder with a cupola (alternatively with a steel shell).

The construction of the external protective enclosure is designed in such a way that the reactor vessel, primary circuit and all related devices which are important from the nuclear and radiation point of view located in the containment are protected against the external events (explosion, fire, plane crash, extreme meteorological conditions and the like) the occurrence of which cannot be ruled out with a sufficient degree of probability. The role of both enclosures is in some projects joined into one, or more particularly, the internal enclosure is realized only in the section of hermetization joints. If the design of the containment is only with one enclose, it fulfils all the functions at the same time. Then it is again the prestressed concrete cylinder with a cupola. The lower part of the containment is in this case usually surrounded by aired interspace.

The protective enclosure (containment) system also fulfils a function of biological shielding.

A.II.8.3.2.2. Secondary Part and External Operations

The secondary part consists of a secondary circuit, auxiliary systems of the secondary circuit and tertiary cooling circuit. The external operations (auxiliary systems) secure supporting functions for the primary and secondary circuit.

Secondary circuit

A basic function of the secondary circuit is steam supply and steam energy transformation into mechanical energy of the rotor steam turbine and its subsequent transformation into electric power in the generator. A steam and energy conversion system device is located in the turbine hall building. The secondary circuit consists of the following main systems:

- Main steam supply system
- Turbogenerator (turbine and generator on the common shaft)
- Condensation and vacuum system
- Main supply system for steam generators

The steam supply system (steam piping from the individual steam generators and the main steam collector connected to the steam piping) supplies steam from steam generators to the high-pressure turbine part in the extent corresponding to the flow rates and pressure which is included in the all operating modes (from system preheating to maximum power operation). The steam supply system includes main steam piping, fast active isolation valves, safety valves and linked steam piping and distribution. The main steam piping are designed and routed in such a way to provide the even steam pressure on the turbine inlets. The system also includes intake piping steam lines to the safety valves of steam generators, discharge stations to atmosphere and discharge stations to condenser. Safety valves and discharge stations conduct a part of the entire steam output outside the turbine in case when it is necessary to decrease the pressure in steam piping or in case of a turbine breakdown.

A turbogenerator transforms steam heat energy to electric energy. A steam turbine is a condensation, of tandem arrangement with a moisture separator and with a reheater behind the high-pressure part. The generator is directly connected to the turbine shaft. Oil management for the turbine and generator is located in the turbine hall; devices are secured against oil leakage from the system.

The condensation and vacuum system condenses and deaerates the steam after it has passed its energy to the turbogenerator. Condensation heat is taken away from steam through water of the tertiary cooling circuit on the heat-exchange area of the condenser. The produced condensate is subsequently heated up in the low-pressure heaters system and by means of the main supply system for steam generators and is available for steam generators supply and repeated steam production.

The purpose of the main supply system for steam generators is feedwater supply to the steam generators with relevant parameters. The feed cabinet includes the main feed pumps and auxiliary feed pumps and subsequent pipeline systems and valves. The regulative feed stations are installed on the feedwater pipelines to the steam generators and the stations can, in cooperation with a feed pump, maintain the necessary level of feedwater in the steam generator.

Auxiliary systems of the secondary circuit

The auxiliary systems of the secondary circuit are:

- PG blowdown system,
- Condensate Cleanup System (BÚK), if used
- Condensate storage system including chemicals dosing to the secondary circuit,
- Intermediate cooling circuits in the turbine hall,
- Inessential service water system (TVN), if used
- Air-conditioning systems.

The intermediate cooling circuits in the turbine hall conducts heat from the selected pumps and from other devices located in the turbine hall and they pass the heat to the inessential service water circuit or directly to the tertiary cooling circuit.

The inessential service water system (TVN), if used, cools the appliances of the secondary circuit, emergency power sources which are not important from the nuclear safety point of view and of the intermediate cooling circuit.

The air-conditioning systems maintain the environment parameters which create the conditions necessary for operating personnel and for the correct function of a technological device in the area where the devices of the secondary circuit are located during operational states and emergency events.

Tertiary cooling circuit

The tertiary circuit system includes a cooling water pumping station, pipeline connection with the turbine hall, heat-exchanging pipes of turbine condensate, pipeline connection with the cooling tower, the cooling tower itself, intake duct of the cooled down water from the cooling tower to the pumping station and other. The cooling water circuit is an enclosed recirculation system with a function of injection of the circuit losses from the cooling water treatment plant. The system removes heat from the condensation turbine system to the surrounding atmosphere by means of a cooling tower.

A natural draft cooling tower of Iterson type, height ca. 180 m, is used to remove the heat to the atmosphere. The tower represents a standard design solution of all suppliers of the reference reactor types[10]. The tower is equipped with warmed water distribution piping, spraying nozzles, cooling system made of plastic blocks and effective eliminators which reduce the drift of water drops into the atmosphere.

External operations (auxiliary systems)

The joint external operations secure the supply of water and other operating media and handling them. They include a reservoir, a cooling water treatment plant (ÚCHV), chemical water treatment plant (CHÚV – demineralization line), industrial nonradioactive waste water and sludge treatment system including oiled-up water treatment plants and waste water treatment plant (ČOV). Systems for monitored waste water discharge including a monitoring tank and pipelines are a part of the external operations. The auxiliary systems also include chemicals, technical gases, lubricants and fuels store, pressured air and cooled water production or other operating media.

The NJZ area will include internal water reservoir which will supply water for a long-term residual heat removal (for 30 days and more)

The water treatment system will be adjusted to the quality raw water pumped from the Váh River and will include a combination of mechanical and chemical procedures. The cooling water treatment is supposed to rid the raw water of undesirable dirt and impurities in the first step of mechanical procedures (fine screen, filtration) and in the second step by means of chemical procedures (rippling, disinfection, decarbonization, softening). The treated cooling water supplies the cooling circuit and supplies the production of demineralized water. The chemical water treatment system is specified for the preparation and storage of demineralized water (demi water) which functions as an excessive feedwater of the primary circuit, secondary circuit and intermediate circuits.

The waste water treatment plant will be, as for capacity, designed for an operation of the NJZ including shutdowns when a usual number of employees will be increased by ca. 1000 persons.

A.II.8.3.2.3. Electrotechnical Systems

An electric scheme consists of sources and distribution systems which are according to their function divided in the following way:

[10] An alternative solution would be represented by 2 cooling towers ca. 164 m high per a unit. It followed from the environmental impacts comparison that the impact of one 180 m high tower or two 164 m high towers is basically the same in the majority of assessment aspects (impact on the landscape, water consumption, amount of discharged water, recipient warming, local climatic conditions). As for the noise load, permanent soil occupation, permanent shielding from the siding of the cooling towers in the near surroundings of the NJZ and construction the impacts of two towers can be more distinct in comparison with one tower. Due to this fact it was recommended when preparing the assessment study for the project of the NJZ to prepare the project of the NJZ with one cooling tower per a unit.

Hybrid towers could represent alternative solutions. These towers partly reduce the cooling water requirements but significantly increase the energy requirements and reduce the efficiency of the heat cycle. They are not considered to be a recommended (BAT) technology in power engineering if there are no specific reasons to use them (e.g. critical lack of cooling water) what is not the case of the locality Bohunice.

Power outlet

The power outlet from a power plant generator is designed through a main transformer and the external overhead line in the voltage level 400 kV. The output of the NJZ will be led to the new electric distribution station Jaslovské Bohunice which will be built as a part of the Slovak Electricity Transmission System (not as a part of the NJZ). The new electric station Jaslovské Bohunice will secure the sufficient reliability of electrical power outlet as well as the sufficient short-circuit endurance for a stand-by power supply for station internal power consumption of the NJZ.

The electric station Jaslovské Bohunice will be connected to the electric grid by means of six 400 kV lines (five of them already existing, the existing lines of which will be locally adjusted to connect them to the new electric station, and one new, build line located in an already existing 220kV line corridor of the electric power outlet from JE V1 to the Križovany station):

- Electric station Križovany (4 lines 400 kV),
- Electric station Bošáca (1 line 400 kV),
- Electric station Sokolnice, Czech Republic (1 line 400 kV).

These lines are/will be a part of the Slovak Electricity Transmission System (not a part of the NJZ).

Operating power supply of internal power consumption

The operating power supply of internal power consumption of the NJZ will be provided by means of step-down control transformers of internal power consumption.

In case of a power failure or non-functionality of the operating power supply of the internal power consumption the necessary part will be powered from auxiliary power supplies (auxiliary supply of the internal power consumption).

Auxiliary power supply of the internal power consumption

A massive solution which secures high reliability and operating flexibility is designed to sustain the auxiliary power supply of the station internal power consumption. It will be able to connect the auxiliary power supply of the NJZ from the main and stand-by power supply of the auxiliary power supply of the internal power consumption. The switching between the operating and auxiliary power supply will be controlled by an automatic system.

The main power supply of the auxiliary power supply of the internal consumption will be in a normal operating mode ready to supply (or will be directly supplying) the relevant load of the station internal consumption. In case of an inspection condition of the main power supply or in case of a power supply breakdown the internal power supply will be switched to the auxiliary power supply. The transformation 400/110 kV on the auxiliary control transformer in the new nuclear electric station Jaslovské Bohunice is considered to be the main source of the auxiliary power supply of the internal power consumption of the NJZ. The voltage will be led to the NJZ by means of simple overhead 110 kV lines.

The stand-by source of the auxiliary power supply will be available in case of a breakdown or in case of a planned shutdown of the main source of the auxiliary power supply and will have the sufficient output to supply the unit. A substation Rz 110 kV of the JE V1 will be used as the stand-by source of the internal power supply consumption and it will be connected with the NJZ by means of an overhead line or by means of underground cable lines, 110 kV. The substation Rz 110 kV of the JE V1 is connected to the electric grid by means of several 110 kV lines what increases its flexibility and resistance to the external breakdowns.

Emergency power supply systems for the systems important from the nuclear safety point of view

Multiple emergency power supply systems will be a part of the unit, they will be usually autonomous diesel generators (or combustion turbines) and batteries installed in several independent and mutually separated redundancies.

Alternative power supply systems

The alternative power supply systems are necessary to manage and reduce the consequences of events included in the design extension conditions (DEC) including severe accidents. It is usually provided by separated diesel generators and batteries, with a long-term autonomous operating time, and related electric distribution devices.

Construction site power supply

For power supply of the main construction site a 110kV connection composed of two lines of the existing 110kV lines of the electric grid will be set up. The power supply of the equipment on the construction site can be also provided at the level of 22kV.

A.II.8.3.2.4. Instrumentation and Control Systems

A modern system based on the digital technology will be used for the instrumentation and control system. The system will take into account the newest protection and safety elements which will be able to assess a possible emergency situation and they will be able without the intervention of the personnel to scram the reactor and ensure the core cooling.

Information and control systems will be equipped with devices so that they will be able to monitor, measure, register and control the operating parameters important for the nuclear safety during normal and abnormal operation and in case of emergency situations. The system will be resistant to potential breakdowns and they will be able to provide the safety and operability of the power plant with a sufficient reliability and quality.

The systems will use a high degree of automation. The staff of the unit control room (operators) will be absolutely informed about the condition of the power plant and can intervene in the control process anytime except for the automatic safety functions.

The reactor units will be equipped with protection safety systems which will be:

- Able to recognize abnormal conditions and automatically start the relevant systems in order to ensure that the design limits are not exceeded.
- Able to recognize emergency situations and start the relevant systems designated to reduce the consequences.
- Able to provide the superior activities of the control systems and operation of the nuclear facility in all design basis conditions of the nuclear facility and an operator will be able to put the system of protection into operation manually.

The protection safety systems will be separated from other control systems so that a breakdown of the control systems would not affect the functionality of the protection safety systems. The protection safety systems will be designed with high functional reliability, back-up and independency of the individual channels (trains) so that no simply breakdown would case the loss of a protection function of the system. To reduce the influence of a breakdown resulting from a common cause, a diversity (variedness) both functional (recognition of states of abnormal operation and emergency states using various parameters characterizing the same event) and the instrumental (constructional) will be applied.

The control and information systems will continuously and at regular intervals, or as needed, record the values of the unit parameters, which are as for the safety analysis necessary for the nuclear safety, as well as the parameters important for the needs of operation control and reverse evaluation of the power plant condition.

Man – machine interface

A modern man-machine interface will be used to control the operation of new facilities, the interface allows the operator of the power plant react in time and correctly to all states of the nuclear facility and power plant systems. Information ordered in an appropriate way will be available for the personnel to support the immediate overview of the entire unit for safe and effective control. The operating information and signalization of an emerged operational occurrence in the course of an abnormal operation or in the course of the emergency conditions will be organized to minimize the load for the operator. The power plant project will secure that in case of emergency situations the operator´s intervention will not be necessary sooner that in the 30th minute. Any operator´s intervention which is required by the project and is necessary sooner than in the 30th minute from the emergence of a situation has to be properly justified. A sufficient number of means, redundant and diverse ones in an appropriate way, for controlling directly in the unit control room and in the emergency control room, will be available for the operator.

Control and service workplaces

The power plant will be in all situations monitored and controlled by operators from the unit control room. The unit control room will be equipped with technology which is based on the computer systems. The process management will be carried out by means of monitors and important parameters will be displayed on conventional panels. Independent safety panels

with conventional elements will be used for the safety systems. As a precaution of the computer systems failure the important monitoring and control functions will be backed up on the panels which will be equipped with conventional elements. The operators of the unit control room will always have available all the necessary data, they will be always fully informed about the power plant condition and they will always have available the means for putting and maintaining the power plant in safe state.

If it is not possible to control the power plant from the unit control room the power plant will be equipped with a backup centre (emergency control room). The emergency control room is physically, functionally and electrically separated from the unit control room. Its equipment allows an emergency reactor scram (and maintaining the reactor in the shut down state), the residual heat removal from the reactor, monitoring of the main nuclear unit parameters and checking the performance of the basic safety functions. The equipment of the emergency control room is, as for the functions performed from the emergency control room and its technical equipment (as far as the ergonomics of MMI), identical or very close to the equipment in the unit control room.

To support an operator in case of an emergency situation also a technical support centre will be established. This centre will be physically fully separated from the unit control room and emergency control room and it will be equipped to communicate with the unit and emergency control room in order to monitor the basic parameters of the unit and the performance of the safety functions.

The NJZ will also be equipped with an emergency control centre the purpose of which is to control and coordinate the activities in emergency situations. The emergency control centre will be equipped with an information system which will provide all the important information about the state of the NJZ and about the main parameters regarding a possibility to control effectively and coordinate the activities in case of an emergency situation. The centre will be equipped with secured means for communication with the control workplaces in the NJZ, with nuclear regulatory body, rescue bodies, state authorities, local administration bodies and other subjects which are a part of the emergency conditions management system. The centre will be designed to resist the consequences emerging from the emergency situations and external influences which could cause the emergency situations.

A.II.8.3.2.5. Principles of Fire Prevention

A standard fire protection goal is to ensure the protection of life and health of natural persons, of property and environment against fire. Conditions of a nuclear power plant, moreover, require that the fire protection ensures that in case of a fire no radioactivity will leak into the environment and that even in case of a fire it will be possible to scram the reactor from any position within the area of the nuclear facility.

The fire protection of the NJZ uses a concept of defence in depth and it has three goals:

- To minimize the possibility of occurrence of fire or explosion;
- To find, check and quench fire, which can occur;
- To ensure that any degree of fire does not obstruct the performance of functions which are necessary for a safe shut down of the reactor and do not considerably increase the risk of leakage of radioactive substances into the environment.

The NJZ will be designed to:

- prevent the initiation of fire by a monitored, separated and restricted amount of flammable substances and sources of ignition;
- isolate the flammable materials and restrict the spread of fire by dividing the power plant building into fire sections separated by fire protection barriers and fire zones which can significantly restrict the impact of fire;
- separate the redundant components of safety shutdown and the affiliated electric sections by fire protection barriers in order to maintain the safety functions after the fire;
- prevent the spreading of smoke, hot gases or substances for suppression of fire from one area into the other one in the amount that could have negative impact on the abilities of the scram function including operators´ activities;
- secure that failure or unintended operation of the fire protection system cannot limit the performance of the safety functions of a device or will not have a negative impact on the operation of safety devices which are always supposed to be in running order;

- take into consideration the current occurrence of fire with a simple failure of the fire protection system and with permitted maintenance of the fire protection system during the operation;
- minimize the radioactivity leakage into the environment as a result of fire.

Criteria for a fire protection design of the NJZ

A fire can be a direct trigger event in the NJZ or it can occur as a result of a previous event which is already in progress in the NJZ. It is supposed that fire can take all the devices located in the source area of the fire out of operation. Fire resistance of each potential source fire zone is designed to prevent the spread of fire to the adjacent areas. It must be assumed that fire can occur in any area of the NJZ and it can take any system of the NJZ out of operation (normal operating system, safety system, including the fire protection system). Fire can develop independently from the trigger event. If a device is taken out of operation due to fire within the struck area it is considered to be the only failure regarding the trigger event.

Fire protection in the NJZ will be based on a combination of passive and active protection.

The passive protection is represented mainly by the following characteristics of the NJZ project:

- use of electrical cables which do not spread fire;
- prevention of the spread of fire from an object to the other object by sufficient distances;
- technical and constructional solutions secure that the objects (buildings) of the NJZ are from the fire protection point of view divided into fire sections mutually separated by fire separating constructions with required fire resistance; the division of the objects into fire sections is based on the analysis of fire risk and on the analysis of placement of the most important safety elements with regard to their redundancy; premises where fire can endanger nuclear and radiation safety are defined as independent fire sections and also as dangerous premises as for the fire;
- fire protection of a fire section is designed as a united system, it also includes several technical solutions focused on the fire prevention and limitation of the spread of fire;
- supporting and outside walls along the border of the fore sections have a certain degree of fire resistance depending on the fire load value; a minimum degree of fire resistance of a fire section is 90 minutes;
- doors, gates on the communications as well as technology crossings (cables, pipelines) through the fire division constructions of a fire section are designed with fire resistance which cannot be lower that the ire resistance of the relevant fire division constructions;
- more than one safety system cannot be located in one fire section;
- technical solutions which are supposed to divide the electrical supply systems into the individual fire sections and measures which are supposed to prevent the connection and crossing of the individual electrical supply systems in one fire section;
- fireproof force and pilot cables and cable lines with functional integrity which do not spread fire are used to supply the fire safety devices and other devices which have to be functional in case of fire;
- the unit and emergency control room are located and designed in such a way that it is not possible that in case of fire both of them will be shut down or broken down;
- oil management is always located in separated area with necessary fire resistance of the outside fire constructions.

The active elements of fire protections applied in the project solution of the NJZ will be particularly:

- electric fire alarm;
- stable firefighting system;
- internal and external fire water distribution lines.

The active fire protection elements are supposed to identify a fire early enough and eliminate it, or more precisely, localize it until the fire brigade arrives.

- all fire risk areas inside the operation objects will be protected by an electric fire alarm (EPS) and depending on the results of fire analysis also with fire extinguishers;
- all areas where devices with oil contents including transformers are located will be equipped with stable firefighting system in an automatic regime;
- areas with a stable firefighting system will be equipped with a water removal system to remove the fire water from fire extinguishing;

- external and internal hydrants connected to the fire water pumping station will be placed on the external premises and inside of the NJZ objects;
- fire water supply will be available even in case of a total power supply failure;
- fire water supply will be available for a 24-hour fire extinguishing;
- emergency lighting, installation of information light panels and the like, if necessary, will be placed along the escape routes;
- monitoring system and fire protection control system will be designed as an autonomous subsystem within the production process control system and will be specified for monitoring of fire protection states, fire detection, fire alarm control and fire warning.

A fire protection project of the NJZ will include also escape routes for personnel and firefighting routes for fire brigade. The draft proposes escape routes and firefighting routes for fire brigade in all buildings. Technical solution of fire water is described in the chapter A.II.8.3.4.4. Water Management Connections and Systems.

A.II.8.3.3. Construction Solution

A.II.8.3.3.1. Conception of the Power Plant Construction Part Solution

The construction part of the power plant is basically divided into the following parts:

- nuclear island,
- conventional island and
- other objects.

Nuclear island

The nuclear island consist of construction objects which include technologies directly concerning the operation of the nuclear part of the power plant and which are predominantly located in the closes surrounding of the reactor (which is a dominant part of the nuclear island). The primary circuit devices, safety and auxiliary systems devices and devices with nuclear fuel are located in the nuclear island objects. Typical representatives of the construction objects of the nuclear island are the reactor building and containment, auxiliary operations building, building of handling the fresh and spent fuel. These objects are from the seismicity point of view designed in the II category which means that they meet the requirements of the seismic resistance up to the level SL-2.

More detailed information about the containment can be found above in the chapter A.II.8.3.2.1. Primary Part. The other objects of the nuclear island are from the constructional point of view designed as monolithic constructions in terms of space with panelled ceiling. The reactor room (including containment) and auxiliary operations of the nuclear island in the immediate vicinity of the reactor building share one massive foundation plate in order to ensure the objects stability.

The other objects concerning the nuclear island (entrance building, stand-by supply building, etc.), which are not in the immediate vicinity of the containment, are from the constructional point of view designed according to their priority. Mostly, they are monolithic constructions in terms of space with panelled ceilings placed on the independent foundation plates. A skeleton is usually used in the objects with lower priority (not related to the nuclear safety of the unit). The constructions, categorized in the category II in terms of seismicity, are placed so that they do not endanger the constructions of the category I in case of a collapse.

As for the construction material, predominantly reinforced concrete, prestressed concrete and steel are used.

Conventional island

The objects of the conventional island, also called turbine island (turbine hall, exchanger station, etc.), are located in a position which is suitably connecting the nuclear island. It is often a case of the turbine hall itself with a turbogenerator (turbine and generator) and affiliated technological operations which are located in the turbine hall. The conventional island objects very often form one common object or they share a common foundation plate. Underground floors are designed as a monolithic skeleton. The aboveground floors are made of a steel skeleton with steel-concrete ceilings. The coating consists of a sandwich panel. From the seismicity point of view the constructions of the conventional island are predominantly

categorized in the category II and are located the way so that they do not damage the constructions in category I in case of a collapse.

A design of the turbogenerator pedestal requires particular attention. There are two approach to the pedestal design. The pedestal is composed of an independent base separated from the turbine hall foundation plate, alternatively the pedestal base is precisely placed on the turbine hall foundation plate.

Predominantly reinforced concrete and steel are constructional materials.

Other objects

The other objects secure other services, media and supporting functions necessary for the operation of the power plant unit. They are cooling towers, compressor plant, cooling water treatment plant, chemical water treatment plant, utility networks, substations, administrative building, etc. They are positioned within the premises to meet the functional and safety requirements and the objects do not affect each other in a negative way. The positioning of the objects is to a great extent dependent on the locality conditions, which means, on the available areas suitable for construction and on the existing infrastructure. The objects are, as for the construction and material, designed to fulfil their purpose in the most optimal way.

It is also necessary to mention the line constructions, networks, pipe bridges and the like. These constructions mostly do not differ in terms of design from similar widely known constructions.

A.II.8.3.3.2. Main Constructional Objects and Sets

Individual sets include the following objects[11].

The nuclear island objects:

- reactor building (includes containment, sometimes also unit control room,
- auxiliary operations building,
- fuel management building,
- power supply building (includes the emergency power sources),
- entrance building (includes entrance inspections, laboratories),
- radioactive waste handling building,
- control systems building (not necessarily as an independent object),
- safety systems building (not necessarily as an independent object),
- cooling systems for TVD (towers or pools),
- building of pumping station of essential service water.

The conventional (turbine island) objects:

- turbine hall building
- exchanger station (often as a part of the turbine hall),
- plant-self supply switchyards (often as a part of the turbine hall).

[9] It is necessary to look at the scope of the sets from an informative point of view. The individual projects can include objects with a different name but similar technology. In some cases an object is not going to be built because the used technologies can share the same object and the project design does not require a separated object.

Other objects:

- electric power outlet,
- transformers and stand-by transformers,
- chemical water treatment plant
- cooling water treatment plant,

[11] It is necessary to look at the scope of the sets from an informative point of view. The individual projects can include objects with a different name but similar technology. In some cases an object is not going to be built because the used technologies can share the same object and the project design does not require a separated object.

- workshops,
- stores,
- cable channels and bridges,
- pipe ducts and bridges,
- cooling towers (ultimate heat sink),
- channels of cooling, service and fire water,
- pumping stations of cooling and fire water,
- communications, sidewalks and car parks,
- outside lighting,
- railway siding,
- rain, industrial, sewage water sewerage system,
- waste water treatment plant,
- sludge treatment from water processing,
- oil, petroleum and polluting substances separators,
- pumping stations of water management (raw water pumping stations),
- water reservoir,
- retention and holder tanks,
- crane railways,
- entrance barriers,
- garages,
- compressor station,
- cold plant, cold water production,
- administrative building,
- operation building
- other.

A.II.8.3.3.3. Urbanistic and Architectonic Solution

The building site for the NJZ is directly adjacent to the premises of nuclear facilities Jaslovské Bohunice. It consists of the premises JE A1, JE V1, JE V2 and other operations connected to a common urbanistic complex. The area is flat and of industrial character due to its existing use. The individual aboveground objects are architectonically simple, of usual geometric shapes. The utility support infrastructure (networks) are predominantly designed as underground. The complex´s communications are designed with the use of paved (asphalt) road communications and sidewalks for pedestrians, the transport services are connected to the public road and railway network which are connected to the higher-level routes. There are platforms for bus services and defined car parking for employees' passenger cars are built in front of the entrance areas of the power plants JE A1, JE V1 and JE V2. Undeveloped areas are grassy and complemented with green vegetation.

Figure A.II.25: Existing structure of the premises of the nuclear facilities Jaslovské Bohunice

The urbanistic conception of the NJZ will be in terms of space and function complementary to the existing structure and it will be also similar with regard to the similar character of the operation. The objects of the NJZ will be primarily designed for available area and height parameters according to the requirements of technology. It will secondary correspond (in terms of height, volume and colour) to the current objects on the premises of Jaslovské Bohunice Nuclear Power Plant so it will not disturb the landscape scenery. The cooling tower will be, as circumstances allow, located in a place so that a look at the premises from surrounding places would be balanced in terms of volume. The conception will also rationally follow the existing transport infrastructure.

All the model solutions of reference projects are similar in term of layout. Mutual cluster of the objects will take into consideration the shape of the premises, local conditions and technological-operational and safety requirements. The following basic requirements can be mentioned:

- the individual construction objects will be placed in positions where they minimize the overall area requirements of the future premises and at the same time they do not affect each other in a negative way;
- the redundant safety constructions will be located as close as possible to the reactor building and at the same time they will be separated as for the layout and construction;
- the buildings which are unimportant from the nuclear safety point of view will be positioned at such a distance so that they do not endanger the important building in case of a collapse;
- the longitudinal axis of the turbine will be directed at the reactor so that the flying fragments of the turbine rotor would struck the reactor building and safety systems building in case of destruction;
- the auxiliary operations will be connected to the main objects of the nuclear island in order to easily handle the material and media;
- the cooling tower will be located at a sufficient distance from the substation and transformers because of their negative affect of humidity and flying drops of cooling water (with consequent freezing in winter time);
- the pumping station of cooling water of the tertiary cooling circuit will be located close to the cooling tower to minimize the space and energetic demands;
- the power output will be oriented either along the longitudinal axis or perpendicularly to the axis;
- harmful substance will be stored the way so that they do not endanger devices important for safety, area of the unit and emergency control room;
- space demands of the technology will be taken into consideration in order to minimize the length of pipelines and cable lines and to reduce the crossing of the individual redundant lines;

As for the architectonic point of view the objects will be designed as industrial objects of simple geometric shapes. The reactor building will dominate in the conception of the nuclear and conventional island and other objects will be escalating towards an imaginary centre of the cluster. One cooling tower with height of ca. 180 m will be a dominant part of the NJZ. The power plant will be, in architectonic terms, complete the existing constructional cluster of the EBO premises.

A.II.8.3.4. Operational Solutions

A.II.8.3.4.1. Nuclear Fuel and the Spent Nuclear Fuel Management

Nuclear fuel is the basic commodity for the operation of a NJZ. The assembly of fresh fuel will be purchased on the world market which can offer sufficient supplies as for the NJZ lifetime period (source: OECD NEA: Uranium 2014: Resource, Production and Demand).

Handling the fresh fuel assemblies is not a problem from the point of view of exposure of employees and inhabitants. Fresh nuclear fuel is transported to the nuclear power plant either by means of rail transport or road transport in transport overpacks. Fresh fuel is in the power plant stores either in dry storage bins in a fresh fuel store or in storage positions below the water surface in a defined part of the spent nuclear fuel pool. The fresh fuel store is designed to protect the stored fuel against the external occurrences like earthquake, extreme climatic influences, etc. Devices necessary for handling and devices for fuel inspection and for safe storage of fuel are a part of the fresh fuel storage. Fresh fuel is in the power plant stored in the amount which allows for the need of the nearest planned reactor refuelling, or more precisely, for a necessary reserve.

Regarding the fact that when using the fuel in the reactor, changes of the fission characteristics occur and therefore it is necessary to replace the spent fuel assemblies after several years of usage for new/fresh fuel. The exchange of the used fuel assemblies in the reactor is carried out periodically, in the course of an operational shutdown (once in 12, 18 or 24 months). When exchanging the fuel only a part of the fuel is exchanged and a part of the fuel assemblies changes the position within the core. The entire exchange is carried out gradually, in the course of several years (usually 4 to 6).

Nuclear fuel becomes spent fuel after it is irradiated in the reactor core and subsequently it is removed from the core for good. An estimate of the amount of spent fuel is stated in the relevant part of the chapter B.II.5. Radiation and other Physical Fields (page 137 of the Report and next pages). The spent fuel is not in the Slovak Republic implicitly considered to be radioactive waste. It can be considered to be a usable source (which can be reprocessed) or it can be stored (if it is declared to be radioactive waste). The spent fuel stays nuclear material, it comes under the legislation of the appointed inspection mode introduced by the system of international warranties which secure that the fuel will not be used to other purposed than a peaceful one. The legislation framework for the spent fuel management is represented by an Order of ÚJD SR No. 30/2012 Coll. which provides the details about requirements at management of the nuclear materials, radioactive waste and spent nuclear fuel.

The spent nuclear fuel (VJP) is after being taken out of the reactor relocated to the spent fuel pool. The pool is located either next to the reactor in the rector hall or in the fuel storage auxiliary building which is connected to the reactor hall by a transport corridor. The pool size corresponds to the requirements of placing the spent nuclear fuel produced in the course of at least 10 years and it provides throughout the whole period sufficient free space for storage of all fuel from the reactor core in case of an absolute core extraction. The fuel in the pool is stored below sufficient water surface containing boric acid and in a compact storage grid which contains integrated material for neutron absorption (usually steel with an admixture of boron). Such a storage with a sufficient reserve secures the constant below-critical level, radionuclides residual heat removal which are present in the spent fuel.

Radioisotope composition of the VJP depends on the initial amount of fission material and on the amount of taken energy. The initial fuel enrichment, burnup and period spent in the nuclear reactor are thus decisive for the final composition of the VJP. After being taken out of the reactor the spent fuel consists of approximately 95,5 % uranium, 3,1 % stable fission products, 0,9 % plutonium, 0, 2 % short-term fission products (Cs and Sr), 0,1 % long-term fission products (mainly I and Tc isotopes), 0,1 % other long-term fission products and 0,1 % minority actinides.

More detailed composition of the spent nuclear fuel for various degrees of enrichment and burnup is pictured in the following tables (source: IAEA-TECDOC-1587 Spent fuel reprocessing options, 2008). Burnup 45 GWd/tU is usual in the today used reactors of Generation II higher values (up to 70 GWd/tU) are possible in the III and III+ reactors.

Table A.II.7: Amount of main actinides in the VJP after 3 years of cooling for various degrees of enrichment and burnup

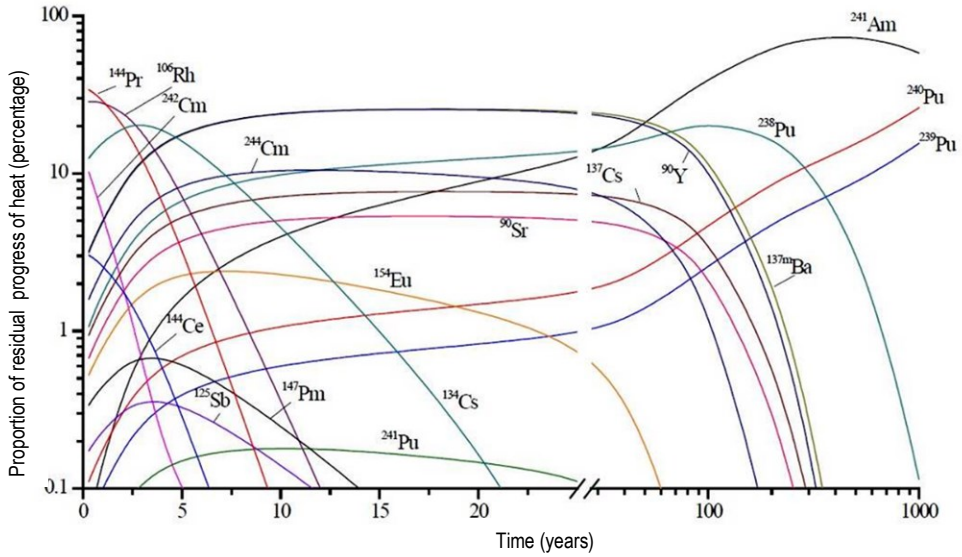
Element	Isotope	Half-life period [year]	UOX 33 GWd/tU [3,5 % U-235]		UOX 45 GWd/tU [3,7 % U-235]		UOX 60 GWd/tU [4,5 % U-235]	
			Isotope contents [%]	amount [kg/tU]	Isotope contents [%]	amount [kg/tU]	Isotope contents [%]	amount [kg/tU]
U	234	246 000	0,02	0,222	0,02	0,206	0,02	0,229
	235	$7{,}04.10^{8}$	1,05	10,3	0,74	6,87	0,62	5,87
	236	$2{,}34.10^{7}$	0,43	4,224	0,54	4,95	0,66	6,24
	238	$4{,}47.10^{9}$	98,4	941	98,7	929	98,7	911
Pu	238	87,70	1,8	0,166	2,9	0,334	4,5	0,59
	239	24 100	58,3	5,68	52,1	5,9	48,9	6,36
	240	6560	22,7	2,214	24,3	2,76	24,5	3,18
	241	14,40	12,2	1,187	12,9	1,46	12,6	1,64
	242	$3{,}75.10^{5}$	5	0,49	7,8	0,884	9,5	1,23

Table A.II.8: Overview of fission products in the VJP after 3 years of cooling for various degrees of enrichment and burnup

Group	UOX 33 GWd/tU [3,5 % U-235]	UOX 45 GWd/tU [3,7 % U-235]	UOX 60 GWd/tU [4,5 % U-235]
	amount[kg/tU]	amount[kg/tU]	amount[kg/tU]
noble gases (Kr, Xe)	5,6	7,7	10,3
alkali metals (Cs, Rb)	3	4	5,2
alkali earth metals (Sr, Ba)	2,4	3,3	4,5
Y and lanthanoids	10,2	13,8	18,3
zirconium	3,6	4,8	6,3
chalcogens (Se, Te)	0,5	0,7	1
molybdenum	3,3	4,5	6
halogens (I, Br)	0,2	0,3	0,4
technetium	0,8	1,1	1,4
Ru, Rh, Pd	3,9	5,7	7,7
various: Ag, Cd, Sn, Sb, …	0,1	0,2	0,3

The spent fuel composition is not constant in time since the individual fission products undergo other radioactive changes with various half-life periods. The following picture depicts the individual radionuclides contained in the VJP for the residual heat generation what is directly proportional to the radioisotope composition of the VJP in time.

Figure A.II.26: Development in time of portion of the important radionuclides in the VJP in the residual heat generation



Further spent fuel management will become a part of the existing systems and conceptions and will be solved at the state level. The spent fuel will be, after meeting the requirements of its safe transport and storage, handed over to a legal body authorized to store the radioactive waste or the spent nuclear fuel (i.e. JAVYS) for its further management. JAVYS is an

owner and authorization holder of a nuclear facility "Temporary storage of the spent nuclear fuel" (for more information see chapter A.II.8.4. Data on Other Facilities and Intentions in the Locality, page 111 of the Report) which functions as a storage of the spent nuclear fuel. By capacity reasons, it is also expected that new storage capacities will be built by means of extension. In the present days the process EIA (Completion of the storage capacity of the temporary storage facility of the spent nuclear fuel in locality of Jaslovské Bohunice) is in progress, which is in now in the stage of completed Evaluation Report and public discussion. According to a recommended variant, the extension of the storage capacity of the temporary storage will be carried out as a dry storage with a constructional connection to the current building and using the storage containers (casks) for a maximum of 85 pieces of spent fuel assemblies, which will be placed in a reinforced concrete storage modules. The new dry storage will be (in accordance with the worldwide experience) of a modular type, which means, that it can be adjusted either in its size or for the arrangement of the storage units in line with the actual needs. This approach means that in case of need the extended temporary storage can be also used for the spent nuclear fuel storage from the NJZ.

In general, there are two possible scenarios for further spent fuel management:

- reprocessing – the purpose is to remove fission and corrosion products from the spent fuel using physical-chemical methods in order to produce new fresh fuel,
- direct storage in a deep geological repository – in this case the spent fuel is considered to be radioactive waste.

The final stage for both scenarios is the storage of the spent fuel or radioactive waste from reprocessing in a deep geological repository. The need for storage of the spent nuclear fuel or radioactive waste from reprocessing in the deep geological repository is not disturbed by relatively intense research activities focused on the arrangement of the fuel cycle and aimed at more effective use of the nuclear fuel (e.g. transmutations, partitioning, etc.) – they can result in a better arranged storage system (e.g. smaller volume) or higher level of safety of the storage facility on the basis of lower radiotoxicity of the spent fuel (see e.g. OECD/NEA: Advanced Nuclear Fuel Cycles and Radioactive Waste Management, 2006).

The intrastate conception of the VJP management is in the present days defined by Strategy for the Final Stage of Peaceful Utilization of the Nuclear Energy. This strategy was developed according to the provisions of Act No. 238/2006 Coll. on national nuclear fund, in the amendment applicable in the time of preparing. It was approved by the government through Provision No. 26 from January 15th 2014. Currently, it is updated to a form of an intrastate programme (Proposal of National Policy and National Programme of the Spent Fuel and Radioactive Waste Management in SR as well as an update of the Strategic Document of the Strategy for the Final Stage of Peaceful Utilization of the Nuclear Energy, National Nuclear Fund, 2015). The strategic documents in the present time do not consider the processing of the spent fuel from Slovak nuclear power plants abroad but its direct storage in an appropriate type of a storage facility. As for the final stage of the VJP treatment, which means its storage in a deep geological repository, the building of a Slovak deep geological repository is considered as a preffered variant. Alternatively (according to the progress in the given area), there is still an effort to participate on the development of the common storage facility with several states (a so-called double way). The proposal of the national programme defines the following partial goals for the area of the spent fuel treatment:

- to build of new storage capacities for the spent fuel (until 2020).
- to approve the decisions about the continuation or termination of the double way of the deep repository development – fully evaluate the idea of the common international deep geological repository (until 2020).
- to work out an outline programme of the research and development in the area of the deep depositing and create internal conditions for its implementation (until 2018).
- to develop and prepare the implementation of the economic stimulation system for the localities affected by the development and operation of the storage facilities (until 2018).
- to work out a plan for further stages of the renewed development of deep storage (until 2016).
- to make a decision (in case of termination of the double way strategy) about the placement of the deep geological repository in the Slovak Republic (until 2030).
- to commission the deep geological repository into operation (approximately until 2065).

The national programme quotes the balances of the spent fuel from the nuclear facilities in the Slovak Republic and their development in the course of time. JAVYS company is responsible for the preparation of the deep geological repository on the basis of a relevant authorization given by the Ministry of Economy SR.

A.II.8.3.4.2. Radioactive waste treatment

Radioactive waste (RAO) is, according to § 2 point k) of the Act No. 541/2004 Coll. Atomic Act, as subsequently amended, defined as "any unusable materials in gas, liquid or solid form which consist of radionuclides or are contaminated by radionuclides and therefore cannot be discharged into the environment". The atomic act also defines the term "radioactive waste treatment" (§ 2, point h), article 2.) using a particular list of activities as "collecting, separation, storage, processing, treatment, management and depositing" where the transport of the radioactive waste is not considered to be the radioactive waste treatment.

The legislative frame for the radioactive waste treatment itself is mainly defined by the Provision of an Ordinance of UJD SR No. 30/2012 Coll. which defines the details about requirements of the nuclear materials, radioactive waste and spent nuclear fuel treatment. This ordinance (according to the instructions of IAEA GSG-1Classification of Radioactive Waste, 2009) classifies the radioactive waste into five categories:

Temporary RAO, the activity during storage (regarding a very short half-life) decreases below the limit for being taken from the control of radiation sources, or more precisely, below the discharge into the environment – this category was introduced mainly because of institutional radioactive waste with dominant very short living radionuclides (the mentioned instruction of IAEA defines the usual limit of half-life approximately up to 100 days). The parts of gaseous radioactive waste of the NJZ which will be discharged after a targeted decrease of radioactivity can be classified within this group.

Very low-radiation RAO, the activity of which is slightly higher than the limit value for discharge of the radioactive materials into the environment, it consists predominantly of the radionuclides with a short half-life or also a low concentration of the radionuclides with a long half-life which require a lower degree of isolation from the environment when stored by means of engineering barriers or they do not require the engineering barriers and the institutional inspection period of the storage facility is shorter than in case of surface storage facility of the radioactive waste. The limit value between the short and long half-life is usually 30 years. The conceptual considerations of a preliminary practical definition of the activities of the waste take into consideration the activity of in terms of safety important radionuclides which amounts to hundredfold of values for release from the emitter control. As for the NJZ it is a case of slightly contaminated solid waste – objects from the controlled zone.

Low-radiation RAO, with the average specific activity of radionuclides with a long half-life, particularly the radionuclides emitting alpha radiation, is lower than 400 Bq/g, the maximum specific activity of the radionuclides with a long half-life, particularly the radionuclides emitting alpha radiation, is locally lower than 4000 Bq/g, they do not produce any residual heat and after a processing meet the requirements and limits of a safe operation for a surface storage of the radioactive waste. With few exceptions, basically all the liquid and solid radioactive waste produces during the NJZ operation can be classified in this category.

Medium level activity RAO, with the average specific activity of radionuclides with a long half-life (more than 30 years), particularly the radionuclides emitting alpha radiation, equals 400 Bq/g or is higher, can produce residual heat and the measures for the residual heat removal are lower than in case of the high-level radioactive waste and after the processing it does not meet the limits and requirements of a safe operation for a surface storage of the radioactive waste. Due to the last part of the definition the solid radioactive waste taken out of the nuclear reactor could be classified in this category in the NJZ or (depending on the processing, treatment and storage of the waste overpacks) also saturated ions coming from the primary circuit water treatment.

High-level RAO, with the average specific activity of radionuclides with short and long half-life, particularly the radionuclides emitting alpha radiation, exceeds the limits set for the low-radiation and medium level activity radioactive waste, which is storable only in a deep geological repository and represents an important factor for the storages designing. The waste is exclusively a product of the spent fuel processing and will not be produced in the NJZ.

A transition between radioactive and non-radioactive materials are radioactive materials, the radioactivity of which is so low that they can be under certain conditions or even without these conditions released from the control of the radioactive emitters – an Ordinance of the Government No. 345/2006 Coll. on basic safety requirements for the protection of health of workers and population against the ionizing radiation, (namely § 5 and Annexes no. 2 and 3 stated in the paragraph).

Prediction of the amount of the radioactive waste produced at the operation of the NJZ is discussed in the relevant part of the chapter B.II.5. Radiation and Other Physical Fields (page 137 of the Report and the following pages). The power plant authorization holder has to separate his radioactive waste in an appropriate way and at the same time a connection with the radioactive waste categorization, which results from the waste storability, established by the legislation has to be clear. The power plant systems secure the processing of radioactive waste in gaseous, liquid and solid form. The purpose of the RAO processing is to reduce the waste volume, separate the radioactive components from the non-radioactive ones and to change the qualities for the needs of further treatment. The treatment will not basically differ from the procedures used in the current operated nuclear power plants.

Gaseous radioactive waste arise primarily from the continuous degasification of coolant in the primary circuit from the gases formed by radiolysis in the reactor or formed as gaseous fission products. Other sources are radioactive gases and aerosols from the other technology systems and pools, which are continuously vented and discharged into gas treatment systems and to a lesser extent discharged as air from the reactor shaft. Activity of the gaseous mixture will be significantly reduced in the gas treatment system through high efficiency aerosol and iodine filters, so radioactive noble gases (Kr, Xe, Ar-14 isotopes) will predominate at the outlet from the ventilation stack followed by carbon C-14 and tritium H-3. Prior to the discharge through the ventilation stack (in a controlled manner based on the authorized limits for gaseous effluents) the radioactive gases are maintained for a suitable period in so-called decaying tanks where due to natural decay their activity is decreased or their short-term components are eliminated.

Liquid radioactive waste is originated within the system of primary circuit water treatment, it includes also water from the auxiliary systems for reactors and from the spent fuel storage pool. Next source of waste radioactive waters with significantly lower radioactivity includes all contaminated or potentially contaminated waters coming from a special sewerage system of the controlled zone rooms, also from laundry rooms of contaminated protective clothing, active spraying systems of hygienic loops, solutions coming from decontamination. The mentioned types of liquid radioactive waste are collected in a collecting vessels from where they are taken for further processing.

The role of processing of the radioactive water in the nuclear power plant is a separation of radioactive components as well as other undesirable components (for example organic dirt) in order to regenerate some usable components (for example water as a pure condensate from evaporators and boric acid) and/or to make it possible to discharge the water. Two technologies and their combination are in general used for processing of the liquid radioactive waste in the nuclear power plant:

Ion exchange in ion exchanger filters where the undesirable components are caught from the liquid waste. The ion exchanger filters are used for cleaning of the primary circuit coolant or for the cleaning of other liquid waste and for condensate final cleaning. The used ion exchangers for the primary circuit coolant cleaning can represent a medium-active waste, the rest of the used ion exchangers will become low-active waste.

Evaporation – it is a case of increasing of water active solutions concentration by means of the evaporation. The result is a concentrate of an in advance defined concentration of salts (so-called salinity) and a condensate which can be cleaned using an ion exchange (see above) and subsequently reused as a technological medium or discharge as a liquid discharge.

The processing of the liquid radioactive waste in the nuclear power plant leads to a reuse of coolant and a part of chemicals in the primary circuit, discharge of liquid discharges (in a controlled way based on the authorized limits for liquid discharges) and storage of radioactive concentrates and suspensions of the saturated ion exchangers in vessels with suitable qualities before further processing.

Of course, the development of other technologies of processing of the liquid radioactive waste in a nuclear facility where it was produced using various physical-chemical principles, for example a reverse osmosis, strengthening of aluminosilicate matrixes is still in progress. In 2013 the EIA processes were completed concerning the changes in the liquid radioactive concentrates processing in JE V2 and EMO 1, 2 the result of which should be a reduction of the volume of the liquid

radioactive waste which is supposed to undergo a further processing (see below) to ca. 5 % of the original volume. The technology which can achieve this result uses both the ionization and the subsequent ultrafiltration and it removes the soluble radionuclides using selective sorbents.

The solid radioactive waste from a normal operation is represented by saturated radioactive filters of all types, activated or contaminated parts of technology changed in the course of maintenance and low-contaminated materials from the controlled zone. The solid waste is collected in the collection points, it is separated as for the further processing and activities:

- from the further processing point of view to:
  - combustible,
  - compactable,
  - incombustible and non-compactable (other),
- from the activity point of view to:
  - the radioactive waste itself, this can be then divided into low-active and potentially very low-active,
  - materials potentially releasable from the control of the radiation sources.

The solid radioactive waste is usually placed in barrels and/or in shielded storage chambers before it is further processed. The storage chambers usually include various parts and devices taken out from the nuclear reactor from its immediate surrounding after a certain time. This radioactive waste, which cannot be stored in the existing storage facility for radioactive waste of the surface type because of its higher radioactivity, will be stored in the chambers during the entire operating lifetime of the power plant and also during the decommissioning; in the course of decommissioning it will be eventually decommissioned together with the nuclear reactor.

The radioactive waste processing is a part of the national system and conception for the RAO processing. According to the relevant regulation of the atomic act, the radioactive waste will be handed over for further treatment within 12 months from its formation to a legal body authorized to store the radioactive waste or spent fuel, which means the company JAVYS. The financing of the activities concerning the further treatment of the radioactive waste is regulated by a principle “the polluter pays”. It means that as far as the operational radioactive waste is concerned the power plant where it was produced pays for further processing (including storage and storage facilities operation aliquot costs) financial amounts which have been arranged with the organization which is responsible for it on the basis of bilateral contracts. The obligation to pay for the processing of the internal operational waste applies regardless of when the processing takes place, for example also in case that the operational waste is further processed during the decommissioning.

JAVYS is an owner/authorization holder of technologies which produce waste package storable in the National Radioactive Waste Repository in Mochovce. The only acceptable form of radioactive waste storage and processing is in the present a full cubic container (internal volume of 3,1 m^3) made of concrete reinforced with amorphous fibres of alloy steel (fibre-concrete container - VBK). The outputs of the individual technologies are mixed in the container in order to comply with the criteria of acceptability for further processing and storage. The empty volume of containers is filled with cement grout and the containers are after the filling up covered with a cover made of fibre-concrete material. The processing procedures and changes of the individual types of waste and final filling up can be changed in order to comply with primary waste composition and at the same to comply effectively with the acceptability criteria of waste packages, also other practical parameters and aspects are taken into consideration when selecting the right way of radioactive waste processing.

A part of the radioactive waste processing chain is also its temporary storage. It is used to balance the time and capacity non-sequence between the successive steps of the radioactive waste processing. Predominantly vacant and rebuilt areas in JE A1 (see chapter A.II.8.4. Data on Other Facilities and Intentions in the Locality, page 111 of the Report and the following pages) are used for a temporary storage of the processed and treated radioactive waste in the premises of EBO. A decision was made later to build a modular integrated storage facility where solid and solidified radioactive waste in various types of packages mainly from the nuclear facilities decommissioning should be stored, which is waiting for warehouse release due to its storage in the National Radioactive Waste Repository in Mochovce, or due to the release from under the control of the radiation sources or due to its storage in other suitable type of the storage facility in the future, for example in a deep geological repository. The construction of the storage is supposed to start in the near future.

Another important part of the radioactive waste processing is its characterization. Its main purpose is to prove that the characteristics of the radioactive waste (or waste packages) are in compliance with the criteria of acceptability in the National Radioactive Waste Repository in Mochovce or with the storage acceptability criteria in a relevant storage facility. The acceptability criteria of waste packages, which are supposed to be stored, can be divided into:

- directly reflecting the analysis results of the long-term (thousands or tens of thousands of years) storage facility safety, for example, overall storable active inventory of important radionuclides (or a maximum average activity of the stored waste packages derived from it) or maximum activity of radionuclides in waste packages,
- reflecting the parameters of the storage safety analysis (e.g. the amount of cement material in the storage system or in waste packages) and/or technological parameters (e.g. the maximum and average weight of the filled container) and
- criteria the impact of which on the storage facility safety can be determined only qualitatively or reflecting "positive experience" of similar storage facilities (for example the qualities of the container itself, contents of some undesirable components and the like).

A basic facility for the national system of processing with very low and low radioactive waste (see the definition enacted in the Ordinance ÚJD SR No. 30/2012 Coll. which provides the details of the requirements concerning the radioactive materials, radioactive waste and spent nuclear fuel processing) is the National Radioactive Waste Repository (RÚ RAO) in Mochovce. RÚ RAO represents a multi barrier surface storage facility which is specified for the final storage of the treated RAO produced during the operation and decommissioning of NPP, in the research institute, in industry and medical facilities of the Slovak Republic. Very low-radiation RAO from decommissioning or from the nuclear facilities operation will be stored in the RÚ RAO in individual storage structures. It means that all the operational waste from Slovak nuclear power plants except for the higher-active (medium level activity) waste, in particular parts of the devices taken out of the nuclear reactors or ion exchangers contents of the higher activities will be stored in the National Radioactive Waste Repository. The National Radioactive Waste Repository Mochovce is approximately 1,5 km north-west of Mochovce Nuclear Power Plant (EMO). It is a surface storage with engineering barriers. The storage structures are at the same time represented by two double rows of concrete boxes. A double row consists of 2x20 boxes, the capacity of one box is 90 (10x3x3) filled fibre-concrete containers (VBK) mentioned above. The capacity of the existing storage structures equal then 7200 VBC, i.e. 22,320 m3 of the processed radioactive waste.

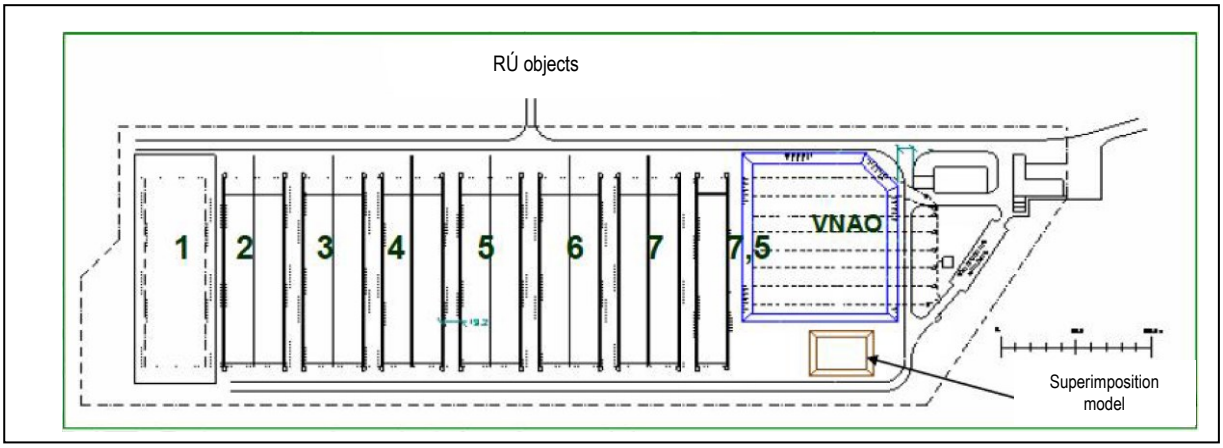
The basic engineering barrier of the storage facility is, besides the concrete storage boxes, also beds of compacted clay (bed thickness 1 m, side thickness 3,5 m) along each double row which can secure the retention of radionuclides important from the long-term safety point of view and water isolation.

The first container filled with radioactive waste was stored in the repository on 14th June 2000. Nowadays it entire first double row is filled and the repositing in the second row has already started. In the recent past the activities (extension of the RÚ RAO for storage of low activity waste and construction of a storage facility for very low active waste. A final statement of the EIA was issued by MŽP (Ministry of Environment) SR in 2013) which would result in:

- efficiency improvement of the storage system by construction of a storage facility for very low active waste in the premise of the existing repository,
- capacity extension by means of gradual building of other storage structures in accordance with the current approach in a form of double rows parallel to the existing ones.

The schematic layout of the National Radioactive Waste Repository is depicted in the following picture.

Figure A.II.27: Schematic layout of the RÚ RAO with marked storage double rows and area for storage of very low active waste



A part of the storage facility is a quite extensive monitoring system, the main part of which is constituted by water monitoring if it occurred in the storage boxes or water monitoring of the immediate surrounding of the storage structures. The monitoring system will work also after the repositing and closure of the storage facility. Each double row of the storage facility will be after filling up covered with a monolithic impervious concrete plate. After the repositing in the premises all storage structures will be covered altogether with several layers (the main component of which will be again compacted clay) and finally grassed.

A proposal of the National Policy and National Programme for Spent Fuel and Radioactive Waste Processing in SR as well as an update of the Strategic Document – Strategy for the Final Stage of Peaceful Utilization of the Nuclear Energy counts with the following goals in the area of radioactive waste processing:

- Construction of an integral RAO storage facility in Jaslovské Bohunice (target in 2018).
- Development of a database of all radioactive waste from nuclear facilities in the Slovak Republic and its continual updating (target in 2016).
- Construction of a facility for metal radioactive waste re-melting (until 2018)
- Construction of a storage facility for very low active waste (until 2018).
- Construction of another storage structure for radioactive waste packages storage after the filling up of the second double row of the RÚ RAO in Mochovce (until 2018).
- Development and preparation of the implementation of economic stimulation system for the localities affected by the development and operation of storage facilities (until 2018).

It is supposed that low active waste from the operation of the NJZ will be stored in the RÚ RAO. If the storage structures are filled up in the second half of this century, new storage structures will be built ahead of time for the needs of later waste storage produced during the decommissioning of the NJZ.

A transition between the radioactive and non-radioactive waste is represented by radioactive materials with such low radioactivity that it is possible to release them from under the control of radiation sources (Clearance from Regulatory Control). Releasable waste (the process is sometimes called “discharge of radioactive substances into the environment”) does not mean “usable on the spot” but usable in a way which does not exceeding of the below mentioned radiological limits according to the Ordinance of the Government No. 345/2006 Coll. on basic safety requirements for the protection of health of workers and the population from ionizing radiation. In particular, the general legislatively established possibilities are:

- unlimited further use,
- targeted and limited use,
- re-processing,
- disposal in waste dumps (non-radioactive),
- combustion,
- disposal in the underground or in special waste dumps (read e.g. dangerous waste).

Radioactive contaminated materials can be released to the environment if an average effective dose of the individuals in a critical group of population caused by the discharge of the materials to the environment does not exceed 10 μSv in any calendar year and at the same time if the collective effective dose does not exceed 1 manSv. The fulfilment of the mentioned criterion has to be proved; if the collective dose is higher than 1 manSv the discharge into the environment can be approved if an optimization study proved that the discharge to the environment is optimal from the radiation protection point of view.

In case of a limited discharge of radioactive contaminated waste to the environment it has to be proved that the control of the discharge and compliance with the planned way of discharge will be secured and in which way. In case of a controlled discharge of radioactively contaminated materials to the environment the conditions for further processing of the materials are set and checked. After an unlimited discharge of radioactively contaminated materials no further institutional inspection of the discharged materials is necessary. An Ordinance of the Government No. 345/2006 Coll. includes further specifications concerning the ways of measurement or declaring of the discharged materials radioactivity, further conditions for the discharge to waste dumps, combustion or processing. The mentioned process is meaningful in case of dismantling and demolition activities which are associated with the decommissioning of a nuclear facility.

The IAEA (Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance. IAEA Safety Reports Series No. 44, IAEA, Vienna 2005) document for the purposes of calculating derivation (from the above mentioned basic radiological limits) of active limits for discharge of radioactive materials to the environment presents the following scenarios:

- material released to a waste dump where an employee working at the waste dump is exposed to the radioactivity from the discharged waste,
- an employee works at a facility where released contaminated metal scrap is added to the melt,
- an employee (e.g. lorry or taxi driver) coming into contact with radiation because he/she pursues an occupation as a car driver the bodywork of which was made of steel metal sheets which were a product of a process of adding the contaminated metal scrap to the melt,
- a scenario of exposure of the population living near the waste dump or other facility where low active materials were discharged,
- a scenario of exposure of the population living near the mentioned re-melting facility,
- the released material (for example concrete brash, steel studding, etc.) used for building construction,
- the released material used for covering of public areas,
- a situation where the presence of the discharged contaminated material could lead to contamination of groundwater and subsequently of the drinking water and water used for garden watering.

A.II.8.3.4.3. Conventional Waste Treatment

All the radioactive waste will be treated in accordance with the existing legislation (currently applicable Act No. 223/2001 Coll. on Waste as amended by later regulations will be on 1st January 2016 replaced by the Act. No. 79/2015 Coll. on Waste and amending certain other acts) and in accordance with the future internal documentation of the power plant which is going to elaborate the act and its application also in accordance with strategic documents of SR in the area of waste management. The strategic documents are:

The waste management plan of the Slovak Republic for years 2011-2015. Its main goal is primarily to divert the waste from disposing repsectively reduction of waste amount stored in waste dumps. Preventive measures are introduced to prevent the waste production, reduce dangerous qualities of waste and support the reusing of products (prevention plans) and also increasing rate of recycling and waste recovery including the energy waste recovery.

The waste management plan of the Self-Governing region of Trnava for years 2011-2015 is a planning document for Trnava region, where the NJZ will be located. The ways of treatment of all kinds of waste in Trnava region are on the agenda divided in a ratio of (ca. 55 %) waste disposal and (ca. 45 %) waste recovery.

At the time of start of the construction and operation of the NJZ a new waste management plan will be applied. It can be expected that the goals of the waste management plan will be reinforcing the decrease of waste production, the increase of percentage of recovery and waste recycling and significant decrease of waste disposal.

The ways of non-active waste treatment (O and N category) during the operation of the NJZ will be then controlled from the 1st January 2016 by the existing legislation in the section of waste management by the Act 79/2015 Coll. and by the implementing regulations.

Basic obligations of the NJZ authorization holder are:

- to prevent waste generation,
- to prepare waste reusing,
- to recycle,

and after all possibilities are exhausted, to dispose the waste.

It will be necessary to classify the waste according to the Catalogue of waste, secure inspection and separated collection, suitable vessels, containers and areas to assemble the waste before it is transfer to recovery or disposal point; to process the measures for a possible leakage of dangerous waste, keep a record of it.

Waste treatment will be secured in accordance with the existing legislation for the area of waste management (the currently applicable Act No. 223/2001 Coll. on Waste as amended by later regulations will be on the 1st January 2016 replaced by the

Act No. 79/2015 Coll. on Waste and amending certain other acts) and will correspond to a currently applied system, which means, handing over to authorized companies which deal with waste recovery and disposal.

Communal waste will be treated in accordance with general binding regulations of a relevant municipality. According to the currently applicable act on waste, the communal waste generated on the premises of a municipality (e.g. residents, business subject) is managed by the municipality in compliance with the applicable VZN. Regarding the fact that the NJZ premises are going to be located in several cadastral areas of the municipalities, investor will agree with the municipalities on which one will collect the KO (VZN of municipalities, communication concerning the terms of payment for the KO of the municipalities in the cadastre of which the NJZ is located, purchase of containers for KO, notification of number of employees to the municipal authority). Considering the space of the premises of the NJZ, high number of employees and specification of the environment (nuclear power engineering), it is possible for the authorization holder to ensure the containers for communal waste and separated components from the communal waste, under the accord of the relevant municipalities, and to conclude a contract with a company which exports the waste from the relevant municipalities. This organization will collect and dispose or recover the communal waste.

Dangerous waste will be collected in the designated area in suitable packages, barrels or containers so that it cannot pollute the environment. The area for dangerous waste collecting will meet the requirements of § 25 of the Ordinance 310/2013 Coll. The collection, recovery or disposal will be executed on the basis of a contract by means of authorized organizations.

In case that some demolition waste is generated in the course of the operation of the NJZ due to construction works, it is necessary that the authorization holder proceeds according to the construction regulations (see below).

Non-active sludge produced from water treatment has a specific position namely in case when the decarbonisation technology for cooling water treatment is not used. Since in case of JE V2 the non-active sludge from cooling water treatment is certified as a by-product (§2 Art. 4 of the Act 79/2015 Coll., soil auxiliary substance) it is expected that also the NJZ will do its best to use the sludge in similar way.

Waste resulting from the preparation and construction will be separated, collected and disposed by means of an authorized organization. The treatment of waste in the course of a construction and construction site preparation will follow the following rules:

- Demolition waste will have to be separated, collected separately; the recovery of separated demolition waste (ferrous metals, cables, plastics, wood, glass) will have to be guaranteed and the demolition brash, concrete, bricks will have to be recycled and the processed demolition waste, as circumstances and requirements allow, will have to be reused (e.g. for backfilling, terrain adjustments using the recycled material within the construction and the like). In case of a surplus of the processed demolition waste from demolitions and construction work, it is possible to offer this waste to other subjects to use it. In case of disposal of old demolition waste it is supposable that suppliers companies will dispose of the waste and store in to existing waste dumps near the construction.
- Soil will be in the course of structural terrain works deposited in a soil dump on the premises of the construction and will be used as backfill material, terrain levelling, reclamation of the area after the decommissioning of the JE V1 and JE V2 and the like. In case of a surplus of excavated soil a part will be disposed in suitable facilities (waste dumps).
- Excavated soil from construction foundations, which will be reused in the construction area, is not waste and the regulations concerning the waste management do not apply to it in case that the material is used for constructional purposes in a natural state in a place where it was excavated.
- Biodegradable waste – clear and cutting and trees or bush processing will be provided on the spot by means of a mobile crushing machine. Thicker trunks will be debranched and the trunks will be provided to energy purposed.
- Dangerous waste disposal, which will be found and recorded on the premises of a construction site, will be carried out on the basis of a contract by means of authorized organizations. The generated types of dangerous waste will be collected in designated areas of the construction in appropriate packages (barrels, containers and the like) so that it cannot pollute the environment and will be handed over to the authorized organizations for further processing. Removal of asbestos (dismantling and subsequent elimination of asbestos roofing from construction objects which are designated for demolition) is possible only through specialized companies which are authorized to carry on business in this area.
- Communal waste produced by construction workers will be separated (paper, plastics, metal, glass, mixed communal waste), collected in appropriate containers and tanks and recovered and disposed through an organization dealing with the collection and further processing of communal waste.

A specific attention needs to be paid to excavated soil from structural terrain adjustments (to 960,000 t) or from excavation works (to 720,000 t). Excavated soil will be deposited on the premises of the construction and will be to the utmost reused in the construction (backfilling, terrain adjustment, adjustment of the surface around the construction, adjustment of the construction site, induced and related constructions and investments and reclamation of areas after elimination of objects on the premises of JE A1 and JE V1). This soil, reused for construction purposes in natural state in a place where it was excavated is not a waste (§1 Art. 2 point "h" of the Act 79/2015 Coll.). The rest of approximately hundred thousand tons resulting from the construction will be deposited in appropriate facilities (waste dump where it can be used for reclamation or as a roofing material) or the soil will be used in other appropriate way.

In time of decommissioning of the NJZ the activity executor will be obliged to follow the rules concerning the section of waste management applicable at that time. It is clear that it will be necessary to take measures for a maximum possible use of the waste. Considering the long time horizon (at the latest from 2087), when the decommissioning process of the NJZ is supposed to start, it is not useful to relate to the existing legislation applicable in the waste management nor to define and relate to the existing facilities for recovery and disposal of waste.

A.II.8.3.4.4. Water Management Connection and Systems

For the needs of the NJZ it is necessary to ensure the following:

- Water supply system and
- System of treatment and discharge of waste and rainfall water.

Water supply system

The water supply system includes a drinking water system, fire water system and raw waster system.

The drinking water system will supply water for sanitary purposes, which means for personal consumption of employees including hygienic and catering purposes water supply. Drinking water will be also used as service water for cleaning works. To provide the supply capacity of drinking water for the NJZ, the existing drinking water pumping station is planned to be used. The drinking water for the NJZ will be supplied from the existing distribution lines which supply the existing facilities in the EBO locality. They are supplied with drinking water by means of a remote feeder from Dobrá Voda, Dechtice and Veľké Orvište water sources.

The system of fire water for the NJZ will be designed in accordance with the modern international experience in the area of fire water. The circulation (tertiary) cooling circuit will be the source of fire water for supplying of the external and internal hydrants on the premises of the NJZ. The overall water volume in the circulation cooling circuit, accumulated in a pool of the cooling tower, will be big enough to cover the needs of water for an extensive norm fire response with sufficient reserve. This volume will be filled in from the raw water treatment system. In order to achieve the necessary flow rate and pressure in the distribution system a new pumping station of fire water of the NJZ will be provided. The relevant pipelines of fire water which will be connected to the individual objects will be built on the premises of the NJZ. Fire hydrants for fire extinguishing inside the objects will be connected to the external distribution line and internal fire hydrants will be established. The fire water pumping station and a part of the pipeline distribution system belonging to seismically resistant buildings will be designed as seismically resistant.

The raw water supply system will supply the losses of the circulation cooling circuit of the essential service water, of the inessential service water and for production of demineralized water. The dominant part (ca. 95 %) is injection of the circulation circuit, which means covering the losses resulting from the circulation cooling water blowdown, vaporisation and flying of drops from the cooling tower. A new system of raw water (independently from the existing facilities in the EBO locality) supply will be built for the needs of the NJZ the modern technical design and lifetime of which will meet the requirements for a secure raw water supply during the entire operation period of the NJZ. A reservoir of the Sĺňava hydraulic structure will be the source of the raw water (analogously as for the existing supplying of the EBO locality). A new raw water offtake structure will be located on the right side of the water dam. The offtake will be provided by means of suction pipelines placed under water surface and lead from the offtake structure. The suction pipelines will consist of 4 pipes which will be inserted in a two part input chamber in the evacuation station. Each chamber will be equipped with an overflow wall, which will secure the sufficient amount of water in the chamber. The water behind the overflow wall is conducted through a channel to mechanically wipeable screens for catching of coarse dirt. Both channels will be equipped by a floodgate closure,

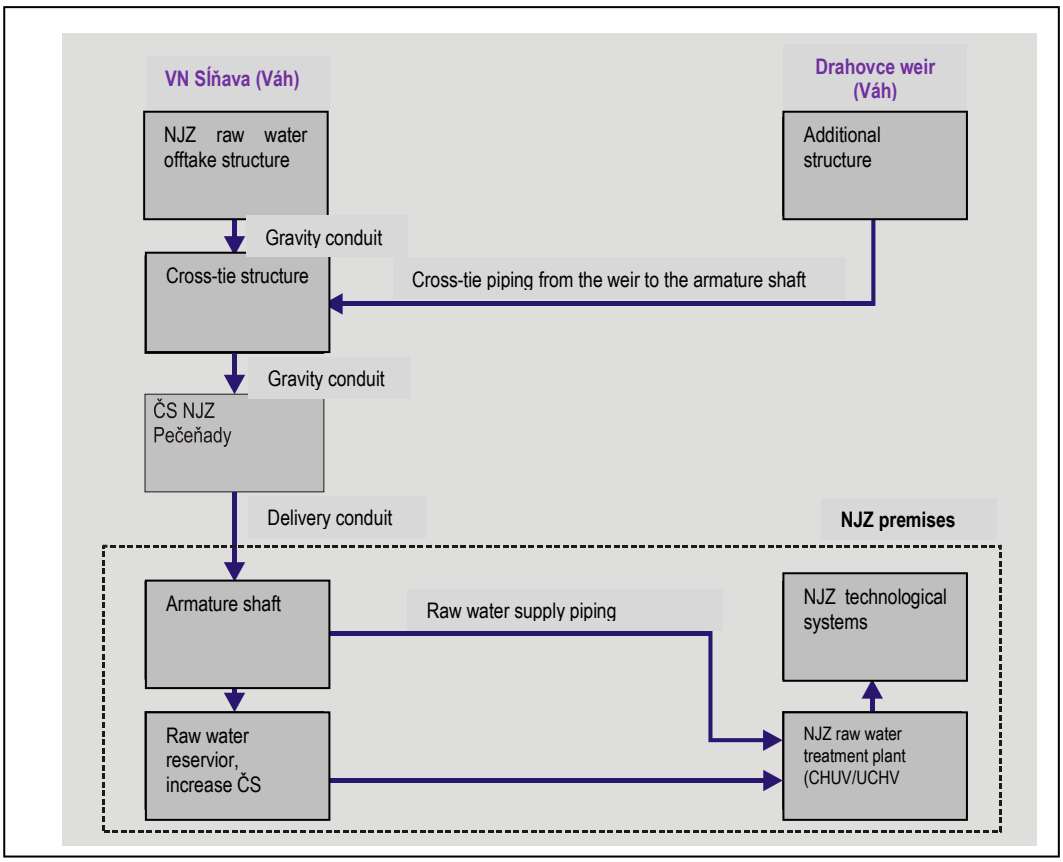
which will be located before the entrance of the mechanical screen, and by a provisional obstruction for maintenance. An evacuation station with a liquid ring vacuum pump for opening of the necessary subatmospheric pressure in the suction pipeline system will be located in the intake structure building.

Behind the machine screens it will be connected to four intake rows – steel pipelines ca. 10 km long which will gravitationally conduct raw water to the pumping station of the NJZ in Pečeňady. The pumping station will be located near the existing premises of Pečeňady pumping stations. A gate chamber will be established on the pipeline near the intake structure where the connections of pipelines from the additional raw water intake structure on Drahovce dam will be developed. Main pipelines in the gate chamber will be equipped with channel slide valves and invoicing water meters. Gravitational natural channels of raw water from the Sĺňava dam will be conducted to the EBO locality in the new excavation ditch which is parallel with the intake channels.

The natural channels in Pečeňady will lead to the new pumping station for the NJZ where water will be conducted by means of a discharge pump and discharge channels in the length of ca. 4,5 km to the NJZ. Raw water in the premises of the NJZ will be conducted to a water reservoir, to a cooling water treatment plant and from there to a cooling circuit system. A part of the treated water will be conducted to a chemical water treatment plant for the needs of filling in of the losses of demi water, mainly in the secondary (steam) circuit. The water reservoir capacity will be sufficient for a supply of cooling water for the needs of important circuits in a stage of reactor residual heat removal and residual heat removal, which is produced in the reactor fuel, for a period of at least 30 days in case of raw water supply shutdown from a standard source. In case of reduced water level of the Sĺňava water dam below the minimum operational level or in case of a planned draining of the Sĺňava water dam the raw water supply system will be backed up by the system of additional gravitational intake from the Drahovce dam in the intake place to the Drahovce channel. In case of a complete planned draining of the Sĺňava water dam due to maintenance reasons when it will be not possible to conduct the water to Pečeňady gravitationally, powerful submersible pumps will be used in the water cushion under the Drahovce dam (the old bed of Váh River).

The fundamental scheme of raw water supply is depicted in the following picture.

Figure A.II.28: The fundamental scheme of raw water supply



System for treatment and discharge of waste and rainfall water

The system for treatment and discharge of waste and rainfall water includes systems for collection, cleaning and discharge of industrial waste water, sewage water and discharge of rainfall water from the premises of the NJZ and from the outside basin of the NJZ premises.

It will be necessary to process a several types of waste water of industrial character resulting from the operation of the NJZ.

It will be predominantly the following types of industrial water:

- waste water from the controlled zone,
- blowdown from the circulation cooling circuit,
- waste water from the cooling water treatment plant and from the chemical water treatment plant,
- potential oiled-up waste water,
- other industrial waste water.

The discharge of waste water and rainfall water from the NJZ is intended for two recipients which are:

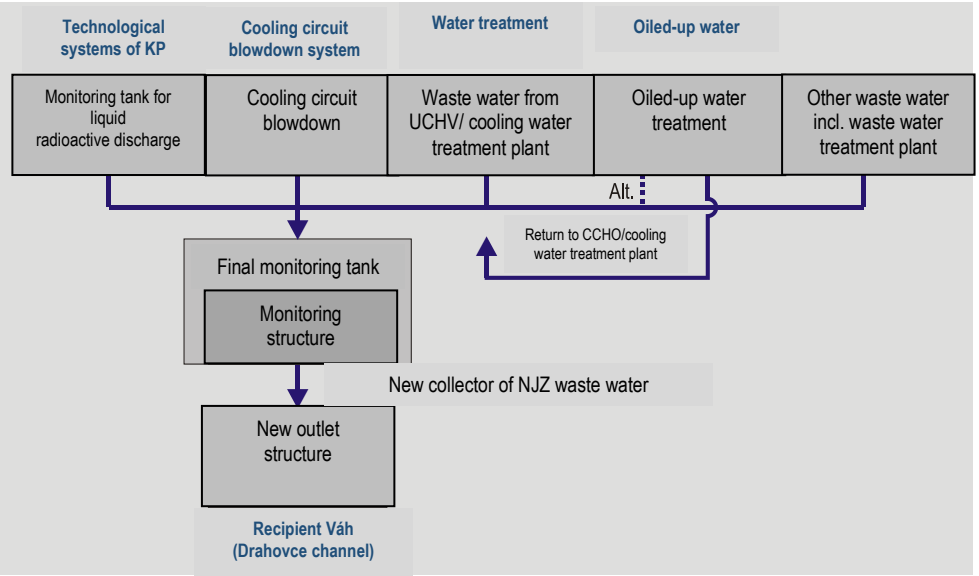
- the Váh River for waste water, discharge through a new waste water collector,
- the Danube River for rainfall water, discharge through a new rainfall water collector.

The discharge of industrial waste water and treated sewage water will be carried out through a new profile, which will be independent from the existing waste pipeline. The first section of the new waste water collector will be located in the excavation ditch conducted through an independent corridor along a fall line of a terrain depression heading from the JE V2 to the edge of the Pečeňady municipality. Additionally, the pipeline will be lead parallel with the existing waste water collector (Socoman) and will end up in the Drahovce channel (recipient of the Váh river) near the existing opening structure of the Socoman collector.

Industrial sewerage systems will be built on the premised of the NJZ to collect and discharge waste water based on the individual types of waste water. Industrial waste water will be discharged to the new treatment plants, depending on its origin, and consequently after the treatment the water will be conducted to the final monitoring tank where the waste water from the controlled zone monitoring tanks (after an inspection proving that it is possible to discharge the water to the environment), the treated sewage water and blowdowns from the cooling circuits will be conducted. Waste water from the controlled zone will be sufficiently diluted. The final monitoring tank wit volume of ca. 500 m^3 will be placed in the common premises of the water management structures of the NJZ and it will include also a monitoring structure for a constant monitoring of the amount and quality of the water discharged from the NJZ and, in case of noticing of unpermitted concentration of the polluting substances, the monitoring structure will stop the discharging and take the corrective measures.

The fundamental scheme depicting the conception of collection, treatment and discharge of waste water is evident from the following picture:

Figure A.II.29: Conception of the collection, treatment and discharge of waste water



Besides the industrial sewage system in the premises also a sewage water system will be established to collect of waste water from sanitary facilities and canteen facilities. The NJZ will be equipped with an independent waste water treatment plant (ČOV) located on the common premises of the water management buildings. All the sewage water from the NJZ will be conducted to the treatment plant. The treatment plant will be designed for an expected number of employees (650) and expected consumption of drinking water during the operation of the nuclear facility with an approximate increase by ca. 1000 external workers who will be present in shutdown periods.

The treated sewage water will be conducted to the waste water monitoring tank. Its amount and quality will be measured on the outlet from the biological waste water treatment plant. The waste water from the final monitoring tank will be after being monitored discharged in accordance with the applicable regulations to the waste water recipient (the Váh River).

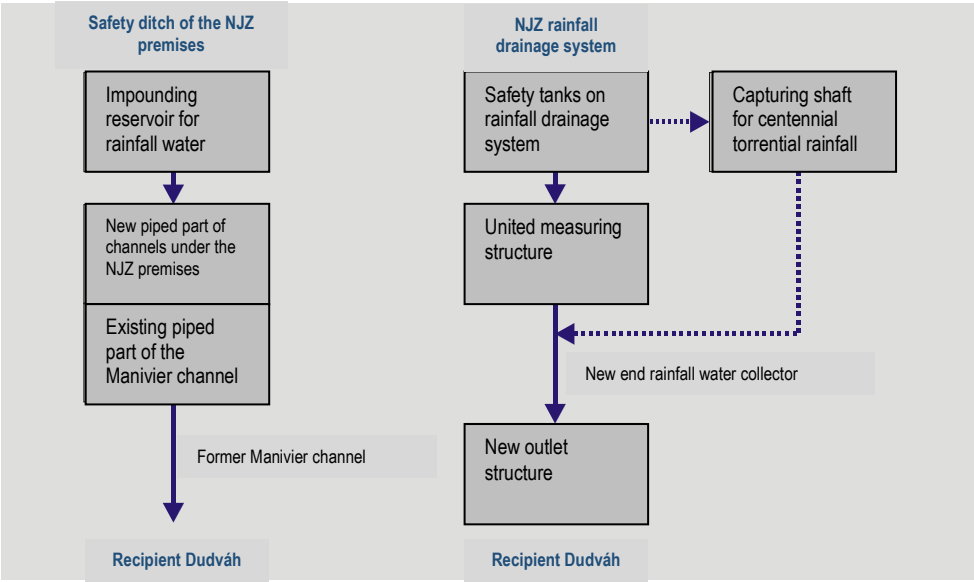
A system separated from the waste water system will be built for rainfall water (which is not waste water).

A new outside rainfall water drainage system will be built for the purposes of rainfall water disposal from the NJZ premises to a retention basin. The retention basins will be equipped with floating barrage for collection of a possible leakage of petroleum substances to the environment. A rough pre-cleaning of rainfall water will be carried out in the retention basin (capturing of floating solids which get to the sewage system through outwash of the paved and unpaved surfaces including the roofs of the objects). The retention basins for the NJZ will be located next to each other in the water management complex and will be complemented by a common impounding reservoir behind the overflow wall for capturing of centennial rainfall. The function of the impounding reservoir is to unload the retention basins, prevent the infestation of the sewage system collector and to balance the outflow of the torrential rainfall water. A united measuring structure will be established behind the outflow of rainfall water from the retention basins and impounding reservoir where the water quantity of rainfall water flowing from the premises of the NJZ will be measured. Rainfall water will be also removed by a new final pipeline collector to the Danube River recipient, which means, to the same river where rainfall water from the existing premises of the EBO is discharged. The new pipeline is being designed because the Manivier channel, which is currently used to conduct the rainfall water from the EBO locality, has limited capacity. The new final rainfall water collector will be lead in parallel with the new waste water collector (see above) and in the area between Pečeňady and Ratkovce municipalities and will empty into the Dudváh river because the crossing through the Žlkovce municipality urban areas along the existing Manivier channel is (regarding the built-up surrounding) practically impossible. The pipeline will be ca. 5 km long and will end with a new outlet structure built on the right bed of the Dudváh River.

A protective stormwater ditch for capturing of torrential rain from the surrounding area, which is slightly sloping down to the area of the NJZ construction site, will be built, before the fencing of the premises, to capture rainfall water from the outside river basin of the NJZ. The goal is to prevent the flooding of the NJZ premises in case of torrential rain and safely conduct the captured water to the Manivier channel. This trough will be built mainly on the north-west side and will lead to a newly

build small impounding reservoir. Rainfall water will be discharged to the impounding reservoir by overflow discharge and will be conducted to the piped part of the Manivier channel (under the JE V1 premises). The water will be further conducted to the Dudváh river basin - the Váh River in the same way as rainfall water is in the present, which means, through the opened Manivier channel to the recipient Dudváh. The impounding reservoir will function as a collector of the conveyed rainfall water from the protective trough and its main function is to capture the drifted mud, washed off by heavy rain from fields in order to prevent the clogging of the channel and decrease its passability. It is not supposed to capture the centennial rainfall; it will predominantly function for capturing of dirt and silt. The superfluous water from rainfall will flow through the overflow edge of the impounding reservoir to the Manivier channel which will continue with the new piped section under the NJZ premises, with the existing section under the JE V1 and will be connected to the former Manivier channel. It will be necessary to extend the existing piping will be by a new section, piped under the NJZ construction site and, moreover, it will be necessary to reconstruct the existing section under the JE V1 premises. The rainfall water will be, after being conducted through the piped section, discharged, altogether with the rest rainfall water from the existing EBO premises, to the opened bed of the Manivier channel and to the recipient Dudváh.

Figure A.II.30: Conception of rainfall water drainage



A.II.8.3.4.5. Electric Connection

The electric capacity of the NJZ will be conducted by a 400 kV line to the new electric station Jaslovské Bohunice which will be located south of the NJZ[12] premises. The same electric station will also provide an internal consumption stand-by power supply using the 110 kV line. Moreover, an internal consumption power supply from the 110 kV substation of the JE V1 will be secured.

A.II.8.3.4.6. Transport Connection

The communication connection of the NJZ will be provided both to the public road network and to the railway network.

Road connection is possible from two main directions. One of the main directions of the premises connection is a connection through Jaslovské Bohunice to Špacince to the road II/560 continuing to Trnava direction. The second direction is located in the direction Piešťany, through the communication to Žlkovce municipality to the road I/61 in the direction to Bratislava – Trenčín and further to the D1 highway. It will be necessary to build a purpose-built two-way class III road connected by a level crossroad to the III class road no. 50415 Žlkovce – Jaslovské Bohunice.

[12] This station will be a part of the Slovak Transmission System

The connection to *railway transport* is secured by a single-track railway siding, which ends in the Veľké Kostoľany railway station where it is connected to the national railway line no. 120 Piešťany – Trnava - Bratislava. In the present time it used for the entire EBO power plant locality, it is ca. 8.1 km long and it will be necessary to build a railway interconnection by means of new railway sidings to connect the NJZ premises.

A.II.8.3.4.7. Operation Staffing

Approximately 650 persons are estimated for the operation and maintenance. The real number of employees will depend on the organizational structure of the authorization holder and on the extent of outsourced services.

A.II.8.3.5. Construction Data

Construction and building activities for the construction of the NJZ will be carried out on:

- main construction site and
- corridors related to the infrastructure network.

A.II.8.3.5.1. Works on the Main Construction Site

Main stages of the construction will be:

- preparation works on the construction site,
- construction works,
- mechanical systems and equipment assembly,
- electrical systems and management and control systems assembly,
- tests.

The preparation works on the construction site will be carried out as a set of individual investments creating conditions for the construction of the NJZ. These investments lie primarily in the preparation and implementation of the delimitation and securing of the construction site, construction equipment, material and energy supply system and further technological, personnel and transport relations. The construction site will be equipped with the necessary construction and assembly equipment; it is supposed that heavy ground machinery and tower cranes will be used.

The terrain surrounding the NJZ locality is flat, individual layers are positioned horizontally and have approximately same thickness. It can be noted for the construction of the NJZ objects, that it is possible to delimit a section (ca. 200 long) on the interest area with plane terrain surface and plan-parallel subhorizontal boundary lines of the subsoils. This conclusion means that the locality can is suitable for the construction since there is basically zero danger of uneven deformations of the bedrock. The following statements are also important:

- loess superstrata show higher compressibility but without a predisposition of soil to collapsing;
- sand layer is not prone to liquification in case of seismic load;
- groundwater level shows minor changes in the course of time and it does not achieve the level of foundation level, water is not aggressive to concrete.

More detailed date to the engineering-geological relations in the locality can be found in the chapter C.II.2.3. Engineering-geological Situation (page 149 of the Report).

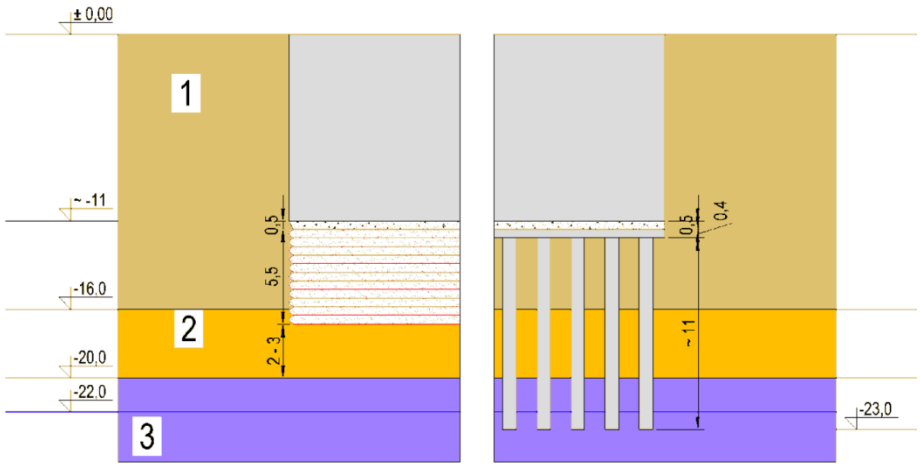
Geological conditions in the locality in connection with the level of seismic danger are limiting factors for construction of the nuclear island objects important from the safety point of view. The shallow foundation in the layers of a loess complex is practically impossible for the construction of objects of the nuclear island which are important in safety terms. Only the objects with a low level of tension on the foundation level can be built on such layers. There are several ways of construction of the objects important in terms of safety; a particular solution will be included in the design after a supplier is chosen. The depth of the construction of important buildings fluctuates between 8 – 12 m for the individual reference projects.

Basically, there are two alternatives of the possible solution which result from the preference of the areal construction but on the subsoil enhanced with suitable technologies:

- enhancement of the subsoil with sandy gravel cushion where a part of soil with less favourable qualities (loess) is replaced with sandy gravel;
- enhancement of the subsoil with piles bearing in the gravel layer which are in the upper section connected by a reinforced concrete plate.

Both alternative include preferred subvariants of using geosynthetic material: sandy gravel cushion reinforced with geosynthetic material or piles reinforced with geosynthetic material. Geofabrics or geograte with high initial tractional firmness are being considered as elements of the geosynthetic materials. The proposal results from the assessment of the reinforced ground constructions sensitivity to seismic load when their high initial firmness improves the toughness of the enhanced bedrock in the period of a short-term seismic load. In both cases the area of a layer of compacted sandy gravel 0.5 m thick remains between the enhanced subsoil area and the foundation plate of the unit. The layer has important positive effect on the interaction of the unit with the subsoil in case of seismic load.

Figure A.II.31: The scheme of alternatives of the subsoil enhancement



1 Loess **2** Alluvial clay **3** Grit

The thickness of the reinforced gravel cushion is, depending on the nuclear unit type 4.5 ~ 6.0 m and a layer of original fine-grained soil with thickness of ca 2.0 ~ 3.0 m remain in the subsoil. The layer of fine-grained soil can create an important part of protection of groundwater accumulated in the sandy gravel layer against a potential contamination. In case of enhancement of the subsoil by piles, they are intended to be 11 m long and buried to 3 m in the gravel layer.

The construction of the NJZ itself will begin with terrain adjustments and excavation works connected with the adjustment of the foundation split. These activities will be followed by the unit construction, which means reinforcing and concreting of the foundation plate of the production unit (nuclear island). Analogous activities will be carried out on the secondary part turbine island and other structures. Extend and composition of the individual constructional parts will depend on the suppliers on the construction. In the course of construction works also technological parts and elements which cannot be assembled additionally to the completed construction (for example because of their measures) and elements embedded in the construction concrete will be being fixed to the construction.

After completion of the construction preparations a gradual assembly of technology (operational sets) will follow and after that the assembly of electrical equipment and management and control systems will follow. The assembly works will end by individual tests of equipment and by individual tests of partial systems and verification of their readiness for commissioning of the unit. Other activities will lead to verification of project functions in the course of the gradual commissioning of non-nuclear and nuclear facilities on the individual output levels until the absolute design output.

After construction completion the areas of construction of the facility will be reclaimed.

It is supposed that the entire construction time will last ca. 6 years (from the beginning until putting into trial operation).

A.II.8.3.5.2. Corridor Works Connected with Infrastructure Networks

It concerns the construction of electric power outlet lines, internal consumption stand-by power supply, pipelines for raw water supply and discharge of waste and rainfall water.

The construction of electricity networks will be composed of foundations concreting for the individual pylons and stretching of cables. Mechanization (a temporary conveyor belt) will be able to move along the entire length of power lines, after works completion terrain adjustments and restoring to the original state will be carried out

Pipelines of water management connection will be provided in a work stripe ca. 36 m long along the entire length of the pipeline. Topsoil and excavated soil will be deposited in this stripe; the excavation itself will be provided in the stripe and an area for assembly of pipeline and mechanization movement will be located there. After the pipeline placing and backfilling the terrain will be adjusted to the original state (topsoil will be spread on the agricultural land) and the areas will be returned to the original purpose.

Construction of both cases will approximately last 1 year.

A.II.8.3.6. Termination of Operation and Decommissioning Data

After the expiry of the operation (intended for 60 years) the function of the NJZ will be terminated and the facility will be subsequently decommissioned. According to the Act No. 541/2004 Coll. the Atomic Act, as amended by later regulations, the following is applied:

Termination of operation: Nuclear facility condition when it ceased to be used for the original purpose and the process is irreversible.

Decommissioning: Activities after the termination of operation which are aimed at nuclear facility removal from under the atomic act effect.

The termination of operation precedes the decommissioning. Main activities of this stage include primarily the reactor shutdown and extraction of nuclear fuel to the storage pool in the power plant, storage of the spent nuclear fuel in the unit pool and its gradual handing over for further processing (in similar way as in the time of the previous normal operation), liquids and gasses removal from the non-operational systems, decontamination of the primary circuit for the purposes of dose rates decreasing, processing of waste from operation and its gradual handing over for further processing (in similar way as in the time of the previous normal operation), monitoring and safety activities, procurement of basic equipment and materials for the needs of termination of operation and preparation of documentation for the procedures leading to the permission of the I. stage of decommissioning. All the systems for receiving, reloading and storage of spent fuel (including auxiliary clearing systems), special air-conditioning systems, including ventilation stack, radiation monitoring, collection and waste water treatment systems, liquids and solid radioactive waste storage, decontamination system and physical protection system, located in the structures directly related to the nuclear island operation, will be still maintained in the operation. It is necessary to say that according to the legislatively applicable regulations the termination of operation is still considered to be a part of the operation. The termination of operation principles are defined in the Strategy for the Final Stage of Peaceful Utilization of the Nuclear Energy government of the Slovak Republic, approved by the government of the Slovak Republic, as follows:

- the level of nuclear, radiation and general safety cannot be reduced, i.e. the JE systems are reduced to the level necessary for safety provision;
- extraction of spent nuclear fuel to the independent spent fuel storage facility;
- radioactive substances which are products of the operation have to be extracted from the power plan for processing and treatment or a relevant and detailed timetable has to be worked out for processing of substances from the first stage of decommissioning with a defined interval of the inspection of the timetable observance;
- operational and auxiliary media from the no longer used systems will be removed; after the removal of media the systems are supposed to be decontaminated or scoured in order to achieve the lower level of residual contamination that the predefined criteria; moreover, all the systems are supposed to be dried when necessary;
- in the course of the termination of operation the gradual permanent shut down of the facility systems and components according to the timetable will take place;

- it is necessary to characterize and list the inventory of radioactive and dangerous substances which are present within the power plant premises and this includes the inspection of existing data, calculations, in-situ measurements and/or representative sampling and sample analysis; the result will be a database which will provide important base for the process of detailed planning and further decommissioning;
- power plant facilities will be divided into:
  - facilities maintained as usual during the operation;
  - facilities and systems which will remain in operation but have to be modified as a result of safety analyses due to economic reasons;
  - facilities preserved (i.e. conserved) for further use in the future;
  - new facilities due to newly arisen needs or replacing of contaminated facilities from the operation;
  - facilities and systems which were completely decommissioned.

Decommissioning of the nuclear facility is defined as a set of activities carried after the termination of operation, the goal of which is to remove the nuclear facility out of the atomic act effect. The decommissioning of nuclear power plants usually takes tens of years. The base of the decommissioning approach of a long-term conceptual planning:

- Firstly, "The Specification Report on the Way of Decommissioning" has to deal with the decommissioning of a nuclear facility; the Report is a part of the documentation necessary for issuing a permission by the ÚJD SR for the placement of the nuclear facility construction;
- Another "Preparatory Conceptual Decommissioning Plan" is a part of the documentation necessary for issuing a permission for building permit by the ÚJD SR for a specific nuclear facility;
- "Conceptual Decommissioning Plan" is a part of the documentation necessary for the application for nuclear facility commissioning and operation; the document is then updated every ten years;
- Decommissioning is usually divided into phases with a defined starting and end state. "Decommissioning Phase Plan" and "Decommissioning Conception for the Time after the End of the Approval Phase Decommissioning" are worked out for each approval phase; the Decommissioning Phase Plan is updated every five years.

It is necessary to have available sufficient financial means for the decommissioning according to the planned timetables. Financial means for "the future costs" is in the Slovak Republic cumulated in the National Nuclear Fund. The owners/authorization holders of the nuclear facilities contribute to the fund according to an in advance approved scheme (see more details in the relevant Regulation of the Act No. 238/2006 Coll. on the Nuclear fund as amended by later regulations). According to the Proposal of the National Policy and National Programme of the Spent Fuel and Radioactive Waste Management in SR (2015), it is required to reassess the calculations for financing of the final part of peaceful utilization of nuclear energy until June 2015 and then every six years and the results have to be implanted in the relevant provisions of the legislative regulations.

Activities connected with the nuclear facilities decommissioning are in the Slovak Republic carried out by the organization JAVYS as an authorized legal body.

The legislative regulations of the Slovak Republic reflect the worldwide approach to the decommissioning when two ways of decommissioning are being considered:

- immediate decommissioning activities will be carried out continually without any delay,
- deferred decommissioning (decommissioning with safe enclosure) where the selected technological units are dismantled (e.g. object with reactors) later, for example after several tens of years.

As far as the radioactive waste and spent fuel are concerned the commencement of decommissioning is conditioned by the state when all the spent fuel is extracted to an individual nuclear facility authorized to process it (to a spent fuel storage, sometimes called "away-from-reactor") and (according to the current approach) there are no liquid radioactive substances in the power plant.

Processing and treatment of decommissioning waste will not basically differ from the processing and treatment of operational waste. On the other hand, decommissioning waste will differ from operational waste both in terms of type and activity and also contents of individual radionuclides. It is expected that when decommissioning of a greater amount of non-active waste and radioactive materials (metals, construction brash) will emerge and due to regarding their radioactivity it will be possible to set them aside from the radiation sources and thus to recycle them or to reposit them to conventional waste dumps. Radioactive waste will primarily consists of low-active waste which could be reposited in a simpler way (for example

it will not be reposited in the current containers but in barrels or packages in holes) maintaining the requirements of a long-term passive safety of the storage system.

The most important part of liquid waste is secondary waste from decontamination; gaseous waste will come only from the ventilation system. Solid waste will come from dismantling and fragmentation and then from demolition works. It is basically possible to say that higher quality waste (essentially, all the waste not storable in a surface storage facility, which the Slovak RÚ RAO is) will be produced towards the end of decommissioning when, according to the existing plans of various levels decommissioning, the reactor and its immediate surrounding will be dismantled including the necessary demolition.

Rough estimates of the amount of decommissioning radioactive waste is provided by suppliers in two ways – estimates of the amount depending on the waste material or estimates of the amount divided into groups according to the design basis decommissioning waste activity. It involves the amount up to 700 tons of medium level activity and ca. 10,000 tons of low a very low activity waste.

There is an established legislative framework in the Slovak Republic for determination of the end of decommissioning. The nuclear facility (or more precisely: what is left from the original nuclear facility after dismantling and demolition works including the nuclear facility premises) which is set aside from the atomic act effect can mean:

- unlimited use under the condition of fulfilment of radiological criteria stated in the regulations on the health protection against the ionizing radiation or
- limited use under the condition of adequate institutional measures.

It is important that in case of the unlimited use of the decommissioned nuclear facility, its area or parts, no other nuclear facility, not even one being decommissioned, is operated in its surrounding.

As for the generation III+ reactors it is required that the nuclear facility project would take into account the needs of decommissioning. The NJZ project will have to take into account:

- the need to reduce the radiation sources in the power plant facilities by the reduction of activation products in metal materials (minimization of volumes of easily activatable elements, improvement of neutron shielding) and reduction of surface contamination (surface quality and decontamination during the operation),
- the need to reduce the dismantling period of radioactive facilities (accessibility, possibility to remove big components in one piece, easily removable shielding, taking out of the connections, fixtures, pipeline constructions, use of the same ventilation systems as during the operation),
- simplification of waste treatment,
- in case of a deferred decommissioning, elimination of corrosion in the long term, long-term nature of the operation of systems useful for decommissioning (fire protection facilities, electric wiring, monitoring devices, deliberation of processes which can affect the integrity and stability of buildings in the long term).

The decommissioning of nuclear facilities will be (according to the applicable legislation, which means, the Act No. 24/2006 Coll. on Environmental Impact Assessment as amended by later regulations) the subject of an independent EIA process which will be based on the updated conceptual plan for decommissioning, the last one before the termination of operation or from the final decommissioning phase plan.

A.II.8.4. Data on Other Facilities and on the Intentions in the Locality

This chapter describes the specific data and requirements relating to the other (existing or being prepared) activities in the Jaslovské Bohunice locality.

A.II.8.4.1. Overview of Other Facilities and Intentions in the Locality

Premises of the companies JAVYS, SE and JESS are located in the Jaslovské Bohunice locality. They are three individual entities with the following five nuclear facilities in various phases of their life cycle:

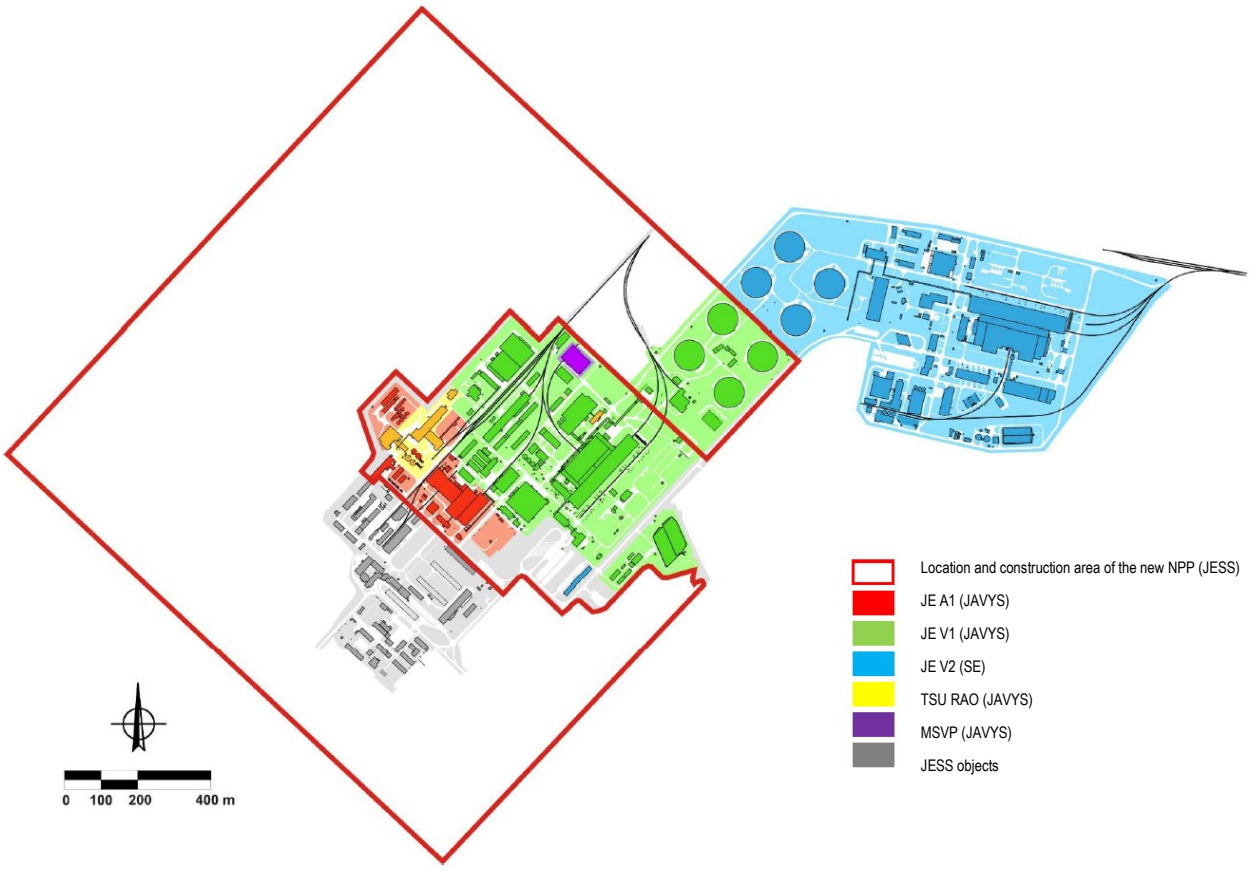
- V2 nuclear power plant (authorization holder - SE),
- intermediate storage facility of spent nuclear fuel (authorization holder - JAVYS),
- processing and radioactive waste treatment technologies (authorization holder - JAVYS),
- decommissioned nuclear power plant A1 (authorization holder - JAVYS),

- decommissioned nuclear power plant V1 (authorization holder - JAVYS),

No nuclear facility is currently located in the JESS premises itself (where the construction of the NJZ is planned).

The location of the individual premises and facilities in the locality is described in the following picture.

Figure A.II.32: Position of the individual nuclear facilities, property structure of the locality



A construction of an integral radioactive waste storage facility IS RAO (the finished EIA process, final statement of MŽP SR issued 9/2012, in design preparation phase) is intended to be built in a part of the existing premises owned by JAVYS company.

In various phases of the design preparation or of the EIA process, there are the following proposed activities in the Jaslovské Bohunice locality: radioactive waste processing and treatment technologies (JAVYS; final opinion of MŽP SR issued 11/2014), prolongation of operational lifetime of JE V2, decommissioning of JE V1 – 2. phase (JAVYS; final opinion of MŽP SR issued 6/2014), construction of a new large capacity fragmentation and decontamination facility JE V1 (JAVYS; final opinion of MŽP SR issued 8/2014), increase of capacity of the existing fragmentation and decontamination facilities (JAVYS; final opinion of MŽP SR issued 2/2013), facility for remelting of metal radioactive waste (JAVYS; final opinion of MŽP SR issued 1/2015) and expansion of capacity of the intermediate storage facility of spent fuel (JAVYS; the prepared Assessment Report 1/2015).

When assessing the impacts of the NJZ on the environment the cumulative affecting influences of the mentioned activities were taken into account. The operations of the nuclear power plants (prepared NJZ, JE V2 in operation) are the most important influences. Decommissioning activities in the power plants (JE A1, JE V1, after termination of operation also JE V2) follow and then other activities on the premises of the nuclear facilities. For completeness it is necessary to mention also the activities outside the premises of the nuclear facilities (e.g. substations) which are of an absolutely non-radiation character.

More detailed information on the mentioned activities can be found in the following text.

A.II.8.4.1.1. Nuclear Power Plant V2

The nuclear power plant V2 with two reactors VVER 440 of an improved type V-213 started to be built in 1976. The third unit[13] was put into operation in 1984, the fourth unit a year later. The installed electric output of the power plant V2 is currently (after modernization works) 2x550 MW_e. As for the used technology JE V2 belongs to the Generation II of nuclear reactors.

In comparison with the units of the power plant V1 (see below) the JE V2 reactor units represent, from the nuclear safety point of view, an improved series of the VVER 440 units.

JE V2 is designed as a double unit. The reactors and main devices of the primary circuit are located in a protective enclosure which functions as a containment and which is equipped with a passive mechanism of pressure suppression (pressurizer relief tower). The primary circuit of each JE V2 unit consists of a reactor and six cooling loops with steam generators. The secondary circuit is composed of steam piping which conduct steam from steam generators to two turbogenerators by means of a steam condensation system and feedwater system for steam generators. The steam is condensed via the tertiary circuit. Cooling towers (two towers per a unit) are a part of the tertiary circuit where the heat is vaporized to the environment.

The safety concept of the JE V2 reactors is based on a combination of active and passive safety systems. A principle of 3x100 % is applied in the active systems when each division itself of the relevant safety system is able to fulfil the safety function. The active safety systems are the high-pressure and low-pressure emergency core cooling system, containment spraying system and essential service water system. The passive safety systems are usually characterized by the principle 2x100 % in case of safety valves on the primary circuit or 4x50 % in case of hydroaccumulators. The safety valves reduce the pressure increase in case of events with heat removal failure from the primary circuit. The hydroaccumulators are specified for the passive cooling of the core in case of coolant inventory decrease in the primary circuit. In case of scram the reactors are equipped with an automatic scram system which works on the passive principle – when achieving the given parameters the electric power supply of the emergency rods is disconnected and the rods are by own gravity inserted to the core and stop the fission reaction.

The VVER 440 type reactors include several inherent safety elements which increase the safety. These elements include the unit arrangement with six loops which are separable by isolation valves positioned on each loops and with two turbines reducing the seriousness of many transitional states. The elements of inherent safety are also the use of horizontal steam generators (it simplifies the transition of core cooling to the natural circulation in the primary circuit in case of power supply failure) with great water inventory also in the secondary part of steam generators what reduces the transitional processes connected with an unbalance between the production and heat removal and provides sufficient time reserve for the NPP personnel to carry out the activities according to the relevant operating procedures.

The V2 power plant came to a combined electricity and heat production in 1987 by building of a centralized head supply system. A heat feeder to Trnava, Hlohovec, Leopoldov, Jaslovské Bohunice and greenhouses in Malženice is a part of the system. From the beginning of the operation a great importance was put on the increase of nuclear safety and operating reliability of the JE V2. Gradually, due to the increasing legislation requirements and needs of operating reliability of the JE V2 an entire line of measures was taken according to the internationally acceptable standards as far as the project, operation, maintenance, facility maintenance programmes, process monitoring and regulatory supervision are concerned. Extensive investment projects, which have been mainly realized in the last ten years, were focused on further improvement of nuclear safety (including the solutions of severe accidents area), seismic resistance of the units and also increase of the output of the units.

In 2012 a project of design life prolongation of the JE V2 started. Currently, it is not decided about the prolongation yet and therefore a concurrence with the operation of the power plant V2 up to the maximum possible time is being considered due to the assessment of the environmental impacts of the NPP (determination of the period of jointly affecting influences with the power plant V2).

[13] Units numbering relates to the previous two units of the power plant V1.

A.II.8.4.1.2. Intermediate Storage Facility of the spent Nuclear Fuel

The intermediate storage facility of spent nuclear fuel (MSVP) represents a nuclear facility which is used for temporary (tens of years) and safe storage of spent nuclear fuel from the reactors of VVER type. The spent fuel is stored in storage pools in the environment of demineralized water.

The MSVP was put into operation in 1986, the active operation started in 1987. Spent fuel is transported to the MSVP after approximately 4 to 7 years´ cooling in the storage pools of the main production unit of the nuclear power plant.

In 1997 to 1999 the MSVP underwent a massive reconstruction aimed at the increase of storage capacity and seismic reinforcement of the object. The entire storage capacity of the MSVP was tripled in comparison with the original capacity. The storage capacity comprises currently 14,112 spent fuel assemblies (5,040 pieces before). This storage capacity will not be sufficient for the storage of all spent nuclear fuel from the JE V1 (being decommissioned), JE V2 and EMO1,2 (in operation) and MO 3,4, (under construction). Due to this fact preparation works are being carried out to build new capacity for the VJP storage.

In time of preparing of the Report the “Completion of the Storage Capacity of the Intermediate Storage Facility of Spent Nuclear Fuel in the Jaslovské Bohunice Locality” was in the process of negotiations of EIA for the proposed activity. The EIA Report (JAVYS 1/2015) says that the subject of the proposed activity is extension of the storage capacity of MSVP by a minimum of 10,100 fuel assemblies (I. phase) and by another 8,500 fuel assemblies (II. phase). January 2021 is supposed to be the start of the operation of the extended part. Termination of the storage of spent fuel in the MSVP is intended for the year 2121. There are three possible variants being considered in the EIA Report for the extension of the storage capacity:

- Storage in a similar way as up to the present, i.e. completion of the construction of storage pools with the use of currently (i.e. after the completed reconstruction) used storage bins KZ-48.
- Extension of capacity through dry storing with construction interconnection with the current MSVP building using transportation-storage containers for a maximum of 84 pcs of fuel assemblies placed on the reinforced floor in a storage hall.
- Extension of capacity by dry storing with a construction interconnection with the current MSVP building using storage cans for a maximum of 85 fuel assemblies located in reinforced concrete storage modules; each fuel cartridge will go through the existing storage pools and after a sufficient period of cooling it will be relocated for further storage in the mentioned way. This was storage is characterized by passive cooling of the fuel assemblies by air. The fuel assemblies are placed in cans located in reinforced concrete modules – cells.

The comparison of the individual variants with respect to the influences on the individual components of the environment including the public health resulted in the fact that the third variant was assessed as the most appropriate and recommended for implementation.

The mentioned assessment report of the reconstruction of storage capacity for MSVP does not explicitly mention the storage of spent nuclear fuel from the NJZ. The dry part of the storage will be of modular type, which means, that it will be possible to gradually expand the storage facility by other modules in accordance with the worldwide experience so that all the spent fuel could from all the Slovak nuclear power plants could be stored in the facility when necessary.

A.II.8.4.1.3. Radioactive Waste Processing and Treatment Technologies

RAO processing and treatment technologies are used to process and treat the low and medium activity RAO produced as a result of decommissioning of the JE A1 (currently in the II. phase of decommissioning), decommissioning of the JE V1 (currently in the II. phase of decommissioning) and RAO from the operation of nuclear facilities and from various areas of human activities as research, medicine and the like (so-called institutional radioactive waste).

The RAO processing and treatment technologies (TSU RAO) consist from the following basic technological groups:

1) A set of technologies classified in the nuclear facility RAO processing and treatment technologies located in the operated objects in the EBO premises. It is used for management of the radioactive waste from the Jaslovské Bohunice locality and solid radioactive waste from Mochovce locality. The set is composed of:
   - Bohunice treatment centre (BSC) with the following technologies:
     - evaporator for increase of concentration of the liquid radioactive waste,
     - cementation,
     - separation of solid radioactive waste,
     - incineration of solid and liquid radioactive waste,
     - high-pressure pressing.

     The BSC technologies lead to a preparation of the RAO package which is currently the only approved form for storage in the RÚ RAO. The approved RAO types are sealed with cement to cubic concrete containers with an edge of 1.7 m, with the inside volume of 3.1 m^3, reinforced with amorphous alloy steel produced by JAVYS under the license of a French company Sogefibre.

     Between 2011-2013 the BSC technologies were improved mainly by changing of the worn out technological parts, by possibility to press the RAO with higher activity in the super compactor and by increase of efficiency and nuclear safety in the incineration plant as a result of the change of the heat medium and purification system for the incineration gas products.
   - Bituminization lines:
     - two basically identical bituminization lines,
     - discontinuous bituminization line,
     - nuclear waste purification station.
   - Metal RAO processing place of work (fragmentation line).
   - Air-conditioning filters processing.
   - Large capacity decontamination line.
2) A set of technologies for RAO processing, which are currently used to fulfil the particular RAO processing tasks from the decommissioning of the JE A1, located in the former operation objects of the JE A1 and in the main production unit of the JE A1. The set includes:
   - facilities for fixation of sludge,
   - fragmentation and decontamination places of work and facilities,
   - contaminated concrete processing place of work,
   - contaminated soil separation place of work,
   - vitrification line,
   - sludge processing facility (SUZA),
   - hot chamber/handling box,
   - other auxiliary lines and facilities.

A.II.8.4.1.4. The Decommissioned Nuclear Power Plant A1

The nuclear power plant A1 with a heterogeneous reactor marked as KS-150 was designed for the electric capacity of 143 MW_e. Metallic uranium was used as fuel, heavy water was used as moderator and carbon dioxide was used as coolant. The nuclear power plant A1 was connected to the electric grid in December 1972. After an accident in 1977 the NPP was shut down and the decision was made not to restore the operation of the JE A1. Subsequently, the activities leading to decommissioning of the JE A1 were carried out. All the spent fuel produced during the operation of the JE A1 was, on the basis of a contract, exported to the Russian Federation (the transfer finished in 1999).

The JE A1 is currently in the 2nd decommissioning phase and the decommissioning works will be, according to the existing plans, running until 2033.

A.II.8.4.1.5. The Decommissioned Power Plant V1

The power plant V1 is equipped with two reactors VVER 440 of older type V-230. The first unit was commissioned in 1978; the second unit was commissioned two years later.

Similarly as in case of the JE V2 many projects were completed in the JE V1 aimed at improvement of safety and operational reliability but a decision about a premature shut down of both units of the JE V1 was eventually made as a condition for European Union accession treaty. The first unit was decommissioned at the end of 2006, the second one in 2008.

The JE V1 is currently in the second phase of decommissioning. The relevant permissions for the commencement of the second phase were issued by ÚJD SR in December 2014 after the termination of EIA process. According to a time schedule the decommissioning works in the JE V1 will continue until 2025.

A.II.8.4.2. The Operational Period and Decommissioning of Other Nuclear Facilities in the Locality

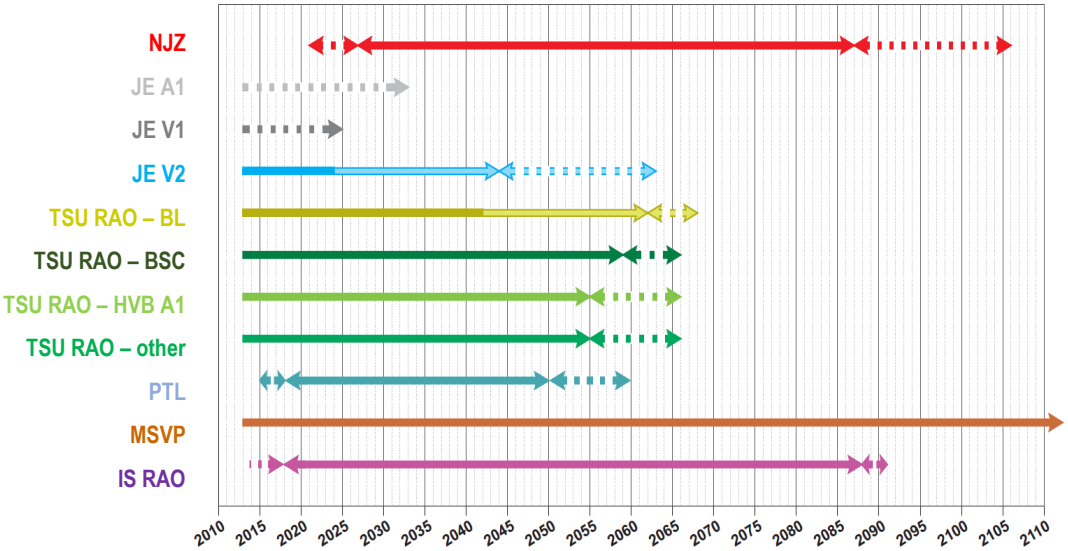
In order to specify the time processes of jointly affecting influences of the NJZ with other facilities, an overview of construction, operation and decommissioning of the individual nuclear facilities in the locality was developed. This overview is based on the last documents of companies JESS, SE and JAVYS and at the same time takes into account the document of Strategy for the Final Stage of Peaceful Utilization of the Nuclear Energy in SR. The following existing and currently being prepared nuclear facilities are included in the overview on the basis of the mentioned documents:

- NJZ (JESS)
- JE A1 (JAVYS),
- JE V1 (JAVYS),
- JE V2 (SE),
- radioactive waste processing and treatment technologies (JAVYS),
- MSVP (JAVYS),
- integral RAO storage facility (JAVYS),
- PTL – remelting line (JAVYS).

The operation length of the JE V2 is designed alternatively taking into account an opened question of prolongation of the design life. These alternatives affect the operation dates and decommissioning dates of other nuclear facilities in the locality (TSÚ RAO).

The graphic scheme of the time process of the jointly affecting influences of the individual nuclear facilities in the Jaslovské Bohunice locality is, starting from 2013, depicted in the following picture.

Figure A.II.33: Time process of the jointly affecting influences of the individual nuclear facilities in the Jaslovské Bohunice site



Note: continuous line = estimated operation period, dashed line = estimated period for construction/decommissioning

It is obvious that the influences of the NJZ operation will cumulatively affect the operation of the JE V2 within 0 to 20 years (a conservative estimate). The current operation of both nuclear power plants (NJZ and JE V2) must be considered the most important cumulative affecting influence which is taken into account in the Report when assessing the maximum possible time range.

The influence of the NJZ operation will further interfere with various phases of the life cycle (construction, operation, decommissioning) of other nuclear facilities in the locality. This cumulatively affecting factor is less important (regarding the lower-conduit radioactive discharges of the facilities in comparison with the nuclear power plant operation) but in the Report is taken into consideration in its potential maximum.

A.II.9. Proposed Activity Alternatives

9. Proposed Activity Alternatives.

The proposed activity is implemented in one alternative, which consists of the construction of a NJZ at the Jaslovské Bohunice site. The choice of this alternative is based on the factoring of the following options of the alternative solution:

- alternatives of the NJZ siting within the Slovak Republic,
- alternatives of the NJZ siting within the Jaslovské Bohunice site,
- alternatives of the NJZ capacity (net installed capacity)
- alternatives of the NJZ technological solution
- reference alternatives (other ways of electric power generation and/or electric power saving),
- alternatives of the NJZ networks (connection to the local infrastructure),
- zero alternative (non-execution of the NJZ).

From the analysis of these options, the following facts follow:

The alternatives of the NJZ siting within the Slovak Republic: The siting of the NJZ at the Jaslovské Bohunice site is anticipated in the *Government Resolution No. 948/2008, Energy Policy of the Slovak Republic, Conception of Urban Development of the Slovak Republic*, and the *Land Use Plan of the Trnava Self-Governing Region*. There are no other alternatives of the NJZ siting currently considered in government and strategy papers in the Slovak Republic. The Jaslovské Bohunice site is suitable from the viewpoint of the legislation requirements for the siting of a nuclear power plant, it has been considered in the long run in terms of nuclear plant electric power generation and of construction

and running of further nuclear plants, and it contains available the necessary areas and infrastructure connections. From the environmental point of view, the selection of this site thus represents an effective utilisation of the available resources. The Customer, the Jadrová energetická spoločnosť Slovenska, a. s., was, according to its shareholders' agreement, founded as a company namely for the NJZ preparation at the Jaslovské Bohunice site.

The alternatives of the NJZ siting within the Jaslovské Bohunice site: The precise siting is treated in the accompanying material to the Government Resolution No. 948/2008, which considers two areas – an area to the south-west from the decommissioned A1 nuclear power plant and an area to the north-east from the existing JE V1. Further it says that the final location will be determined by the conclusions of the Feasibility Study, which may possibly recommend an option different from the two listed ones. The Feasibility Study elaborated in 2012 determined an area for the construction which contains both the above-mentioned areas. This area will be used for the construction of the new plant, including the related and induced investments, as a whole. This area is also considered by the *Land Use Plan of the Trnava Autonomous Region*.

Alternatives of the NJZ capacity (of the installed capacity): The net installed capacity of the NJZ in the Jaslovské Bohunice site of less than 1,700 MW_e is in line with the *Energy Policy of the Slovak Republic* and the *Land Use Plan of the Trnava Autonomous Region*, which consider the net installed capacity of the NJZ at the site no more than 2,400 MW_e. The capacity, at the same time, respects the requirements of the Scope of Assessment for the assessment elaboration of the proposed activity for the alternative of "one reactor unit with a pressurised water reactor of the generation III+ with the maximum net installed capacity of 1,700 MW_e".

Alternatives of the NJZ technological solution: Only a source with a pressurised water reactor (PWR) of the generation III+ is considered, the reason being that these kind of sources are currently the best technology available. The PWR type reactors are the most frequently utilised type of source, both in Europe and world-wide, with a whole range of safety advantages. In the conditions of the Slovak Republic, one of the advantages is long-term operation experience. Such a source may be supplied by several producers, their selection not being the subject of the EIA. The selection of the supplier will be carried out in the next steps of the preparation of the project, from which beforehand none of the applicants may be ruled out, and, on the contrary, none of the producers may be required to participate. The environmental impact of all the commercially available sources with the PWR generation III+ reactor are similar in their quality and quantity aspects. The EIA process considers a common conservative envelope of all the properties which may have an impact on the environment. The same is true for the safety requirements of the legislation relating to the nuclear sources.

Reference alternatives (other ways of electric power generation and/or electric power saving): The proposed activity solves the universally accepted demand for this type of source (nuclear source), expressed in the relevant strategy papers of the Slovak Republic including government resolutions. The Customer, the Jadrová energetická spoločnosť Slovenska, a. s., was, according to its shareholders' agreement, founded namely for the NJZ preparation at the Jaslovské Bohunice site. Other sources (including savings) are dealt with in the approved strategy papers in the relevant contexts and by other investors.

Alternatives of the NJZ networks (connection to the local infrastructure): At the Jaslovské Bohunice site, all the necessary infrastructure is available for the operation of the existing sources (especially the electric power outlet into the transfer grid and the water management network). The siting and the routes of the infrastructure for the new source are thus unequivocally determined by the existing infrastructure corridors, with the usage of the existing corridors representing from the environmental point of view an effective utilisation of the available resources.

Zero alternative (non-execution of the activity): The zero alternative is an option which would ensue if the proposed activity were not implemented. This alternative is not in line with the strategy papers (especially Government Resolution No. 948/2008, Energy Policy of the Slovak Republic, Urban Development

Conception of the Slovak Republic, and Land Use Plan of the Trnava Self-Governing Region). Nevertheless, the EIA process deals with the assessment of this alternative, in compliance with the requirements of the Act No. 24/2006 Coll. on Environmental Impact, as amended.

From the abovementioned data, and also based on the current status of the approved and prepared relevant strategy papers of the Slovak Republic and the availability of the best technology, it follows that there is no other realistic alternative available for the proposed activity than the one being proposed, that is, neither a different site nor a different technology.

For this reason, the Ministry of Environment of the Slovak Republic has, on the basis of the Customer´s request and evaluation of the facts listed in it, abandoned the requirement of an alternative. In the Scope of Assessment it requires (besides the zero alternative) an elaboration of the assessment for the alternative of one reactor unit with a pressurised water reactor of the generation III+ with the maximum net installed capacity up to 1,700 MW_e.

A.II.10. Overall Costs

10. Overall Costs (approximate).

App. € 4 to 6 bn.

A.II.11. Community Concerned

11. Community Concerned.

Those communities are considered as concerned in the territories of which the proposed activity is to take place, that is in the territory of which all the units of the proposed activity will be physically located, such as the area for the NJZ siting and construction and the corridors of relevant infrastructure, including their immediate surroundings.

Further, those communities are considered as concerned that might be concerned by a declared zone of emergency planning. Although that is not currently defined for the NJZ (it will be defined during the subsequent proceedings, outside of the EIA process), but according to the IAEA[14] safety manuals for reactors with a capacity >1,000 MW, the recommended radius of the inner zone of emergency planning is between 3 and 5 km. Thus, the cadastre territories of the communities located within 5 km from the border of the NJZ site are conservatively considered to be concerned.

Finally, those communities are considered as concerned which may be substantially impacted by the influences of the proposed activity. As follows from the analyses of the potential impact on the various parts of the environment, carried out in the relevant chapters of this Report, the extent of significant influences will not exceed the abovementioned extent of the site of the proposed activity and conservatively considered emergency planning zone.

With regards to the facts listed, the following list of communities concerned has been established.

[14] IAEA Safety GuideNo. GS-G-2.1 Arrangements for Preparedness for a Nuclear or Radiological Emergency

Table A.II.9: List of Communities Concerned

Region	District	The cadastre territories of the communities	Area of NJZ construction siting	Corridor – raw water	Corridor – waste water and rainfall water	Corridor – electricity	5 km zone from the NJZ area
Trnava	Trnava	Jaslovské Bohunice	●			●	●
		Malženice					●
		Radošovce	●				●
		Dolné Dubové					●
		Kátlovce					●
		Špačince					●
	Hlohovec	Ratkovce	●		●		●
		Žlkovce					●
		Červeník			●		
		Trakovice					●
		Madunice		●	●		
	Piešťany	Nižná					●
		Pečeňady	●	●	●		●
		Veľké Kostoľany	●	●			●
		Dubovany		●			●
		Drahovce		●			
		Dolný Lopašov					●
		Chtelnica					●
		Piešťany		●			

The location of the communities concerned and their spatial relation to the proposed activity is clear from the map annex No. 1 of this Report.

Addresses of the communities concerned:

Jaslovské Bohunice

Obec Jaslovské Bohunice
Námestie sv. Michala 36/10A
919 30 Jaslovské Bohunice
+421 33 557 10 20, +421 917 814 918
www.jaslovskebohunice.sk

Malženice

Obec Malženice
Malženice 294
919 29 Malženice
+421 33 743 41 13, +421 905 898 197
obec@malzenice.sk
www.malzenice.sk

Radošovce

Obec Radošovce
Radošovce 70
919 30 Jaslovské Bohunice
+421 33 559 23 03
www.obecradosovce.sk

Dolné Dubové

Obec Dolné Dubové
919 52 Dolné Dubové
+421 33 559 21 16, +421 33 559 26 33
www.dolnedubove.sk

Kátlovce	Obec Kátlovce 919 55 Kátlovce +421 33 557 61 33 obeckatlovce@stonline.sk www.katlovce.sk
Špačince	Obec Špačince Hlavná 183/16 919 51 Špačince +421 33 557 31 23, +421 33 557 31 09 info@spacince.sk www.spacince.sk
Ratkovce	Obec Ratkovce Ratkovce 97 920 42 Červeník +421 33 743 41 76 ouratkovce@ratkovce.sk www.ratkovce.sk
Žlkovce	Obec Žlkovce č. 158 (budova kultúrneho domu) 920 42 Červeník +421 33 743 41 53 www.zlkovce.sk
Červeník	Obec Červeník Kalinčiakova 26 920 42 Červeník +421 33 734 11 27 cervenik@cervenik.sk www.cervenik.sk
Trakovice	Obec Trakovice Trakovice č. 38 919 33 Trakovice obec@trakovice.sk www.trakovice.sk
Madunice	Obec Madunice P. O. Hviezdoslava 8/368 922 42 Madunice +421 33 743 11 23 madunice@madunice.sk www.madunice.sk

Veľké Kostoľany	Obec Veľké Kostoľany M. R. Štefánika 800/1 922 07 Veľké Kostoľany +421 33 778 11 02, +421 915 107 289 velkekostolany@velkekostolany.sk www.velkekostolany.sk
Nižná	Obec Nižná Nižná č. 80 922 06 Nižná +421 33 778 82 27 ocunizna@gmail.com www.obecnizna.sk
Pečeňady	Obec Pečeňady Pečeňady č. 93 922 07 Pečeňady +421 33 778 11 15, +421 33 771 90 05 info@pecenady.sk www.pecenady.sk
Dubovany	Obec Dubovany Dubovany č. 200 922 08 Dubovany +421 33 77 961 01 dubovany@dubovany.sk www.dubovany.sk
Drahovce	Obec Drahovce Hlavná 429/127 922 41 Drahovce +421 33 778 35 21 oudrahovce@oudrahovce.sk www.drahovce.com
Dolný Lopašov	Obec Dolný Lopašov Dolný Lopašov 79 922 04 Dolný Lopašov +421 33 779 41 02 www.obecdlopasov.sk
Chtelnica	Obec Chtelnica Námestie 1. Mája 495/52 922 05 Chtelnica +421 33 779 41 25, +421 33 779 42 05 chtelnica@chtelnica.sk www.chtelnica.sk

Piešťany	Mesto Piešťany Námestie SNP 3 921 01 Piešťany +421 33 776 53 11, +421 33 776 53 01,02 msu@piestany.sk, sekretariat@piestany.sk www.piestany.sk

A.II.12. Self-Governing Region Concerned

12. Self-Governing Region Concerned.

Trnava Self-Governing Region	Trnavský samosprávny kraj P.O. Box 128, Starohájska 10 917 01 Trnava +421(0) 33 555 91 11 urad.vuc@trnava-vuc.sk www.trnava-vuc.sk

A.II.13. Authorities Concerned

13. Authorities Concerned.

The following list contains the authorities concerned:

- Nuclear Regulatory Authority of the Slovak Republic
- Public Health Authority of the Slovak Republic
- Regional Public Health Authority, Trnava
- Ministry of Health of the Slovak Republic
- Ministry of Environment of the Slovak Republic
- Ministry of Interior of the Slovak Republic
- Ministry of Transport, Construction and Regional Development of the Slovak Republic
- Slovak Environmental Agency, Banská Bystrica
- Slovak Environmental Inspection Authority, Bratislava
- Transport Authority, Bratislava
- The Regional Monument Board, Trnava
- National Labour Inspectorate of the Slovak Republic
- Labour Inspectorate, Trnava
- Technická inšpekcia, a. s., Nitra
- The Presidium of the Fire and Rescue Corps of the Ministry of Interior of the Slovak Republic
- The Regional Headqarters of the Fire and Rescue Corps, Trnava
- The Regional Headqarters of the Fire and Rescue Corps, Piešťany
- The Regional Headqarters of the Fire and Rescue Corps, Trnava
- Regional Authority Trnava, relevant departments
- Regional Authority Piešťany, relevant departments
- Regional Authority Hlohovec, relevant departments

A.II.14. Approving Authority

14. Approving Authority.

District Authority Trnava	Okresný úrad Trnava odbor výstavby a bytovej politiky Kollárova 8 917 02 Trnava +421(0) 33 556 43 29
Nuclear Regulatory Authority of the Slovak Republic	Úrad jadrového dozoru Slovenskej republiky Bajkalská 27 P. O. Box 24 820 07 Bratislava +421(2) 5822 1111
Public Health Authority of the Slovak Republic	Úrad verejného zdravotníctva Slovenskej republiky Trnavská cesta 52 826 45 Bratislava +421(2) 4437 2641

A.II.15. Departmental Authority

15. Departmental Authority.

Ministry of Economy of the Slovak Republic	Ministerstvo hospodárstva Slovenskej republiky Mierová 19 827 15 Bratislava 212 +421(2) 4854 1111

A.II.16. The Type of the Required Approvals under the Special Regulations

16. The Type of the Required Approvals under the Special Regulations.

The basic overview of the required approvals under the special regulations is as follows:

- Permission for the siting of a nuclear power plant construction (Nuclear Regulatory Authority of the Slovak Republic).
- Site permission (Regional Authority Trnava).
- Permission for the construction of a nuclear power plant (planning permission), permission for the entry into operation of a nuclear power plant, permission for running a nuclear power plant, permission for radioactive waste and spent nuclear fuel management, permission for nuclear material management in a nuclear power plant, permission for the import and export of nuclear materials, permission for the transport of radioactive materials, permission for specialist training of the employees (Nuclear Regulatory Authority of the Slovak Republic).
- Permission for activities resulting in radiation (Public Health Authority of the Slovak Republic).

A.II.17. Opinion on the Cross-Border Impacts

17. Opinion on the Cross-Border Impacts.

The proposed activity is among activities that are subject to the international evaluation from the viewpoint of the cross-border environmental impact (annex No. 13 of the Act No. 24/2006 Coll. on Environmental Impact, as amended) in the following way:

Article 2. Thermal power plants and other combustion units of heating capacity of 300 MW and more, furthermore nuclear power plants and other nuclear reactors (excepting research plants for generation and conversion of fissile and enriched materials that the maximum heating capacity of does not exceed 1kW of permanent heat load).

Under the Section 40 of this law, therefore, it is an object of a review of the cross-border impact. The process of the cross-border review will also be in line with bilateral agreements concluded with the neighbouring countries. The relevant authority to assess the cross-border impact is the Ministry of the Environment of the Slovak Republic.

When considering the proposed activity of the NJZ, all the legislative and other requirements for the protection of the environment and public health take into account the area concerned and the groups of inhabitants that come into close contact with it. The potentially most concerned area and the so-called critical groups of inhabitants (i.e. groups of representative persons who are most concerned by the proposed activity and its radiation influences) are to be found in the immediate surroundings of the site of the proposed activity.

The distance from the nearest inhabited areas of the surrounding communities is a few kilometres at the most. According to the results of the carried-out assessment of the impact on the public health and the various parts of the environment, including the analysis of the influences of non-standard conditions (see the relevant chapters of this Report), in this nearest area all the requirements for the protection of health and environment are fulfilled. On the contrary, the distance of the proposed activity from the borders of the nearest countries ranges from tens to hundreds of kilometres and it is as follows:

- Czech Republic 37 km,
- Austria 54 km,
- Hungary 61 km,
- Poland 139 km,
- Ukraine 330 km.

As such, therefore, provided that the requirements are met for the protection of environment and the public health in the nearest area concerned, the origination of substantial cross-border radiation impact on the border regions is virtually eliminated. Regardless of this fact, however, analyses are carried out in this Report of the radiation impact for the border regions of the nearest neighbouring countries, both for the regular running of the NJZ and (especially) for the representatively conservative cases of design accidents and severe accidents (see the chapter C.III.19 Operational Risks, page 351 of this Report).

B. DATA ON THE DIRECT IMPACTS

B. DATA ON THE DIRECT IMPACTS OF THE PROPOSED ACTIVITY ON THE ENVIRONMENT AND HEALTH

B.I. Input Requirements

I. Input Requirements

All the input requirements are stated conservatively, in their potential (envelope[15]) maximum.

B.I.1. Soil

1. Soil – the soil occupation together in ha, and the developed area out of that (ha, agricultural soil fund, forest areas, soil quality), out of that temporary and permanent occupation.

Soil occupation: permanent occupation of the areas: up to 46 ha
temporary occupation of the areas: up to 37 ha

Given the varying space arrangement of the NJZ units, the area for the NJZ siting and construction is delimited by a conservative border which makes possible all the considered orientations of the NJZ objects and respects the border delineated in the Land Use Plan of the Trnava Self-Governing Region. Thus defined area (see annex No. 1 of this Report) includes an area for the siting of the main reactor building (ca 81.3 ha, out of that ca 79.8 ha of arable land and ca 1.5 ha of other areas), area of the construction site equipment and areas of technological infrastructure (ca 40.1 ha, out of that ca 38.1 ha of arable land and ca 2.0 ha of other areas). The real permanent and temporary occupation will be markedly lower than this conservatively delineated area for the NJZ siting and construction.

The area of the existing premises of the Jaslovské Bohunice nuclear power plant is about 150 ha. From this area, about 36.5 ha may be used for the NJZ.

After the finishing of the construction of the NJZ, the area of the construction site equipment will be vacated.

The termination of the NJZ operation will not require any permanent or temporary occupation of the areas.

infrastructural grids: of little significance

A permanent occupation of the soil represents in its total several hectares at most. The routes of the inlet of the raw water and outlet of the waste water and rainfall water will lead under the terrain, without significant demands on permanent occupation. Overhead electric lines only require the area for the bases of the poles.

B.I.2. Water

2. Water – the total water intake, maximum and average intake (m^3/h., m^3/year), out of that the share of potable water, service water, the source of water (public water system, surface resource, other), location of the intake mechanism, total consumption of water (m^3/h., m^3/year).

Raw water: altogether: up to ca 1.42 m^3/s
up to ca 45,000,000 m^3/year

resource: the Váh River

The listed values represent the average maximum instant and maximum annual use (with conservatively considered continuous operation), related to the climate characteristics of the year 2029. By the influence of the climatic change, conservatively considered for the SRES A2 pessimistic climatic scenario (estimating the growth of the average annual

[15] For detailed comments on the manner of establishment of the conservative (envelope) parameters see chapter Introduction (p. 7 of this Report) and its sub-chapter Report Methodics.

temperature by 3.95°C by the end of the century, that is to 14.4°C), the maximum short-term consumption is 1.45 m^3/s (year 2045) and 1.52 m^3/s (year 2085). From this amount, ca 1.17 m^3/s is lost in vapour and fume on the cooling tower, the rest is calculated as waste from the blowdown from the thickened circulation water, production of demineralised water and softened water and to supplement the losses in the technological water systems. An average condensation in the cooling circuit of Z = 5 is considered. The raw water intake will be independent of the existing consumption systems. Raw water will be taken from the Váh River (Sĺňava dam) in the offtake structure in the proximity of the existing NPP Bohunice 3, 4 (V2) offtake structure (the offtake point will be located on the right bank of the Sĺňava dam, the use is organisationally in line with the Handling Guidelines of the Drahovce-Madunice Dam). From the offtake structure it will be drained by a gravitation pipe into the Pečeňady pumping station and further transported by the discharge system into the NJZ technological water reservoir with the capacity of at least 30 days for the needs of cooling down in case of the loss of the raw water supplies. The system of supplies of the raw water will be backed up by the substitute offtake system. For technological purposes, the water will be treated in the treatment plant, by a combination of mechanical and chemical processes.

The expected short-term intake of raw water for other nuclear plants at the site is 0.93 m^3/s (year 2029), 0.72 m^3/s (year 2045, in which the decommissioning of JE A1 and V1 will be terminated); by the year 2085 the other nuclear plants at the site will have been decommissioned. The overall maximum short-term use during the simultaneous operations of the NJZ and other nuclear plants at the site will not exceed 2.35 m^3/s (year 2029), 2.17 m^3/s (year 2045) and 1.52 m^3/s (year 2085).

During the NJZ construction there is no need for the utilisation of the technological water. The consumption of water for the construction purposes will be carried out from the branch pipe from the technological water system of the decommissioned JE A1 and JE V1 in the amount of up to about 200,000 m^3/year.

After the termination of the NJZ operation the technological water consumption will be significantly lower than during the operation period and, depending on the progress of the decommissioning activities, it will continue decreasing.

Potable water: average annual intake: up to about 50,000 m^3/year

resource: public system

The stated value is based on the conservatively estimated number of 650 permanent employees with a specific use of 120 l/person/day and 1,000 external workers during the outages (about 1 month in the year) with the same specific use. The calculation value of 35,000 m^3/year of the potable water consumption was conservatively increased to 50,000 m^3/year on the basis of the operational experience from the existing operations at the site. The potable water will be, similarly to the existing plants at the site, taken from the long-distance water ducts Dobrá Voda, Dechtice and Veľké Orvište on the contractual basis with their operator.

The potable water intake for the existing plants at the site ranges around the level of 260,000 m^3/year (out of that up to 80,000 m^3/year for JE V2 and up to about 180,000 m^3/year for the decommissioned JE A1 and V1, including TSÚ RAO and MSVP. The overall use (during the simultaneous operations) will be up to 310,000 m^3/year and with the termination of the decommissioning of the other plants it will be decreasing.

The use of the potable water during the construction will be on the level of about up to 138,000 m^3/year (about 3,000 employees with a specific use of 120 l/person/day + up to 30 m^3/day for the production of concrete during the 200 working days per year). During the intake of the potable water for other plants on the level of about 260,000 m^3/year, the overall use of the potable water at the site during the NJZ construction will be up to about 398,000 m^3/year. The current source of the potable water has sufficient capacity to cover this consumption.

After the termination of the operation, the use of the potable water will be significantly lower than during the operation and, depending on the course of the decommissioning activities, it will decrease further.

Firefighting water: intake: unspecified

The system of the firefighting water (especially the firefighting water storage and supply) will abide the valid regulations and experience in the area of fire protection. The system of firefighting water will be supplied from the cooling circuit, which will be able to cover every requirement for the supply of fire water with a sufficient reserve.

The firefighting water at the site is currently managed by independent systems of firefighting water transport in compliance with the valid regulations.

To ensure the necessary amount of firefighting water during the period of the construction, raw water or potable water is usable.

The management of the firefighting water after the termination of the operation will at first be identical with the supply during the operation that is from the cooling water system. Later, after the decommissioning of the systems of the cooling water supply, the firefighting water will be managed through the system of the potable water supply. The decommissioning itself of the system of the fire fighting and service water will be carried out as one of the last activities.

B.I.3. Raw Materials

3. Raw Materials – type, use (daily, annual), way of acquiring (own resource, import).

Nuclear fuel: up to 35.0 t UO_2/year[16]

This amount corresponds to about 53 fuel assemblies per year. The nuclear fuel will be purchased on the market. The fuel will be based on the UO_2, with the maximum enrichment of the fuel being up to 5% of U-235. The usage of the MOX fuel is not envisaged, nor is it ruled out in the future. The lengths of the fuel cycles are considered to be within 12–24 months, the fuel consumption is expected to range within 55–70 MWd/kgU. The nuclear fuel in the form of the fuel rods will be arranged into rectangular or hexagonal fuel assemblies. The overall amount of fuel in the active zone of the reactor will be up to 158 t (UO_2).

The current use of the nuclear fuel for the operating nuclear plants at the site is up to 20.0 t of UO_2 per year, the overall use (during the simultaneous operations) will thus not exceed 55.0 t UO_2 per year.

During the construction there is no demand for the use of the nuclear fuel.

After the termination of the operation there is no demand for the use of the nuclear fuel.

Operational and other material: hundreds t/year

The operational materials are the chemicals for the treatment of the technological water, lubricants, propellants and technological gases.

The use of chemicals will range on the level of several tons for each chemical substance. They are mostly boric acid H_3BO_3, lithium hydroxide LiOH, ferric sulphate $Fe_2(SO_4)_3$, ammonia water, hydrazine hydrate, sodium hydroxide NaOH, nitric acid HNO_3 and others.

The petrol substances needed will include the engine petroleum, turbine oil, transformer oil, engine oil, synthetic oil, light heating oil and other oils and lubricants. Their amounts will be on the maximum level of dozens of tons per year for each substance.

Among the technical gases necessary for the NJZ operation there is above all hydrogen, carbon dioxide, followed by other technical gases such as nitrogen, oxygen, acetylene, argon, and others. The amount is not specified more closely.

Similar consumption currently occurs with the existing operated nuclear plants at the site.

The use of civil and construction materials for the period of construction will be up to 500,000 m^3 of concrete, up to 80,000 of reinforced concrete and up to 30,000 t of steel constructions.

During the termination of the operation there will be no significant additional demands on the use of the operational materials, civil material or construction material.

B.I.4. Energy Resources

4. Energy Resources – type, consumption (daily, annual).

Electric power: up to 120 MW_e

This value represents the consumption of the NJZ operation. The consumption is caused by the activity itself and the back-up powering of the consumption.

The NPP Bohunice 3, 4 (V2) consumption is currently up to ca 70 MW_e, and ca 3 MW_e for the JAVYS facilities; the overall capacity (during the simultaneous operation of the plants) will thus not exceed ca 193 MW_e. The source utilised for the consumption is the electric power generation and the back-up powering from the distribution system.

The consumption of the electric power during the construction is not more closely specified, but it will represent a common level of consumption.

The consumption of the electric power during the termination of the operation is not further specified, but it will represent a common level of consumption.

[16] Except the first fuel charge.

B.I.5. Demands on Transport and Other Infrastructure

5. Demands on Transport and Other Infrastructure.

Road transport: homeward transport intensity: ca 250 vehicles/24 hours (out of that ca 60 heavy-weight vehicles)

This value is a conservatively stipulated average of the all-day intensity of the NJZ homeward transport (that is, the number of the incoming vehicles). The intensity of the NJZ outward-bound transport (number of outgoing vehicles) will be identical. The overall intensity is made up by the sum of the homeward and outward-bound transport. Further detail about the transport intensity is the following:

Employee transport: The number of the NJZ employees during the operation will be about 650, the ratio of the individual vehicle transport and public transport (buses) will be about 40%:60%. The overall demands for the transport of the employees will thus be on the level of about 180 personal vehicles and about 20 buses per day.

Transport of operational materials: The number of vehicles transporting the operational materials expected during the peak time is on the level of 60 transport vehicles per day; the average daily intensity is significantly lower.

Nuclear fuel transport: It may be a combination of train, road, ship and air transport. The expected intensity of the road cargo transport is several vehicles per year.

Radioactive waste transport: The number of vehicles providing the transport of radioactive waste is expected on the level of about ten cargo vehicles per year.

Non-radioactive waste transport: The number of vehicles transporting non-radioactive waste is expected on the level of about a hundred cargo vehicles per year.

The transport route will run along the No. III/50415 road, in the direction of Žlkovce (ca 80%) and in the direction of Jaslovské Bohunice (ca 20%).

The intensity of the homeward transport, related to the activity of the nuclear power plants at the EBO site in the present, is on average about 1,000 vehicles/24 hours (out of that about 150 heavy-weight). During the period of the simultaneous operations the overall intensity of the homeward transport of the NJZ+EBO will not exceed ca 1,250 vehicles/24 hours (out of that about 210 heavy-weight).

During the construction of the NJZ the overall intensity of the homeward construction transport of the NJZ will be about 1,000 vehicles/24 hours (out of that about 300 heavy-weight) divided as follows:

Employee transport: It is estimated that at the peak of the construction there will be about 3,000 employees working at the site. It is estimated that the ratio of individual automobile transport and public transport (buses) will be 40%:60%. The overall intensity of the homeward transport will be on the level of about 700 passenger vehicles and about 60 buses daily. The naturally used routes are considered, with the following division of the traffic into the road No. III/50415 – Žlkovce direction (ca 80%) and Jaslovské Bohunice direction (ca 20%).

Transport of civil and construction materials: The overall intensity of the homeward transport will be on the level of about 250 cargo vehicles per day, supposing that a part of the materials (cement, lime) will be transported by the railway. The transport routes for the road cargo transport have been defined along which the transport of the necessary materials will be carried out, based on the location of the material resources. The real estimation of the ratio of the directions of the transport along the road No. III/50415 is the following – the direction of Žlkovce (ca 50%) and direction of Jaslovské Bohunice (ca 50%).

The termination of the NJZ operation does not exert additional demands on the road transport in comparison with the period of the operation or the construction; the same system of transport management and a gradual decrease of its intensity are expected.

Railroad transport: intensity of homeward transport: insignificant

The period of the NJZ operation does not represent significant demands on the use of the railroad transport.

The current intensity of the railroad transport, related to the activity of the nuclear plants at the Jaslovske Bohunice NPP site, is insignificant and does not exceed several units per month.

In the period of the NJZ construction the intensity of the incoming railroad transport may be expected on the level of several units per 24 hours.

The termination of the NJZ operation does not exert additional demands on the road transport in comparison with the period of the operation or the construction; the same system of transport management and a gradual decrease of its intensity are expected.

Special transport: almost insignificant

The transport of heavy-weight and excessively big components: It is the transport of several units, especially during the construction, meaning that from the viewpoint of intensity this transport is insignificant. From the viewpoint of space requirements it is possible to calculate with only local adjustments to the existing infrastructure and with temporary

limitations. It is also possible to plan this kind of transport with the help of the water transport, which may be managed through the Danube River and the Váh River.

Other infrastructure: adjustment/reinforcement necessary

Connection of the NJZ into the distribution system will require the construction of a new Jaslovské Bohunice switchyard (electric power plant) and its connection into the transfer system of the Slovak Republic.

The NJZ will be managed independently of the existing water management systems of the nuclear facilities at the EBO site. A new supply system will be built for the supply of raw water; there will also be new systems constructed for the discharge of the waste and rainfall waters. The existing infrastructure systems at the EBO site will thus not be affected.

Other infrastructure of the area concerned will not be affected.

B.I.6. Demands on the Labour Force

5. Demands on the Labour Force.

Number of employees: ca 650

A conservative estimation of the overall number of employees at the power plant is up to ca 650 people (and another ca 1,000 external employees during the outage (ca 1 month per year)).

The number of the employees of the existing power plants at the site ranges around up to 2,650 people (out of that JAVYS: ca 800 permanent employees and 450 employees of the suppliers, Slovenské elektrárne, a. s.: ca 1,300 permanent employees and 100 employees of the suppliers. These data, however, are variable and it is rather a decrease that is expected); the overall number of the employees at the site (during the simultaneous operations) will thus not exceed ca 3,300 people.

During the construction of the NJZ the number of employees is conservatively estimated at about 3,000 people.

The number of the employees during the termination of the operation is not further specified, but it will normally not exceed the number of the employees during the operation, and will decrease.

B.II. Output Data

II. Output Data

All the data about the output are stated conservatively, in their potential (envelope[17]) maximum.

B.II.1. Air

1. Air – the principal sources of the air pollution (stationary, mobile), qualitative and quantitative characteristics of emissions, way of emission capture, manner of measuring emissions, influence of the source timewise (permanent, regular, accidental).

Emissions into the air: almost insignificant

The NJZ is not a combustion source, therefore it will not be a significant source of emissions into the air. In relation to the NJZ, only back-up technological equipment will originate (back-up diesel generators and back-up boiler house, which will not be permanently operated sources) and cooling towers. The emissions of the principal pollutants: particulates, SO_2, NO_x and CO will be produced especially during the regular tests of the equipment in the range of up to 100 hours a year (this period is necessary from the viewpoint of the functionality of the machines, maintenance, etc.)

[17] For detailed comments on the manner of establishment of the conservative (envelope) parameters see chapter Introduction (p. 7 of this Report) and its sub-chapter Report Methodics.

Table B.II.1: Emissions of stationary non-radioactive sources of air pollution

		DGS for DBC	DGS for CI	DGS for SBO	Boiler house
Number of sources	[pc]	4	2	2	3
Mass flow NO_x	[g/s]	3.06	0.87	0.87	1.6
	[t/year]	1.102	0.313	0.313	0.576
Mass flow particulates	[g/s]	0.8	0.2	0.2	0.4
	[t/year]	0.288	0.072	0.072	0.144
Mass flow CO	[g/s]	4.0	1.14	1.14	0.6
	[t/year]	1.440	0.410	0.410	0.216

Note: DGS – diesel generator station, DBC – design basic conditions, CI – conventional island, SBO – station blackout; a complete outage of the consumption supply including the diesel generator

The number of the observed pollutants will be negligible with regards to the frequency of the operation of these plants, and therefore insignificant from the viewpoint of the environmental impact. Similar conclusions may be inferred for the existing plants at the EBO site.

An important period from the viewpoint of the origination of emissions will be the period of the NJZ preparation and construction. In these stages what is expected is mostly particulate matter emissions; emissions of other pollutants are related to the usage of the instrumentation technology and calculation of the fuel consumption.

In the period of the preparation there will be earthworks carried out, due to which we may characterise the future construction site as a temporary non-point source of air pollution; the main pollutant will be represented by particulate matter. The open soil is mostly a source of secondary dustiness, caused by the wind and the stirring up of the dust by the construction equipment and transport. A very important source of secondary dustiness will be the transport of the soil to the waste dump. The non-point sources of air pollution will only occur temporarily in certain stages of the construction and during dry weather. Given the weight of the dust particles, the pollution will be of a local character.

The period of the construction will be characterised by activities connected to the construction of the main production unit, cooling tower and other objects. During this period the share of the activities giving rise to secondary dustiness will be significantly lower than in the preparation period and gradually, in relation with the covering of the unreinforced surface, the risk of its origination will diminish.

Emission factors of particulate matter of the PM_{10} a $PM_{2.5}$ fractions for the listed activities are stipulated on the basis of the US EPA AP-42 emission database and general emission factors published in the Journal of the Ministry of Environment of the Slovak Republic No. 5/2008. The origination of the PM_{10} a $PM_{2.5}$ emissions is influenced by the natural moisture and content of the silt. For the decisive activities, based on the local conditions at the NJZ site, the emission factors are stated on the basis of the listed methodics in the following way:

Table B.II.2: Emission factors for the construction activities

	PM_{10}	$PM_{2.5}$
Bulldozer emissions	2.366 kg/h.	0.756 kg/h.
Loader emissions	0.002 kg/t	0.0006 kg/t
Transport on the unreinforced roads	4592.6 g/vehicle/km	459.3 g/vehicle/km
Demolition and grinding of the construction scree	5.9 g/t	1.8 g/t

A further source of emissions that will originate during all the stages – preparation, construction and operation – will be the vehicle transport caused by the NJZ operation. The transport, categorised under mobile sources by the Law on Air, is a source of dust emissions and pollutants originating in propellant combustion. The amount of pollutant emissions depends above all on the transport intensity in the given period and the development of the emission properties of the motorised vehicles.

The emission factors have been calculated for the impact assessment on the basis of the expected development of the rolling stock structure in the future, based on the trend of the increasing number of the registered passenger and transport vehicles fulfilling the higher emission norms EURO 4–6. Newer vehicles with higher emission standards will be mostly represented in the dynamic structure of the vehicle park. The increase of emissions of the pollutants due to the heightened intensity of the transport will have little significance, in comparison with the zero status; in relation with the decrease of the emissions produced by motorised vehicles during the period of the NJZ construction and operation, a lower production of unit emissions of the NO_x and CO substances is expected than in the present time.

During the period following the termination of the operation, the activity of point and line sources related to the operation will cease too. Emissions related to the dismounting and demolishing works will not exceed the amount of emissions during the period of the preparation and realisation.

Waste heat: waste heat: up to ca 3,150 MW_t

vaporisation: up to ca 1.17 m^3/s

The waste heat will be eliminated in the cooling tower by the vaporisation of the cooling water. When considering the influence of the climatic change, conservatively estimated for the SRES A2 pessimistic climatic scenario (expecting the growth of the average annual temperature by the end of the century by 3.95 °C, i.e. to 14.4 °C) the vaporisation will be 1.19 m^3/s (year 2045) and 1.25 m^3/s (year 2085).

The waste heat of the existing operated plants at the EBO site (NPP Bohunice 3, 4 (V2)) is about 2,000 MW_t with the vaporisation of about 0.75 m^3/s. For the period of the simultaneous operations of the NJZ and NPP Bohunice 3, 4 (V2), the overall vaporisation from the nuclear plants at the site will be only up to 1.92 m^3/s.

During the period of the construction and termination of the operation no significant waste heat will be produced.

B.II.2. Waste Waters

2. Waste Waters – the overall amount, type and quality parameters of the discharged waste waters (in m^3/year), point of discharge [recipient, public canalisation, waste-water treatment plant (common, own, capacity, efficiency)], the source of the origination of the waste waters, management.

Industrial waste water:

overall: up to ca 0.25 m^3/s
up to ca 8,000,000 m^3/year

recipient: the Váh River

These values represent the average maximum short-term and annual amount of industrial waste water (with conservatively considered intermittent operation of the NJZ). When considering the influence of the climate change, conservatively estimated for the SRES A2 pessimistic climate scenario (expecting the growth of the average annual temperature by the end of the century by 3.95°C, that is to 14.4°C), the maximum short-term amount will be 0.26 m^3/s (year 2045) and 0.27 m^3/s (2085). The amount of the industrial waste water will correspond to the amount of the consumed raw water, after the deduction of the amount of the vaporisation and fume on the cooling tower, condensation in the cooling circuit and consumption for the production of demineralised water and softened water and to fulfil the losses in the technological water systems. The quality of the industrial waste waters will correspond to the limits stipulated by the Government Decree No. 269/2010 Coll., or the valid water management permission (for the data about the expected concentration of the particular parameters of the waste water quality and their comparison with the limits, see chapter C.III.5. The Influences on the Water Conditions, page 291 of this Report). The industrial waste waters will be managed through a new sewage collector into the recipient Váh.

Industrial waste waters from the existing plants at the site are discharged by the Socoman collector into the recipient Váh. The amount of the industrial waste water from the plants at the site is currently up to 6,100,000 m^3/year (permitted limit for the JAVYS machines and EBO together is 8,041,680 m^3/year), with a significant trend of decline. The overall amount (for the period of simultaneous operations) will thus not exceed 14,100,000 m^3/year and will likely be less than that.

During the period of the NJZ construction industrial waste water will not be produced.

During the termination of the operation there will be a gradual significant diminishing of the amount of the industrial waste water compared with the period of operation. Immediately upon the decommissioning of the reactor (before the extraction of the nuclear fuel from the NJZ into the spent fuel storage) the discharge will reach the level of 3,500,000 m^3/year; after the extraction of the nuclear fuel it will fall down to about 1,200,000 m^3/year with a further trend of decrease, and after the decommissioning of further objects the offtake will be terminated.

Sewage water: overall amount: up to ca 35,000 m^3/year

recipient: the Váh River

The amount of the sewage water will correspond to the amount of absorbed potable water after the subtraction of the consumption (conservative estimation is about 66% of the amount of the absorbed potable water). The quality of the sewage waste waters will correspond to the common waste water from the hygiene facilities. The originating sewage waters will be discharged by the canalisation system to the NJZ sewage water treatment plant and following the treatment they will be discharged by a new collector (together with industrial waste waters) into the recipient Váh.

The amount of the sewage water from the plants at the site is about up to 85,000 m^3/year (out of that JE V2 amounts to up to about 65,000 m^3/year, other plants up to about 20,000 m^3/year), the overall amount (during the simultaneous operations) will thus not exceed about 120,000 m^3/year. The sewage waters from the existing plants at the site are, after the treatment, discharged by the Socoman collector (together with the industrial waste waters) into the recipient Váh.

During the period of the construction the overall production of the sewage waters at the EBO site will be on the level of up to about 132,000 m^3/year. During the construction the NJZ waste water treatment plant (built as one of the first objects)

will be used for the treatment of sewage water and, temporarily, for the treatment of the sewage water from the construction site equipment. The treated sewage water from the NJZ waste water treatment plant and from the temporary sewage water treatment plant from the site will be, during the NJZ construction and until the construction of the new collector of waste water for the NJZ, discharged by the existing Socoman collector into the recipient Váh.

The production of the sewage waters during the termination of the operation is not further specified, but it will be a common, gradually decreasing amount, which will not exceed the abovementioned output for the operation period.

Rainfall water: altogether: up to ca 102,000 m^3/year

recipient: the Dudváh River

This amount is based on the NJZ premises area size (ca 46 ha), the average rainfall of about 550 mm/year and the drainage coefficient of 0.4. The rainfall water represents water from rain and other precipitation which does not imbibe but is drained into the recipient. Rainfall does not fall into the category of waste water; the quality of the rainfall water will not be changed. The treatment of rainwater will include its draining by the new underground collector into the recipient Dudváh. The rain canalisation system will be equipped with retention reservoirs and a collection reservoir to collect the torrent rain with the periodicity of n = 0.01 (a hundred-year rain, according to the data of the Slovak Hydrometeorological Institute for the EBO site of 32 mm/15 min with the intensity of 355 l/s/ha). The rainfall water from the surrounding terrain will be collected in a protection ditch and discharged by the Manivier canal (which has a capacity sufficient to drain the torrent rain including the hundred-year rain) into the recipient Dudváh; the amount of this water will be about 16,500 m^3/year.

The amount of the rainwater from the premises of the plants at the site is about 330,000 m^3/year (ca 150 ha, average rainfall 550 mm/year and outflow coefficient of 0.4); the overall amount (during the simultaneous operations) will be up to about 432,000 m^3/year. The rainfall water from the premises of the existing plants and from the surrounding terrain is discharged by the Manivier canal into the recipient Dudváh.

During the period of the construction the amount of the rainfall waste water will grow (together with the gradual occupation and reinforcement of the areas, building of the objects and the canalisation system), until it reaches the stated amount for the operation period.

During the termination of the operation and the vacating of the areas (if it happens) we can expect a decline of the rainfall water amount compared to the operation period.

B.II.3. Waste

3. Waste – the overall amount (t/year), type and category of waste, place of origination, waste management.

Non-active waste: communal and other waste: up to 1,200 t/year

dangerous waste: up to 120 t/year

The amount and structure of the originating non-radioactive waste will basically, quantity- and quality-wise, reflect the structure of waste from the existing operated units (NPP Bohunice 3, 4 (V2)). It will be represented by common types of waste originating from cleaning, maintenance, repair, operation and replacement of non-active equipment, construction waste from repairs and others. The composition of the anticipated types of waste, originating during the NJZ operation, is listed in the following table.

Table B.II.3: List of the expected types of waste, generated during the NJZ operation

Catalogue number	Name of the waste according to the waste catalogue	Waste category
08 01 11	waste paint and varnish containing organic solvents or other dangerous substances	N
08 01 12	waste paint and varnish other than those mentioned in 08 01 11	O
08 03 17	waste printing toner containing dangerous substances	N
08 04 09	waste adhesives and sealants containing organic solvents or other dangerous substances	N
10 01 26	wastes from cooling-water treatment	O
12 01 01	ferrous metal filings and turnings	O
12 01 02	ferrous metal dust and particles	O
12 01 03	non-ferrous metal filings and turnings	O
12 01 04	non-ferrous metal dust and particles	O
12 01 13	welding wastes	O
12 01 20	spent grinding bodies and grinding materials containing dangerous substances	N
12 01 21	spent grinding bodies and grinding materials other than those mentioned in 12 01 20	O
13 01 10	mineral-based non-chlorinated hydraulic oils	N
13 01 11	synthetic hydraulic oils	N
13 02 05	mineral-based non-chlorinated engine, gear and lubricating oils	N

Catalogue number	Name of the waste according to the waste catalogue	Waste category
13 02 06	synthetic engine, gear and lubricating oils	N
13 05 02	sludge from oil/water separators	N
13 05 06	oil from oil/water separators	N
14 06 03	other solvents and solvent mixtures	N
15 01 01	paper and cardboard packaging	O
15 01 02	plastic packaging	O
15 01 03	wooden packaging	O
15 01 06	mixed packaging	O
15 01 10	packaging containing residues of or contaminated by dangerous substances	N
15 01 11	metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty pressure containers	N
15 02 02	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	N
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	O
16 02 13	discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12 (waste light bulbs, PC)	N
16 02 14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13 – other appliances	O
16 06 01	lead batteries	N
16 06 02	Ni-Cd batteries	N
16 06 05	other batteries and accumulators	O
17 04 05	iron and steel	O
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	O
17 04 07	mixed metals	O
17 04 11	cables other than those mentioned in 17 04 10	O
17 06 04	insulation materials other than those mentioned in 17 06 01 and 17 06 03	O
17 09 03	other construction and demolition wastes (including mixed wastes) containing dangerous substances	N
17 09 04	mixed construction and demolition wastes....	O
19 08 09	grease and oil mixture from oil/water separation containing edible oil and fats	O
20 01 08	biodegradable kitchen and canteen waste	O
20 02 01	biodegradable waste	O
20 03 01	mixed municipal waste	O

The waste management will comply with the valid legislation in the area of the waste economy (currently valid Act No. 223/2001 Coll. on Waste as amended will be replaced on 1 January 2016 by the Act No. 79/2015 Coll. on Waste and on Amendment of Certain Acts) and will reflect the system in use, that is the submission to authorised companies, specialising in waste processing and disposal.

The waste production at the EBO site is currently 1,300 t/year, out of that about 90 t/year is hazardous waste (the data for 2013 in sum for EBO and JAVYS), but the production varies from year to year depending on the current activities. The waste treatment is managed in compliance with the Act on Waste and it consists in ceding the waste to the authorised companies that specialise in waste processing and disposal.

During the preparation of the site and construction of the NJZ it is possible to expect the overall production of about 380,000 t of construction waste, out of that 80,000 t will originate from the demolition of the existing objects. The composition of the expected types of waste, originating during the NJZ construction, is listed in the following table.

Table B.II.4: List of the expected types of waste, generated during the preparation and construction of the NJZ

Catalogue number	Name of the waste according to the waste catalogue	Waste category
07 02 13	waste plastic	O
08 01 11	waste paint and varnish containing organic solvents or other dangerous substances	N
08 01 12	waste paint and varnish other than those mentioned in 08 01 11	O
08 01 17	wastes from paint or varnish removal containing organic solvents or other dangerous substances	N
08 03 17	waste printing toner containing dangerous substances	N
08 04 09	waste adhesives and sealants containing organic solvents or other dangerous substances	N
12 01 01	ferrous metal filings and turnings	O
12 01 02	ferrous metal dust and particles	O
12 01 03	non-ferrous metal filings and turnings	O
12 01 04	non-ferrous metal dust and particles	O

Catalogue number	Name of the waste according to the waste catalogue	Waste category
12 01 10	welding wastes	N
12 01 13	spent grinding bodies and grinding materials containing dangerous substances	O
12 01 20	spent grinding bodies and grinding materials other than those mentioned in 12 01 20	N
12 01 21	ferrous metal dust and particles	O
13 01 10	mineral-based non-chlorinated hydraulic oils	N
13 01 11	synthetic hydraulic oils	N
13 02 05	mineral-based non-chlorinated engine, gear and lubricating oils	N
13 02 06	synthetic engine, gear and lubricating oils	N
13 05 02	sludge from oil/water separators	N
13 05 06	oil from oil/water separators	N
14 06 03	other solvents and solvent mixtures	N
15 01 01	paper and cardboard packaging	O
15 01 02	plastic packaging	O
15 01 03	wooden packaging	O
15 01 06	mixed packaging	O
15 01 10	packaging containing residues of or contaminated by dangerous substances	N
15 01 11	metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty pressure containers	N
15 02 02	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	N
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	O
16 02 13	discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12 (waste light bulbs, PC)	N
16 02 14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13 – other appliances	O
16 06 01	lead batteries	N
17 01 01	concrete	O
17 01 02	bricks	O
17 01 03	tiles and ceramics	O
17 01 06	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substances	N
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	O
17 02 01	wood	O
17 02 02	glass	O
17 02 03	plastic	O
17 02 04	glass, plastic and wood containing or contaminated with dangerous substances	N
17 03 02	bituminous mixtures other than those mentioned in 17 03 01	O
17 04 05	iron and steel	O
17 04 07	mixed metals	O
17 04 09	metal waste contaminated with dangerous substances	N
17 04 10	cables containing oil, coal tar and other dangerous substances	N
17 04 11	cables other than those mentioned in 17 04 10	O
17 05 03	soil and stones containing dangerous substances	N
17 05 04	soil and stones other than those mentioned in 17 05 03	O
17 05 05	dredging soil containing dangerous substances	N
17 05 06	dredging soil other than those mentioned in 17 05 05	O
17 06 01	insulation materials containing asbestos	N
17 06 03	other insulation materials consisting of or containing dangerous substances	N
17 06 04	insulation material other than those mentioned in 17 06 01 and 17 06 03	O
17 06 05	construction materials containing asbestos	N
17 09 03	other construction and demolition wastes (including mixed wastes) containing dangerous substances	N
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	O
20 01 08	biodegradable kitchen and canteen waste	O
20 03 01	mixed municipal waste	O

An important item as far as the amount is concerned will be the excavated soil from rough terrain adjustment of the site (up to 960,000 t), and from the excavation works (up to 720,000 t).

Waste management during the preparation and construction will comply with the valid legislation in the waste management field (the currently valid Act No. 223/2001 Coll. on Waste as amended will be replaced on 1 January 2016 by the Act No 79/2015 Coll. on Waste and on Amendment of Certain Acts).

During the termination of the operation the amount of the operation waste compared with the period of the operation will be decreasing. Gradually, at the beginning of the dismounting and demolition works, the amount of waste of a construction and dismounting character will grow. The most important will be the amount of the construction scree (in the amount up to ca 1,000,000 t), which it is possible (under the currently valid waste catalogue) to categorise into the sub-groups of 17 01 concrete, bricks, tiles ... 17 06 insulation materials ... and 17 09 other wastes from building sites and demolitions. Besides these wastes there will be an amount (up to ca 100,000 t) of wastes of the 17 04 sub-group metals including their alloys (civil steel constructions including reinforced concrete, metal from non-radioactive technological equipment, cable distribution system ...), and 17 02 wood, glass, plastic (windows, doors, inside furnishings, plastic parts of the technology ...). With regards to the long-term horizon until the commencement of the decommissioning, it is not effective to refer to the currently valid legislation in the field of waste management. Waste treatment will follow the currently valid regulations relating to this area. Basically, a similar system as under the current conditions may be expected, that is recycling, re-using and the utilisation of the services of authorised organisations.

B.II.4. Noise and Vibrations

4. Noise and Vibrations (sources, intensity).

Noise: see the following table

Sources of noise are related to the main operation – the electric power generation – as well as to secondary activities – water management, electric power outlet, waste management, and so on. The sources of noise are placed mostly in the inner spaces, and on the roofs and facades of the objects. On the basis of the materials available it is possible to identify the main technological sources of noise the overview of which, including their acoustic characteristics, is listed in the following table.

Table B.II.5: Sources of noise and their acoustic characteristics – the NJZ

Name	Machine/building	$L_{A,W}$ [dB]	Character *
NJ1	Cooling tower	93.0	3
NJ 2	Cooling water pumping station	50.0	0
NJ 3	Turbine hall	64.0	3
NJ 4	Transformer, 3 pc	94.0	3
NJ 5	Essential service water pumping station and sprinkle basins	86.0	0
NJ 6	Reactor hall	65.0	3

* Character: 0 – point source, 3 – vertical non-point source (per 1 m^2)

On the basis of the materials available it is possible to single out the main technological sources of noise the overview of which, including their acoustic characteristics, is listed in the following table.

Table B.II.6: Sources of noise and their acoustic characteristics – current status

Name	Machine/building	$L_{A,W}$ [dB]	Character *
SZ 1	Cooling tower	78.0	3
SZ 2	Low-pressure compression station	77.0	4
SZ 3	Turbine hall	53.9	3
SZ 4	Transformer, 4 pc	77.0	3
SZ 5	Reactor hall	60.0	3
SZ 6	Diesel generators 3 + 3 pc	60.0	0

* Character: 0 – point source, 3 – vertical non-point source (per 1 m^2), 4 – horizontal non-point source (per 1 m^2)

The operation of main equipment of the electric power plant will be intermittent and identical during the day and night. A mobile source of noise will be represented above all by road and railroad transport on the public routes outside of the NJZ premises.

During the preparation and carrying out of the NJZ construction, the building and construction activity at the site and the out-of-site transport will act as a source of noise; in both cases the usual construction and ground machines and means of transport will be employed. The sources of noise listed in the following table are taken into account in these periods.

Table B.II.7: Sources of noise and their acoustic characteristics – the NJZ preparation and construction

Works	Mechanisation	$L_{A,W}$ [dB]
Earthworks	Dozers and loader excavators	107
Concrete works and civil construction	Additional mixer	103
	Concrete mass pump	105
	Tower crane	90
Technology positioning	Mobile crane	100

These activities will be local, they will be limited to the construction site and timewise tied to the period of preparation and building.

A mobile source of noise will be represented above all by road transport on the public roads outside of the NJZ premises. From the viewpoint of noise production the transport employing the rail trailer is of secondary importance, which is connected to the EBO premises. The trailer transport will only be utilised sporadically.

During the termination of the operation, decommissioning of all the unnecessary and unusable objects will be carried out. All the works related to the termination of the operation will be carried out on the NJZ premises. We can reasonably expect that the nuclear plant decommissioning activities will not exceed the acoustic parameters of the equipment during the standard operation or construction.

In relation to the NJZ operation, the operation of a new switchyard is expected, which is also accounted for in the evaluation of the overall cumulative influence of the noise in the nearest future after the entry of the NJZ into operation.

Vibrations: without any significant output

The proposed NJZ activity is not a source of significant vibrations that might spread into the environment. The dynamic influences of the vehicles moving along the public roads may be a potential source of vibrations. They are common transport vehicles the impact of which is attenuated in the road base course in the immediate proximity of the roads.

The same conclusion may be drawn for the existing installations on the NJZ premises.

Blasting works using explosives will not be carried out during the construction and following the termination.

B.II.5. Radiation and Other Physical Fields

5. Radiation and Other Physical Fields (heat, magnetic, and others – source and intensity).

Radioactive emissions into the air:

noble gases:	up to 6.2E+13 Bq/year
tritium:	up to 6.7E+12 Bq/year
C-14:	up to 1.0E+12 Bq/year
iodines:	up to 2.5E+09 Bq/year
aerosols:	up to 1.9E+09 Bq/year
Ar-41:	up to 1.3E+12 Bq/year

These values are the envelope (maximum) annual activities of the emissions of each main group of radionuclides into the air during the normal operation. They are based on the publicly accessible data of the suppliers of the reference types of reactors. On the basis of the operation experience we can reasonably expect that the real emissions into the air will be significantly lower than the values envisaged by the design (which is also evident from the JE V2 operation, which, moreover, represents an older design of a generation II reactor, see below).

A detailed radionuclide composition of the NJZ emissions into the air according to the data of each supplier, which has been used for the evaluation of radiological effects of the normal operation of the NJZ, is stated in the following table.

Table B.II.8: The envelope maximum values of each particular radionuclide in the annual emissions from the NJZ into the air

Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]
Ar-41	1.30E+12	Cr-51	2.26E+07	Kr-85	5.18E+13	Xe-131m	9.62E+12
Ba-137m	1.33E+08	Cs-134	8.51E+07	Mn-54	1.59E+07	Xe-133m	7.40E+10
Ba-140	1.55E+07	Cs-136	3.15E+06	Nb-95	9.25E+07	Xe-135	7.40E+10
C-14	1.00E+12	Cs-137	1.33E+08	Ru-103	2.96E+06	Xe-135m	1.48E+11
Ce-141	1.55E+06	Fe-59	2.92E+06	Ru-106	2.89E+06	Xe-137	1.48E+11
Co-57	3.03E+05	H-3	6.66E+12	Sb-125	2.26E+06	Xe-138	3.70E+10
Co-58	8.51E+08	I-131	1.55E+08	Sr-89	1.11E+08	Zr-95	3.70E+07
Co-60	3.26E+08	I-133	2.37E+09	Sr-90	4.44E+07		

The primary source of radioactive gases is the nuclear fuel itself, in which the fission reaction is going on. The fission reaction also produces radioactive isotopes of gases. Through the fuel cladding micro-leakages, a limited amount of the gases pervades the coolant of the primary circuit, which is in permanent contact with the fuel cladding. Another source of radioactive gases in the primary circuit coolant is the interactions of the neutrons released from the active zone with the cores of the isotopes of the elements present in the coolant molecules, its alloys, impurities and corrosive products from the primary circuit materials. Through the primary circuit coolant, radioactive gases pervade the other systems of the power plant, which are bordered by the primary circuit. The greatest source of the gas emissions containing radionuclides is the venting of the degasifier of the primary circuit water. Other sources are radioactive gases and aerosols from the other technology systems and pools, which are continuously vented and discharged into gas treatment systems and to a lesser extent discharged as air from the reactor shaft. Activity of the gaseous mixture will be significantly reduced in the gas treatment system through high efficiency aerosol and iodine filters, so radioactive noble gases (Kr, Xe, Ar-14 isotopes) will predominate at the outlet from the ventilation stack followed by carbon C-14 and tritium H-3. The system of the NJZ gas filtering stations will be operated incessantly during the normal operation of the NJZ. During the NJZ normal power operation, the system of gas filtering stations will be working steadily with an approximately constant flow rate of the cleaning system and with small constant emissions from the delay lines. The emissions from the NJZ will be discharged into the atmosphere in a controlled way through a ventilation stack following a radiology check. The ventilation stack will form a part of the reactor building or will be located in its close proximity and will be 56 to 100 m tall depending on the particular type of the reactor. During the operation, the emissions into the air will be divided more or less regularly timewise. Huge differences in the emissions into the air and their composition during the normal power operation and the outages due to the refuelling will not occur. The spent fuel pool share of the overall emissions into the air will only be several percent. The activity of the coolant in the storage basin (spent fuel pool) is significantly lower in comparison with the activity of the coolant of the primary circuit, so that the gases discharged from the storage basin are less active than the gases led from the coolant of the primary circuit into the gas filtering system.

Emissions into the air from the existing nuclear plants at the site are the following:

noble gases (including Ar-41):	up to 1.4E+13 Bq/year
tritium:	up to 8.0E+11 Bq/year
C-14:	up to 4.5E+11 Bq/year
iodines:	up to 4.6E+05 Bq/year
aerosols:	up to 7.1E+07 Bq/year

These values represent an envelope selection of the maximum measured emission values of each particular radionuclide during the years 2003 to 2013 from the operated NPP Bohunice 3, 4 (V2). To them, the envelope values (selection of maximum values) have been added of the measured emission activity of particular radionuclides during the years 2009 to 2013 from other JAVYS nuclear plants at the site (the decommissioned NPP Bohunice A1 and 1, 2, the facilities for the RAO processing and spent nuclear fuel storage), which however, except aerosols, have virtually zero manifestation in the overall resulting values.

A detailed radionuclide composition of the emissions from the existing nuclear plants into the air is listed in the following table. Among the dominant radionuclides in the gas emissions on the NPP Bohunice 3, 4 (V2) are included also short-term radionuclides, which do not occur on the NPP Bohunice 1, 2 (V1) and other nuclear plants of the JAVYS company any more, similarly to the noble gases not appearing on these nuclear plants.

Table B.II.9: The envelope measured annual maximum values of particular radionuclides in the emissions from the existing nuclear plants at the site into the air

Nuclide	Maximum measured values of the annual emissions [Bq/year]			Nuclide	Maximum measured values of the annual emissions [Bq/year]		
	JE V2	JAVYS	Total		JE V2	JAVYS	Total
H-3	7.50E+11	5.17E+10	8.02E+11	Sb-124	2.43E+06	1.26E+04	2.44E+06
C-14	4.36E+11	1.13E+10	4.47E+11	Sb-125	-	2.35E+05	2.35E+05
Ar-41	1.05E+13	-	1.05E+13	I-131	4.60E+05	-	4.60E+05
Cr-51	4.29E+06	1.26E+05	4.42E+06	I-133	-	-	-
Mn-54	9.71E+06	1.18E+05	9.83E+06	Xe-131m	1.72E+12	-	1.72E+12
Fe-55	-	1.97E+06	1.97E+06	Xe-133m	-	-	-
Fe-59	2.62E+06	5.40E+04	2.67E+06	Xe-133	3.78E+11	-	3.78E+11
Co-57	8.00E+04	7.14E+04	1.51E+05	Xe-135m	6.77E+10	-	6.77E+10
Co-58	9.51E+06	1.68E+04	9.53E+06	Xe-135	7.01E+11	-	7.01E+11
Co-60	8.06E+06	7.81E+05	8.84E+06	Xe-137	-	-	-
Zn-65	6.80E+05	3.15E+05	9.95E+05	Xe-138	1.41E+11	-	1.41E+11
Se-75	8.40E+05	-	8.40E+05	Cs-134	3.30E+05	1.13E+05	4.43E+05
Kr-85m	5.50E+10	-	5.50E+10	Cs-136	-	-	-
Kr-85	2.68E+11	-	2.68E+11	Cs-137	7.40E+05	7.24E+06	7.98E+06
Kr-87	1.13E+11	-	1.13E+11	Ba-137m	-	-	-
Kr-88	1.64E+11	-	1.64E+11	Ba-140	-	-	-
Sr-89	1.10E+05	-	1.10E+05	La-140	-	-	-

Nuclide	Maximum measured values of the annual emissions [Bq/year]			Nuclide	Maximum measured values of the annual emissions [Bq/year]		
	JE V2	JAVYS	Total		JE V2	JAVYS	Total
Sr-90	2.20E+05	1.80E+05	4.00E+05	Ce-141	1.90E+05	2.10E+04	2.11E+05
Zr-95	1.65E+06	2.04E+04	1.67E+06	Ce-144	6.20E+05	5.33E+05	1.15E+06
Nb-94	-	8.82E+04	8.82E+04	Hf-181	1.05E+05	-	1.05E+05
Nb-95	4.39E+06	5.46E+04	4.44E+06	Pu-238	2.14E+04	1.28E+03	2.27E+04
Ru-103	1.90E+05	1.26E+04	2.03E+05	Pu-239/240	4.24E+04	8.68E+03	5.11E+04
Ru/Rh-106	9.30E+05	2.23E+05	1.15E+06	Am-241	4.40E+04	1.22E+04	5.62E+04
Ag-110m	1.08E+07	1.39E+05	1.09E+07				

Sources of radioactive emissions from NPP Bohunice 3, 4 (V2) are basically identical to the NJZ sources described above. The primary source of the radioactive gases is the nuclear fuel, in which the fission reaction occurs, with fission products also being radioactive isotopes of gases. Another source of radioactive gases in the coolant of the primary circuit is the interactions of the neutrons released into the active zone with the cores of the elements' isotopes found in the molecules of the coolant, its alloys, impurities and corrosive products. From the coolant gases are discharged in the degasifier and technological basins which are permanently ventilated and discharged to the gas filtering systems. The activation of the natural components of the air, especially argon, further contributes to the gas emissions on the premises in the proximity of the reactor pressure vessel.

The contribution of the gas emissions from the JE V2 spent fuel storage and handling areas (spent fuel storage pool – fuel elements) is included in the overall sum of the envelope annual gas emissions from the existing nuclear plants at the site. The coolant of the spent fuel storage pool is periodically discharged to the treatment station, where the radionuclides disperse in the coolant and other impurities are eliminated. Due to this treatment, the concentration of the radionuclides in the storage basin water is significantly lower in comparison with the concentration of radionuclides in the primary circuit coolant. For this reason, similarly to the NJZ, also in the case of JE V2, the share of gas emissions from the fuel handling areas is at the most a few percent from the overall gas emissions, which is also confirmed by the operational measurement of activities in the air systems. On the whole, the JE V2 gas emissions have long-term steady levels without demonstrations of growth trends.

The gas emissions are discharged into the atmosphere in a controlled way through ventilation stacks after the application of highly-effective filtering and a radiology check.

For illustration and comparison, below are the design and limit permitted values of the emissions of the dominant radionuclides from JE V2 into the air, which prove that the real maximum values of the emissions discharged into the air are much (several orders) lower than the maximum design values stated by the supplier and the stipulated permitted limits.

	design value	permissible limit	measured maximum value
noble gases (including Ar-41):	3.85E+15 Bq/year	2.0E+15 Bq/year	1.4E+13 Bq/year
tritium:	3.64E+13 Bq/year	-----	7.5E+11 Bq/year
iodines:	4.42E+11 Bq/year	6.5E+10 Bq/year	4.6E+05 Bq/year
aerosols:	3.09E+11 Bq/year	8.0E+10 Bq/year	5.8E+07 Bq/year

Construction stage:

During the construction no radioactive emissions from the NJZ will be discharged into the air. The emissions from the existing nuclear plants will not be in any way modified due to the NJZ construction.

Stage of the termination of the operation:

In the stage of the termination of the NJZ operation (that is, after the decommissioning of the reactor) the emissions of noble gases and iodine into the atmosphere will decrease by two or three orders compared to the normal operation due to the interruption of the fission reaction in the fuel. Emissions of tritium, C-14 and other radionuclides will also decrease by one or two orders due to the reduction of the activation of the coolant and its alloys by neutrons from the active zone.

Out of the four basic operational sources of air contamination (primary circuit venting, vaporisation from the equipment, secondary circuit venting, activation of the air in the reactor shaft), basically only the vapours from the liquid radioactive media will apply, especially from the spent fuel storage basins. After the extraction of the spent nuclear fuel from the storage pool and the processing of the storage basin water, this source will likewise not apply anymore.

Gas RAO will be discharged identically as during the normal operation to the filters of the air systems, where the radioactive aerosols undergo a highly-effective separation.

Stage of decommissioning:

In the stage of the NJZ decommissioning we can expect a further decrease (of one to two orders) of radioactive emissions into the air compared with the stage of the termination of the operation. In this stage the emissions will not contain noble gases at all and virtually no iodine isotopes.

A source of contamination of the environment in the further stages of the decommissioning is decontamination and dismounting activities and the operation of RAO processing (fragmentation) technologies, during which active aerosols originate to a greater extent. Dismounting activities and the RAO processing technology will be managed in such a way as to reduce the leakage of the aerosols to the greatest extent possible.

Gas RAO will be discharged to the filters of the air systems, where the radioactive aerosols will undergo a highly-effective separation. Under these conditions it can be expected that compared to the stage of the termination of the operation, the activity discharged into the atmosphere will significantly decrease.

Radioactive emissions into watercourses: tritium: up to 7.5E+13 Bq/year
corrosion, fission products: up to 1.0E+10 Bq/year

These values represent an envelope (maximum) annual activities of emissions of each radionuclide group into watercourses during normal operation. They are based on publicly accessible data of suppliers of the reference types of reactors. On the basis of the operational experience we can realistically expect that the actual emissions into the rivers will be lower than the design values (which is apparent also from the JE V2 operation, which, moreover, represents an older design of a generation II reactor, see below). A detailed radionuclide composition of the NJZ emissions into watercourses according to the data of particular suppliers that have been used for the evaluations of the radiological consequences of the normal NJZ operation is stated in the following table.

Table B.II.10: Envelope maximum values of the particular radionuclides in the annual emissions from the NJZ into the watercourses

Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]	Nuclide	Emission [Bq/year]
H-3	7.50E+13	Co-60	3.00E+09	Sb-125	8.15E+08	Cs-134	5.60E+08
Cr-51	6.00E+07	Ni-63	9.60E+08	Te-123m	2.60E+08	Cs-137	9.45E+08
Mn-54	2.70E+08	Ag-110m	5.70E+08	I-131	5.00E+07		
Co-58	2.07E+09	Sb-124	4.90E+08	I-133	4.41E+06		

The source of radioactive emissions into the watercourses is the treated water from technological circuit treatment stations, tanks and pools (basins), waste water from the laundry and hygiene circuits, waste water from the steam generator blowdown and radiation check laboratories. Waste water is treated in the systems of waste water processing, where the radioactive substances are concentrated into the smallest volume possible. Thus, on the one hand, there is a relatively small volume of the concentrated radioactive substances originating, which we can denote as liquid RAO, and on the other hand, a relatively big volume of the treated medium for further use. The treated medium is then used for the needs of technological systems and auxiliary NJZ operations. If the offtake into the technological systems and auxiliary operations is small, these waters are discharged as being over the balance outside of the NJZ premises. If the offtake into the technological systems is higher, it is necessary to complement the missing volume by demineralised water. The treated waste water is concentrated in the monitoring tanks. The radiochemical inspection in these tanks determines how to deal with these waters. It is possible to decrease them into the environment only if they fulfil the relevant authorised limits. If the waters demonstrate higher activity values, they are pumped back for an additional treatment.

The volume activity of the treated waste waters is mostly caused by a radioactive isotope of hydrogen, tritium (H-3). Tritium originates in the primary circuit above all by the activation of boron B-10 by neutrons on the basis of the reaction B−10(n,2α)→H−3 or B−10(n,α)→Li−7(n,αn)→H−3). Boron B-10 is a compound of the primary circuit coolant in the form of boric acid and serves as a soluble absorbent of neutrons for the control of the fission chain reaction. Further sources of tritium may be the neutron activation of lithium, Li-6 isotope and in a lesser extent, also Li-7, and beryllium Be-9. Lithium may be used as a hydroxide for the control of pH of the primary circuit coolant and beryllium as a source of neutrons or part of construction materials of the active zone and primary circuit. Under the same conditions the tritium production only depends on the reactor output. It is impossible to effectively catch tritium, with its chemical properties being the same as hydrogen, and concentrate it by the treatment systems. That is why it has to be periodically discarded from the power plant after the thinning by other decreased waters under the minimum stipulated value (concentration limit). Other radioactive liquid emissions represent uncleanable leftovers from the cleaning process and their maximum permitted amount of discharge is limited by the value of the summary volume activity beta.

The share of liquid emissions from the spent fuel storage pool is included in the overall sum of the envelope annual liquid discharges from the NJZ. The concentration of the radioactive substances in the water of the spent fuel storage pool is considerably lower in comparison with the primary circuit coolant. The reason for a lower activity is the absence of the fission process in the storage basin and thus a provoked activation of the coolant of the basin. The activity of the coolant of the storage basin is being intermittently or periodically monitored. With each activity increase, which may be caused by micro-leakages of the stored spent fuel or contamination of the surface of fuel rods, the coolant of the basin is treated in the treatment station. That is also the reason why the activity of the discharged drainage water from the storage basin is lower than that of other drainage water. The contribution of the treated water from the drainage waters of the spent fuel storage basin to the overall liquid emissions into the hydrosphere is negligible.

The liquid emissions from the NJZ including the tritium waters will be released into the recipient (the Váh River) after the radiology check in a controlled manner through the new final waste water collector (together with industrial and sewage waste waters). The discharge will be taking place periodically during the year and the emissions into the watercourses will

thus be approximately regularly divided during the operation. There will not be significant differences in the emissions into the watercourses and their composition during the normal power operation and during outage due to the refuelling.

Emissions into the watercourses from the existing nuclear plants at the site are as follows:

Tritium: up to 1.2E+13 Bq/year
corrosive and fission products: up to 2.2E+08 Bq/year

These values represent the envelope selection from the maximum measured values of the activity of the emissions of particular radionuclides for the years 2003 to 2013 from the operated JE V2. To them, the envelope values (maximum selections) have been added of the measured values of the discharged activities of particular radionuclides for the years 2009 to 2013 from other plants at the site (decommissioned JE A1 and 1, 2, the installation for the RAO processing and spent fuel storage), which form only an insignificant part of the tritium emissions, but a significant part of the emissions of other radionuclides into the watercourses from the EBO premises.

A detailed radionuclide composition of emissions from the existing nuclear plants into the water recipients is stated in the following table. Similarly to the gas emissions, also with emissions into the watercourses from the decommissioned JE A1 and V1 and other nuclear plants of the JAVYS company, short-term nuclides do not occur or only occur sporadically. For this reason these radionuclides are not included among the dominant radionuclides used for the purposes of balancing and evaluating the dose load of the inhabitants.

Table B.II.11: The envelope measured annual maximum values of each particular radionuclide in the emissions from the existing nuclear plants at the site into watercourses

Nuclide	Envelope of the measured values of the annual emissions [Bq/year]			Nuclide	Envelope of the measured values of the annual emissions [Bq/year]		
	JE V2	JAVYS	Total		JE V2	JAVYS	Total
H-3	1.02E+13	9.23E+11	1.11E+13	Ru-103	4.40E+05	-	4.40E+05
Cr-51	3.78E+06	-	3.78E+06	Ru/Rh-106	1.35E+06	-	1.35E+06
Mn-54	9.29E+06	7.87E+05	1.01E+07	Ag-110m	8.42E+06	1.39E+06	9.81E+06
Fe-55	-	1.36E+07	1.36E+07	Sb-124	4.45E+06	-	4.45E+06
Fe-59	8.90E+05	-	8.90E+05	Sb-125	-	1.32E+06	1.32E+06
Co-57	3.10E+05	5.94E+05	9.04E+05	Te-123m	-	-	-
Co-58	4.50E+06	-	4.50E+06	I-131	8.70E+05	-	8.70E+05
Co-60	1.24E+07	2.19E+07	3.43E+07	I-133	-	-	-
Ni-63	-	-	-	Cs-134	5.90E+06	2.71E+06	8.61E+06
Zn-65	1.05E+06	2.52E+06	3.57E+06	Cs-137	1.43E+07	8.97E+07	1.04E+08
Se-75	6.47E+05	-	6.47E+05	Ce-141	6.20E+05	-	6.20E+05
Sr-89	6.30E+05	-	6.30E+05	Ce-144	4.33E+06	3.54E+06	7.87E+06
Sr-90	1.26E+06	6.62E+06	7.88E+06	Hf-181	3.70E+04	-	3.70E+04
Zr-95	7.74E+05	-	7.74E+05	Pu-238	7.52E+03	8.00E+04	8.75E+04
Nb-94	-	8.53E+05	8.53E+05	Pu-239/240	4.00E+04	9.40E+04	1.34E+05
Nb-95	1.01E+06	-	1.01E+06	Am-241	4.11E+03	1.02E+05	1.06E+05

The emissions are discharged into the recipient (the Váh river, in special cases the Dudváh river) in a controlled way following a radiology check.

In the case of JE V2, the waste water containing radioactive pollution comes from the primary circuit technological circuits, hygienic loops and special laundry. The waste water is cleaned by sedimentation, distillation, filtering, ion exchange and a combination of these processes. The treated water returns back to the JE V2 technological circuits through the clean condensate tanks. A smaller volume of the treated water, representing the so-called over-the-balance water, is collected in the monitored tanks, where it is radiochemically inspected (for the volume activity beta and tritium) and subsequently diluted with the help of blowdown from the cooling towers, and it is discharged into the recipient in a controlled way. The main radionuclide in the waste water discharged from JE V2 is tritium, which originates through the same mechanism as has been described for the NJZ. The tritium cannot be eliminated from the waste water by the help of the common cleaning processes and it is not possible to even prevent its creation in the primary circuit coolant. It is possible to partially eliminate the creation of tritium by the optimisation of the primary circuit chemical regime, especially through maintaining a suitably low concentration of the boric acid in the coolant. A positive influence on the concentration of tritium in the primary circuit coolant, and therefore also the decrease of the tritium discharge into the JE V2 waste water, was observed especially after the introduction of the fuel assemblies containing gadolinium as a combustible absorber, which at the same time decreases the overall need for B-10 and in that way also the creation of tritium. Altogether the JE V2 discharges into the watercourses are of a regular and long-term steady character without an exhibition of growth trends. The share of drainage waters from the spent fuel storage basin in the JE V2 emissions into the watercourses is insignificant. It is due to the low activity of the coolant in the storage basin, small volume of the drainages from the storage basin and effective treatment of drainage waters.

For illustration and comparison we list design and limit permissible values of emissions of the dominant radionuclides from the JE V2 into the watercourses, which prove that the real maximum values of the emissions into the watercourses are for the corrosive and fission products several orders lower than that maximum design values stated by the supplier,

and the permissible limits. The tritium emissions have a long way to go to exceed the design value and the permissible limit:

	design value	permissible limit	measured maximum value
tritium:	2.0E+13 Bq/year	2.0E+13 Bq/year	1.1E+13 Bq/year
corrosive and fission products:	1.3E+10 Bq/year	1.3E+10 Bq/year	7.7E+07 Bq/year

Construction stage:

During the construction stage no radioactive emissions from NJZ will be discharged into the watercourses. The construction will be going on simultaneously with the operation of the existing nuclear plants at the site. The emissions of the existing plants into the rivers will not be, as a result of the NJZ construction, modified in any way.

Stage of the termination of the operation:

During the stage of the termination of the operation and the decommissioning there will be a gradual significant decrease of the emissions (by up to several orders) compared to the operation period. Similarly to the normal operation, all the discharged water from the NJZ will be monitored and the discharge will be regulated in such a way as not to exceed the stipulated concentration and balance limits. In the stage of the termination of the operation it may be expected that the summary activity excluding the tritium will be by about three to four orders lower than during the normal operation and the main radionuclides will be Cs-137, Cs-134, Fe-55, Co-60 and Ni-63. The summary activity of tritium is expected about ten times lower than during the normal operation, its level determined most of all by the processing of the water from the NJZ basin and the treated water from the decontaminations.

Stage of decommissioning:

A source of contamination in further stages of the decommissioning will be the decontamination and dismounting activities and the operation of technologies of RAO treatment (fragmentation), during which radioactive aerosols originate to a greater extent, and the radionuclides are discharged into the liquid RAO during the decontamination especially from the inside surfaces of the contaminated technological equipment. The dismounting activities and RAO treatment technologies will be carried out in such a way as to reduce the leakage of radionuclides to the greatest possible extent.

Contaminated waters will be run through the system of treatment stations and monitoring tanks. The discharged water will be monitored and the discharge will be regulated in such a way as not to exceed the stipulated concentration and balance limits. It may be expected that the summary activity excluding tritium will be one to two orders lower than in the stage of the termination of the operation and the principal radionuclides will be Cs-137, Cs-134, Fe-55, Co-60 ad Ni-63. The summary activity of tritium is expected by about ten times lower than in the stage of the termination of the operation.

Ionizing radiation field: insignificant

A field of ionizing radiation means the influence of the electromagnetic (gamma) radiation that is neutrons, directly from the technological objects (without the contribution of discharges). It is not significant even in the immediate proximity of the technological objects, both the NJZ and the existing plants, including at the stage of their decommissioning.

During the construction there will be no sources of ionizing radiation used which could have a practical significance from the point of view of the environment protection. The sources that may have to be taken into account are the enclosed emitters, which form parts of various machines (for example, defectoscopic machines for the monitoring of weldings, and so on).

Radioactive waste: overall volume: up to 125 m^3/year

This value represents a conservative envelope value, based on the production per unit of about 50 – 70 m^3/1,000 MWe of the installed capacity per year and the envelope data provided by the suppliers of the reference units. The value of 125 m^3/year represents more than 40% conservative margin compared to the requirements of the EUR document (European Utilities Requirements for Light Water Nuclear Power Plants, 2012), which stipulates the limit value for pressurised water reactors of 50 m^3/1,000MW_e/year of solid low- and medium-level activity waste. Under the term solid waste we mean solidified liquid waste, solid pressed or noncompactable waste. The EUR requires that at the same time the stipulated limit of the dose equivalent rate be fulfilled (typically, the value of such a limit is stated at 10 mSv/h) on the surface of the overpacks containing the waste, and that the stipulated target value of the volume does not contain contaminated materials, equipment, maintenance and repair substances. Further it is required that capacities be created for a minimum 5-year storage of low- and medium-level activity waste directly in the power plant. This storage capacity, however, may be lower if the operator has a permanent waste storage available (which is also the case with the NJZ at the EBO site).

The NJZ radioactive waste will be represented mostly by concentrates from the vaporising station, spent ion exchangers and sludge, filters of active air systems, used measuring probes and sample cartridges, further contaminated unusable parts, protection equipment and clothes, selected materials from the monitored zone, and such. As far as the types of waste are concerned, according to the suppliers' data the volume of the solid radioactive waste should be equal to double the volume of the solidified liquid RAO.

As far as the RAO classification is concerned from the viewpoint of the classes defined by legislation, only very-low-level, low-level and intermediate-level wastes will be produced. The overwhelming majority of the waste will be very-low-level and low-level, which will be, following the treatment, deposited in the surface storage. The radioactive waste of higher levels (intermediate-level), which should not end up in this kind of storage, is represented for example by certain types of

ion exchange media and in-core parts. The amount of this waste will be at most in the uncertainty range of the estimations of the overall amount of waste (for an illustration, it is possible to state that in 2013 there was altogether 10.5 kg of such intermediate-level activity waste on JE V2; cumulatively since the commencement of the JE V2 operation, it has been about 21 t).

In summary, the composition of the NJZ radioactive waste will not significantly differ from the structure of radioactive waste originating in the nuclear power plant today, with the trend of a decrease of the amount.

RAO production from the existing JAVYS facilities varies, depending on the currently carried out decommissioning activities on JE A1 and 1, 2. Within the operation of JE V2, there is up to 25 m^3 of liquid RAO created per year, including up to 20 m^3 of radioactive concentrates, up to 5 m^3 of spent sorbents and an insignificant amount of radioactive oil. Further, the operation of JE V2 creates up to 15 ton of solid RAO. The RAO production on the JE V2 has a long-term trend of decrease.

During the NJZ construction, radioactive waste will not be produced.

During the termination of the operation and decommissioning, RAO will be produced in the amount of thousands of m^3. It will be mostly comprised of assorted contaminated materials (contaminated technological systems or civil constructions) from dismounting and demolition, and radioactive waste originating from decontamination.

Spent nuclear fuel: up to 35.0 t UO_2/year

This amount means about 53 fuel assemblies per year. The amount of spent nuclear fuel produced corresponds to the amount of the fresh inserted fuel.

The same assumption is valid for the operation of the existing plants (JE V2). The current production of the spent nuclear fuel from JE V2, which as the only one from the operated nuclear plants at the site currently produces spent fuel, is up to 20.0 t of UO_2/year. The overall production (during the simultaneous operations of the NJZ and JE V2) of the spent fuel will thus not exceed about 55.0 t of UO_2/year.

During the NJZ construction, spent nuclear fuel will not be produced.

After the termination of the operation and extraction of the fuel from the reactor no spent nuclear fuel will be further produced.

Non-ionising radiation: insignificant

The proposed activity is not a significant source of non-ionising radiation (a magnetic or electric field). The electric lines (electric power outlet or backup power), located in an outside, publicly accessible space, will meet the required limits.

B.II.6. Smell and Other Output

6. Smell and Other Output (source, intensity).

Smell and other output: no output

The proposed activity is not a source of smell and/or other output into the environment.

B.II.7. Supplementary Data

7. Supplementary Data (e.g. significant terrain modifications and landscape interference).

No further output, significant terrain modifications or landscape interference is part of the proposed activity.

C. COMPLEX CHARACTERISTICS AND IMPACT ASSESSMENT

C. COMPLEX CHARACTERISTICS AND ENVIRONMENTAL IMPACT ASSESSMENT INCLUDING THE HEALTH

C.I. Delimitation of the Borders of the Area Concerned

I. Delimitation of the Borders of the Area Concerned

The area concerned is characterised as an area that might be significantly impacted by the influences of the proposed activity. As follows from the evaluations carried out in the relevant chapters of this Report, the extent of the significant influences will not exceed the area of the cadastre territories of the communities concerned. Thus, the area concerned is delimited by the following cadastres:

Jaslovce k. ú., Bohunice k. ú., Paderovce k. ú., Malženice k. ú., Radošovce k. ú., Dolné Dubové k. ú., Kátlovce k. ú., Špačince k. ú., Ratkovce k. ú., Žlkovce k. ú., Červeník k. ú., Trakovice k. ú., Madunice k. ú., Veľké Kostoľany k. ú., Zákostoľany k. ú., Nižná k. ú., Pečeňady k. ú., Horné Dubovany k. ú., Dolné Dubovany k. ú., Drahovce k. ú., Dolný Lopašov k. ú., Chtelnica k. ú., Piešťany k. ú.

The location of the cadastres concerned and their spatial relation to the site of the proposed activity are evident from the Annex 1 of this Report.

The term “area of interest” is also used within this Report. It delimits the area in which the descriptions of the status of the environment and the impact analyses are carried out. This area of interest is not cohesively delimited, but its expanse depends on the range of the potential influences on one or another part of the environment. Further data on the extent of the area of interest are obvious from the chapters on the particular parts of the environment.

C.II. Characteristics of the Current Status of the Environment

II. Characteristics of the Current Status of the Environment in the Area Concerned

C.II.1. Geomorphological Conditions

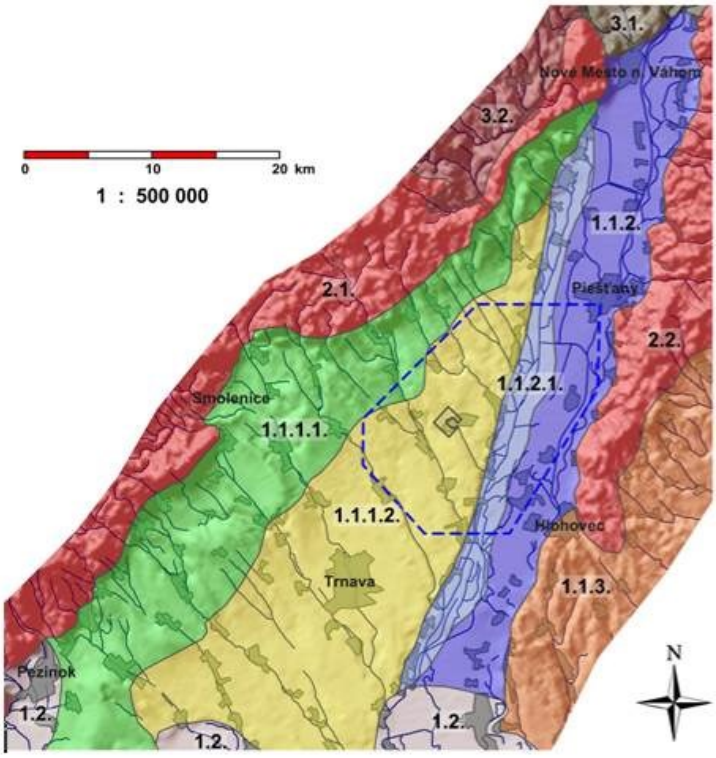
1. Geomorphological Conditions – type of relief, sloping, segmentation.

C.II.1.1. Geomorphological Conditions

The surroundings of the NJZ site extend to the geomorphological units of Danubian Hills and Danubian Lowland; the borders of this area are delimited by the morphostructures of the Little Carpathians and Považský Inovec mountain ranges; on the north it touches upon the Považské podolie basin [*Mazúr & Lukniš 1986; Maglay 2010*]. The area forms part of the unit of Danubian Hills, Trnava Plateau sub-unit and Sub-Little-Carpathian Hills.

Trnava Plateau, forming the NJZ site and a significant part of its surroundings, is typical for its less segmented relief. A different character of the relief is the result of slightly different processes of the forming, which were mostly eolian and fluvial, with a dominance of accumulation over erosion. Today's more marked unevennesses are the result of the fluvial erosion activity of streams and drain erosion. The Plateau has an almost flat, slightly rippled surface with the sloping of up to 2° [*Mazúr E. & Jakál J. [Eds.] 1978*].

Figure C.II.1: Geomorphological division and geomorphological division scheme of the surroundings of the NJZ site, adapted from *Mazúr & Lukniš* [1986]



Area	Unit	Sub-Unit	Part
Danubian Lowland (1.)	Danubian Hills (1.1.)	Trnava Hills (1.1.1.)	Sub-Little-Carpathian Hills (1.1.1.1.)
			Trnava Plateau (1.1.1.2.)
		Lower-Váh Plain (1.1.2.)	Dudváh Marshland (1.1.2.1.)
		Nitra Hills (1.1.3.)	
	Danubian Flat (1.2.)		
Tatra-Fatra Area (2.)	Little Carpathians (2.1.)		
	Považský Inovec (2.2.)		
Slovak-Moravian Carpathians (3.)	Považské podolie (3.1.)		
	Myjava Hills (3.2.)		

Legend:

NJZ Surroundings

NJZ Site

The most significant recent process of the terrain formation in the area is the watercourse activity. The Trnava Hills are covered by a network of smaller watercourses, flowing mostly in the direction of north-west to south-east. The watercourses of the Trnava Hills are drained by Dudváh, belonging to the Váh river basin. The surroundings of the NJZ site extend in the area of the Trnava Hills to the valleys of the small streams of Krupský potok, Dubovský potok, Horná Blava, Manivier, Chtelnička, Lopašovský potok, Lančársky potok and Šteruský potok.

The altitude of the terrain surface in the wider surroundings of the NJZ site ranges in the interval of 130–210 m above sea level. The most striking positive morphostructures in the area are the core mountain ranges of the Little Carpathians and the Považský Inovec.

C.II.2. Geological Conditions

2. Geological Conditions – a geological characteristic of the area, engineering-geological properties, geodynamic phenomena (e.g. slide, seismicity, erosion and others), deposits of mineral resources, the state of the pollution of the rock environment.

C.II.2.1. Geological Conditions

The surroundings of the NJZ site are a part of the Blatno Depression, which is the northern protrusion of the Danubian Basin as a part of the Pannonian Basin System [*Kováč 2000*]. According to the regional geological division [*Vass et al. 1988*], the Blatno Basin (Depression) is a geological unit of the lowest level and forms part of the Trnava-Dubník Basin and the Danubian Basin. The Blatno Depression is a neogene morphostructure with the most dynamic period of development in the

Baden period (Middle Miocene). Areally extensive Quaternary blanket units, neogene sedimentary fill and its pre-Tertiary substrate form the geological construction of the basin.

Quatenary sediments may be divided into several lithogenetic types. The major members of the profile are formed by eolian sediments (including polygenetic), and alluvial and fluvial sediments in their subsoil.

Eolian sediments: The loess strata complex originated in at least three of the main glacial stages; they are sediments settled due to the eolian activity during the periods of Mindel, Riss and Würm (Pleistocene). The body of loess and loess silts at the NJZ site is continuously covered by fluvial and alluvial sediments and reaches the thickness of about 8–20 metres, locally more. Instances of loess blanket of a greater thickness are located about 1 km to the north-west from the NJZ site border, where they reach up to 30 m. A part of the loess body is formed by polygenetic sediments, represented by the positions of loess silts.

Alluvial (plain) sediments: In the fluvial gravel overburden and in the loess body subsoil, there are clay, lightly sandy, non-calcareous, alluvial silts of final plain sedimentation of the thickness of about 2–4 metres. On the southern side of the NJZ site, where clay sediments of a buried river distributary have been evidenced, their thickness may exceed 10 m. Locally, alluvial clays may be missing from the profile.

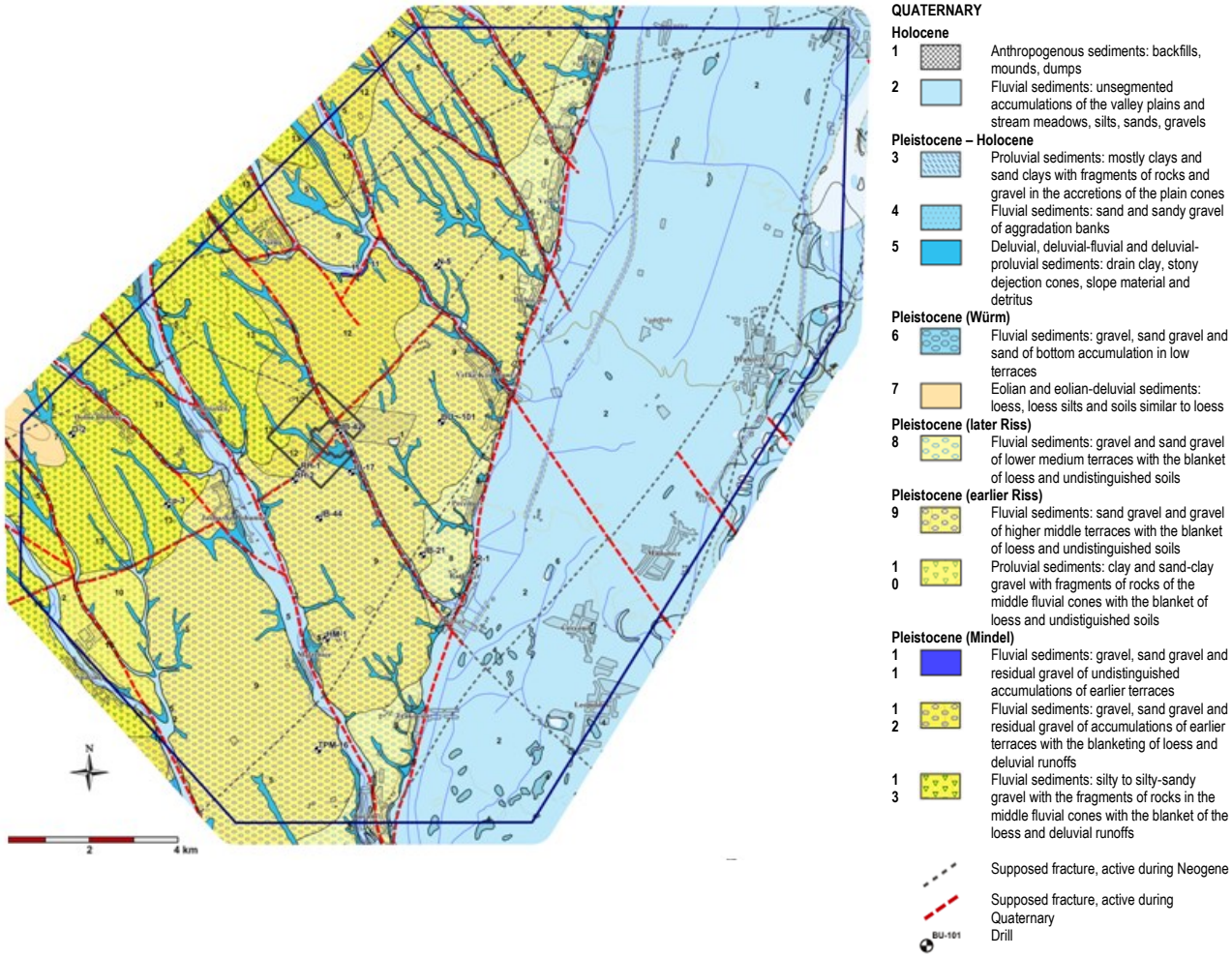
Fluvial sediments: They create pre-Quaternary subsoil on the whole area of the site. In the published map [*Maglay et al. 2006*] they are marked as sandy gravel and gravel of the upper terraces with a loess overburden. The bottom accumulation of the gravel reaches the thickness of up to 3–4 m and upper of 6–8 m.

According to new findings, the border of Quaternary and Neogene is formed by the border of alluvial clay and fluvial gravel, which are considered a part of the Kolárov strata complex of the Pliocene period [*Kováč et al. [2011], Šujan M. jr. 2012*].

In the subsoil of Quaternary sediments, there are *Neogene sediments*. At the NJZ site and in its immediate surroundings, Neogene sediments do not rise to the surface. Tertiary basin filling comes to the surface at a good distance from the reviewed locality (in the marginal parts of the Brezovce Carpathians and in isolated instances on the elevations near Horné Dubové or at the Šarkan elevation point near Boleráz). Significant stages of the development of the basin are Lower to Middle Miocene, Upper Miocene to Dacian and Ruman – Pleistocene period. The influence of the new building object may be expected at the sediments of the youngest Neogene – fluvial gravel and sand with positions of clay sand and clays of Pliocene (to Upper-Pannonian) period, belonging to the Volkov and Kolárov strata complexes.

The pre-Tertiary subsoil has no direct relationship to the NJZ site itself.

Figure C.II.2: Geological map of the NJZ site surroundings, adopted from MAGLAY et Al. [2006:2011]



C.II.2.2. Hydrogeological Conditions

Neogene structures: From the viewpoint of hydrogeological division into regions it is the region N 049 Neogene of the Trnava Hills [*Šuba et al. 1984*] with the overall area of 453 km^2 and the overall usable amount of underground water of 151 l.s^{-1} [*Čaučík et al. 2011*]. The hydrogeological complex of Neogene basin structures of the Blatno Depression is characterised by sediments and variable porous permeability, low values of hydraulic gradients with the alternation of more and less permeable environments. The middle values of flow rate for the Neogene sediments of the Trnava Hills range in the interval of T ≈ 3×10^{-4} ~ 3×10^{-3} m^2.s^{-1}. The youngest Neogene hydrogeology unit is distinguished by its permeability – fluvial gravel and sand with positions of clay sand and clay of Pliocene (up to Upper-Pannonian) period, classified among the Volkov and Kolárov strata complexes. Further lithostratigraphic units of Neogene are characteristic by the dominance of different varieties of claystone and siltstone over sandstone and other hydraulically more conductive environments. A hydroeconomic importance of Neogene sediments is limited from the viewpoint of the supply for larger settlement units, that is, local.

Quaternary structures: From the viewpoint of the hydrogeological division into regions it is the region of Q 050 Quaternary of the Trnava Hills [*Šuba et al. 1984*] with the overall area of 480 km^2 and the usable amount of underground water of 661 l.s^{-1} [*Čaučík et al. 2011*]. The horizon of Quaternary sediments is divided into genetic types with their own characteristics. Especially the overburden unit of the eolian sediments stands out by its markedly different properties. According to the most recent findings,

gravel forms part of the Kolárov strata complex of the Pliocene period (except the recent alluvium of Váh) [*Šujan M. jr. 2012*].

Eolian sediments: Loess and sand loess of the Pleistocene are the dominating blanket unit in the Trnava Hills. Given their granulated character with the dominance of silt and addition of sand and clay they are very little permeable and create a regional hydrogeological insulator on the surface of the terrain. A rather thick unsaturated zone has developed in the loess, with the surface of the underground water often being in the depth of more than 10 m. Due to these properties it fulfils an important protective role against the subsoil collectors, or it can serve as a rock environment having the least interaction with the circulation of the underground waters. The dominating presence of silt and clay fraction in the frame of the soil limits the flow rate of the environment; generally, its values are lower than 10^{-6} $m^2.s^{-1}$.

Proluvial sediments: Sand gravel with fragments of rocks, creating fluvial cones and fans is spread mostly by the marginal parts of the mountain ranges. Its presence at the NJZ site is not likely.

Fluvial sediments: The hydrogeological unit of the fluvial sediments is formed mostly by the clay gravel sand covered in loess or loess silts and Váh alluvium. Conventionally, this unit has been classified as part of the Pleistocene river terraces of several generations, but according to the more recent data it (except the recent Váh alluvium) belongs to the Pliocene. The unit of the fluvial sediments in the area of the Trnava Hills has been hydraulically tested at 148 hydrological drills altogether. The medium value of the flow rate coefficient has been established as $T = 2{,}3.10^{-4}$ $m^2.s^{-1}$, the medium value of the filtration coefficient ranges around $3{,}7.10^{-4}$ $m.s^{-1}$.

Upper-Pleistocene and Holocene gravelsand sediments of river alluviums in the plains of the local watercourses and the dominant recipient Váh had in the past the primary significance from the point of view of supplying the inhabitants with drinking water. In this region 386 hydrogeological drills and hydrodynamical tests have been carried out. The medium value of the flow rate coefficient has been established as $T = 3{,}5.10^{-2}$ $m^2.s^{-1}$, medium value of the filtration coefficient ranges high, up to about $1{,}2.10^{-2}$ $m.s^{-1}$.

The underground water at the NJZ site has been accumulated in the collector of fluvial gravel and sand, which is hydraulically connected with the collector of Limnice gravel and sand. The overload horizon formed by a loess complex and plain clay acts as a hydrogeological insulator. From the side of the subsoil the collector is limited by the insulator of Limnice clay.

Draining of the collector occurs in the direction of north-west to the south-east to the alluvial plains of Váh and Dudváh. The difference between the maximum and average levels of surfaces is rather small and within the NJZ site it ranges around 0.7 m.

The surface of the underground water in the space of the future NJZ construction site and its immediate surroundings is at 150.0 ~ 151.0 above sea level. Depending on the morphology of the terrain it usually reaches the depth of around 22 ~ 23 metres under the terrain. In the elevated parts of the surface relatively (compared to the terrain surface) the surfaces drop down to the 30 metres under the terrain, in local depressions they can also reach a level of around 15 metres under the terrain. The surface is slightly sunk under the level of the division of gravel and upper-soil alluvial clay.

From the listed data it follows that the digging of excavations, except special cases, will not likely be influenced by the underground water. Into the permanent aquifers of gravel and sand, depth foundations will likely be built in, since these layers have the most favourable engineering-geological properties.

For the evaluation of the chemical properties of the underground waters at the evaluated site, as well as the evaluation of the possible influences on the civil structures, chemical analyses of the samples of the underground waters have been used, taken during the research works from the drills of the NJZ series (engineering-geological research of the NJZ site in 2011 [*Šujan et al. 2012a*]). The waters have been evaluated as not aggressive against concrete and corrosive against steel.

C.II.2.3. Engineering-Geological Conditions

Given the position of the NJZ site in the near proximity to the EBO premises, for the evaluation of the engineering-geological prospecting level, there were several reports available (1965–1982), which document the preparation of the objects of the particular electric power plants. From the reports, data were excerpted about 114 drill logs with an overall footage of about 3,300 m and data about more than 900 samples of soil, for which geotechnical parameters were defined. In 2011, an engineering-geological prospecting of the NJZ site was carried out [*Šujan et al. 2012a*]. The subject of the geological task envisaged the processing of the materials for the aims of the NJZ project feasibility study. At the NJZ site, three core borings made with the final depth of 50 m for the purposes of engineering geology. Further field tests were carried out, as well as measurements consisting of 4 testing measurements of a dynamic penetration by earth-boring tools and three points of static penetration. The results, acquired by the works at the NJZ site in 2011, together with the information from archive works (1965–1982), form the input data for the processing of the description of the construction site and its surroundings.

Within the site and close proximity of the EBO premises, there were several geophysical tasks carried out (in the years 1983–1997), which focused methodically on seismic measurements, geoelectric measurements and borehole logging measurements in the borings. In the space of the Blatno Depression several further stages of the seismic research were carried out focusing on the search for the deposits of natural hydrocarbon, the results of which formed a part of input for the solution of geological tasks related to the preparation of the NJZ project. In the 2011 a geophysical research of the NJZ site was carried out. Within the prospective NJZ site there were two basic (1,400 m long) and two additional (600 m) geophysical profiles established. Subsequently, geoelectric and seismic measurements we carried out on these profiles [*Šujan et al. 2012b*].

The performed geological works correspond by their extent and methodics to the requirements for the stage of the orientation engineering-geological research under the Ministry of Environment Decree No. 51/2008 Coll., implementing Act No. 569/2007 Coll. on Geological Works (Geological Act) as amended, that is the verification stage under the Safety Guide IAEA NS-G-3.6 Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants.

The proposed profile of the base soil was researched for the maximum estimated reach of the additional load of the future NJZ objects that is about 50 m. The geological profile of the NJZ construction site is characterised by the presence of a loess complex, a body of river sediments and Neogene subsoil. It is basically divided into three units:

a) fine-grain soils strata above the gravel layers:
   - loess horizon,
   - alluvial clay;

   In the interval starting with the surface down to about 16 m under the surface, the unit contains eolian and polygenetic sediments that is loess and loess clay, and alluvial clay on the basis of about 16–20 m under the surface. The age of the eolian and polygenetic sediments ranges from Mindel to Holocene, the subsoil alluvial clays sedimented in the Lower Pleistocene. The dominant geotechnological type is middle-plasticity clays (CI/F6) of firm to stiff consistence; alluvial clays are of predominantly stiff to very stiff consistence.

b) unit of gravels and sands:
   - upper gravel strata complex,
   - middle gravel strata complex,
   - bottom gravel strata complex;

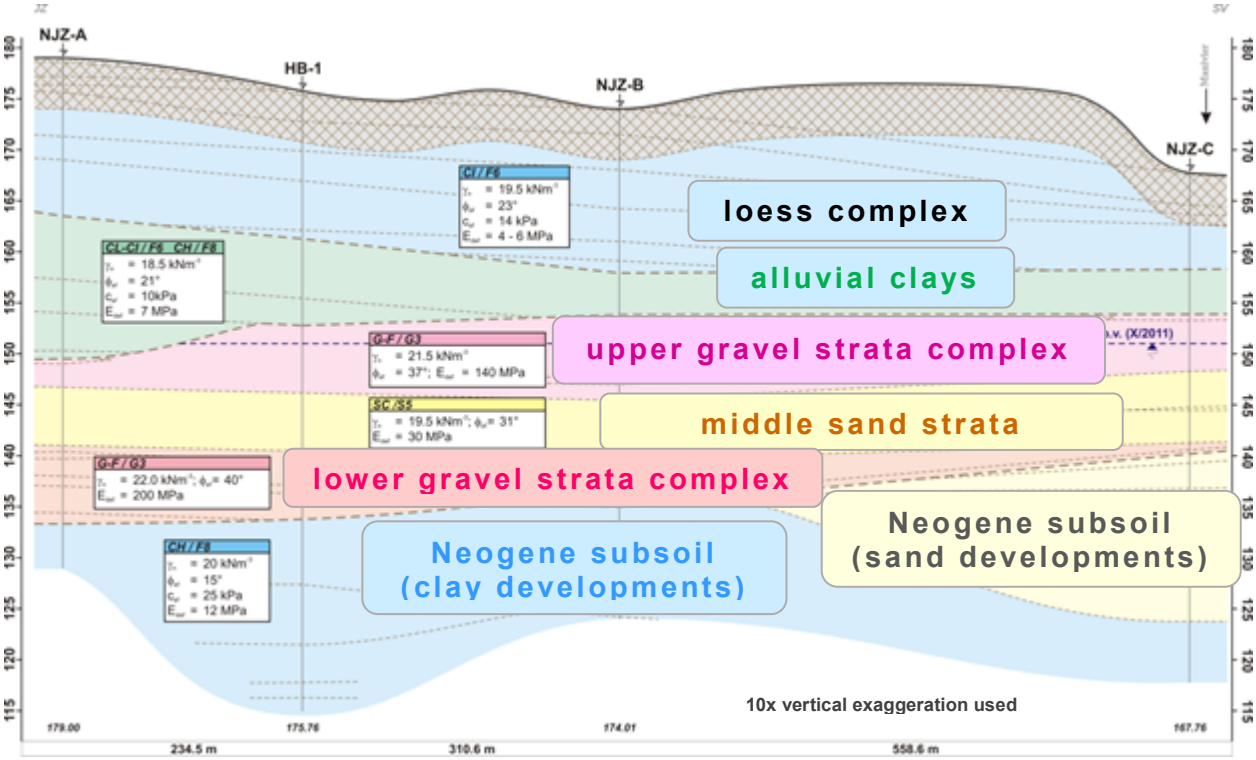
   Soils of this unit form the depth interval of 20 to 39 m under the surface of the terrain. They are fluvial sediments, settled by the activity of the paleo-Váh in the period of Upper Pannonian stage to Pliocene. The gravels and sands function as a collector of the underground waters, the free surface reaches the level of about 22 to 23 metres under the terrain.

c) subsoil of Neogene sediments.

   Predominantly fine-grain soils of the Neogene subsoil rise from the depth of about 39 metres under the terrain. They are the Pannonial fluvial-Limnice sediments. The dominant geotechnical type is clay with a high plasticity (CH/F8), less so clays with a middle plasticity (CI/F6) of stiff, partly very stiff consistence.

The basic geotechnical parameters of each particular unit are shown in the following generalised cross-section.

Figure C.II.3: Generalised geological-geotechnical cross-section of the NJZ construction site



C.II.2.4. Seismicity, Tectonics, and Geodynamic Phenomena

C.II.2.4.1. Seismicity

Existing Seismic Task for the Site

The analysis of a seismic threat for the site of the Bohunice Nuclear Power Plant was carried out in the years 1996–1997 in compliance with the Safety Guide of the International Agency for the Nuclear Energy 50-SG-S1 (Rev. 1), 1991. The results are currently valid and accepted by the supervision body (Nuclear Regulatory Authority of the Slovak Republic) and verified within the 1998 IAEA revision mission. They are also accepted in the Extraordinary National Report of the Slovak Republic, processed in compliance with the Convention on Nuclear Safety (April 2012) within the process of complex risk evaluation and safety of the nuclear plants ("stress tests") after the breakdown which occurred following the earthquake and tsunami on 11 March 2011 in the Fukushima-Daiichi nuclear power plant.

The analysis contained the probability seismic hazard analysis (PSHA) for the site [*Labák et al. 1997a*] and subsequently characteristics were stipulated of the review level earthquake [*Labák & Moczo 1998*]. In the probability analysis, peak ground acceleration (PGA) and horizontal share of the response spectrum in the pseudo-spectral acceleration (PSA) were considered as characteristics of the seismic soil movement. The horizontal and vertical spectra of the response were established as characteristics of a review level earthquake (RLE). The basis for the PSHA was formed by the seismological [*Labák et al. 1997b*] and geological databases [*Kováč et al. 1996*], which were created for that purpose in the relevant radiuses from the site in the sense of the IAEA methodics [*IAEA 1991*]. Through the synthesis and interpretation of the seismological and geological databases, a seismotectonic model was created, which delimits the seismic source zones, minimum magnitude, maximum magnitude and numerical relations. For a wider region, there were eight independent area seismic source zones established and a background zone. As a minimum magnitude, the magnitude value was chosen from the surface waves M_S = 4.33 (momentum magnitude M_w = 5). Maximum magnitude was established on the basis of the data about historical seismic activity and geological-tectonic data. Further, on the basis of the macroseismic observations, by a regress analysis an attenuation relation was found for the macroseismic intensity in the Western Carpathians. The

resulting relation was compared with the relations for other analogical regions and subsequently 5 attenuation relations were chosen for the PGA and PSA.

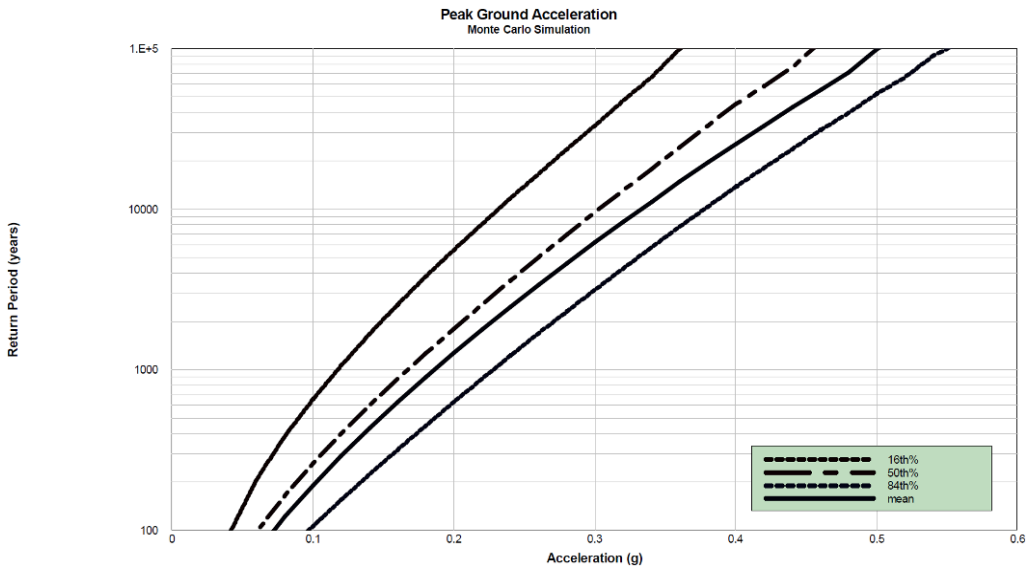
The alternative values of the input parameters were formed by the PSHA input, with the hazard calculation carried out a) by the method of the logical tree and b) by using the Monte Carlo simulation. The nods of the branching out in the logical tree (1,440 branches) were zoning, maximum magnitude, numerical relation and attenuation relation. For the Monte Carlo simulations what was considered was the continuous distribution of the value uncertainty in determining the numerical relation; other alternative values of the input parameters were the same as in the first case. Together, 100,000 scenarios were simulated.

The values of PGA and PSA were calculated for the return period of 475 years, which corresponds to the level of SL-1[18], and for the return period of 10,000 years, which corresponds to the level SL-2. The following step was the de-aggregation of the probability calculation of the seismic threat and the identification of a defining earthquake, for which the horizontal and vertical spectra of response were established on the basis of the available attenuation relations. The basic output of the analysis of the seismic threat for the site of the Bohunice Nuclear Power Plant was the values of the horizontal and vertical accelerations for the RLE according to the following table.

Table C.II.1: Values of the horizontal and vertical accelerations for the RLE for the EBO site

Frequency [Hz]	Horizontal spectrum [g]	Vertical spectrum [g]
PGA	0.344	0.214
10.00	0.621	0.503
5.00	0.800	0.423
3.33	0.761	0.312
2.00	0.562	0.196
1.33	0.387	0.141
1.00	0.287	0.107
0.67	0.182	0.073
0.50	0.127	0.054

Figure C.II.4: 16-, 50- and 84-percentile curves and the middle curve of the seismic hazard for the PGA values, established by the seismic hazard probability calculation by the Monte Carlo method



[18] The SL-1 value has been established on the basis of the EC-8 Eurocode and corresponds to the return period of 475 years, therefore being established more conservatively than required by the Decree No. 430/2011 Coll., which stipulates the application of the return period of 100 years for SL-1.

New Probability Evaluation of the Seismic Hazard

For the stage of the request of approval for the NJZ siting, a new probability calculation will be submitted for the site based on the current IAEA Safety Guides (especially the document № SSG-9 Seismic Hazards in Site Evaluation for Nuclear facilities [*IAEA 2010*]). The study will include all the basic sets of input, such as the new seismologic database and earthquake catalogue, geological database, seismotectonic model and selection of the ground motion prediction equations (GMPE).

The seismologic database will form together with the geological database a set of the input data necessary for the probability calculation of the characteristics of the seismic hazard at the NJZ site. The seismologic database was compiled for the so-called NJZ Region (a symmetric area with the perimeter of 305 km from the NJZ site). The NJZ Region includes parts of the territories of Slovakia, Hungary, Austria, Czech Republic and Poland and partly intrudes upon German, Slovenia, Croatia and Serbia.

When compiling the seismologic database, there were 5 so-called national earthquake catalogues used (catalogues created by national seismologic services), bulletins (yearbooks) of the national seismologic services from Austria, Czech Republic and Hungary, an earthquake catalogue from the local EBO network, two regional catalogues ACORN and CENEC and data from world-wide earthquake databases (e.g. ISC catalogue). A part of the compilation of the seismologic database was an elimination of overlapping data about earthquakes.

The compiled seismologic database contains data on 9,142 earthquakes, which were observed in a macroseismic (felt) and/or seismometric way (by devices), that were recorded in the NJZ Region in the years 350–2011. An earthquake in the database is characterised by data about its time, location, size and their uncertainties. The compiled seismologic database was converted to the same unit to determine the size of the earthquakes – the momentum magnitude M_w. For the purposes of homogenisation, the seismologic database was divided into two time sections: pre-seismometric (pre-device) period (years 350–1900) and seismometric (device) period (1901–2011). The homogenised seismologic database (earthquake catalogue) contains data on 2,652 earthquakes, the minimum momentum magnitude M_w being higher or equal to 1.5. The map of the earthquakes' epicentres contained in the catalogue with the indication of the momentum magnitudes is shown in the following images.

Figure C.II.5: Map of epicentres of the earthquakes (Jaslovské Bohunice NJZ catalogue) with the indication of momentum magnitudes M_w

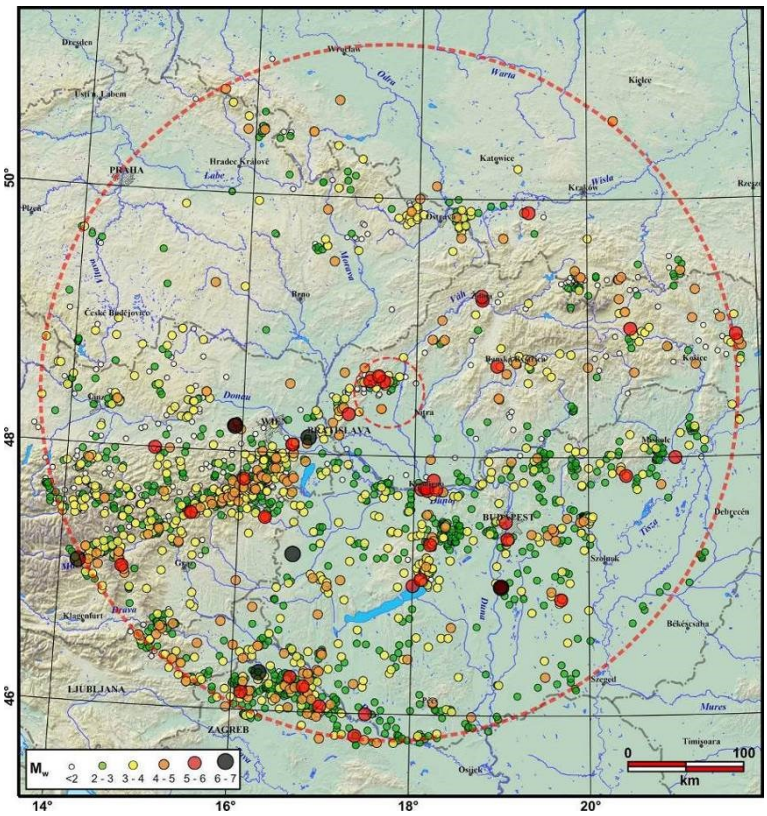
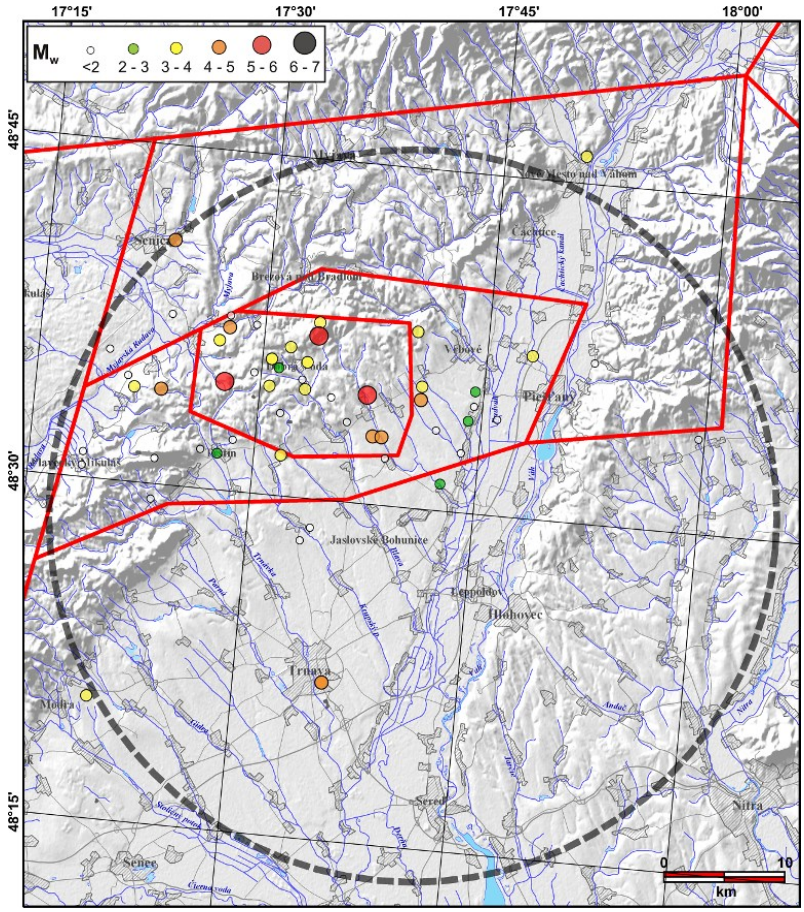


Figure C.II.6: Map of epicentres of the earthquakes and the bordering of the source zones in the Near Region of the NJZ with the indication of momentum magnitudes M_w



The probabilistic seismic hazard calculation will be carried out for the return period of 475 years (according to EC-8 that is the SL-1 level according to IAEA [*IAEA 1991; IAEA 2010*]), period of 10,000 years, that is the SL-2 level according to IAEA [*IAEA 1991; IAEA 2010*] and the review level earthquake (RLE) period. The calculation part of the task will be finalised in the stage of the request for the approval of the NJZ siting; several steps and activities have been recommended for the improvement of the existing knowledge, supplementation and, possibly, a more detailed research of the site and near surroundings of the NJZ, which would contribute to a better understanding of the seismic risk at the Jaslovské Bohunice site. It is especially the research in the SK2 source zone (Dobrá Voda), the research of a recent tectonic evolution and in the approval stage, the construction and running of a seismic station at the NJZ site (with its integration into the local seismic network of Jaslovské Bohunice). The goal of a more complex and detailed research of the Dobrá Voda source zone and the recent tectonic evolution is to gain more input data on the basis of which it may be possible to decrease the uncertainties of the values of the units entering the calculation.

As the demands on the time of the acquisition of the necessary data by performing the listed activities are rather high, the relevant PSHA calculation will be available in the stage of the request for the approval of the nuclear power plant siting. The principal results of the calculations will be the curves of seismic threat for the peak acceleration (PGA) and for the periods of 0.1, 0.2, 0.3, 0.5, 1.0, 1.5, 2.0 and pseudo-spectral acceleration (PSA) in the values of the given return periods.

C.II.2.4.2. Tectonics

South-east from the NJZ site, according to the published map documentation [*IAEA 1991*], there are two fault lines meeting, which are classified, due to their age, as Quaternary. The younger fault runs in the direction of north-west to south-east and it overlaps with the line of the Manivier canal and the line of the older pre-Quaternary covered fault. The older fault line has the direction of north-east to south-west. The line is interrupted by the preceding fault and similarly copies an older one –

pre-Quaternary covered fault. The kinematic function of the faults corresponds to the paleostress field from the boundary of Pliocene and Quaternary, which has been derived for the territory of Slovakia that is for the region of the Rišňov Depression.

From the line of the fault its activity in the Quaternary period is not evident, because by no means does it separate the displayed Quaternary that is Pleistocene rock complexes. Nor is it possible to derive the activity of the fault from the varying thickness of loess sediments and terrace sediments (or fluvial gravels and sands) interpreted on the basis of the drill works. It is possible to apply similar arguments also in the case of the older Quaternary fault line depicted on the EBO premises. Neither this fault line separates the rock boundaries of sediments of higher and medium terraces (Middle Pleistocene in the sense of the quoted map) present in the subsoil of the NJZ site, whereas, on the contrary, the displayed boundary covers the fault line.

In the sense of the stated arguments and according to the quoted map documentation we may remark that the fault lines running in the proximity of the NJZ site could not have been active in the period following the Middle Pleistocene, which represents a period of about 780,000 years. At the same time, there has been no correlation of these lines with the faults found, which were indicated on the basis of the interpretation of the results of the shallow and medium-deep structural research in the area. New results of the geological works from this locality confirm the statement. The minimum age of the sediments of the alluvial complex (uninterrupted gravel overburden) is about 830,000 years, with certain data pointing to rather higher ages up to the lower border of the Pleistocene. The data point to a tectonic peace in the NJZ site area, at least from the period of 780–830,000 years until now. The findings will be confirmed and updated within the detailed research in the following steps of the design documentation.

C.II.2.4.3. Geodynamic Phenomena

For the evaluation of the potential external risks within the NJZ site, selected geodynamic phenomena are important, the presence of which may be expected in the region. A specific process, which may be induced by the seismic load, is the soil liquefaction. From among the exogenously generated processes they are mostly the possibilities of the origination of slope deformations, or other displays of instability of the foundation soils. The commentary about these phenomena is the following:

Slides: Given the low relief energy, the occurrence of slope movements in the territory of the Blatno Depression is rather rare. The slides are mostly found in the marginal parts of the depression on the contact with the core mountain ranges, in the distance of at least 10 km from the NJZ site (western margin of the Považský Inovec).

Erosion: The current water and wind erosion within the Blatno Depression applies in a negligible extent. The area belongs to a region with insignificant to no erosion.

Soils with unstable volume (volume change of the soils): The occurrence of volume-changing soils is not ruled out in the given area. By this term we understand a sudden reduction of the volume due to the influence of excessive moistness or supplementary burdening. As the possible change of volume is a potential risk for buildings with their foundations in the loess, this property has been researched and will be taken into account during the construction of the foundations of the objects.

Liquefaction of soils: A specific type of instability in non-cohesive soils represents a possibility of liquefaction when imposed to an earthquake. The evidence of the liquefaction potential has not been found for any soil from the subsoil profile.

C.II.2.5. Natural Resources

Energy resources: In the period of the 1950's to the 1970's, the Blatno Depression was the object of several stages of hydrocarbon deposit research. A result of the research works was the identification of several deposits of inflammable natural gas, but without a real economic significance. From the listed stages of the geological works an extensive database comes of especially drill and geophysical data, which were used for tasks related to the EBO site and NJZ site. The deposits of the natural gas and non-bitumenous gases are localised on the sediments. Generally, they are non-balance deposits without any economic potential.

Geothermal waters: A specific type of energy resource is represented by geothermal waters, the occurrence of which may be tied to the carbonic developments of the Tatrikum cover and superficial blankets (Fatrikum and Hronikum), or parts of the Miocene sedimentary filling. Similar types of waters in the wider area are currently little used and there is no real expectation of their greater utilisation in the near future. In the close proximity of the NJZ site there are no used geothermal drills located and the expected unit capacities of potential drills do not create an economic perspective of realisation.

Non-ore resources: Deposits of non-ore resources are to be found outside of the proximity of the NJZ site on the margins of the Little Carpathians and the Považský Inovec. The deposits of non-ores are part of the pre-tertiary geological formations. None of the deposits intrudes into the area of the NJZ site. In the wider surroundings, there are three deposits of dolomite registered (Hrádok, Lúka and Hubina) and one deposit of decorative stone (Chtelnica – Malé Skalky) and one of feldspars (Hlohovec).

Construction materials: Of economic importance are only the deposits of construction materials, however, also without spatial contact with the NJZ site. In the wider surroundings they are the deposits of gravel-sands in the Váh alluvium (Nové Mesto nad Váhom, Hubina, Hrádok, Beckov – Prúdiky, Hlohovec – Svätý Peter, Madunice and Koplotovce), further the deposits of crushed stone (Moravany, Lúka II. and Jalšové, Trstín I – dolomite, Dechtice – Dolná Skalová – limestone, Dolný Lopašov – dolomite, and Lančár – dolomite) and deposits of brick clays (Boleráz and Hlohovec).

C.II.3. Soil Conditions

3. Soil Conditions – culture, soil type, soil kind and fertility, level of proneness to mechanical and chemical degradation, quality and level of soil pollution.

C.II.3.1. Soil Conditions

The share of the agricultural soil from the overall territory of the Trnava Region is about 70%. From the agricultural soil, the arable land dominates (about 90%), other kinds of the agricultural soil (hop-field, vineyard, garden, fruit orchard and a permanent grassland) form about 10%, forest soil covers “only” about 16% from the overall territory of the region (source: Trnava Self-Governing Region). In most of the districts, just like in the whole of the Trnava Region, the arable land dominates.

Most of the soil-forming substrates in the wider area of interest are formed by the rocks of Pleistocene and Holocene. On a part of the area concerned included in the Trnava Plateau, the soil-forming substrate is comprised of loess, in the Little-Carpathian Hills it is loess clays. The Lower-Váh Plain is composed of another soil-forming substrate – carbonate plain sediments. In the whole area concerned we can find a wide scale of soils, from muck to ilimeric soil, and in the Váh plain it is a range of hydromorphic soils.

Type of soil: In the wider area of interest, there are soil types of various kind and often temporary representation. A very much dominant type near the western margin is the brown earth. A dominant part of the territory of the Trnava Plateau is covered by muck. The right bank of the Váh (Dudváh plain) and valleys of streams are filled by gleyic phaeozem which is the third most importantly represented type. The narrow area of the Váh plain is typical for the occurrence of the fluvial earth. On the margins of the Little Carpathians and Považský Inovec mountain ranges there are rendzinas and pararendzinas developed, mostly unsaturated cambisol and lithosol. The content of humous in the soils of the area concerned is usually high (more than 2.3%), with a lesser representation of soils with a medium content of humous (1.8–2.3%). A further group is formed by soils of the developed area (communities, EBO premises), where the soils have been intensively anthropogenously influenced in the long term. The original soil types have been modified, re-created, at some places they have an effloresced character. The man’s intrusion into the natural soil-forming processes has given rise to the anthropogenic soils, which represent soils intensively cultivated, long-term degraded or destroyed overall. They are represented mostly by the soils in the gardens of the family estate area and nearby private plots on the margins of the communities or degraded soils on the social fallows, protective road zones, production premises and other

developed areas. From the viewpoint of the anthropogenic and anthropogenically influenced soils in the area concerned and its surroundings, there are mostly typical antroearth of dump form and anthropogenically influenced agricultural soils.

Soil types: From the viewpoint of the soil kinds in the wider area of interest, dominant are soils of medium weight, silty, in places there are isles of sand-clay or clay soils; in the narrow area of the Váh plain clay-silty soils occur.

Soil quality, classes of protection: In the area for the NJZ siting and construction the following soil-ecological units (BPEJ) are anticipated: 0144202, 0147202, 0139002, 0139202, 0143002, 0143202. The dominant part of the area for the siting and construction of the NJZ includes estimated BPEJ belonging into the groups 2 and 3 of the soil quality, which is soils with a high production ability (high fertility). A part of the soils represents estimated BPEJ belonging into the group 6 of the soil quality that is soils with a medium production ability.

Slope: The slope of the soils is an important physical parameter, which significantly influences the quality and the way of the usage of the soil and the given locality. From the viewpoint of the slope and exposition, the soils concerned are classified under code 0 (flatland without a display of an area water erosion 0°–1°) and code 2 (gentle slope of about 3°–7°).

Soil pollution: A great part of the area concerned is agriculturally intensively used, which is a potential risk factor of the soil contamination. Despite this fact, the area concerned belongs to the least contaminated soils in Slovakia.

Soil stability: The proneness of the area to slides depends on the geological structure and rock type, as well as the character of the relief, especially the steepness of the slopes, hydrogeological and climatic conditions. In the area concerned there are no slope slides recorded. The nearest slope slide area is located at about 11 km to the east from the NJZ; it is namely a stripe near the east banks of the Váh between the communities of Šintava and Ducové on the slopes of the Považský Inovec.

Water erosion: Among the main factors conditioning the intensity of the water erosion is the steepness of the area, the plant cover, amount and intensity of the precipitation and the graininess of the soil. Most of the agricultural soils in the area concerned are not, given the relief character, under threat from water erosion or its intensity is very low. In the mostly flat terrain (Dudváh plain, plain of the Blava stream, Trnava Plateau) there is territory without display of a water erosion; on the contrary, on the sloppy terrain (Radošovce cadastral territory), weak water erosion may be observed. Increased occurance of the water erosion may occur also on the agricultural soils without vegetation or with minimum vegetation cover. The erosion activity of the watercourses in the area concerned is currently stabilised, drain and runoff being the main activities. In the flat terrain of the Dudváh plain with high level of the water in the watercourses there is the danger of soaking and leaching of soils. Water erosion threatens mostly the slopes of the Little Carpathians, Považský Inovec, Myjava Hills and White Carpathians, that is regions outside of the areas concerned.

Wind erosion: An important influence on the wind erosion is exercised by the exposure towards the wind, the grain composition of the soils and their protection by the vegetation cover. The potential risk of the threat to the soils from the wind erosion is lower in the depressions with clay-silty soils than in an open flatland or hills with clay or sand soils. This type of erosion causes damage not only to the agricultural soil and in the agricultural production, but it also results in the pollution of roads, watercourses, creation of drifts and air pollution. This phenomenon may be observed in the non-vegetation period. In the area concerned we may classify the wind erosion as higher to high, since it is an open, mostly flat relief with a great-unit way of utilisation, without a more intensive planting of wind-breakers, which would partly eliminate this undesired phenomenon.

Soil acidification The soils of the area concerned are little prone to acidification; soil acidification from the local sources shows to a minimum extent. In the wider area of interest, acidification of soils occurs due to long-distance transmission from the emission sources in the wider surroundings, especially the industrial sources of Trnava, Leopoldov and Hlohovec.

C.II.4. Climatic Conditions

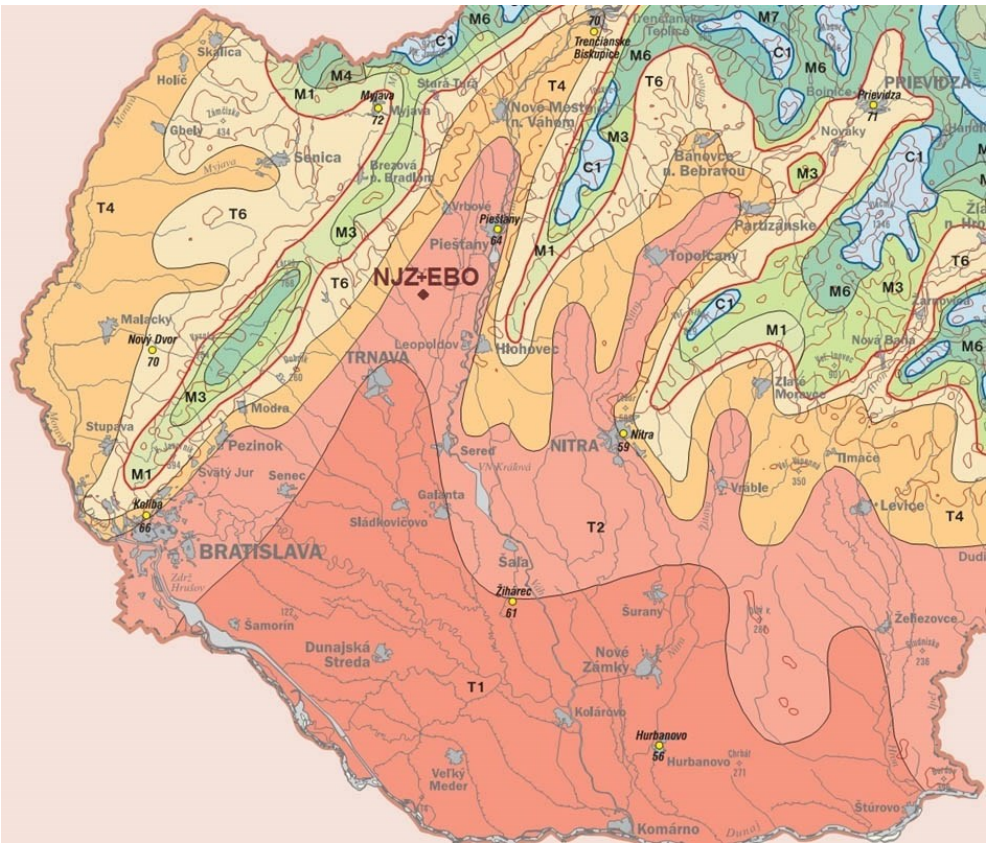
4. Climatic Conditions – rainfall (e.g. the overall annual rainfall and its course in time), temperature (e.g. average annual temperature and its course in time), windiness (e.g. the direction and force of the dominant winds).

C.II.4.1. Climatic Conditions

Under the global climatic classification, the EBO site falls into a mild zone on the border between the Atlantic-Continental area and the European-Continental area, in a transit zone between the ocean and mainland climates. The dominant air masses are the air masses of the mild zone. The area, for its open position, has naturally good circulation, and its rainfall is influenced especially by the leeward position of the nearby mountain ranges. The wider area of interest of the NJZ site belongs to the warm climate region and is classified on the basis of climate indicators into the districts T1, T2, T4 and T6.

The climate areas are shown in the following picture.

Figure C.II.7: Climate areas map



	T1	warm, very dry, with mild winter
	T2	warm, dry, with mild winter
	T4	warm, mildly dry, with mild winter
	T6	warm, mildly moist, with mild winter
	M1	mildly warm, mildly moist, with mild winter, hilly
	M3	mildly warm, mildly moist, hilly to mountainous
	M4	mildly warm, moist, with mild winter, hilly to flat
	M6	mildly warm, moist, mountainous
	M7	mildly warm, very moist, mountainous
	C1	mildly cool

For detailed statistical processing of the climatic characteristics, the data from the 1981–2010 period have been used, especially from the Jaslovské Bohunice weather station. The analysis of the current data of the Slovak Hydrometeorological Institute from the following years (until 2013) confirms these characteristics. The climatic characteristics may be described in the following way:

Air temperature: Temperature status of the EBO site is characterised by the typical continental annual and daily course with its maximum in July and minimum in January. The average annual temperature of the air at the Jaslovské Bohunice site in the period 1981–2010 was 9.8°C. The variability of the weather as well as the climate is influenced by another important phenomenon, which is the global warming. It shows not only globally, but in the recent thirty years also in the Central-European region.

Air humidity: The annual course of the relative humidity of the air is about the opposite to the progress of the air temperature. Generally, its maximum is in December and minimum in April (a secondary minimum being in July).

Atmospheric rainfall: In the analysed area the overall precipitation has an annual progress with the principal maximum in June and July, with signs of a repeated precipitation growth in November and in December, and minimum in February. The precipitation in the warm semester has rather a character of showers and downpours, in the cold semester it is mostly permanent precipitation with little amount of rainfall. The average annual rainfall in Jaslovské Bohunice in the 1981–2010 period was 553 mm.

Snow cover: The cumulated height of the snow cover per month (monthly sum in cm) reached in the dominant months of the year (December–January) more than 44 cm. The average height of the snow cover (the quotient of the sum of the overall snow cover and the number of days with snow cover) reached 6.2 cm in the observed 30-year period and the average height of the snow (the quotient of the sum of the overall snow cover and the number of days between the first and the last day with snow cover) 3.3 cm.

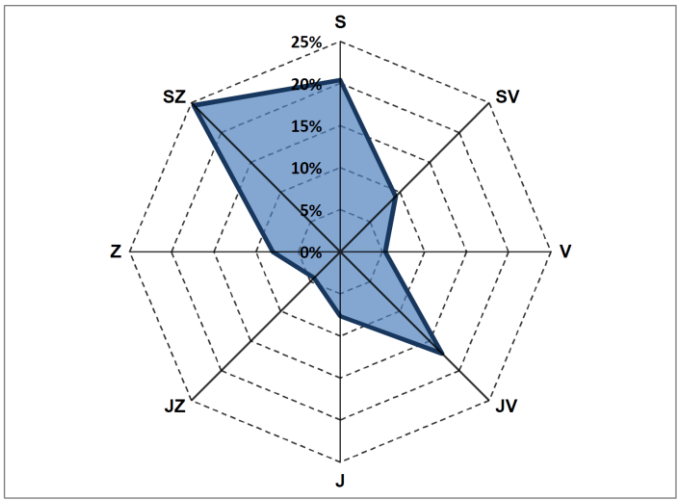
Air pressure: The changes in the air pressure are rather un-periodic, due to which the annual and daily course are not clearly determined, unlike with other meteorological elements. The average annual pressure of air was 995.1 hPa, with the maximum in winter and minimum in summer months.

Wind: Windroses showing the directions (number of the wind directions and the calm) and speeds of the wind were processed for the 1987–2010 period, when the station was located in the height of 178 m above sea level and the height of wind gauge was 19 m over the terrain. These statistical characteristics are summed up in the following table and the image.

Table C.II.2: Relative frequency of occurrences of wind directions at the Jaslovské Bohunice site during the period 1987–2010

	Calm	S	SV	V	JV	J	JZ	Z	SZ	Total
Calm	0.0331	0	0	0	0	0	0	0	0	0.0331
0 - 2 m/s	0.0000	0.0563	0.0380	0.0191	0.0302	0.0283	0.0226	0.0211	0.0342	0.2498
2 - 4 m/s	0.0000	0.0678	0.0359	0.0168	0.0457	0.0275	0.0141	0.0228	0.0594	0.2900
4 - 6 m/s	0.0000	0.0360	0.0124	0.0090	0.0435	0.0124	0.0048	0.0169	0.0652	0.2003
6 - 8 m/s	0.0000	0.0252	0.0046	0.0055	0.0308	0.0053	0.0018	0.0117	0.0522	0.1371
> 8 m/s	0.0000	0.0182	0.0019	0.0028	0.0205	0.0031	0.0007	0.0075	0.0350	0.0898
Total	0.0331	0.2040	0.0928	0.0533	0.1710	0.0764	0.0441	0.0801	0.2460	1.0000

Figure C.II.8: Windrose of the Jaslovské Bohunice site for the period 1987–2010



From the data listed it is clear that the dominant wind at the site is north-west (25% share) to north (20% share), another dominant wind is the south-east one (17%). The average wind speed during the year is 4.1 m.s^{-1}.

Sunshine: Sunshine is a qualitative index of the dose rate of the sunshine, and its amount is in a close correlation relationship with the global sunshine. Its annual course results from the combination of astronomical properties of the length of sunshine and the annual course of cloudy weather. The average annual amount of the sunshine was 1,939.6 hours with a maximum in July and minimum in December.

Atmospheric phenomena: The average number of days on which a storm occurred was 22.8 with a maximum of 36 cases per year. A storm may occur almost in any month of the year; during the whole observed period it happened zero times only in November and December.

Other meteorological phenomena are related to storms. The hailstorm occurs infrequently and is rather limited from the spatial point of view. The highest number of the days with hail per year was recorded in 2004, and it was 4 cases. The hoarfrost occurs in the cold time of the year and its origination is conditioned by the combination of temperature, humidity and wind conditions. The highest occurrence of hoarfrost (8 days) was observed in 2006. The occurrence of black ice concentrates into the majority of the months of the cold semester, most likely between November and February. The highest number of days with black ice per month was observed in January 1999 (12 days) and per year also in 1999 (20 days). The average number of days with black ice per year was about 7 days.

Extreme conditions: Extreme meteorological conditions for the NJZ site have been established for all the recommended meteorological parameters in accordance with the manuals of IAEA and WENRA. A possible combination of conditions was also taken into account and an analysis of the climatic change influence was carried out on the extreme meteorological conditions with the prediction for up to year 2100. Some specific phenomena were not evaluated which cannot occur at the site, such as tropical cyclones, hurricanes, typhoons, sand and dust storms. For the NJZ site, a sufficient amount of meteorological data is available directly at the site, where measurements for a number of parameters have been carried out since 1961. Where the amount of parameters was not available for at least 30 years, the establishing of the extreme was supplemented by the analysis of the data from other nearby weather stations. The established extreme meteorological conditions for the NJZ site correspond with the values established for other nuclear power plants in the Central-European region. In no parameters have there been uncommonly high (or, on the contrary, low) values of extremes. The proposed parameters of the extreme climatic and meteorological conditions are

described in the chapter A.II.8.3. Specific Data for the NJZ (page 61 of this Report and the following pages).

C.II.5. Air

5. Air – status of air pollution.

C.II.5.1. Air Quality

The basic starting point for the evaluation of the air quality in Slovakia is the results of the measurements of the air pollutant concentration, carried out by the Slovak Hydrometeorological Institute (SHMÚ) at the stations of the National Air Quality Monitoring Network (NMSKO), a part of which is also formed by 4 countryside backup stations with an EMEP monitoring programme.

In the Trnava Region, there are 3 NMSKO stations, out of that 1 countryside EMEP. The results of 2012 monitoring at these stations, presented in the Report "Air Pollution Assessment in the Slovak Republic – 2012" (SHMÚ, 2014) are listed in the following table.

Table C.II.3: Assessment of air pollution according to the limit values for protection of human health for the year 2012 (SHMÚ)

Pollutant	NO_2		PM_{10}		PM2.5 *	CO	Benzene
Period of average	1 hour	1 year	24 hours	1 year	1 year	8 hours	1 year
Limit value [µg/m³] (permitted number of exceedance)	200 (18)	40 -	50 (35)	40 -	28 -	10,000 -	5 -
Station							
Trnava, Kollárova Street	(0)	20.8	(28)	27.9	22.0	4,190	1.5
Senica, Hviezdoslavova Street			(26)	27.1	20.8		
Topoľníky, Aszód			(15)	24.5	20.7		

Numbers of limit value exceedances are stated in the brackets.
* Limit valid starting with 1/1/2015

From the viewpoint of the pollution development, it is possible to remark, with regards to the nearest station in Trnava – Kollárova Street, that there is a positive trend of PM_{10} concentration development, which represents a dominant air pollutant in the region.

Table C.II.4: PM_{10} pollution development in the Trnava – Kollárova station according to the SHMÚ observations

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Numbers of exceedances of the 24-hour limit	*104*	*112*	*71*	35	*53*	32	*56*	*59*	28
Average annual concentration [µg/m³]	*43.9*	*43.3*	38.9	28.0	23.4	28.6	35.0	36.7	27.9

Limit exceedance is marked by italics.

Within the territory of the Slovak Republic, the NJZ site itself and its surroundings belong from the viewpoint of the air pollution to the less burdened regions, characterised as having a "mild pollution". Thanks to the favourable orographic and climatic conditions, the region is has good circulation, which means there is a sufficient dispersion of the emitted polluting substances. Besides the distance pollutant transmission, the air quality is influenced especially by emissions from the big industrial sources located in the observed region. For this reason we may observe a higher pollutant concentration especially in the surroundings of larger settlements (namely Trnava and Hlohovec). There is also a line source of pollution in the region, represented by the D1 highway.

Following the measurements in the NMSKO network, the SHMÚ carries out area assessment of the air quality through mathematic modelling. With regards to the results of the modelling contained in the Report "Air Pollution Assessment in the Slovak Republic – 2012" (SHMÚ, 2014), the results of the measurements at the Topoľníky backup station and on the basis of the NJZ site position, the estimated values of the regional background for each pollutant are currently the following:

- NO_2 (average annual concentration) 7 µg/m^3
- CO (8-hour concentration) 350 µg/m^3
- PM_{10} (average annual concentration) 25 µg/m^3
- PM_{10} (annual number of exceedances of the limit value) 15
- $PM_{2.5}$ (average annual concentration) 21 µg/m^3
- benzene (average annual concentration) 0.5 µg/m^3
- benzo(a)pyrene (average annual concentration) 0.1 ng/m^3

In the area concerned, no exceedance is observed of the legislative limits for the protection of people's health according to the Decree No. 360/2010 Coll. on Air Quality.

C.II.6. Hydrological Conditions

6. Hydrological Conditions – surface water (e.g. watercourses, water bodies), underground water including geothermal, mineral water, springs and spring areas including thermal and mineral springs (capacity, quality, chemical composition), hydrologically protected areas, sanitary protection zones, underground and surface water pollution levels.

C.II.6.1. Surface Water

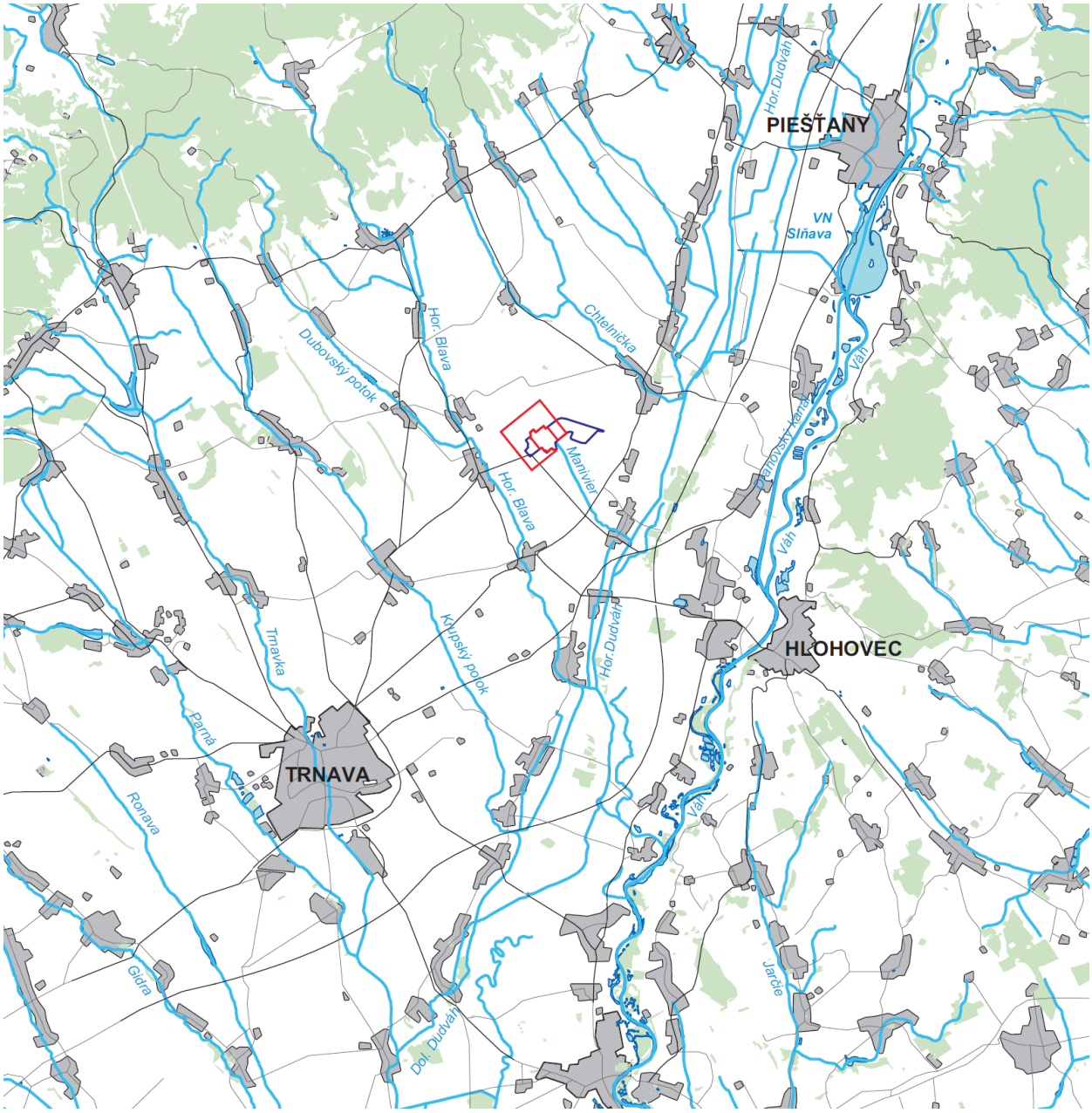
C.II.6.1.1. Hydrological Division

The area concerned belongs to the partial basin of the Váh and to the basic basin of the Čierna voda.

The Váh River originates in the area of the Low and High Tatras and it is created by the confluence of the Biely Váh and Čierny Váh. It flows through the Liptov Valley westwards, its flow turns south by the town of Žilina, flows further through the valley in the Central-Western Carpathians zone, the Danubian Lowland and flows into the Danube River by the town of Komárno. The Váh is characterised by the so-called Váh Cascades – a system of dams and water power plants, which were built in the past as a preventive measure against the frequently repeated floods and for the production of electric power. The Váh River is the main source of technological water and the main recipient of the waste water for the nuclear plants at the Jaslovské Bohunice site. The basin area is 19,696 km^2, the overall length of the watercourse is 403 km. The Lower Váh flows through the area down to the outfall into the Danube River. While the Váh over Žilina has the character of a mountain river, under Žilina its fall decreases from 1.3 down to 0.7 ‰. Under Nové Mesto nad Váhom the river flows into the lowland, and its slope diminishes further down to 0.04 ‰. The lower part of the Váh, given the lesser slope, does not suffer much from erosion. In the lowland area, due to the insufficient capacity of the riverbed itself, it has been necessary to create protective dams on both the banks (one meter above the 100-year water).

The main erosive basis, which drains the area in the immediate proximity to the area of the nuclear power plants at the NJZ site, is the Dudváh River. Its regulated riverbed has a flow parallel to the riverbed of the Váh. Both the rivers maintain a north-south direction of the flow with Dudváh draining the right-bank tributaries (flowing from north-west to south-east) and Váh takes the short and steep flows running down from the Považský Inovec slopes (east to west). The right-side tributaries, which take water away from the area in the immediate proximity to the EBO premises, are the rivers originating in the Little Carpathians, which also have their infiltration areas here. From the Little Carpathians, Dudváh is fed with the flows Holeška, Chtelnička, Blava, Krupský potok, Trnávka with the tributary Parná, Gidra, and other, smaller streams. The right-side tributaries that take water from the area observed are the streams Chtelnička, Blava, Krupský potok and the artificial canal Manivier.

Figure C.II.9: Watercourses and water bodies in the wider surroundings of Jaslovské Bohunice



The best-known dam, which also serves for the pumping of industrial water for the nuclear power plant at the EBO site, is the Sĺňava reservoir. The reservoir is located in the northern part of the Danubian Lowland at the foot of the Považský Inovec, between the town Piešťany and community Drahovce. It is composed of a weir and a system of right-side and left-side dams on both the banks of the Váh. The area of the Sĺňava reservoir is 480 ha, its length is 6.4 km, the greatest width is 2 km and it may take in 12.12 million m^3 of water. In the direction of the flow it is bordered by the Drahovce dam, where the flow is divided into the old riverbed of Váh and the Drahovce canal, on which the Madunice water power plant is built. Besides the mentioned function of the water intake for the nuclear power plant at the EBO site, the Sĺňava reservoir also serves as a storage of water for the watering, partial decrease of the high water flow rate in the Váh riverbed, it provides the protection of the agriculturally used territories from the floods, protection of communities from the floods and is also used for sports and recreation and for fish growing. The water is pumped from the reservoir through a pump station in Pečeňady and it is used for the nuclear plant on the EBO premises (and will also be used for the NJZ needs) as technological water.

Besides the water reservoir Sĺňava, there are no water reservoirs in the area concerned. The upper part of the Kráľová water reservoir intrudes into the area of interest; in the wider surroundings there are the following water reservoirs built: Biela skala (Častá), Blatné and Šenkvice (Šenkvice), Vištuk, Budmerice, Doľany, Suchá nad Parnou, Boleráz, Dolné Dubové, Horné Orešany, Ronava, Buková, Jablonica, Prietrž, Brezová (Brezová pod Bradlom), Chtelnica, Pustá Ves (Pustá Ves), Osuské, Čerenec (Prašník, Vrbové), Striebornica (Moravany nad Váhom), Slovlik (Leopoldov). In the wider surroundings there are the following ponds: Hornokrupský, Trnavský, Dechtické, Horná Streda, Lukáčovské, Zálužiansky, Alekšinské.

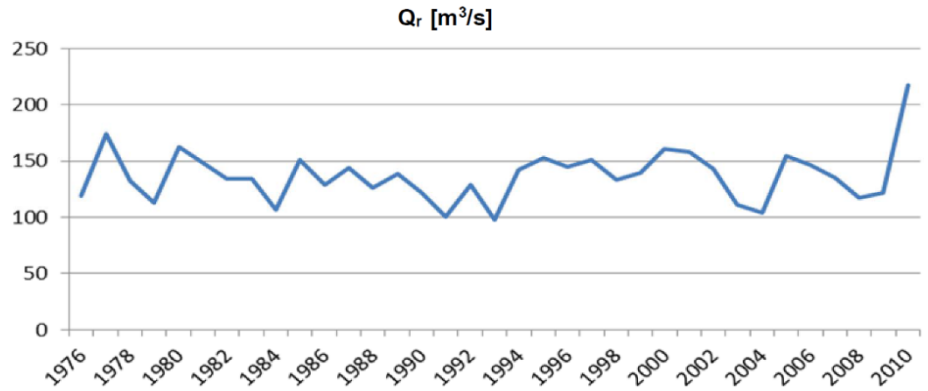
C.II.6.1.2. Hydrological Characteristics

Hydrological data characterising long-term water flow rate are usually established for a hydrologically representative period. Currently, the period 1961–2000 is used in Slovakia (all data according to the SHMÚ).

The average long-term rainfall per basin is about 1,000 mm in the upper parts of the Váh main flow, 951 mm in the Hlohovec profile and 924 mm in the Šaľa profile. Compared to the all-Slovak average, this value is higher by 181 mm.

The most general out-flow characteristic of the basin is the long-term average flow rate (Q_a), expressing the natural potential of the surface water sources. This flow rate is Q_a = 140.121 m^3/s in the Hlohovec – Váh profile and Q_a = 141.96 m^3/s in the Šaľa – Váh profile. The average annual flow rate (Q_r) of Váh has long ranged between 100 and 160 m^3/s.

Figure C.II.10: Average annual flow rate (Q_r) at the Hlohovec – Váh water gauge station



On the basis of these observations it may be expected, that the Váh flow rate will be rather stabilised around this value in the nearest future. However, higher variations of the average monthly flow rates may be expected, when periods with above-average rainfall will alternate with periods of dry spells to a greater extent than it has been so far, which will be causing even higher differences of the average flow rate for the particular months. For the stated 35-year period, the minimum daily flow rate has been recorded as Q_{mind} = 7.046 m^3/s (13/10/1985) and maximum Q_{maxd} = 1,480.667 m^3/s (19/5/2010).

Hydrological characteristics of the watercourses in the area concerned are listed in the following tables.

Table C.II.5: Basic hydrological characteristics for the period 1961–2000

Watercourse	Profile name	Hydrological number	River kilometre	Basin area	Average annual values		
					Rainfall [mm]	Specific out-flow [l/s/km^2]	Flow rate [m^3/s]
Jablonka	Čachtice	4-21-09-069	9.5	163.25	702	5.53	0.903
Váh	Piešťany	4-21-10-005	113.8	10,288.90	954	13.60	139.900
Váh	Hlohovec	4-21-10-008	99.0	10,441.34	951	13.42	140.121
Holeška	outfall	4-21-10-016	0.0	81.78	655	4.59	0.375
Upper Dudváh	above Borovský canal	4-21-10-017	18.8	141.70	635	3.31	0.469
Chtelnička	outfall	4-21-10-028	0.0	59.99	610	3.95	0.237
Borovský canal	outfall	4-21-10-024	0.0	136.96	605	2.85	0.390
Upper Dudváh	Veľké Kostoľany dam	4-21-10-029	18.4	278.45	623	3.09	0.859
Manivier	Žlkovce	4-21-10-032	0.5	15.00	577	2.00	0.030
Upper Blava	above community Paderovce	4-21-10-036	22.2	73.85	656	4.33	0.320
Upper Blava	under Dubovský stream	4-21-10-038	20.0	99.74	639	3.61	0.360
Upper Blava	Bučany	4-21-10-040	0.0	131.26	623	3.20	0.420
Upper Dudváh	outfall	4-21-10-042	0.0	498.58	612	2.76	1.380
Lower Blava	above Lower Dudváh	4-21-16-007	0.0	160.15	587	2.75	0.440
Trnávka	outfall	4-21-16-034	0.0	324.06	630	3.78	1.225
Lower Dudváh	Hoste	4-21-16-044	16.6	506.05	--- *	3.12	1.580
Lower Dudváh	Čierny Brod	4-21-16-044	2.7	750.49	605	2.46	1.850
Váh	Šaľa	4-21-10-057	58.5	11,217.61	924	12.66	141.960

* ... the parameter was not observed in the given period

Table C.II.6: Long-term flow rate for the period 1961–2000

Watercourse	Profile name	Long-term average monthly and annual flow rate [m^3/s]												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Q_a
Jablonka	Čachtice	0.99	1.42	1.66	1.38	1.03	0.89	0.68	0.47	0.36	0.47	0.62	0.92	0.90
Váh	Piešťany	99.78	118.14	200.27	244.95	192.47	156.78	139.22	106.08	96.91	98.76	106.82	118.44	139.90
Váh	Hlohovec	100.04	118.50	200.72	245.30	192.73	157.00	139.39	106.20	96.70	98.88	106.99	118.69	140.13
Holeška	outfall	0.38	0.54	0.74	0.72	0.47	0.32	0.22	0.16	0.14	0.19	0.28	0.36	0.38
Upper Dudváh	above Borovský canal	0.48	0.67	0.92	0.90	0.56	0.40	0.27	0.21	0.18	0.23	0.35	0.45	0.47
Chtelnička	outfall	0.26	0.37	0.44	0.36	0.27	0.23	0.18	0.12	0.09	0.12	0.16	0.24	0.24
Borovský canal	outfall	0.40	0.56	0.77	0.75	0.49	0.33	0.23	0.17	0.15	0.19	0.30	0.38	0.39
Upper Dudváh	Veľké Kostoľany dam	0.88	1.23	1.69	1.64	1.08	0.73	0.50	0.38	0.32	0.43	0.65	0.83	0.86
Manivier	Žlkovce	0.03	0.04	0.06	0.06	0.04	0.03	0.02	0.01	0.01	0.02	0.02	0.03	0.03
Upper Blava	above community Paderovce	0.33	0.46	0.63	0.61	0.40	0.27	0.19	0.14	0.12	0.16	0.24	0.31	0.32
Upper Blava	under Dubovský stream	0.37	0.51	0.71	0.69	0.45	0.31	0.21	0.16	0.13	0.18	0.27	0.35	0.36
Upper Blava	Bučany	0.43	0.60	0.83	0.80	0.53	0.36	0.24	0.18	0.157	0.21	0.32	0.41	0.42
Upper Dudváh	outfall	1.41	2.00	2.20	1.62	1.40	1.21	1.03	1.11	1.19	1.08	1.11	1.21	1.38
Lower Blava	above Lower Dudváh	0.54	0.70	0.68	0.57	0.42	0.35	0.29	0.24	0.25	0.32	0.40	0.56	0.44
Trnávka	outfall	1.34	1.82	2.22	2.06	1.40	1.02	0.74	0.58	0.55	0.71	0.99	1.32	1.23
Lower Dudváh	Hoste	1.99	2.46	2.84	2.63	1.60	1.14	0.80	0.66	0.73	1.10	1.30	1.71	1.58
Lower Dudváh	Čierny Brod	2.33	2.89	3.33	3.09	1.88	1.34	0.94	0.78	0.86	1.30	1.53	2.01	1.85
Váh	Šaľa	101.90	121.09	204.11	248.48	194.94	158.66	140.57	107.14	97.50	99.92	108.40	120.43	141.96

C.II.6.1.3. Surface Water Quality

The water quality in the Váh basin is influenced mostly by the point sources of pollution (industrial and communal waste water), since the Považie region is one of the most industrial regions of Slovakia. The influence of the main flow regulation is also important because of the system of water power plant dams and canals.

The data about the surface water quality are based on the monitoring of the surface water quality for the years 2010 and 2013, processed by SHMÚ.

In 2010 the surface water quality in the partial Váh basin was observed in 98 monitored places, out of that 12 monitored places were located on the Váh River, others on its tributaries and on melioration and derivation canals. The most important Váh tributary (river Nitra and its tributaries) was observed in 32 monitoring places. The requirements for the surface water quality according to the Annex 1 of Government Decree No. 269/2010 Coll., which establishes the requirements for achieving a satisfactory water condition, were fulfilled for all the observed indicators in 11 monitored places: Váh – Okoličné, Váh – Hubová, Blatnický potok – Príbovce, Turiec – Vrútky, Krpeliansky canal – Lipovec, Váh – Dubná Skala, Teplička – Omšenie, Váh – Piešťany, Tŕstie – above Stará Turá, Váh – Horné Zelenice, Váh – above Sereď. All the listed monitored places are located on the Váh and its tributaries, mostly in its upper part, where the influence of the human activities is less marked than on its middle and lower parts. Generally, we may say that the quality of the water in Váh (with the exception of a sporadic exceedance of the $N\text{-}NO_2$) is satisfactory; it is especially the smaller Váh tributaries that are problematic. From the Váh tributaries, the worst quality condition, with the highest number of indicators not fulfilling the requirement of the annex No. 1 of the Government Decree No. 269/2010 Coll., was recorded on the smaller streams Trnávka (8 indicators not fulfilling the requirements in the monitored place under the Trnava waste water treatment plant), Šárd (8), Jarčie (7), Šterus stream (7), Salibský Dudváh (6), Cintorínsky stream (6), Bábsky stream (5), Krupský stream (4), and Dubová (3, under Piešťany). The monitored place Trnávka – under Trnava waste water treatment plant – belongs in the long run to the monitored places with the lowest quality of water, which is caused by a combination of negative factors – a low-flow-rate recipient flowing through an agricultural area and the presence of a large agglomeration; moreover, Trnava is an important industrial centre.

In 2013, the surface water quality in the partial basin of Váh was observed through 88 monitored places, out of that 11 monitored places were located on the Váh, others on its tributaries and on melioration and derivation canals. Since 2011, the results of the monitoring have been updated and presented in this division:

- part A (general indicators),
- part B (non-synthetic substances),
- part C (synthetic substances),
- part D (radioactivity), and
- part E (hydrobiological and microbiological indicators).

Results of the 2013 monitoring related to the requirements for the quality of the surface water, listed in the Annex No. 1 of the Government Decree No. 269/2010 Coll., are summarised in the following way:

Among the general indicators (part A), the requirements for the quality of the surface waters were fulfilled in all the monitored places for the indicators of temperature, dried and annealed dissolved substances, overall amount of iron, magnesium, sulphates, free ammonia, surface-active substances, phenol index, non-polar extractable substances, chromium (VI), chlorobenzene, and dichlorobenzenes. The highest number of exceedances of the limit values were in the nitrite-N indicators in all the partial basins. In the alluminium indicator, which was observed in 2 monitored places in the partial basin of Danube and Moravia, the limit values were exceeded in all the places.

For the groups of the synthetic and non-synthetic substances (parts B and C), the requirements were not fulfilled in the indicators: As, Cd, Hg, Zn, hexachlorobenzene, di(ethylhexyl)phthalate (DEHP), 4-methyl-2,6-di-tert-butylphenol, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene, fluoranthene, PCB, biphenyl and cyanides. The highest permitted concentration was exceeded in the indicators Hg, Cd and 4-methyl-2,6-di-tert-butylphenol.

For the radioactivity indicators (part D), the requirements were fulfilled in all the monitored places in the indicators of the overall activity per volume of alpha, tritium, strontium and caesium.

From the group of hydrobiological and microbiological group of indicators (part E) the requirements were not fulfilled in the indicators of saprobic index of biosestone, abundance of phytoplankton, chlorophyll and coliform bacteria, thermotolerant coliform bacteria, gut enterococcus and cultivable microorganisms at 22 ºC. The highest number of exceedances were in the indicator of gut enterococcus (in 9 partial basins), thermotolerant coliform bacteria (in 9 partial basins) and coliform bacteria (in 4 partial basins).

Water quality in the Váh basin is influenced especially by the point sources of pollution (industrial and communal waste waters), because the Považie region belongs to the industrially and agglomerative most developed regions of Slovakia. Significant is also the influence of a huge regulation of the main flow, because of the system of water power plants and

canals. The Váh is also a recipient of waste waters from the nuclear power plants at the Jaslovské Bohunice site (JAVYS, Slovenské elektrárne, a. s. EBO).

The qualitative data of the Váh above the place of the discharge of the waste water from the nuclear plants (Piešťany water gauge station, river km 122.8) and under the discharge object (Hlohovec water gauge station, river km 99.0) are listed in the following table.

Table C.II.7: Qualitative data of the Váh waters above and under the discharge object of the waste water from the nuclear power plants at the EBO site

Indicator	Emmission limit [mg/l]	Station	Average annual pollution [mg/l]				
			2009	2010	2011	2012	2013
BSK_5	7	Sĺňava	1.91	2.02	2.14	1.92	2.12
		Hlohovec	2.15	1.68	2.13	1.95	2.07
$CHSK_{Cr}$	35	Sĺňava	9.71	9.08	12.62	9.17	8.83
		Hlohovec	11.68	10.42	15.75	9.79	12.62
NL	--	Sĺňava	12.3	9.6	8.0	8.0	17.7
		Hlohovec	12.5	25.3	10.3	12.1	16.63
RL_{550}	900	Sĺňava				190.5	207.3
		Hlohovec	176.7	136.7	273	195	214.9
$N\text{-}NH_4^+$	1	Sĺňava		0.06	0.03	0.047	0.065
		Hlohovec	0.075	0.067	0.049	0.057	0.066
NO_3^-	5	Sĺňava		1.60	1.36	1.43	1.65
		Hlohovec	6.13	6.44	4.87	1.28	2.940
SO_4^{2-}	250	Sĺňava	36.76	36.80	37.15	37.57	38.52
		Hlohovec	30.67	36.25	37.07	41.04	38.12
Cl^-	200	Sĺňava	10.99	11.00	10.33	13.62	13.16
		Hlohovec	13.88	8.78	10.08	12.69	12.21
NEL	0.1	Sĺňava	0.04	0.04			0.02
		Hlohovec					
$P_{celk.}$	0.4	Sĺňava	0.0675	0.0675	0.0575	0.0842	0.077
		Hlohovec	0.09	0.0633	0.0617	0.06	0.072
Fe	2	Sĺňava					
		Hlohovec		0.336		0.176	
N_2H_4	--	Sĺňava					
		Hlohovec					
PAL	--	Sĺňava					0.1
		Hlohovec					

Source: Slovak Water Management Enterprise (state-owned enterprise), Piešťany (for some indicators, the data were not made available or the measurements are not carried out).

By the comparison of the values of the particular pollution indicators it is obvious that it is not possible to identify such immission indicators the worsening of which is unequivocally caused by the discharge of the waste water from the nuclear power plant discharge object (Socoman). When comparing the immission values of particular indicators with the immission limits, stipulated in Government Decree No. 269/2010 Coll., it is obvious that the consequence of the waste water discharge from the nuclear power plants does not cause an exceedance of an immission limit in the Váh watercourse (except the parameter NO_3^-, which it is not possible to influence by the process of water treatment and its level depends on the level of condensation of the circulation cooling circuit; following 2010, the immission limit for this parameter has been fulfilled).

As far as the expected development of the Váh water quality for the nearest period, the maintenance of the commenced trend of the gradual improvement is expected. The main reason of the partial improvement of the water quality since 2010 has been the passing of the Government Decree No. 279/2011 Coll., which declares the obligatory part of the Water Plan of Slovakia, containing the programme of measures to reach environmental goals. Besides, the Act No. 364/2004 Coll. on Waters has been amended, and other related laws and regulations. On the basis of these legislative measures the Slovak Water Management Enterprise (state-owned enterprise) requires the improvement of the conditions and exerts a permanent pressure on the polluters who negatively influence the surface water quality with the waste water discharge. The Ministry of the Environment of the Slovak Republic has recently passed an implementation of the Water Framework Directive, on the basis of which there is now a regular monitoring of water courses being carried out. Thanks to the activities of the Ministry of

the Environment and other bodies, the adoption of more decisive legislative regulations in the area of surface water quality maintenance and the performance of inspections, the attitude of particular polluters gradually improves (industrial agglomerations, cities, communities, as well as enterprises in the area of animal production and agriculture). A drawback, solved gradually, is the still unfinished sewage system in many communities and the missing waste water treatment plants in some agglomerations. Despite the trend of quality improvement being very mild, we may expect a further gradual improvement of the water quality in the Váh and other watercourses in Slovakia in the following period.

C.II.6.2. Ground water

Multiple territorial units characterized by similar hydrogeological properties, or types of permeability and character of ground water circulation, respectively, are found within the wider territory of interest. Within the meaning of the Regulation of the Government of the Slovak Republic No. 282/2010, Coll., Laying down Threshold Values and the List of Ground Water Bodies, the site is classified in the following:

- in the Pre-Quaternary Period formation SK2001000P 'Inter-grain Ground waters of the Danube Basin and its Offsets in the Váh River Catchment Area'. Limnic and fluvial-limnic sediments, particularly sands and gravels where inter-grain (porous) permeability prevails, are collector rocks. The average thickness of hydrological collectors is 20 to 50 m, or more, locally. In case of gravels, the filtration coefficient value ranges within orders of 10^{-4} to 10^{-3} m/s, in case of sands, those values are lower.
- from the Váh River alluvium border towards the east, in the Quaternary Period formation SK1000400P 'Inter-grain Ground Waters of Quaternary Period Depositions of the Váh and Nitra Rivers and their Tributaries Coming from the Southern Part of the Váh River Catchment Area'. Fluvial gravels, sandy gravels and sands of the Pleistocene – Holocene stratigraphic classification are collector rocks. The inter-grain (porous) permeability prevails there. The average thickness of hydrological collectors is 10 to 30 m, filtration coefficient value ranges within orders of 10^{-4} to 10^{-3} m/s there.

The schematic geological profile of the NJZ is as follows:

- 0.0 – 15.0~29.0 m: non-saturated zone- the horizons of loess, loess clays, calcareous clays – no saturation with fresh ground water;
- 15.0 (29,0) – 39,0 (46.0) m: hydrological collector I – sandy gravels, gravels, sands;
- 39.0 (46.0) – 50.0 m: neogenic plastic clays - isolator;
- 50.0 m – the depth is not verified within wider surroundings, hydrological collector II is found there formed by sands, claylike sands, within the depth range of 48.0 to 58.0 m under the ground (it is documented by HB-1 drill hole (well) within the NJZ area).

The superficial part is formed by loess and loess clays with the average thickness of approximately 15 to 20 m and a very low permeability. The loess complex achieves its greatest thickness just within the EBO site area.

Under the loess complex, hydrological collector I (ground water saturated) is found, formed by fluvial sediments in the litological development of gravels, sandy gravels and sands. It is a common collector of ground waters containing Váh River sediments from the Upper Pannonian (or Pont) to the lower part of Pleistocene. The collector is extended continually and its thickness is variable. The collector achieves its greatest thickness in the EBO site surroundings (about 26 m), the collector receives a wedge shape in the South-East direction and it achieves the thickness of only approximately 2 m at the edge of the alluvial river plain. The first hydrological collector shape follows the morphology of underlying clay beds functioning as a hydrogeological isolator. The free mode flowing process using the inter-grain (porous) permeability prevails within the collector, some confined ground water level can only be detected locally, namely in points where the collector thickness is reduced. The ground water supply to the first hydrological collector occurs probably in the more distant interface area between the Brezovské Karpaty Mountains and the Trnava-Dubnica Basin in the form of ground water transfer from the carboniferous rocks of the mountains to the sedimentary filling of the basin. Partial infiltrations from surface waters can be expected in areas of erosive bases of watercourses cut into the basin. In case of loess sediments, areal infiltrations from precipitations are negligible.

Other hydrological collectors are also found under the hydrological collector I within the lithologically varied complex of limnic sediments. The collectors are separated from each other, and from the hydrological collector I, by isolators. The point closest to the NJZ site where hydrological collector II was documented is the HB-1 drill hole (well). It is found within the depth range of 48.0 to 58.0 m under the ground and is formed predominantly by sands, or claylike sands to sandy clays

involving higher claylike fraction contents. The collector is confined with impermeable plastic clays. There are no possible connections between hydrological collectors I and II within the NJZ area. With regard to the fact that hydrological collector II is protected from both the overlying and underlying rock strata by isolators (impermeable clays) and, in view of its depth location, too, it can be excluded from the assessment in connection with the NJZ.

Geological environment characteristics were identified on site in the past on the basis of multiple survey and experimental geological Works, above all, in connection with the construction of individual nuclear power plants (JE A1, JE V1, JE V2). Geological and engineering-geological works date back to the year 1965, the first geophysical works were performed as early as in 1987 and they have gradually been going on till the present day. All the geological works always include assessments and further details on hydrogeological conditions. Information provided in the present study leans on knowledge taken from all the hydrogeological reports covering the Bohunice nuclear facilities site.

See the following table for the overview of basic data of the Bohunice nuclear facilities site geological environment applicable to the NJZ within the non-saturated zone and within hydrological collector I [*Kostolanský M. et.al. 2012*].

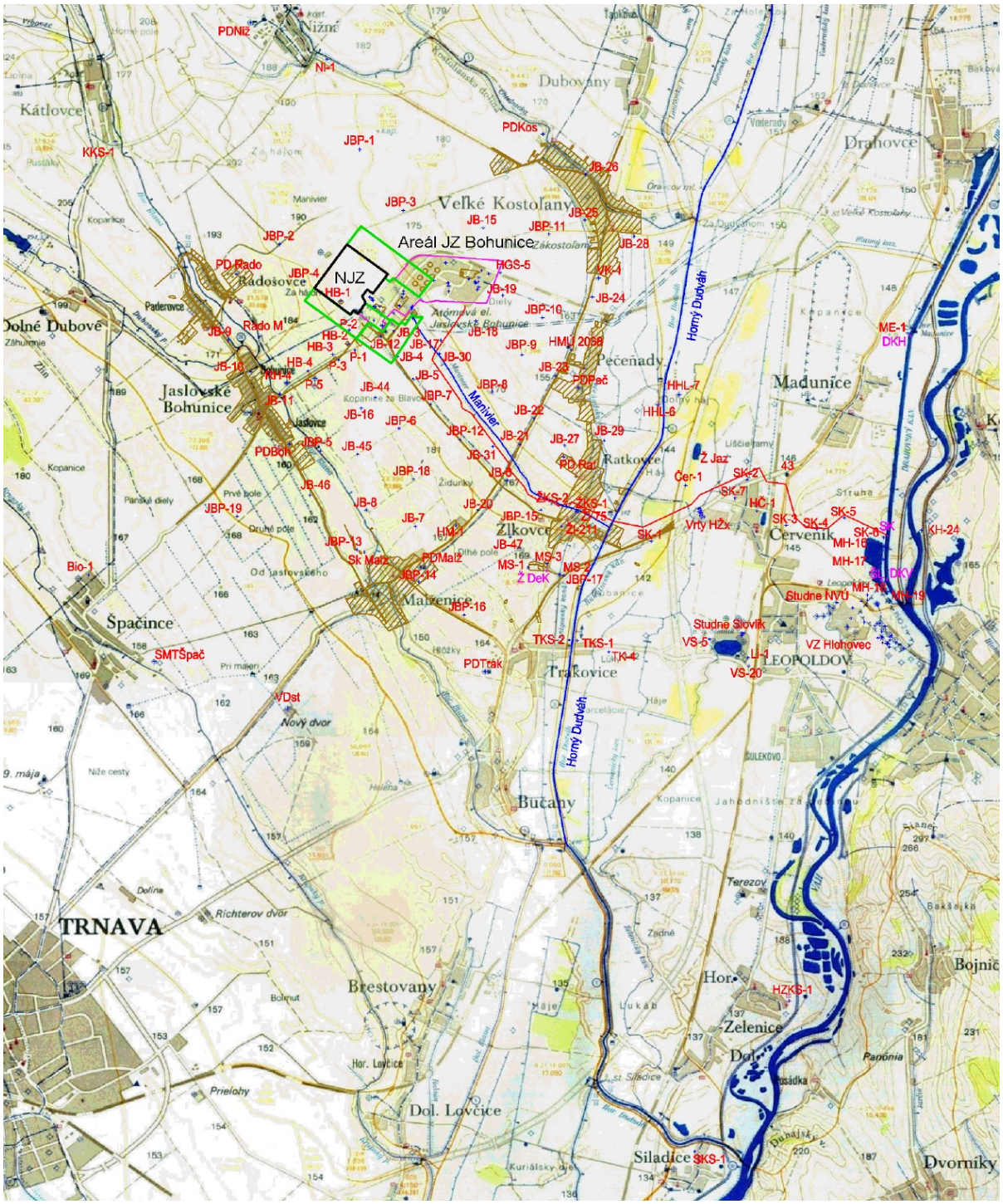
Table C.II.8: Overview of some basic data on geological environment of the Bohunice nuclear facility site

Environment parameters			Value	Unit
Non-saturated zone (predominantly loess)				
k_f	filtration coefficient	average	4.00E-06	[m/s]
n	total porosity	from - to	0.36 to 0.50	[-]
b	non-saturated zone thickness	average	17.5	[m]
ρ	volumetric mass	reference	2720	[kg/m^3]
Saturated zone (predominantly gravel-sands)				
k_f	filtration coefficient	average	1.00E-03	[m/s]
n	total porosity	average	0.2	[-]
n_e	effective porosity	average	0.15	[-]
ρ	volumetric mass	reference	1850	[kg/m^3]
b	hydrological collector thickness	average	21.5	[m]
I	hydraulic gradient (no pumping)	average	0.0005	[-]
v	transported pollution dispersion speed	average	0.29	[m/day]
	JE A1 site ground water level swing (2012)	average	0.35	[m]
α_L	longitudinal dispersion	average	4.5	[m]
α_O	cross dispersion	average	4.05	[m]

A monitoring system is installed within the wider surroundings of JZ Bohunice and NJZ sites. The system along with the implementation of monitoring itself and professional evaluations of results provide the complex ground water quality monitoring of hydrological collector I (and, in some cases, hydrological collector II, too), as well as the monitoring of the engineering barriers state (the aeration zone – non-saturated geological stratum) within the whole Bohunice nuclear facilities industrial complex.

188 monitoring objects were used for the implementation of the monitoring within the ground water monitoring system as to the end of the year 2013. See the following figure for the state of the monitoring system – the layout of monitoring objects.

Figure C.II.11: Layout of monitoring objects within the Bohunice nuclear facilities area



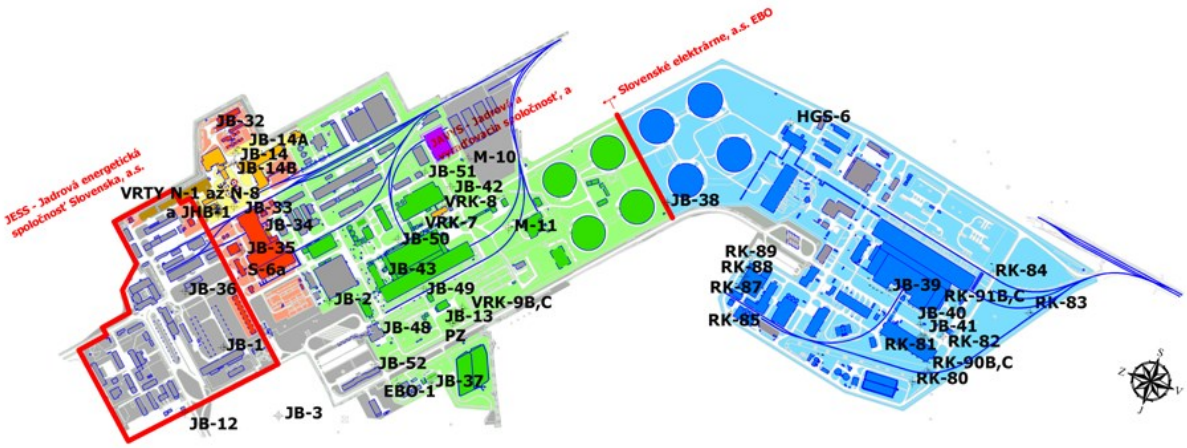
Key:

JB-7	- hydrogeological drill hole, well
Ž Dek	- surface watercourse sampling point
	- EBO underground gravity waste water drainage pipeline route - Socoman
	- NJZ main construction site area
	- other areas of interest of the NJZ
	- existing Bohunice nuclear facilities site

The underlying map is a cut-out of water management maps of the Slovak Republic (1:50 000 – 35-31 Senica, 35-32 Piešťany, 35-33 Trnava, 35-34 Hlohovec)

See the following figure for the state of the monitoring system within the whole Bohunice nuclear facilities industrial complex – the layout of monitoring objects. 72 monitoring objects were used within the underground infiltration and drainage waters (monitoring of the engineering barriers state) monitoring system for the implementation of the monitoring as to the end of the year 2013.

Figure C.II.12: Layout of monitoring objects within the Bohunice nuclear facilities sites



Key: **JB-7** - hydrogeological drill hole, well
- site border

The following table presents relation between relevant functional and monitored objects to administrative territories of municipalities.

Table C.II.9: Allocations of monitored objects to administrative territories of municipalities

Municipality	Monitored objects
Bučany	OÚBuč
Červeník	HŽ-2, HŽ-3, SK-2, SK-3, SK-4, SK-5, SK-6, SK-7, HČ-1, Čer-1, SK
Hlohovec	DKV, MH -18, KH -24, S -1, S -2, S -3, S -5, S -6, P8(H), SP-1(H), P1(H), P2(H), P3(H), P4(H), P6(H), P7(H), P9 (H), P10(H), P11(H), P12(H), P15(H)
Horné Zelenice	HZKS -1
Jaslovské Bohunice	HB-2, HB-3, HB-4, N-1, N-2, N-4, N-5, N-6, N-7, N-8, JHB-1, S6a, JB-1, JB-2, JB-3, JB-4, JB-5, JBP -7, JB-9, JB-11, JB-12, JB-13, JB-14, JB-14A, JB-14B, JB-16, JB-30, JB-31,JB-32, JB-33, JB-34, JB-35, JB-36, JB-37, JB-42, JB-43, JB-44, JB-45, JB -46, JB-48, JB-49, JB-50, JB-51, JB-52, JBP -5, JBP -19, M-10, M-11, P-1, P-2, P-3, P-5, PDBoh, PZ, RH-4, VRK-7, VRK-8, VRK-9B, VRK-9C
Kátlovce	KKS-1
Leopoldov	HL-1, HLK-1, HS-2, KT-1, L-1, L-2, L-3,N -1(L), N -2(L), P -13(L), P -10(L), P -12(L), ŠL, VS -5
Madunice	DKH, ME-1
Malženice	JBP-6, JB-8, JB-7, JBP-14, PDMalž
Nižná	Ni-1
Pečeňady	HGS-5, HHL-6, HHL-7, HMÚ2038, JB-18, JB-19, JB-23, JBP-9, JBP-10, PDPeč,RK-80, RK-81, RK-82, RK-83, RK-84, RK-85, RK-88, RK-89, RK-90B
Radošovce	JBP-2, JBP-4, PDRado, RadoM
Ratkovce	JB-17, JB-22, JB-27, JB29, JBP-8, PDRat
Siladice	SKS-1
Špačince	Bio-1, SMTŠpač, VDst
Trakovice	JBP-16, PDTrak, TKS -1, TKS-2
Veľké Kostoľany	HGS-6, JB-14, JB-26, JB-28, JB-38, JBP-1, JBP-3, JBP-11, PDKos, VK-1
Žlkovce	JB-6, JB-20, JB-21, JB-47, JBP-12, JBP-15, JBP-17, MS-1, MS-2, MS-3, SK -1, Ždek, ŽJaz, ŽKS-1, ŽKS-2, ŽL-75, ŽL-211

Monitoring frequencies of ground water regime (levels) and quality are given in the ground water monitoring program (as to the year 2013) expressed in the form of the following table.

Table C.II.10: Ground water monitoring programme for the Bohunice nuclear facilities sites and their surroundings

Subsystem, monitored site	Monitoring		Monitored objects
	Frequency	Parameters	
JAVYS, JE A1 site	monthly	H-3, level	N-1, N-2, N-4, N-5, N-6, N-7, N-8, JHB-1, S6a
		H-3, level	JB-1, JB-14, JB-14A, JB-14B, JB-32, JB-33, JB-34, JB-35, JB-36
	quarterly	γsp., FCh	N-1, N-4, JB-14B, JB-32, JB-33, JB-35
		αsp., Sr-90	N-1, JB-14b, JB-32, JB-33, JB-35
	annually	γsp., FCh	S6a, JB-1, JB-14, JB-14A, JB-34, JB-36, N-3, N-8
JAVYS, MSVP site		γsp., Sr-90	N-8, S6a, JB-14A, JB-34
		k.vz.	N-1, JB-14B, JB-32, JB-33 (EBO)
SE EBO, JE V2 site	monthly	H-3, level	JB-2, JB-37, VRK-7, JB-43, JB-48, JB-49, JB-50, JB-51, JB-52
	quarterly	H-3, level	VRK-9B, VRK-9C, JB-42, M-10, M-11, JB-13, VRK-8, PZ
		γsp., FCh, Sr-90	JB-43, JB-37, JB-48, JB-49, JB-50
		H_3BO_3	JB-43, JB-42, JB-37, VRK-7, M-11, JB-48, JB-49, JB-50, JB-51, JB-52
	annually	γsp., FCh, Sr-90	JB-13, VRK-8, VRK-9C, JB-51, JB-52, JB-2 (γsp. only, FCh)
SE EBO, JE V2 site	quarterly	H-3, level	RK-82, JB-39, JB-40, JB-41
		H-3, level	RK-80, RK-81, RK-83, RK-84, RK-85, RK-88, RK-89, RK-90B
		H-3, level	RK-90C, RK-91B, RK-91C, HGS-6, JB-38
	annually	γ sp., FCh, Sr-90	RK-80, RK-90C, JB-39, JB-40, JB-41, RK-85, RK-88, RK-89 (FCh only)
SE EBO, Bohunice nuclear facilities site	monthly	level	HB-1, HB-2, HB-3, HB-4 (for JAVYS)
	quarterly	H-3, level	JB-3, JB-4, JB-12, JB-44 (for JAVYS)
	quarterly	H-3, β, level	PDMalž, PDBoh
Bohunice nuclear facilities site surroundings as far as the Dudváh River	annually	H-3, level	PDRado, PDKos, PDPeč, PDTrak, VDst, Bio-1, RH-4, SMTŠpač
		H-3, level	OÚBuč, KKS-1, Ni-1, ŽKS-1, ŽKS-2, TKS-2, JB-23, JB-26
	annually	H-3, level	P-1, P-2, P-3, P-5, VK-1, ŽL-75, ŽL-211, JB-9, JB-11, JBP-14
		H-3, level	MS-1, MS-2, MS-3, HGS-5, HMÚ2038, Rado M, Ždek, HHL-6
		H-3, level	JB-3, JB-4, JB-5, JB-6, JB-7, JB-8, JB-12, JB-15
		H-3, level	JB-16, JB-17, BJ-18, JB-19, JB-20, JB-21, JB-22, JB-28, JB-29
		H-3, level	JB-30, JB-31, JB-44, JB-45, JB-46, JB-47
		H-3, level	JBP-1, JBP-2, JBP-3, JBP-4, JBP-5, JBP-6, JBP-7, JBP-8, JBP-9
		H-3, level	JBP-10, JBP-12, JBP-16, JBP-17, JBP-19
		γ sp., FCh, k.vz.	JB-12 (pre JAVYS + EBO): 2x (γ + α + Sr-90 + FCh)
Dudváh River area Socoman Drahovce Channel Váh River Leopoldov	quarterly	H-3, β	S-1, S-2, S-3, S-5, S-6
		H-3, level	P8(H), MH-18, HŽ-2, HŽ-3, SK-1, SK-2, SK-3, SK-4, SK-5, SK-6, SK-7
		γ sp., Sr-90	S-1, S-2, S-3, S-5, S-6, P8(H), MH-18/HŽ-2 (+FCh)
	annually	H-3, level	SP-1(H), P1(H), P2(H), P3(H), P4(H), P6(H)
		H-3, level	P10(H), P11(H), HL-1, P-10(L), P-12(L), VS-5
		H-3, level	DKH, ME-1, SK, DKV, ŠL, TKS-1
	annually	H-3, level	P7(H), P9(H), P12(H), P15(H), KT-1, L-1, L-2, L-3
		H-3, level	N-1(L), N-2(L), P-13(L)
		H-3, level	HLK-1, HS-2, HČ-1
		γ sp., FCh, Sr-90	SK-1, SK-2, SK-3, SK-4, SK-5, SK-6, SK-7
		H-3, level	KH-24, HHL-7, Žjaz, Čer-1
		k.vz.	S-1, MH-18, HŽ-2 (H-3, γsp., Sr-90) (JAVYS)
Dudváh-Váh Rivers confluence area	annually	H-3, level	SKS-1, HZKS-1
Explanatory notes:	Monitored parameters: Level: ground water level, H-3: tritium volumetric activity αsp.: alpha spectrometry (alpha nuclides volumetric activity), γsp.:gamma spectrometry (gamma nuclides volumetric activity), β: total beta volumetric activity, Sr-90: Sr-90 volumetric activity, FCh: selected physical-chemical parameters, H_3BO_3: boric acid concentration, k.vz.: surveillance sample		
Notes:	Drill holes in areas JE V1 and JE V2 sites d using 'C' character are intended for the monitoring of hydrological collector II. Drill holes using the same numbers, but identified using 'B' character are intended for the monitoring of hydrological collector I.		

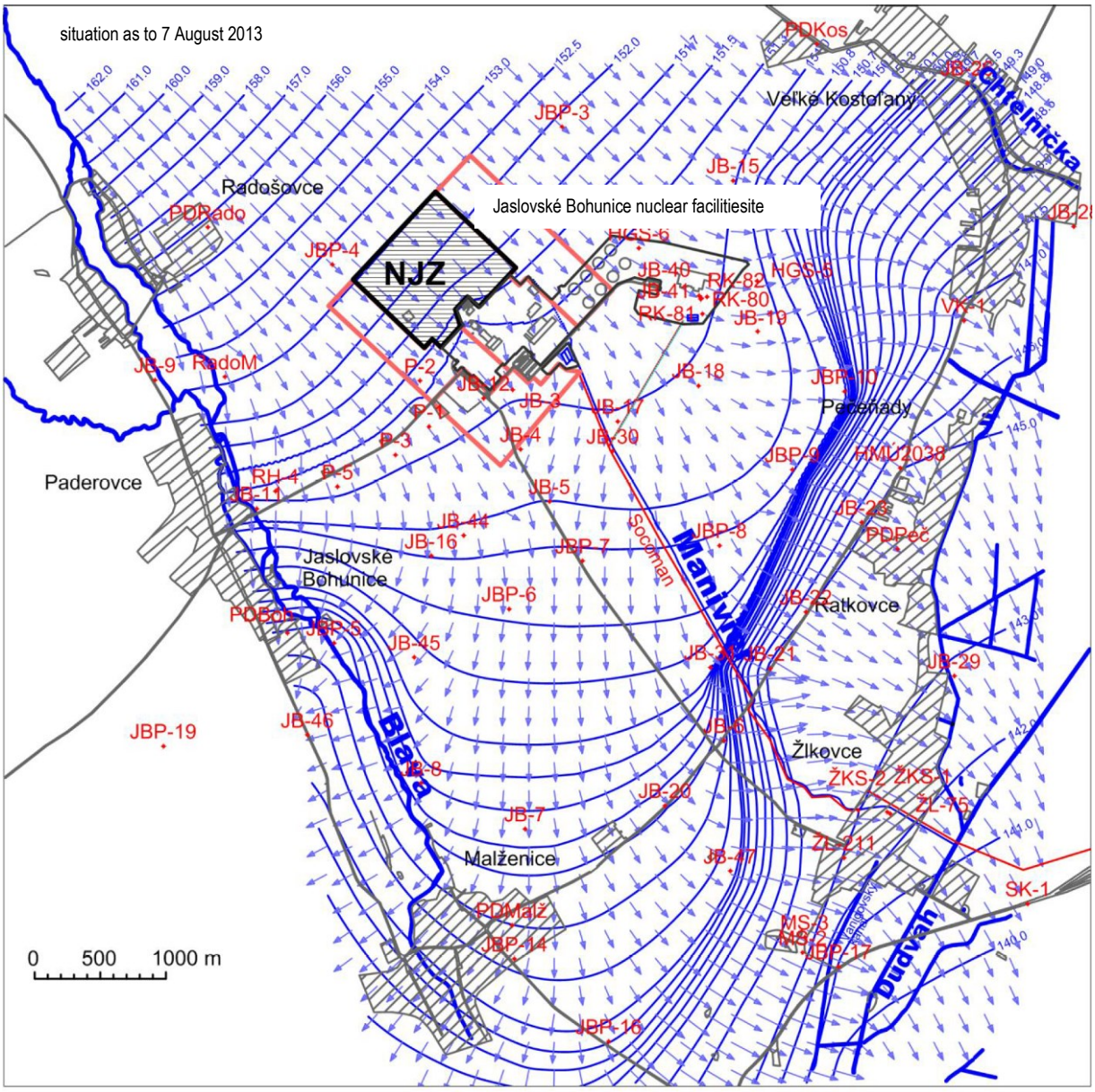
The ground water flow within the concerned territory can be described on the basis of long-term regular monitoring of levels – ground water levels since the year 1990. See the following table for long-term characteristics of the ground water regime.

Table C.II.11: Ground water levels in selected monitoring drill holes on the territory for the period of 1990 till 2013

Territory	Drill hole	Ground water and terrain levels [m above sea level]					
		Maximum	Minimum	Average	Amplitude [m]	Liner [m above sea level]	Average depth under liner [m]
NJZ	JB-1	151.19	149.60	150.19	1.59	170.28	20.09
	JB-36	151.27	149.67	150.28	1.60	170.80	20.52
	JB-3	151.06	149.34	150.24	1.72	168.59	18.35
	JB-12	151.12	149.52	150.11	1.60	172.11	22.00
	P-2	152.14	149.66	150.26	2.48	177.90	27.64
	JB-38	151.20	149.84	150.52	1.36	170.81	20.29
JAVYS JE A1	JB-32	151.43	149.89	150.45	1.54	170.68	20.23
	JB-14B	151.37	149.75	150.38	1.62	170.83	20.45
	N-1	151.21	149.48	150.20	1.73	170.76	20.56
	N-3	151.21	148.20	149.80	3.01	168.66	18.86
	N-4	151.24	149.45	150.19	1.79	170.85	20.66
	N-5	151.23	149.46	150.19	1.77	170.75	20.56
	N-8	151.23	149.44	150.19	1.79	170.66	20.47
	JB-33	151.25	149.47	150.30	1.78	170.81	20.51
	JB-34	151.28	149.52	150.39	1.76	170.79	20.40
	JB-35	151.26	149.63	150.37	1.63	170.94	20.57
JAVYS MSVP	M-10	151.29	149.96	150.55	1.33	170.77	20.23
	M-11	151.26	149.88	150.48	1.38	170.54	20.05

The present (08/2013) flow character is represented using hydroisohypses in the following figure. Hydrological collector I ground water flows are illustrated. The ground water regime on the JE A1 site territory is influenced by the permanent operation (since the year 2000) of the ground water remediation pumping from N-3 drill hole whereby the reach of the cone of depression is documented using ground water level isolines.

Figure C.II.13: Map of hydroisohypses and ground water flows – Bohunice nuclear facilities and NJZ sites

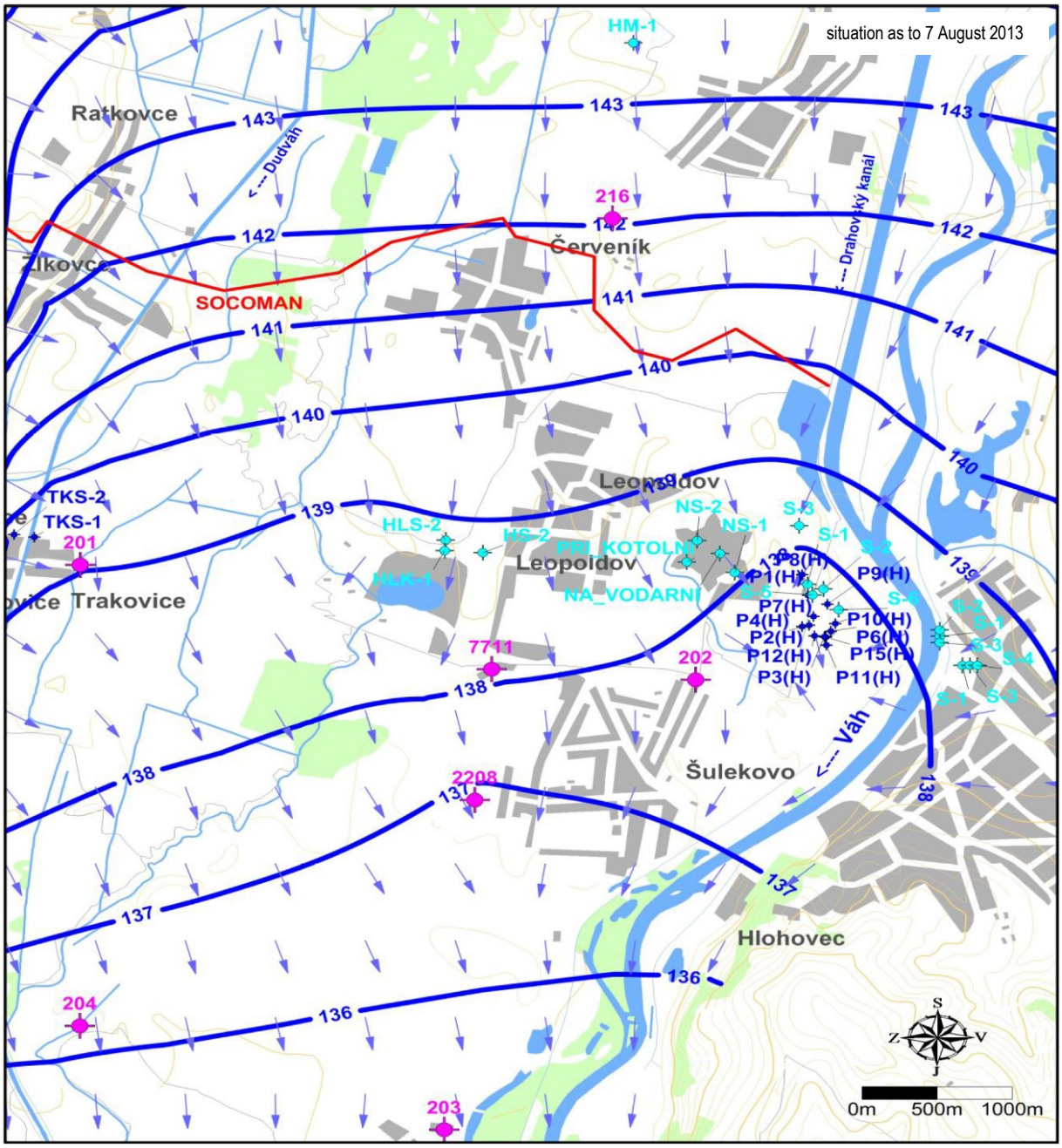


Key:

- 1.7E-014 / 0.03 - ground water flow direction and ground water level gradient
- 152.00 - measured ground water level hydroisohypse
- JB-3 - functional hydrogeological drill hole, well
- NJZ construction site area
- other NJZ areas of interest
- existing Bohunice nuclear facilities site

The surroundings of the Socoman, Drahovce Channel and Váh River are specific territories. Ground water level regimes are highly variable on these territories. They depend on the ground water take-off from the sources of underground water wells, but also on surface watercourse level fluctuations. The watercourses represent the main infiltration areas for those objects. See the following figure for the present (08/2013) character of flowing.

Figure C.II.14: Map of hydroisohypses and ground water flows - Socoman, Drahovce Channel and Váh River surroundings



Key:

- utilized well, pumped water well
- SHMÚ monitoring probe
- monitoring drill hole
- 136 - measured ground water level hydroisohypse [m above sea level] august 2013
- 9E-006 0.023 - ground water flow direction and ground water level gradient

From the hydro-chemical classification point of view (Gazda's classification [*Kostolanský et.al 2014*]), it is possible to characterize ordinary ground waters within the concerned territory as a basic, well-marked, calcareous-(magnesite)-hydrogencarbonate chemical type of ground water. Higher indications, such as ferrum and manganese that are of geogenic origin, and increased content of nitrates resulting, to a large extent, from the agrochemical soil treatment were documented by survey works.

From the point of view of industrial activities performed on the concerned territory, the ground water quality monitoring can be divided into the ground water physical-chemical characteristics monitoring and the ground water specific characteristics monitoring.

The present section deals with physical-chemical characteristics (see Chapter C.II.15.3 'Ionizing Radiation', Page 230 of the present Report for ground water radiation characteristics). Based on the assessment of monitoring results, the following table gives overview information on some selected physical-chemical characteristics of ground water found in monitoring drill holes on the concerned territory for the period from 2006 till 2013.

Table C.II.12: Overview information on selected physical-chemical characteristics of ground water on the concerned territory

Territory	Drill hole	pH		Total hardness [mmol/l]		Conductivity [µS/cm]	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
NJZ	JB-1	6.79	7.48	3.44	3.73	685	703
	JB-36	6.73	7.32	3.74	6.15	930	1,210
	JB-12	7.02	7.97	3.15	4.72	485	808
JAVYS JE A1	JB-32	6.75	7.98	3.09	5.09	555	687
	JB-14B	6.32	7.88	1.59	4.20	602	689
	N-1	6.72	7.88	1.99	5.24	583	703
	N-3	6.86	7.92	1.71	5.32	327	747
	N-4	5.64	8.29	2.35	5.58	394	900
	N-8	6.91	7.91	1.63	4.05	530	735
	JB-33	6.84	7.58	1.95	3.94	604	710
	JB-34	6.83	7.44	3.42	4.03	652	716
	JB-35	6.80	7.54	3.24	3.88	646	758

No sources of mineral of thermal water and no zones of their protection are registered or recorded on the concerned territory. The nearest mineral and thermal water sources are found in Piešťany, (their distance ~18 km, without any hydrogeological connection with the NJZ site). No territory protected from the water management point of view in compliance with Act No. 364/2004, Coll., §§ 31 to 34, on Waters (the Water Act), as amended, interferes in the concerned territory, except for zones of protection around water sources – wells.

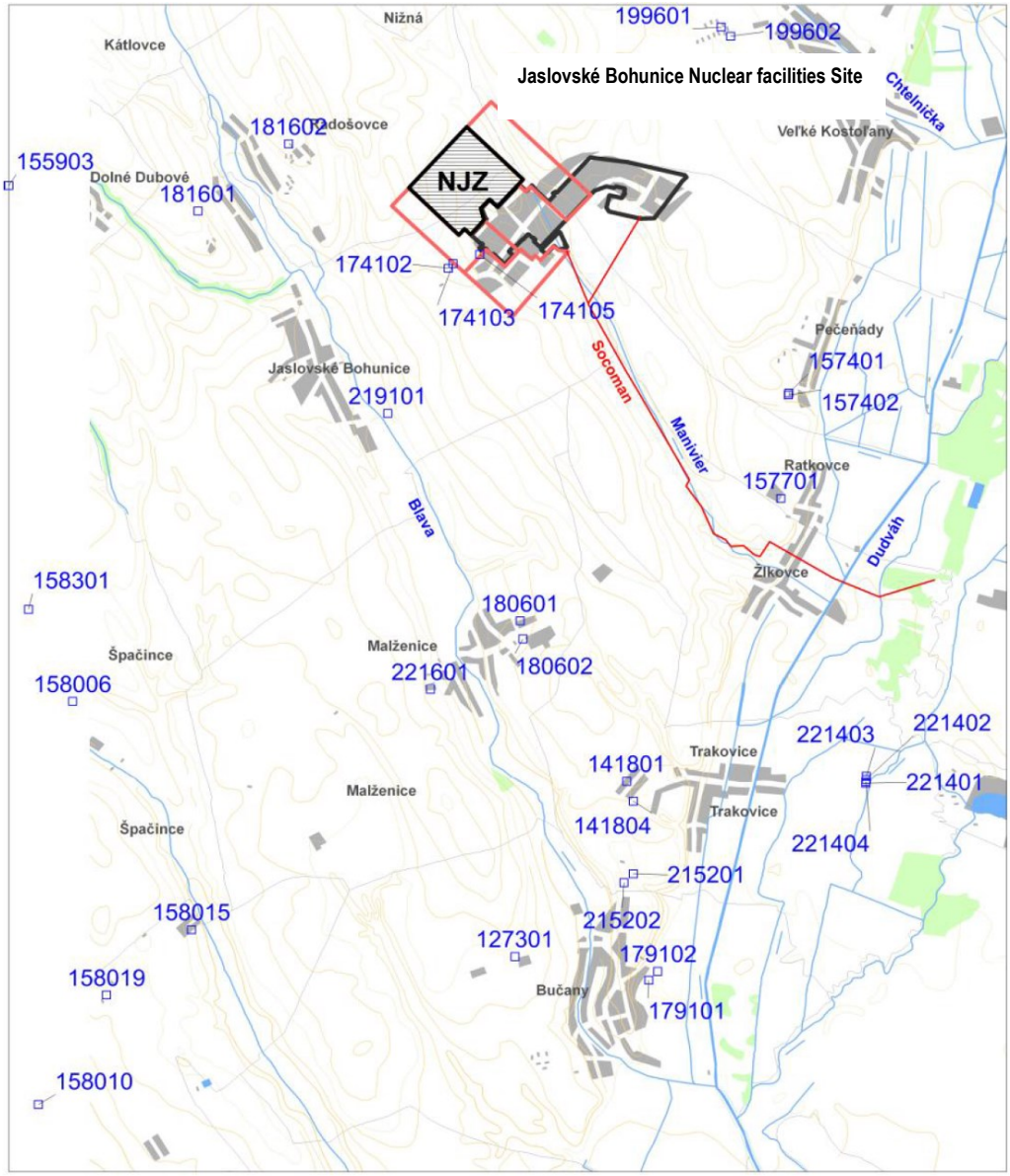
The closest zones of protection are the 2nd degree ground water hygienic protection zone found in areas near Madunice municipality (~ 9 km to the East of the NJZ site) and near Veselé municipality at Piešťany (~ 10 km to the North of the NJZ site). To mention even greater distance (~18 km), e. g., the 2nd degree natural healing source protection zone in Piešťany is situated.

Further on, a water source is found in Dechtice (~ 10 km from the NJZ site), or in Dobrá Voda (the Dobrá Voda – Dechtice water source is situated ~ 18 km from the NJZ site). The water source capacity is 60 l/s and it supplies the Trnava Associated Town Water Main with water. A prevailing part of municipalities situated on the concerned territory is supplied with potable water from the water source found in Veľké Orvište, Piešťany County. The utilization of Rakovice - Borovce water source (the distance of ~ 12 km from the NJZ site, the capacity being 120 l/s) is conditioned on the water treatment facility construction due to a higher content of manganese (0.9 to 1.09 mg/l).

JAVYS company is an owner of HB-1 to HB-4 wells (Registration Codes: 174102, 174103 – see the figure below) situated to the South-West, at the road leading from the JAVYS site to the Jaslovské Bohunice municipality (the farthest well – HB-4 – is found 1.5 km from the NJZ site border); they have not been utilized since the year 2002. The Regional Authority in Trnava issued Decision No. KÚ-OŽP-1/00134/2001/Cá applying to HB-1 well where the following conditions were specified: the water source zone of protection covering the area of 20 x 20 m, the authorized take-off of 600 to 700 l/min. The West Slovakia Regional National Committee issued common Decisions No. PLVH-4/1251/1980-2 and PLVH-4/2076/1982-2 covering HB-2, HB-3 and HB-4 wells and laying down a zone of protection around each of the wells sized 57.5 x 50 m and maximum capacities for each of the wells (HB-2: 9 l/s, HB-3: 6 l/s and HB-4: max. 5 l/s).

Moreover, the following wells are utilized by surrounding cooperative farms (PD), particularly to supply cattle with water, namely wells situated on territories of PD Jaslovské Bohunice (Registration Code (EK): 219101), PD Malženice (EK: 180601), PD Radošovce (EK: 181602), PDVeľké Kostoľany (EK: 199601), PD Pečeňady (EK: 157401), PD Trakovice (EK: 141804), SEMAT Špačince (EK: 158006), BIOGAL Špačince (EK: 158301) and Veľký Dvor State Farm (EK: 158015). The take-offs are, however, insignificant and they are not utilized to provide a mass water supply to the population. The above mentioned wells are registered as utilized ground water sources in the SHMÚ Bratislava database.

Figure C.II.15: Map of registered water sources



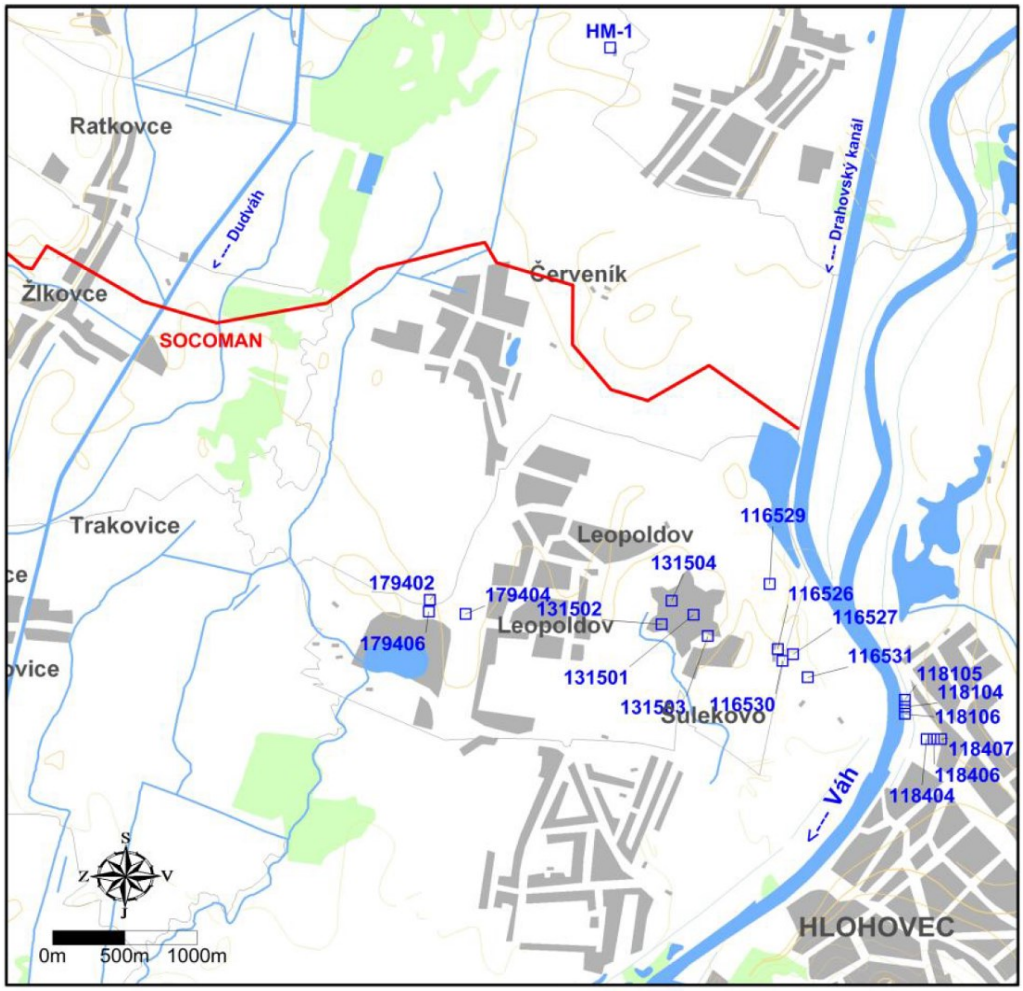
Key:

127301 - registered water sources, EK - SHMÚ registration code

- NJZ construction site area
- other NJZ areas of interest
- existing Bohunice nuclear facilities site

Wells representing water sources for Hlohovec (TAVOS, j.s.c.), Slovak Distilleries and Liqueur Factories, j.s.c. and ÚVTOS Leopoldov are situated on territories surrounding the Socoman, Drahovce Channel and Váh River. Their authorized capacities are as follows: Hlohovec water source (TAVOS, a.s. - S-1 well (Registration Code (EK): 116 526) $Q_{authorized}$ = 20.0 l/s, S-2 well (EK: 116 527) $Q_{authorized}$ = 20.0 l/s, S-3 well (EK: 116 529) $Q_{authorized}$ = 30.0 l/s, S-5 well (EK: 116 530) $Q_{authorized}$ = 20.0 l/s, S-6 well (EK: 116 531) $Q_{authorized}$ = 10.0 l/s). The capacities authorized for wells utilized by Slovak Distilleries and Liqueur Factories are as follows: HS-1 well: $Q_{authorized}$ = 10.0 l/s, HS-2 well (EK: 179 404): $Q_{authorized}$ = 15.0 l/s, HLS-2 well (EK: 179 402): $Q_{authorized}$ = 10.0 l/s, HLK-1 well (EK: 179 406): $Q_{authorized}$ = 6.0 l/s. In case of ÚVTOS Leopoldov: KT-1 well (EK: 131 502): $Q_{authorized}$ = 1.3 l/s, HL-1 well (EK: 131 503): $Q_{authorized}$ = 2.8 l/s and N-1 - N-2 wells (EK: 131 502 and 131 504): $Q_{authorized}$ = 16.0 l/s (however, they were not operated in the year 2013). See the figure below for the layout of registered water sources:

Figure C.II.16: Map of existing registered water sources in the Socoman – Drahovce Channel – Váh River area



Key:

▭ - registered water sources, SHMÚ registration code

C.II.7. Fauna and Flora

7. Fauna and flora – qualitative and quantitative characteristics, characteristics of biotopes, protected rare and endangered species and biotopes, significant animal migration corridors.

C.II.7.1. Biogeographical Characteristics of the Territory

On the basis of the zoogeographical classification – the terrestrial biological cycle (Jedlička, Kalivodová in: Landscape Atlas of the Slovak Republic, 2002), it is possible to include the eastern part of the wider territory of interest to the Pannonian Section (Province of Steppes) and its western part to the Deciduous Forest Province (Sub-Carpathian Section). From the limnical biological cycle point of view (Hensel, Krno in: Landscape Atlas of the Slovak Republic, 2002), the wider territory of interest is included in the Pontocaspian Province, Danube District and Western Slovakia Part.

On the basis of the phytogeographical – vegetation classification (Plesník in: Landscape Atlas of the Slovak Republic, 2002), the wider territory of interest belongs to the Oak Zone, Lowland Sub-Zone, Hilly Country Area, Trnava Hilly Country District; the western part of the wider territory of interest belongs to the Sub-Small Carpathian Hilly Country Sub-District and its eastern part belongs to the Trnava Plain. Parts of the Lower-Váh River Flood Plain District, of the Dudváh Marshland Sub-District and of the Váh River Flood Plain Sub-District interfere in the territory.

The geobotanical classification of the territory, i. e., the layout of climax plant communities to which relevant zoological coenoses and microbiological coenoses are also bound, reflects the primary landscape structure, covers all the original ecosystem biological diversity units (the diversity on the level of ecosystems) and results from the Geobotanical Map of Slovakia (Michalko et al., 1986). The Map represents a map type depiction of the reconstructed vegetation. In compliance with the geobotanical map, the following units were earmarked on the wider territory of interest:

Lowland alluvial forests: They include hygrophilous and partially mesohygrophilous forests that are found on alluvial depositions along watercourses or in the vicinity of natural water reservoirs. They are bound to higher and relatively drier positions of alluvial flood plains where they are affected more rarely and during shorter time periods by periodically repeated surface floods or by the fluctuating ground water level. The forests are mostly made-up of ash-/elm-trees and oak/elm-trees. Their development and structure are decisively affected by the water regime along with soil properties. The lowland alluvial forests covered a larger area of the territory of interest in the past. They extended on the wide Dudváh River flood plain.

At present, a larger part of the lowland alluvial forests is transformed into agricultural land. Remnants of the alluvial forest have only survived in the Dedova jama (Grandpa's Pit CHA) area where Common Ash *(Fraxinus excelsior)*, Narrow-Leaved Ash *(Fraxinus angustifolia)*, Smooth Elm *(Ulmus minor)*, White Poplar (*Populus alba)* and Common Oak *(Quercus robur)* are found and woody species typical for the soft-wood alluvial forest are also present. Nitratephilous species mostly grow in the herbaceous coppice.

Willow-/polar-tree alluvial forests: They extend on Holocene river flood plains in the warm Pannonian area, on wet, periodically flooded fluvial sediments. Communities of standard willow-/poplar-tree forests *(Salicion albae)*, or communities of scrub type Willow Trees *(Salicion triandrae)* are included along with their development stages. They have specific demands for hydrological conditions on areas where they grow, depending on river level movements, qualitative structure and settling speed of depositions. They are found along larger watercourses.

As for the wider territory of interest, willow-/polar-tree alluvial forests developed on glues around the Váh River and on primary alluvial depositions. At present, they are transformed into agricultural land or they cover very small areas around the Váh Channel whereby they have been quite modified.

Oak-/hornbeam-tree Panonian forests: They are found in the warmest territories of Slovakia, predominantly on sandy or gravelly terraces or alluvial cones. Those communities belong to the driest units occurring on wide river flood plains and terraces. The herbaceous stratum is the most pronounced and numerous in spring. The oak-/hornbeam-tree Pannonian forests extended over large areas in the past, they covered the territory between the Dudváh and Váh Rivers.

At present, those areas are transformed into agricultural land.

Oak- and mossy-oak-tree forests: Xerothermophilic oak forests are included that are found predominantly on extreme relief forms and on alkaline to neutral substrata. Oak-/mossy-oak-tree forests covered small areas between Veľké Kostoľany and Pečeňady municipalities in the past.

At present, those areas are transformed into agricultural land.

Oak xerothermophilic Pont-Pannonian forests: They extend to the North-West border of the territory of Slovakia. They cover warm areas, exposed southern slopes and can also be found on plateaus of loess hilly countries. From the floristic point of view, the forests are very varied and rich, species of steppe-forest character and sub-Mediterranean species are found there. Like the oak-/mossy-oak-tree forests, the above forests only covered a small area of the territory of interest to the South and South-West of Pečeňady municipality.

At present, those areas are transformed into agricultural land.

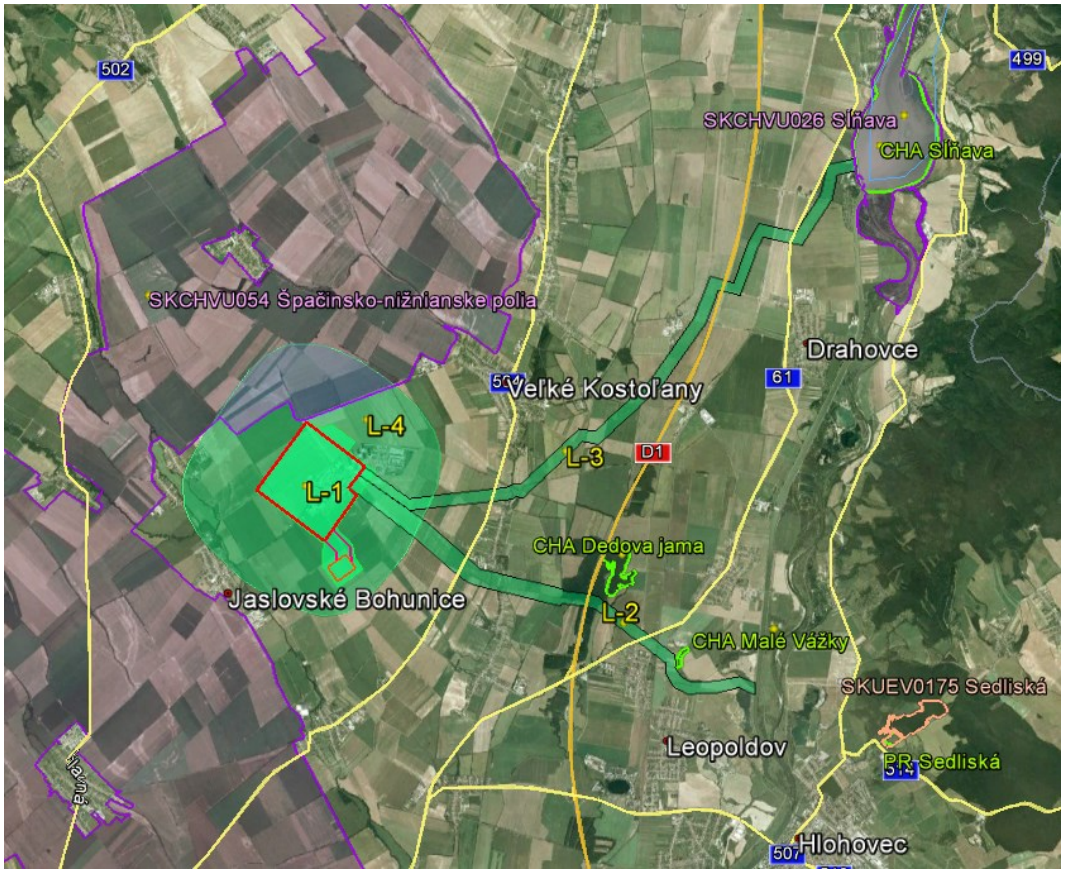
C.II.7.2. Fauna and Flora

C.II.7.2.1. Fauna

C.II.7.2.1.1. Survey Sites

The fauna survey was performed on the area selected for the NJZ siting and construction, including areas and biologically significant parts of corridors reserved for the technical infrastructure. Survey sites are delimited and designated using 'L-X' codes – see the following figure.

Figure C.II.17: Determination of survey sites



The surveys were performed during the whole 2014 vegetation period. On the whole, 7 to 12 surveys were performed on each site for the monitored time period, their numbers and schedules depending on the size and character of particular sites. The time difference between individual surveys was at least 7 days.

Both the presence and population levels of individual animal species (birds and mammals) were monitored using the point method. The method is mainly used to count territorial animal species (particularly birds) during their (reproductive) vegetation period, however, it can also be applied during other time periods of the year, e.g., during stock-taking and large-area surveys. When applying this method, all seen or heard individuals are counted at exactly determined points and during exactly specified time period. The number of points was 60, their layout and mutual distances were specified in advance and ranged from 200 to 300 m. Animals were counted for 10 minutes at each point. The height of birds' flights were also estimated on sites L1 and L4, namely on the basis of comparisons with known or assumed heights of objects found in the nearest vicinity.

Insects, amphibians and reptiles were identified along the whole transect (e. g., not only at the counting points). Species that are more difficult to identify were caught and, following the determination, let loose immediately at the point of capture.

Beetles were also identified using underground traps (glass jars put under the ground surface) exposed for the time period of 10 days. The presence of mammals and some species of birds (birds of prey and owls) was also identified by means of monitoring other signs of their stay on the territory, such as especially footprints (traces), droppings, vomitus or perished individuals.

C.II.7.2.1.2. Survey Results

Agricoenoses are the prevalent habitats on the predominant part of the concerned territory; they are represented by large areas of arable land with different agricultural cultures among which corn, sunflower, oil-seed rape and cereals (barley, wheat) prevail. L1 site is an exception – its territory represents, above all, the built-up EBO site. Forest stands are minority participants on the territory, namely in the Madunický háj (Madunice Grove) area in the vicinity of L2 site. The non-forest woody plant vegetation is present on the surveyed sites in the form of line scrubs (bushes and lines of trees) along roads and watercourses, rarely in the form of islands of bushes and trees or of solitary plants. In addition to water biotopes of the Váh River (Drahovce Channel) and the Sĺňava Water Reservoir found in boundary parts of L2 and L3 sites, water biotopes are also represented by the Upper Dudváh River course and water channels Manivier, Pečeňady, Rakytov a Červenice that cross the surveyed sites to different extents. Stagnant water biotopes on L2 site include former gravel pits at Ratkovce and Leopoldov municipalities. CHA Malé Vážky marshland biotope is also found in the boundary part of L2 site near Červeník municipality.

On the whole, 103 species of vertebrates and 104 species of insects were identified on all the monitored sites. As for the vertebrates, birds (65 species) prevailed whereby less mammals were identified (30 species). 5 species of amphibians and only 3 species of reptiles were identified. The highest number of insect species was represented by beetles (46 species), less butterflies (20 species) and heteroptera (13 species) were identified. Other orders were only represented by 1 to 9 species.

50 vertebrate species (49 %) also utilized at least of one of the monitored sites for their reproduction. Further 25 species appeared there regularly, but without any reproduction, and the remaining 28 species, were only identified rarely on the monitored sites. With regard to spatial activities and complicated biological (reproductive) cycles of insects, no such evaluation was possible for this animal species on the basis of identified data.

As regards vertebrates, field (steppe, 34 species) and arboraceous (tree) (36 species) species prevailed on the majority of the monitored sites. They are bound to the non-forest (predominantly line) woody plant vegetation in the open agricultural landscape. Similarly, the majority of insect species, particularly beetles, heteroptera and butterflies, was bound to the open landscape with field (meadow) or ruderal vegetation. Aquatic animal species, particularly vertebrates (22 species), and insects, particularly dragon flies, some beetles, heteroptera and diptera (7 species), mainly appeared on site 2 (CHA Malé Vážky and gravel pits at Ratkovce and Leopoldov municipalities). There were 11 synantropous vertebrate species, their appearances were bound to EBO site objects and to existing roads.

Out of the total number of all vertebrate species identified on the concerned territory, 86 species (83 %) are protected within the meaning of Decree No. 24/2003, Coll., implementing Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended. Out of those 86 species, 16 species are included in the List of Community Importance Species. As for insects, 7 species only belong to protected species within the meaning of the above mentioned act, out of which 3 species are included in the List of Community Importance Species. This disproportionality between numbers of protected species of vertebrates and insects results from the fact that, in compliance with EU legislation (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds) that was also transposed by the Slovak Republic into its national act, all species of wild birds naturally appearing on the European territory of European Union member states (i. e., sparrows, common starlings, magpies, too) are protected. From the point of view of real danger or risk of extinction of those birds on the concerned territory, however, in compliance with the Red List of Birds in Slovakia, only 3 species (Imperial Eagle, Jerfalcon and Gray Partridge) belong to the category of highly vulnerable species, 2 species (Barn Owl, Barn Swallow) belong to the category of vulnerable species and 5 species (Northern Goshawk, Delichon Urbica, Sand Martin (Riparia iparia), Crested Lark and Northern Wheatear) belong to the category of nearly endangered species. Other bird species identified on the concerned sites represent less endangered species.

C.II.7.2.1.3. Hydrobiological Characteristics

The description of hydrobiological characteristics and the assessment of the territory were concentrated on all aquatic bodies affected directly or indirectly by the proposed activity. The following sites were selected:

- Water Reservoir Sĺňava – at the water take-off location,
- Dudváh River – it will be a location where rain water and waste water will be discharged from the NJZ and it is crossed twice by technical infrastructure corridors,
- Drahovce Channel – it will be a location where waste water will be discharged by the NJZ,
- Váh River – it will be affected indirectly by the waste water discharge via the Drahovce Channel and Dudváh River.

Typical fish species were identified in the above mentioned bodies, as far as invertebrates, phytoplankton and macrophytic vegetation are concerned. Representatives of thermophilic species typical for medium and lower sections of watercourses are characteristic for the above mentioned types of water; they are adapted to water level fluctuations, temperature fluctuations, changes in oxygen conditions and nutrient contents in watercourses and water bodies.

Water Reservoir Sĺňava: It extends on the area of 480 hectares, starting from the dam body (jetty) to the Krajinský Bridge in Piešťany. The reservoir was built in 1960s. Due to the reduction of flow speed caused by the water reservoir completion, species of fish living in flowing waters fish disappeared. The fish pass made in the jetty in Drahovce only enables free fish migration in a limited mode because of an inappropriate technical design. The diversity of ichthyofauna species is complemented by means of migration form the original Váh River basin upstream of Piešťany. The structure of fish species is remarkably affected by introduced fish stocks, as the Water Reservoir represents a significant angling area. The following fish species can be mentioned: Common Carp *(Cyprinus carpio)*, Wels Catfish *(Silurus glanis)*, Northern Pike *(Esox lucius)*, Zander *(Stizostedion lucioperca)*, Common Bream *(Abramis brama)*, Vimba Bream *(Vimba vimba)*, Bigheaded Carp *(Hypophthalmichthys spp.)*, European Perch *(Perca fluviatilis)*, European Chub *(Leuciscus cephalus)*, European Eel *(Anguilla anguilla)*, Goldfish *(Carassius auratus)*, Barbus *(Barbus barbus)*, Asp *(Aspius aspius)*, Grass Carp *(Ctenopharyngodon idella)*, Common Nase *(Chondrostoma nasus)*, Doctor Fish (Tench) *(Tinca tinca)* a. o.

Dudváh River: The Dudváh River is a typical lowland watercourse with permanently low flow rates and short-time extremes; it is remarkably affected by human interventions. The watercourse provides the drainage of water during increased rainfall periods and the irrigation. The watercourse is channelized along the concerned territory, there is almost no bank vegetation in the northern half of the concerned territory. The diversity of fish species is remarkably affected by introduced fish species (fish stocks) as the Dudváh River is among angling areas. The following fish species appear in the watercourse, e., g.: European Chub *(Leuciscus cephalus)*, Common Dace *(Leuciscus leuciscus)*, Common Bleak *(Alburnus alburnus)*, European Bitterling *(Rhodeus sericeus amarus)*, Gobio *(Gobio gobio)*, Eurasian Ruffe *(Gymnocephalus cernuus)*, Common Carp *(Cyprinus carpio)*, Northern Pike *(Esox lucius)*, Common Roach *(Rutilus rutilus)*, Goldfish *(Carassius auratus)*, Common Nase *(Chondrostoma nasus)*, Doctor Fish (Tench) *(Tinca tinca)*, Brown Trout *(Salmo trutta m. fario)*, Rainbow Trout *(Onchorhynchus mykiss)*, rarely appearing White-Finned Gudgeon *(Gobio albipinnatus)* and Spined Loach *(Cobitis taenia)* a. o.

Drahovce Channel: The Drahovce Channel represents one of the last elements in the Váh River Dam Cascade System. The following are major parts of the water construction: Drahovce Weir forming a weir-type storage basin along with lateral earth-fill dams, the intake channel, the Madunice Hydro Power Plant and the discharge channel downstream of the Madunice Hydro Power Plant that empties into the Váh River 4.6 km away. The proposed discharge object for the waste water pipeline from the NJZ is situated approximately 3.5 km downstream of the Madunice Hydro Power Plant. From the ichthyological point of view, the mentioned section of the channel is affected by the structure of populations living in the Váh River course itself to a large extent. The following common fish species appear there: Common Roach *(Rutilus rutilus)*, Goldfish *(Carassius auratus)*, Common Carp *(Cyprinus carpio)*, Barbus *(Barbus barbus)*, Common Bream *(Abramis brama)*, Silver Bream (*Abramis bjoerkna)*, White-eye Bream *(Abramis sapa)*, Common Bleak *(Alburnus alburnus)*, European Chub *(Leuciscus cephalus)*, Orfe Fish *(Leuciscus idus)*, Asp *(Aspius aspius)*, Common Nase *(Chondrostoma nasus)*, Northern Pike *(Esox lucius)*, European Perch *(Perca fluviatilis)*, Wels Catfish *(Silurus glanis)*, Gobio *(Gobio gobio)*, Zander *(Stizostedion lucioperca)*, Vimba Bream *(Vimba vimba)* a. o.

Váh River

The Váh River represents a dominating factor of the river network in Piešťany and Trnava Districts. The Váh River has a relatively natural character between the Water Reservoir Sĺňava and the town of Hlohovec. Developed bank vegetation, islands and shallows are found there which form favourable conditions for the existence of a more varied fish community that is affected by introduced fish species (fish stocks) to some extent. Approximately 36 fish species were identified in the described section, the following can be mentioned, e.g.: .: Orfe Fish *(Leuciscus idus)*, European Chub *(Leuciscus cephalus)*, Common Nase *(Chondrostoma nasus)*, Barbus *(Barbus barbus)*, Zander *(Stizostedion lucioperca)*, Blue Bream *(Abramis ballerus)*, pleskáč tuponosý *(Abramis sapa)*, White-eye Bream *(Abramis brama)*, Common Carp *(Cyprinus carpio)*, Northern Pike *(Esox lucius)*, Wels Catfish *(Silurus glanis)*, Asp *(Aspius aspius)*, Goldfish *(Carassius auratus)*, Doctor Fish (Tench) *(Tinca tinca)*, Grass Carp *(Ctenopharyngodon idella)*, Brown Trout *(Salmo trutta m. fario)*, Rainbow Trout *(Onchorhynchus mykiss)*, rarely and sporadically appearing Striped Ruffe *(Gymnocephalus schraetser* – species of national importance), Cactus Roach *(Rutilus pigus virgo)*, Vimba Bream *(Vimba vimba)* a. o.

C.II.7.2.1.4. Significant Animal Migration Corridors

Animals, especially birds, migrate through/over the concerned territory along a wide front, i.e., without remarkably delimited migration corridors. This is evidenced by the fact that no significant gatherings or regular overflights of larger flocks of birds were detected on the territory in spring or autumn periods. The only exception applies to post-nesting gatherings of some species (e. g., Common Starlings and birds of prey – Common Buzzards) in fields after harvests.

The significant bird migration corridor – the Sĺňava Water Reservoir – and the trans-regional biological corridor – the Váh River – are only in a marginal touch with L2 and L3 sites (the raw water take-off object and the waste water discharge object). Another biological corridor of regional significance – the Upper Dudváh River – also crosses those sites. However, the watercourse has not a higher significance for the migration of terrestrial vertebrate species.

No migration corridors of amphibians and reptiles were identified on the territory. Whole lives of the majority of species appearing on the concerned territory are bound to water, or, except for the reproduction period, they live in the immediate vicinity of the existing water sources as the sources (except for the gravel pit at Ratkovce municipality) are isolated by areas of fields under cultivation that mostly represent impassable obstacles for them.

From the point of view of spatial motion activities performed by animals, particularly birds, altitudes of their flights over the territory are also important, especially the so-called collision altitude when there is a risk of their clash (collision) with high objects such as cooling towers, or high voltage transmission lines. It followed from the site surveys that the highest number of individual animals moving around L1 and L2 sites where there exists the highest risk of collisions moved at altitudes from 0 to 50 m above ground and, the other way round, the least number of individuals moved at altitudes above 151 m.

C.II.7.2.2. Flora

C.II.7.2.2.1. Survey Sites

The flora and biotopes were mapped on the concerned territory during the vegetation period from April till September 2014 so that all sites were covered that will be affected directly or indirectly by the proposed activities. The total number of surveyed sites was 38 (see the next figure). Plant species, classification of biotopes and assumed schedules of tree and shrub vegetation clear-cuts were identified for each site.

Figure C.II.18: Determination of floristic survey sites

C.II.7.2.2.2. Survey Results

The real vegetation represents vegetation that appears on the concerned territory at present. Due to human activities, the original natural vegetation has been gradually changed. The percentage share of original plant communities is very low. They are only preserved in the form of small enclaves in the agricultural countryside, they are often strongly affected by occurrences of weedy and invasive plant species.

The largest area of the concerned territory is covered by intensively farmed fields (X7 biotope 'Intensively Farmed Fields). That unit has no phytocoenological determination. The majority of arable land is available in the pooled, large-unit form and it is utilized to grow one- or two-year agricultural cultures. Among the units, but especially at their edges, weedy (segetal) communities are growing, predominantly coming from classes *Secalinetea* and *Polygono-Chenopodietea*. Their floristic structure depends on agrotechnical procedures. The following species are present there: *Chenopodium hybridum*, *Chenopodium album)*, Common Fumitory *(Fumaria officinalis)*, *Amaranthus hybridus agg.*, *Amaranthus retroflexus*, but also synanthropic plant species such as *Artemisia vulgaris*, Creeping Thistle *(Cirsium arvense)*, Couch Grass *(Elytrigia repens)*, Canadian Fleabane *(Conyza canadensis)*, Prickly lettuce *(Lactuca seriola)*. The following species also occur in numerous cases: Hemp-Agrimony *(Eupatorium cannabinum)*, Scentless Chamomile *(Tripleurospermum perforatum)*, Shepherd's-Purse *(Capsela bursa-pastoris)*. Out of other accompanying species, the following ones achieve a larger cover: Common Tansy *(Tanacetum vulgare)*, Greater Burdock *(Arctium lappa)*, Common Knotgrass *(Polygonum aviculare)*, Common Nettle *(Urtica dioica)*, to mention grass species: Orchard Grass *(Dactylis glomerata)*, False Oat-Grass *(Arrhenatherum elatius)*, Meadow Fescue *(Festuca pratensis)* and Meadow Foxtail *(Alopecurus pratensis)*.

As for ruderal communities, the most frequent occurrences show phytocoenoses of *Arction lappae* and *Dauco-Melilotion* associations. Greater Burdock *(Arctium lappa)*, Downy Burdock *(A. tomentosum)*, Poison Hemlock *(Conium maculatum)*, White Nettle *(Lamium album)*, Motherwort *(Leonurus cardiaca)*, Parsnip *(Pastinaca sativa)*, Valerian (Herb) *(Valeriana officinalis)*, Field Horsetail *(Equisetum arvense)*, Large-Flowered Hemp-Nettle *(Galeopsis speciosa)*, Spear Thistle *(Cirsium vulgare)* and other species are growing there. Communities belonging to *Convolvulo-Agropyrion* species occur at exposed

locations with disrupted surfaces and in non-maintained areas. Drier locations, causeways, edges of roads and fields are colonized by herbaceous ruderal, slightly to fully nitrophilous communities classified in X4 unit 'Thermophilic Ruderal Vegetation Outside Dwellings', but also by nitrophilous vegetation whose phytocoenoses are classified in X3 unit 'Nitrophilous Vegetation Outside Dwellings'.

Original woody plants of alluvial forests are replaced with poplar monocultures where various poplar crossbreeds occur. ** Remnants of former alluvial forests only survived in the Madunický háj (Madunice Grove) area (site No. 31) whose integrity was disrupted by the D1 Motorway construction. The Madunický háj (Madunice Grove) houses 70- to 90-year-old trees including Narrow-Leafed Ash *(Fraxinus angustifolia)*, Common Ash *(F. excelsior)*, Common Oak *(Quercus robur)*, Field Maple *(Acer campestre)*, Common Hornbeam *(Carpinus betulus)*, White Poplar *(Populus alba)*, Eastern Black Walnut *(Juglans nigra)* whereby Field Elm *(Ulmus minor)* and European White Elm *(U. laevis)* are disseminated. Invasive woody plants also occur rarely such as Black Locust *(Robinia pseudoacacia)* and Boxelder Maple *(Negundo aceroides)*. On the basis of preserved structure of species, the site belongs to Community importance biotopes of Ls 1.2 'Oak-Elm-Ash Lowland Alluvial Forests 91FO'.

Fragments of former soft alluvial forest classified in Salicion albae association appear to the North-East of Pečeňady municipality (site No. 13). Appearances of invasive species within the biotope, but mainly a high cover by Black Locust *(Robinia pseudoacacia)*, do not meet conditions for the classification of that biotope among Community importance biotopes.

The non-forest tree-scrub type vegetation is highly reduced on the concerned territory because of intensive farming performed on the agricultural soil. Trees and scrubs mainly occur in the form of line vegetation along drainage channels and roads, or they function as a "border" between individual agricultural allotments where they are used as line stands or function as windbreaks. Those trees and scrubs are significant ecostabilization elements in the intensively farmed agricultural landscape and are important biotopes utilized by animals. They also provide important aesthetic and soil protection functions. The windbreaks are formed predominantly by planted introduced Black Poplars *(Populus nigra)* and Black Locusts *(Robinia pseudoacacia)*.

The bank vegetation is represented by considerably ruderalized small-area remnants of willow-poplar lowland forests of *Salici-Populetum* association. They are found on the concerned territory along the Dudváh River course flowing through cadastral areas of Ratkovce and Pečeňady municipalities (site No. 29). The structure of their species is remarkably changed. The tree stratum consists of Black Locusts *(Robinia pseudoacacia)*, Pears *(Pyrus sp.)*, Common Aspens *(Populus tremula)*, Field Maples *(Acer campestre)*, Common Ashes *(Fraxinus excelsior)* and English Walnuts (*Juglans regia)*.

Meadows and grazing grounds are not present on the concerned territory as they were transformed into fields. Meadow and grazing ground species along with ruderal species only appear in narrow bands as herbaceous undergrowth of trees and scrubs lining roads. In the most frequent case, they form communities of *Dauco-Melilotion* association represented by Hawkweed Oxtongue *(Picris hieracioides)*, Common Chicory *(Cichorium intybus)*, Wild Carrot *(Daucus carota)*, Couch Grass *(Elytrigia repens)*, Curly Dock *(Rumex crispus)*, Yarrow *(Achillea millefolium)*, Yellow Sweet Clover *(Melilotus officinalis)* a. o.

Due to ameliorative and regulation interventions made in the past, significant water regime changes occurred on the concerned territory which resulted in the reduction of marshland vegetation areas. At present, the marshland vegetation is only present in the surroundings of drainage channels where it is a part of the bank vegetation, or it only forms a herbaceous stratum without any woody component. Species of Sedges *(Carex sp.)* appear there, especially Acute Sedge *(Carex acuta)*, Common Bulrush *(Typha latifolia)*, Narrowleaf Cattail *(T. angustifolia)*, Swamp Forget-me-not *(Myosotis scorpioides agg.)*, Creeping Buttercup *(Ranunculus repens)*, Reed Canary Grass *(Phalaroides arundinacea)*, Yellow Iris *(Iris pseudacorus)*, Common Reed *(Phragmites australis)*, Marsh Woundwo *(Stachys palustris)*, Field Mint *(Mentha arvensis)*, Wild Teasel *(Dipsacus fullonum)*, Branched Bur-Reed *(Sparganium erectum)* whereby Common Duckweeds *(Lemna minor)* can be found on open water bodies. Canadian Waterweed *(Elodea canadensis*), occurring in water, belongs to invasive plant species and forms continuous coppices at some locations. All the marshland biotopes are affected by occurrences of ruderal species. The following species grow there: Dane Weed *(Sambucus ebulus)*, Common Nettle *(Urtica dioica)*, Comphrey *(Symphytum officinale)*, Cardus Thistle *(Cirsium lappa)*, Curly Dock *(Rumex crispus)*, Field Bindweed *(Convolvulus arvensis)*, Comphrey *(Symphytum officinale)*, Wheatgrass *(Agropyron repens)*, Creeping Thistle *(Cirsium arvense)*, Common Wormwood *(Artemisia vulgaris)*, Poison Hemlock *(Conium maculatum)*, European Birthwort *(Aristolochia clematis)*, Goosegrass *(Galium aparine)*, Broadleaf Chervil *(Chaerophyllum aromaticum)*, Field Horsetail *(Equisetum arvense)*, Purple Deadnettle *(Lamium purpureum)* a. o. In the past, carnivorous plants Common Bladderworts *(Utricularia vulgaris)* appeared on the territory; they were destroyed due to the getting of gravel sand in an area at Drahovce

municipality. Dense covers are formed by Rigid Hornwort *(Ceratophyllum demersum)* and Canadian Waterweed *(Elodea canadensis)* along with multiple Pondweed *(Potamogeton sp.)* species. In recent years, Lesser Duckweed *(Lemna minor)* and the non-original Water Fern *(Azola filiculoides)* have spread abundantly along the original Váh River basin. Aquatic and litoral communities are represented there by the following communities: *Lemnetea* class (communities of plants floating on the water level and floating, but not enrooted in the bottom), by *Potametea* class (fresh water plant communities), by *Phragmitetea* class (communities of ditch reeds and high sedges) and by fragments of sedges) and coppice fragments of *Caricion gracilis* association. All of them are affected by occurrences of ruderal species. Those biotopes are significant not only from the botanical and landscape points of view, but they also represent a valuable biotope of amphibians, reptiles and other animals bound to the aquatic environment.

Dense, engaged covers of *Caricetum gracilis* community dominated by Acute Sedge *(Carex acuta)* occur in the northern part of the drainage channel (the South-East part of the cadastral area of Pečeňady municipality). At present, they represent remnants of former sedge communities and their structure corresponds to the classification among national importance biotopes Lk10 'High Sedge Vegetation'.

Invasive plant species (i. e., non-original species) occur in abundant numbers throughout the concerned territory. They spread spontaneously, drive the original species out of their natural biotopes and reduce gradually their biological diversity, but also the biological diversity of the whole territory. The following woody plants included in the group of invasive plants have been registered on the concerned territory so far: Black Locust *(Robinia pseudoacacia)*, Tree of Heaven *(Ailanthus altissima)* and Boxelder Maple *(Negundo aceroides)*. From the biotope point of view, they are included in X9 ''Non-Original Woody Plant Covers'. That unit has no phytocoenological determination. Locust-tree covers form communities of *Chelidonio-Robinion* and *Baloto nigrae-Robinion* associations. The following invasive herbs occur on the concerned territory: Annual Fleabane *(Stenactis annua)*, Canadian Waterweed *(Elodea canadensis)*, Small-Flowered Touch-me-not *(Impatiens parviflora)*, Boxthorn *(Lycium barbarum)* and White bryony *(Bryonia alba)*. As for invasive tree species, Black Locust *(Robinia pseudoacacia)* occurs most frequently in the mapped biotopes; it becomes dominant in many covers and affects the structure of the accompanying vegetation. Due to their aggressive propagation, those invasive species represent danger for all biotopes appearing on the concerned territory.

Decree No. 158/2014, Coll., amending Decree No. 24/2003, Coll., implementing Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended, specifies a list of invasive plant species that need to be removed and, at the same time, removal methods are also specified. The following invasive woody plants are found on the concerned territory: Tree of Heaven *(Ailanthus altissima)*, Boxelder Maple *(Negundo aceroides)* and Boxthorn *(Lycium barbarum);* the land owner (administrator, tenant) is obliged to remove those tree species and take care of the land to prevent any repeated propagation of the invasive species at expenses of the originator of their propagation, if known, otherwise at expenses of the state - § 7 of Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended. Prior to their liquidation (but also prior to the liquidation of other invasive species), it is recommended to get in touch with the State Nature Conservation Authority of the Slovak Republic to consult the way of their removal.

C.II.7.2.2.3. Protected and Endangered Species of Plants and Biotopes

Within the meaning of Decree No. 158/2014, Coll., amending Decree No. 24/2003, Coll., implementing Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended, no protected species of Community or national importance occurs on the concerned territory. In compliance with the Red List of Ferns and Seed Plants of Slovakia (Feráková, Maglocký, Marhold, 2001), two species were identified during surveys: Lily of the Valley *(Convallaria majalis)* – threat degree LR:nt (almost endangered species) and Summer Snowflake *(Leucojum aestivum)* – threat degree VU (vulnerable). Within the meaning of the above mentioned decree, no social value has been determined for those species. Both the species were identified in Madunický háj (Madunice Grove – site No. 31).

Within the meaning of Annex 1 to Decree No. 579/2008, Coll., amending Decree No. 24/2003, Coll., implementing Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended, the following biotopes are found on the concerned territory:

- Ls1.2 'Oak-Elm-Ash Lowland Alluvial Forests 91FO' – the Community importance biotope, the social value of the biotope is determined by the mentioned decree to be 23.23 €/m^2 (forest stands of the Madunický háj (Madunice Grove), cadastral areas of Ratkovce, Pečeňady municipalities);

- Lk10 'High Sedge Vegetation' – the national importance biotope, the social value of the biotope is determined by the mentioned decree to be 7.30 €/m^2 (tree-scrub cover in the surroundings of the drainage channel in the South-East part of Pečeňady municipality cadastral area).

At present, communities, or biotopes of Community or national importance are already remarkably modified and exposed to dynamic and intensive impacts of anthropization.

C.II.8. Landscape

8. Landscape – landscape structure, landscape character, scenery, stability, conservation.

C.II.8.1. Landscape

C.II.8.1.1. Contemporary Landscape Structure

The concerned territory and its surroundings represent a typical farmed landscape of the Trnava Hilly Country. The landscape mosaic is made up of large areas of arable land with different cultures (see the next figure) separated from each other by class III roads, local and tertiary roads.

Figure C.II.19: Landscape mosaic in the EBO site surroundings

The city of Trnava is the focal point of the residential structured territory of interest, however, dwellings of rural type prevail remarkably on the concerned territory. State roads of local, regional and trans-regional significance and some railway routes form the basic communication scheme of the territory.

The EBO site is the most pronounced landscape element of the anthropogenic origin. As for the other infrastructure, a dense network of overhead transmission lines of all categories and an elevated hot water pipeline also emerge visually within the landscape.

Blava and Dubovský potok (Dubové Creek) watercourses, but also the Manivier Channel that are regulated along certain sections (especially on the built-up territory), can be included in the group of natural elements found on the concerned territory. The watercourses are of lowland character, represent hydrological corridors around which vegetation is concentrated in the form streamside stands. Those vegetation elements belong to the most pronounced ones on the concerned territory, as forest stands are absent there. Except for those streamside stands, the non-forest bank woody plant vegetation is, moreover, represented by lines of trees growing at roads that are, in many cases, overripe and not

continuous, and by solitaire woody plants in fields. Vegetation areas are complemented by residential greeneries (gardens at family houses, cemeteries, cultivated garden-type areas, etc.).

C.II.8.1.2. Landscape Face and Scenery

The landscape character and scenery of the wider territory of interest are expressions of to what extent the original landscape was affected by the man. The landscape character development on the concerned territory was especially affected during the period of socialism. The pooling of grounds, regulation of watercourses, or removals of tiny landscape elements (especially vegetation covers) in order to industrialize the large-scale agricultural production resulted in changes in the landscape character. Thus, the original small-scale landscape of the monitored territory has only come down in relicts, above all, in more rugged parts of the territory and in immediate connections to residences (personal household plots, orchards, vineyards).

Such an object as a nuclear power plant, and, especially, highly visible cooling towers, are markedly predominant elements that cannot be overlooked when monitoring the landscape. Depending on viewer's perception abilities, it is possible to perceive elements found within a landscape, whether of natural or anthropogenic origin, in very different ways. Big size technical objects situated on a territory are generally assessed in a negative manner (as disturbing the landscape character), however, a certain group of viewers can assess them in a positive manner (as country enlivening elements). Thus, when assessing the landscape scenery, subjective approaches is predominant (Pauditšová et al., 2010).

When assessing the landscape character, contemporary landscape structure relief and elements are determining factors. As, from the relief point of view, the territory is little rugged with minimum differences in terrain altitude, it is obvious that it is a territory with good visibility under appropriate climatic conditions. Based on conclusions drawn from analyses of older reports (Pauditšová, Pauditš, 2007), the whole nuclear power plant site is situated within a zone of good visibility. It is a land strip between the Small Carpathian Mountains and the Považský Inovec Mountains, of North-East-to-South-West orientation where objects higher than the full-grown woody plant vegetation (approximately 20 to 30 m) are very well visible. Of course, the visibility of objects found in the landscape is affected by the current weather.

With regard to the little rugged relief, the absence of forest stands and tiny occurrences of the non-forest woody plant vegetation, it is possible to state that natural conditions do not markedly support the landscape character variety on the concerned territory so that the landscape structure mosaic is of a very low variability. The landscape character is formed especially by large areas of fields that are visually discontinued by vegetation elements, skylines of residences and transportation lines here and there. High-voltage posts and a dense network of overhead transmission lines are disturbing technical elements. The EBO site, or its cooling towers, are the most visible elements.

Figure C.II.20: Technical elements as a part of the landscape character

C.II.8.1.3. Landscape Stability and Conservation

Ecostabilization elements occur on the concerned territory to a minimum extent, the total ecological stability of the assessed territory is low to very low. The landscape dominated by large areas of farmed soil, with the lack of the non-forest woody

plant vegetation, where non-original plant species appear and anthropogenic social-economic elements and phenomena are present, and has a low ecological stability coefficient.

Ecostabilization elements are represented on the concerned territory by watercourses, permanent grass stands and non-forest woody plant vegetation lines. Parks and other residential vegetation made up of the vegetation growing in public areas and gardens at family houses found on built-up territories of municipalities can be included in the category of ecostabilization elements situated on the concerned territory.

The non-forest woody plant vegetation lines are usually found along line elements of the landscape They are especially streamside stands localized along watercourses and lines of trees (they are often sparsely standing) along roads. Those vegetation elements are of lower quality in places, but despite this fact, they represent significant ecostabilization elements not only on the concerned territory, but also within the wider territory of interest.

As for elements reducing the ecological stability, line barrier elements are concentrated on the concerned territory. Above all, they are high-voltage overhead transmission lines (their dense network in connected with the presence of an electric power function on the territory) and roads. The negative influence of those elements is related with disturbances of natural migration routes of animals. In case of the overhead transmission lines, potential risks exist for birds (especially during migration periods), on the other hand, areas in the surroundings of pole bases are overgrown by plants that form a basis of existence for biotopes of multiple animals. They are often the only areas of greenery in large agricultural fields.

Roads are a typical landscape element supporting the landscape fragmentation and they are frequently sources of collisions when the roads cross migration corridors of terrestrial organisms. Damage to loss of biotopes of various groups of organisms, as well as reductions of numbers of species or individuals within populations are characteristic impacts of the fragmentation and disturbances of migration corridors. However, multiple roads situated on the territory of interest have a potential to support the ecological stability along with vegetation elements, e. g., lines of trees along roads. The ecological stability on the concerned territory is also reduced as a result of the intensive agricultural production. Large areas of fields are cultivated without any presence of vegetation elements that would meet basic needs of organisms (shelters, sources of food, etc.).

C.II.9. Protected Territories

9. Protected territories in compliance with special regulations and their zones of protection [e. g., national parks, protected countryside areas, proposed protected bird areas, areas of Community importance, Community system of protected areas (Natura 2000), protected aquatic areas],
protected trees.

C.II.9.1. Natural Science Protected Areas

C.II.9.1.1. Protected Areas

No large-area protected territories (national parks, protected country side areas) are found on the concerned territory.

Within the meaning of Act No. 543/2002 Coll., on Nature and Landscape Conservation, as amended, the following three protected areas (CHA) and one nature reserve (PR) are identified on the concerned territory and in its closest surroundings:

CHA Dedova jama: The protected area is proclaimed to protect remnants of the original alluvial forest that is significant as a refuge of animal, an important landscape forming element and a site of unique appearance of Summer Snowflake population and other protected plant species. It covers an area of 29.57 hectares and degree 4 of protection applies there. It is found approximately 4.9 km to the East of the NJZ site (150 m away from a pipeline system corridor).

CHA Malé Vážky: The protected area is proclaimed to protect aquatic biocoenoses important from the scientific-research, education and cultural-pedagogical points of view. Its area is 3.48 ha and degree 4 of protection applies there. It is found approximately 6.9 km to the East of the NJZ site (in a close vicinity of the pipeline system).

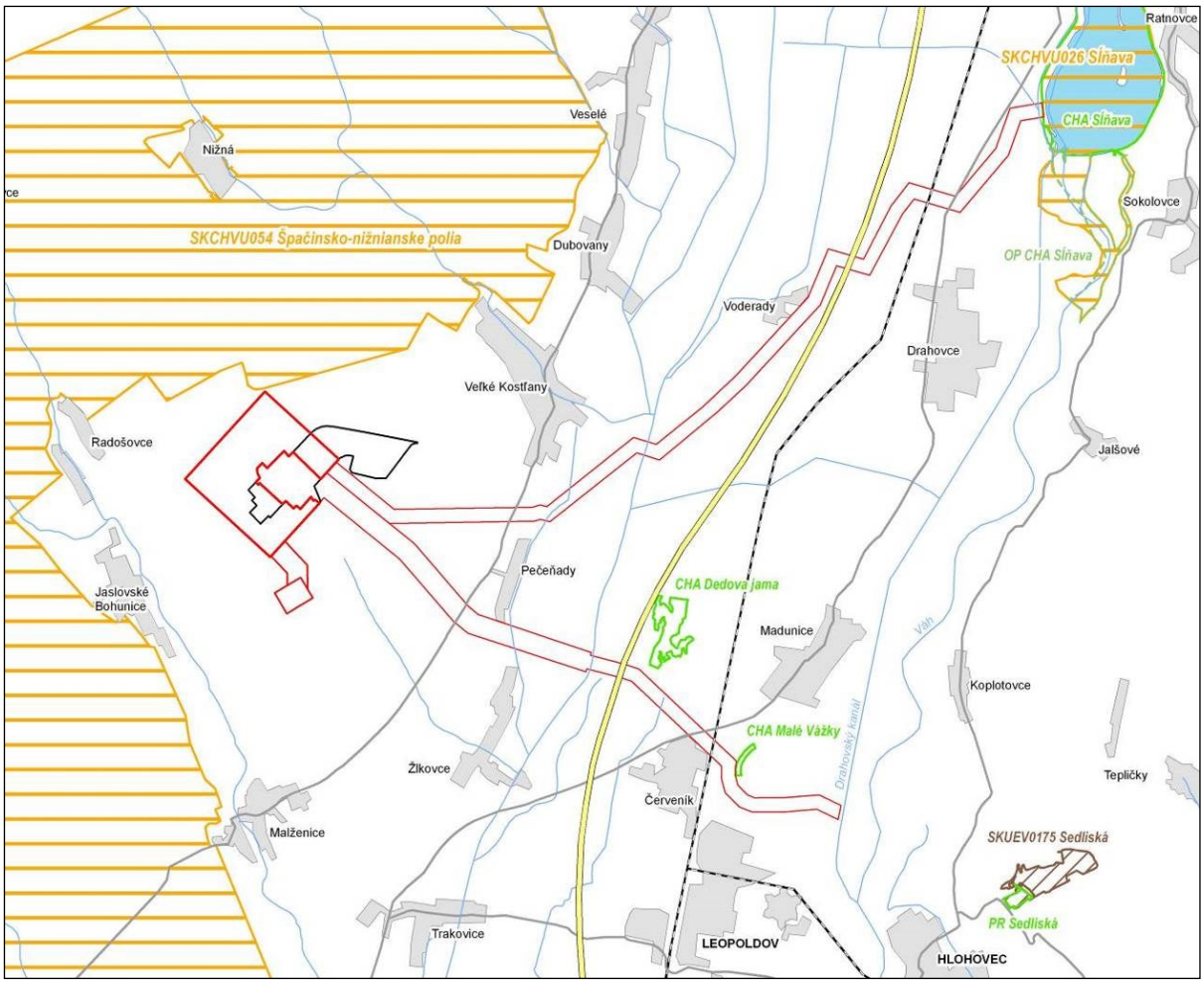
CHA Síňava: The protected area is proclaimed to protect water birds and aquatic biocoenoses for scientific-research purposes. Its area is 465.55 hectares (the zone of protection represents 66.55 hectares

out of the whole area) and degree 4 of protection applies to the area (degree 3 within the zone of protection). The area is situated approximately 11.4 km to the North-East of the NJZ site (the raw water take-off object is found at the edge of the water reservoir).

PR Sedliská: The nature reserve is proclaimed to protect xerothermic covers od steppe character including rich occurrences of Small Pasque Flowers *(Pulsatilla pratensis subsp. nigricans, P. vulgaris ssp. grandis)* accompanied by further significant thermophilic species of animals and plants and for scientific-research and cultural-educational purposes. Its area is 5.5 hectares and degree 4 of protection applies there. It is situated approximately 11.3 km to the East of the NJZ site, i. e., off the concerned territory.

Spatial allocations of those protected areas are obvious from the following figure.

Figure C.II.21: Localization of Natura 2000 protected areas and sites



C.II.9.1.2. Natura 2000 Sites

The implementation of Natura 2000 system is the basic part of European policy to protect biodiversity and ecosystems. Natura 2000 represents a continuous European ecological network of special protected areas that are in a special interest of the European Union. Within the meaning of Act No. 543/2002, Coll., on Nature and Landscape Conservation, § 28, as amended, Natura 2000 is defined as a "Continuous European System of Protected Areas". It is made up of 2 types of areas: Protected Bird Areas and Areas of Community Importance.

The following bird areas included in the National List of Protected Bird Areas are identified on the concerned territory:

SKCHVU054 Špačinsko-nižnianske polia: One of the most significant areas in Slovakia for the Jerfalcon nidification. The area was proclaimed by Decree No. 27/2011, Coll. The Protected Bird Area border runs in the distance of approximately 100 m to the North of the proposed NJZ construction site area, approximately 250 m from the NJZ main construction site and approximately 1000 m from the proposed cooling tower location.

SKCHVU026 Sĺňava: The water body significant for the nidification of water birds. It is among areas of highest concentrations of gulls in Slovakia, it is a significant wintering area and a migration corridor for many bird species in spring and autumn periods. The territory was proclaimed by Decree No. 32/2008, Coll. The Protected Bird Area is situated in the distance of approximately 11.4 km to the North-East of the NJZ site, the raw water take-off object site is proposed at the edge of the Sĺňava Water Reservoir (i. e., this is the point of contact with the protected bird area).

The following European importance area included in the National List of European Importance Areas (ÚEV) is identified within the wider territory of interest, out of the contact with the proposed area:

SKUEV0175 Sedliská: Biotopes that are object of protection: 6210 Xerophilic Grass-Herbaceous and Scrubby Coppices on the Calcerous Bedrock (Important Sites of Orchideaceae), 6240* Sub-Pannonian Grass-Herbaceous Coppices, 40A0* Xerothermic Scrubs, 91H0* Thermophilic Pannonian Oak Forests. The following are species under protection: Wind Flower. Area acreage: 46.09 ha. Area administrator: Protected Countryside Area Malé Karpaty. The European importance area is situated in the distance of approximately 11.2 km to the South-East of the NJZ (approximately 2.5 km away from the proposed discharge object localized on the Drahovský kanál (Drahovce Channel) bank.

Spatial allocations of the mentioned areas are obvious from the preceding figure.

C.II.9.1.3. Other Nature Protection Elements

The proposed activity will not intervene in any protected landscape element, any protected tree, any World Cultural and Natural Heritage sites (UNESCO), any biosphere reserve (proclaimed under UNESCO Man and Biosphere Programme).

The following marshlands of regional and local interest are identified on the concerned territory and in its closest surroundings (they are indicated graphically in the next Chapter C.II.10. 'Territorial Ecological Stability System', page 192 of the present Report):

Regionally Significant Marshland (RVM):

Sĺňava Water Reservoir: The territory is a part of Regional Biological Centre VN Sĺňava, CHA Sĺňava, SKCHVU026 Sĺňava. The raw water take-off object is proposed at the edge of the Sĺňava Water Reservoir, i. e., this is the point of contact with the regionally significant marshland.

Locally Significant Marshland (LVM):

Vinišovka-Baková: The territory is a part of Local Biological Centre (LBc) Vinišovka-Baková. The LBc is situated in the distance of approximately 1.57 km to the East of the proposed activity (corridor – raw water).

Water bodies on the right side of the diversion channel (Drahovce): The territory is situated in the distance of approximately 1.55 to 2.30 km to the North-West of the proposed activity (corridor – raw water).

Gravel Pit Leopoldov: The territory is a part of Local Biological Centre Štrkovka. The proposed activity (corridor – waste water) is situated in the contact with the Locally Significant Marshland (along the length of approximately 280 m).

Malé Vážky: The territory is a part of CHA Malé Vážky, LBc Červeník-Ypsilon and the gene pool area G23. The proposed activity (corridor – waste water) is in contact with the Locally Significant Marshland (along the length of approximately 200 m).

Ypsilonka: The territory is a part of LBc Červeník-Ypsilon and the gene pool area G24. The proposed activity (corridor – waste water) is situated in the distance of approximately 50 m to the South of the Locally Significant Marshland.

Struky: The territory is a part of LBc Červeník-Ypsilon and the gene pool area G24. The proposed activity (corridor – waste water) is situated in the distance of approximately 300 m to the South of the Locally Significant Marshland.

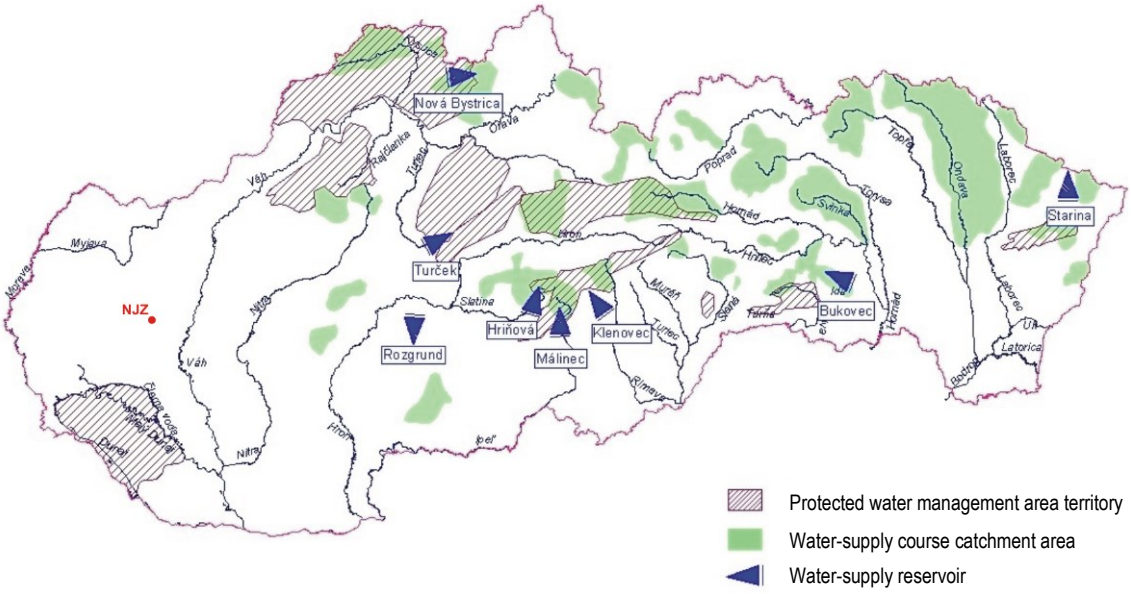
Gravel Pit Ratkovce: The gravel pit was produced during the D1 motorway construction. The formation of a permanent water body also enabled the reproduction of amphibian species such as e. g., Agile Frog *(Rana dalmatina)*. The Locally Significant Marshland is situated in the contact with the proposed activity (corridor – waste water) along the length of approximately 130 m.

C.II.9.2. Water Management Protected Areas

Within the meaning of Act No. 364/2004, Coll., on Waters, as amended, the following protected areas are defined: protected water management areas, zones of protection of water-supply sources, sensitive areas and vulnerable areas.

At present, ten protected water management areas (CHVO) are established within SR. The concerned territory or its vicinity do not include any CHVO, within the meaning of Act No. 364/2004, Coll., on Waters, § 31, as amended.

Figure C.II.22: Protected water management areas, catchment areas of water-supply courses and water-supply reservoirs



Zones of protection of water-supply sources are covered in relevant sections related to surface and ground waters (see Chapter C.II.6. Hydrological Conditions, page 161 of the present Report).

Those surface water bodies are considered as sensitive areas where, due to increased concentrations of nutrients, undesired states of water quality occur or can occur whereby the water is or can be utilized as a water-supply source, as well as it requires a higher degree of discharged waste water purification in the interest of increased water protection. In the year 2003, the Regulation of the Government of the Slovak Republic No. 617/2004, Coll., was issued where the establishment of sensitive and vulnerable areas is specified in detail. All surface water bodies situated on the territory of the Slovak Republic, or flowing through this territory, were established as sensitive areas. This means that the whole territory of the Slovak Republic was established as a sensitive area, i. e., including the concerned territory.

Vulnerable areas are agriculturally utilized territories from which rain water drains away to surface water or soaks into ground water where the nitrate concentration is higher than 50 mg/l, or this level can be exceeded in the near future. With regard to agricultural activities, the concerned territory is among vulnerable areas.

C.II.9.3. Other Protected Areas

No additional protected areas are identified on the concerned territory.

C.II.10. Territorial Ecological Stability System

10. Territorial ecological stability system (local, regional, trans-regional).

C.II.10.1. Territorial Ecological Stability System

The territorial ecological stability system (ÚSES) is a full-space structure of mutually interconnected ecosystems, their components and elements ensuring the variety of life conditions and life forms in the landscape. The basis of the system is represented by biological centres, biological corridors and interaction elements on multiple hierarchical levels.

An agricultural landscape integrated into arable land fields with areas of up to 500 hectares predominantly exists within the wider territory of interest. They are areas of the lowest ecological stability degree. The vegetation growing on the built-up territory of municipalities represents ecologically essentially more stable areas of the cultural landscape. Basic elements of the territorial ecological stability system situated in the wider territory of interest are formed by preserved elements of the original alluvial forests and covers on banks of watercourses. However, it will be necessary to complete the formation of the fully functional scheme of the territorial ecological stability system on the territory and add the missing biological centres, biological corridors and interaction elements.

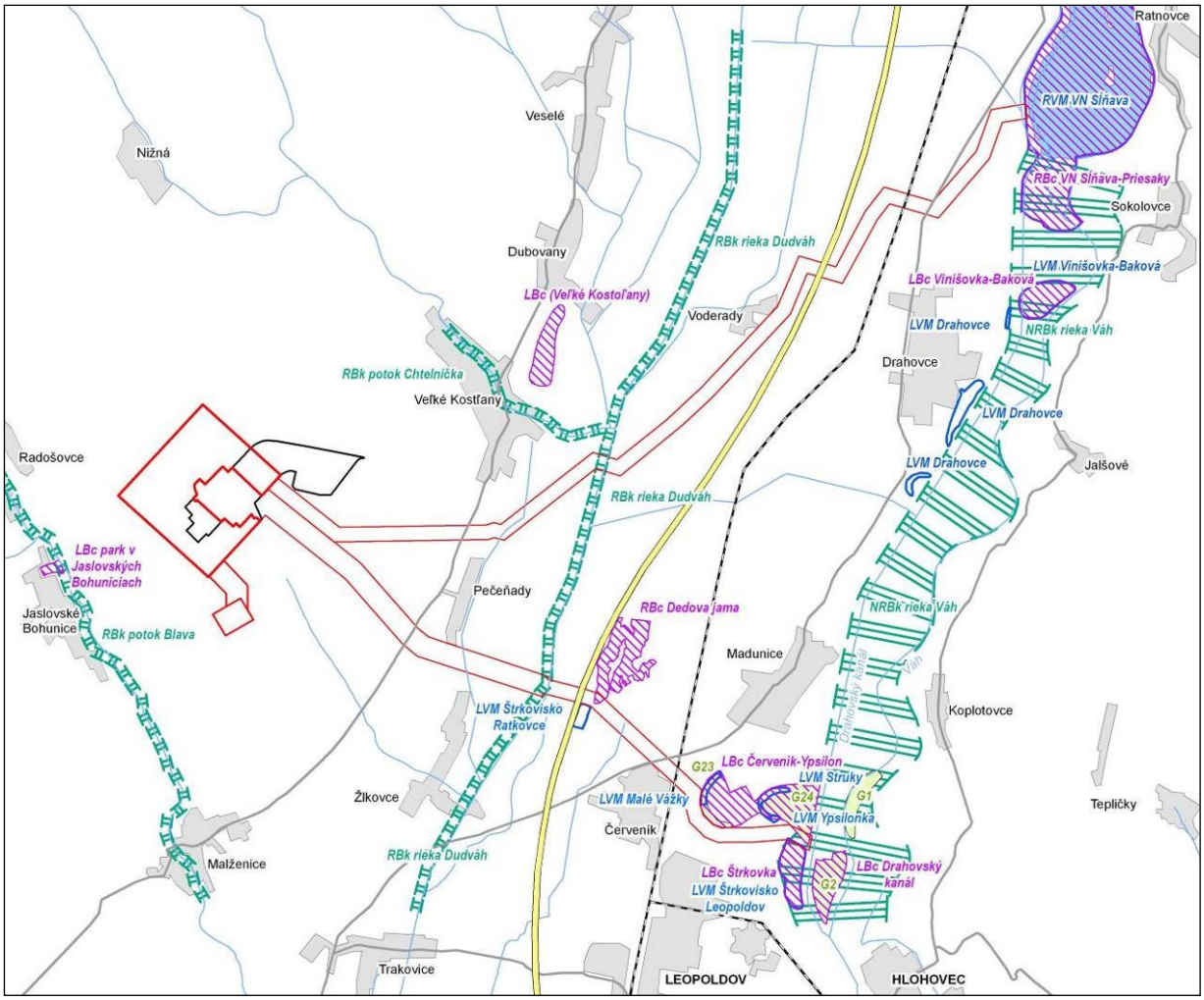
All the hierarchical levels of the territorial ecological stability system elements – the trans-regional, regional and local ones are present within the wider territory of interest. The determination of the existing, or possibly proposed territorial ecological stability system elements results from the following background documents:

- RÚSES of Trnava District – Districts of Trnava, Hlohovec and Piešťany are included,
- RÚSES of Trnava District – the update of Trnava District RÚSES (updates of RÚSES of Hlohovec and Piešťany Districts were not made),
- Trnava Self-Governing Region Land Use Plan – the Land-Ecological Plan,
- Trnava Self-Governing Region Land Use Plan,
- MÚSES of Hlohovec Town,
- Land Use Plan Documentation of concerned towns and municipalities.

No interaction elements were determined on the regional or local levels in the above mentioned documentation items.

The localization of ÚSES within the wider territory of interest is obvious from the next figure.

Figure C.II.23: Localization of elements of the ÚSES, LVM, RVM



The following are individual territorial ecological stability system elements:

NRBk Váh River: It connects regional biological centres in the surroundings of the watercourse, it is formed predominantly by remnants of streamside stands, alluvial forests, marsh and aquatic biotopes. It includes the territory bordered by the Váh River basin and the Drahovce Channel.

The proposed activity (corridor – waste water, as far as the cadastral area of Červeník municipality is concerned, interferes with NRBk Váh River (the water discharge facility is localized on the Drahovce Channel bank).

RBc Gravel Pits in the Váh River Alluvium: The territory stretches from Sĺňava to Hlohovec along both the banks. The following are preserved on the territory: streamside stands along the Váh River and its side channels, remnants of the original alluvial forests of *Salicion albae* association, marshlands, meadows in inundation areas, grazing grounds, bushes, gravel pits, fruit groves, fields, etc. The Váh River course is accompanied by continuous stands, narrow strips alternate locally with broader areas of well-engaged forests representing groups of forest types of oaks and elms. White Willows *(Salix alba)*, Bruttle Willows *(S. fragilis)*, White Poplars *(Populus alba)* and Black Poplars *(P. nigra)* prevail in the tree stratum of the soft alluvial forests, the bushes stratum is represented by Common Osiers *(Salix viminalis)*, Grey Willows *(S. cinerea)* whereby nitrophilous species such as Common Nettle *(Urtica dioica)*, Cleavers *(Galium aparine)* and Ground Ivy *(Glechoma hederacea)* prevail in the herbaceous stratum. That whole represents the best preserved Váh River streamside stands on the monitored territory. The Váh River is an important migration route of birds, its side channels and bays serve as their food and rest base during their migration. The territory completes the Váh River

course both biologically and aesthetically and at the same time, it is a significant animal biotope (fishes, tiny productive animals). Excellent water bird rearing grounds are found there, especially those of Dabbling Ducks (genus *Anas*), Eurasian woodcocks *(Scolopax rusticola)*, Common Snipes *(Gallinago gallinago)*, Little bitterns *(Ixobrychus minutus)*, Warblers *(genus Acrocephalus)* etc. The territory is among important natural-landscape elements enlivening the monotonous face of the farmed landscape.

Note: This RBc is only described in the text section of the Trnava Self-Governing Region Land Use Plan (2013), without any graphical representation that is why, it is not possible to identify possible collisions with the proposed activity. However, it is assumed that the RBc is a part of the NRBk Váh River. The proposed activity (corridor – waste water) will not interfere directly with any gravel pit in the Váh River alluvium. LBc Štrkovka (in the cadastral area of Leopoldov municipality) is the closest gravel pit to the proposed activity – it is in contact with the LBc (along the length of approximately 280 m).

RBc VN SÍňava and Priesaky: It interconnects regional biological centres in the surroundings of the river course, it is formed predominantly by remnants of streamside stands of alluvial forests, marshland and aquatic biotopes. At the same time, the territory represents the following: the small-area protected territory of CHA SÍňava, the protected bird area SKCHVU026 SÍňava and the regionally significant marshland.

The proposed activity (raw water take-off object) is in contact with this RBc.

RBc Dedova jama: It is situated within the cadastral area of Červeník municipality with the area of 30 hectares. The territory represents remnants of the original so-called hard floodplain including occurrences of rare Summer Snowflake *(Leucojum aestivum)*, Grass-Leaved Iris *(Iris graminea)*, European Bladdernut *(Staphylea pinnata)* and Cornelian cherry *(Cornus mas)*. It is also significant as a refuge of rare animals, especially birds. At same time, a part of the territory represents a protected area (CHA Dedova jama).

The proposed activity (corridor – waste water) crosses the southern edge of RBc along the length of approximately 145 m.

RBk Dudváh River: The biological corridor represents remnants of streamside stands including the original woody plant structure formed by willows, alders, ashes and poplars.

The proposed activity (corridor – raw water) crosses the RBk Dudváh River (in the cadastral area of Veľké Kostoľany municipality) and the corridor – waste and rain waters (in the cadastral areas of Pečeňady and Ratkovce municipalities).

RBk Chtelnička Creek: The biological corridor represents a natural watercourse with partially preserved streamside stands. The RBk is situated in the distance of approximately 290 m to the North of the proposed activity (corridor – raw water).

RBk Blava Creek: It is a natural watercourse with continuous streamside stands including remnants of biologically valuable biocoenoses. The RBk is situated in the distance of approximately 1.10 km to the West of the NJZ siting and construction area.

LBc Jaslovské Bohunice Park: It is characteristic of occurrences of domestic woody plant species such as Common Ash, Norway Maple and Small-leaved Lime. Earthbound vertebrates are found there typical for rural parks. The LBc is situated in the distance of approximately 1.22 km to the West of the proposed activity (the NJZ siting and construction area).

LBc Vinišovka-Baková: It represents originally cut-off Váh River side channels within the dam-to-dam space. At present, they have a marshland character with favourable conditions for the spawning of fish and permanent presence of amphibians. The streamside vegetation is a place where birds are nesting. The LBc is situated in the distance of approximately 1.57 km to the East of the proposed activity (corridor – raw water).

LBc Forest Stands (cadastral area of Kostoľany municipality): It represents a compact part of forest stands. The stands are made up of poplars, Narrow-Leafed Ashes, Common Alders, Boxelder Maples, and, in peripheral areas, Black Locusts, too. The LBc is situated in the distance of approximately 1.07 km to the North of the proposed activity (corridor – raw water).

LBc Červeník-Ypsilon: The gravel pit that went through successive stages after the termination of mining and, at present, it is stabilized, with significant plant and animal communities. The biological centre is a rearing ground of Mute Swan *(Cygnus olor)*. A gene pool area (G24) is a part of the territory.

The proposed activity (corridor – waste and rain waters) is partially in contact (along the length of approximately 820 m) and partially crosses the southern promontory of the LBc (along the length of approximately 300 m).

Note: This territory is not specified in the Trnava Self-Governing Region Land Use Plan (2013). This territory is specified as LBc in the Červeník Municipality Land Use Plan. The Leopoldov Municipality Land Use Plan specifies this territory as RBc in the text part only, without any graphical representation. As for the Local Territorial Ecological Stability System of Hlohovec town, the territory is specified as RBc together with a graphical representation including CHA Malé Vážky and gene pool areas G23 and G24.

LBc Drahovský kanál (Drahovce Channel): The site is situated between the Drahovce Channel and the old Váh River basin to the North-West of Hlohovec town – grazing grounds and meadows are crossed by a protection dam, they are bordered by the original Váh River basin on one side and by the channel at the other side. From the ecological point of view, it is a significant biotope of thermophilic animals and an ecostabilization element. Old World Swallowtail, Southern Festoon, Sand Lizard, European Ground Squirrel, Eurasian Pygmy Shrew, Grey Partridge, Common Quail, Hoopoe, Common Stonechat, Northern Wheatear, a.o., appear there. G2 gene pool area is also a part of the territory. The LBc is situated in the distance of approximately 180 m to the South-East of the proposed activity (corridor – waste water).

LBc Štrkovka: The territory is represented by a water body formed after the termination of gravel sand mining. Fragments of alluvial forests are found on its banks. Gravel pit water body edges are lined by Reed communities and, locally, by bushy willows, too. This is a significant site for nidification and migration of water birds and birds living near water. It also represents a generation site of amphibians.

The proposed activity (corridor – waste water) is situated in the contact with the LBc (along the length of approximately 280 m).

C.II.11. Population

11. Population – demographic data (e. g., number of inhabitants concerned, age structure, health, employment rate, education), residences, activities (agriculture, industry, forest management, services, relaxation and tourist industry), infrastructure (transport, product pipelines, telecommunications, waste and waste management).

C.II.11.1. Demographical Characteristics

C.II.11.1.1. Input Methodological Data

The Jaslovské Bohunice site is situated in the western region of Slovakia. From the point of view of the territorial and administrative structure of the Slovak Republic, the site is located in the central part of the Trnava Self-Governing Region, at the northern edge of the Trnava District, approximately 12 km of the town of Trnava, in the southern part of the Piešťany District and in the north-western tip of the Hlohovec District.

The demographic data is given for the following three areas:

Concerned territory: Cadastral areas within the distance of 5 km away from the NJZ site and municipalities, through which the routing of NJZ technical infrastructure corridors is considered. Thus, they are cadastral areas of concerned municipalities within the meaning of Act No. 24/2006, Coll., on Environmental Impact Assessments, as amended, on whose cadastral territories the proposed activity is to be implemented and of municipalities whose territories can be potentially significantly affected by the proposed activity (see Chapter A.II.11. Concerned Municipality, page 119 of the present Report).

Further territory: A zone of cadastral areas of municipalities related to the concerned territory and extending to the distance of up to 30 km from the NJZ site.

Total territory: The total territory includes cadastral areas of municipalities within the distance of 0 to 30 km from the NJZ site, i. e., and united areas of concerned and further territories.

In order to assess the demographical state of the population, data provided by the Statistical Office of the Slovak Republic is used covering the period from 2008 till 2013. Numbers of the population for the year 2011 take into account results of the Population, Houses and Apartments Census made as to 21 May 2011, when ŠÚ SR rebalanced the initial numbers of the population from 1 January 2011 on the basis of the Census results and, subsequently, final numbers of the population of the Slovak Republic were balanced, i. e, as to 31 December 2011, in compliance with 2011 demographical events (numbers of births, deaths, transmigrations). Therefore, it is possible to observe a population decrease in 2010-to-2011 year-on-year comparisons.

Concerned Territory

The concerned territory includes 19 municipalities belonging to 3 districts (Hlohovec, Piešťany, and Trnava) of the Trnava Self-Governing Region (TTSK). They are the following municipalities (approximate aerial distances between the urban areas and the NJZ are given in parentheses):

TTSK, Trnava District: Radošovce (2.0 km), Jaslovské Bohunice (2.3 km), Dolné Dubové (4.0 km), Malženice (4.7 km), Kátlovce (4.7 km), Špačince (6.6 km).

TTSK, Hlohovec District: Ratkovce (4.6 km), Žlkovce (4.6 km), Trakovice (6.7 km), Červeník (7.1 km), Madunice (8.0 km).

TTSK, Piešťany District: Pečeňady (3.7 km), Nižná (3.8 km), Veľké Kostoľany (3.9 km), Dubovany (5.4 km), Chtelnica (8.0 km), Dolný Lopašov (8.4 km), Drahovce (9.6 km), Piešťany (13.7 km).

Further territory

The further territory includes 212 municipalities belonging to 13 districts and 4 Self-Governing regions – Bratislava (BSK), Trnava (TTSK), Trenčín (TSK) and Nitra (NSK). The Military Area Záhorie is exempted from the list of municipalities whose north-eastern tip extends to the further territory (the exemption is reasoned by the absence of permanently inhabited residential structures on the territory). The following districts are the farthest ones from the NJZ site (numbers of residences falling into the further territory are given in parentheses):

BSK: Malacky District (3 municipalities), Pezinok District (11 municipalities), Senec District (4 municipalities).

TTSK: Galanta District (18 municipalities), Hlohovec District (19 municipalities), Piešťany District (19 municipalities), Senica District (11 municipalities), Trnava District (39 municipalities).

TSK: Myjava District (13 municipalities), Nové Mesto nad Váhom District (25 municipalities).

NSK: Nitra District (20 municipalities), Šaľa District (2 municipalities), Topoľčany District (28 municipalities).

C.II.11.1.2. Population Numbers and Density

Concerned Territory

In the year 2013, 53,523 inhabitants lived on the concerned territory, out of which 25,977 men (48.5 %) and 27,546 women (51.5 %). The total population in the year 2013 was higher by 141 inhabitants than in the year 2014, out of which: by 35 women and 106 men. The average population density achieved 173 inhabitants/km^2. The population numbers and density development on the concerned territory are obvious from the following table.

Table C.II.13: Population numbers and densities on the concerned territory for the period 2008 till 2013 (states as to 31 December)

Area [km^2]	2008		2009		2010		2011		2012		2013	
	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]
308.50	54,067	175	54,141	175	54,286	176	53,282	173	53,382	173	53,523	173

In the year 2013, Piešťany town was the greatest residence on the concerned territory with the population of 28,047. The

Piešťany town population represents 52.4 % of the population living on the concerned territory. Veľké Kostoľany was the municipality with the highest population in the year 2013 (2,757 inhabitants), whereby the lowest population lived in Ratkovce municipality (325 inhabitants).

In the year 2013, Piešťany town was the residence with the highest population density (635 inhabitants /km^2) whereby the following were municipalities with the highest population densities: Madunice (182 inhabitants/km^2), Červeník (165 inhabitants/km^2), Trakovice (127 inhabitants/km^2), Špačince (115 inhabitants/km^2), Veľké Kostoľany (113 inhabitants/km^2), Drahovce (106 inhabitants/km^2), Jaslovské Bohunice (104 inhabitants/km^2). The following were municipalities with the lowest population densities in the year 2013: Dolný Lopašov (42 inhabitants /km^2), Radošovce (57 inhabitants/km^2), Pečeňady (62 inhabitants/km^2).

Further Territory

In the year 2013; 437,461 inhabitants lived within the further territory, out of which 213,704 men (48.9 %) and 223,757 women (51.1 %). With regard to the year 2012, the population number increased by 558 inhabitants in the year 2013 out of which by 289 women and by 269 men. The average population density achieved 136 inhabitants /km^2. The population numbers and density development on the further territory are obvious from the following table.

Table C.II.14: Population numbers and densities on the further territory for the period 2008 till 2013 (states as to 31 December)

Area [km^2]	2008		2009		2010		2011		2012		2013	
	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]
3214.61	439,202	137	440,108	137	441,000	137	436,52	136	436,903	136	437,461	136

In the year 2013, the following were residences with the highest population densities: towns of Trnava (922 inhabitants/km^2), Leopoldov (731 inhabitants/km^2), Nové mesto nad Váhom (620 inhabitants/km^2) and municipalities of Píla (673 inhabitants/km^2), Biely Kostol (641 inhabitants/km^2). The following were municipalities with the lowest population densities in the year 2013: Nová Lehota (11 inhabitants/km^2), Stará Lehota (14 inhabitants/km^2), Hubina (18 inhabitants/km^2) and Lošonec (22 inhabitants/km^2).

Total Territory

In the year 2013, 490,984, inhabitants lived on the total territory, out of which 239,681 men (48.8 %) and 251,303 women (51.2 %). With regard to the year 2012, the total population number increased by 699 inhabitants in the year 2013 out of which by 324 women and by 375 men. In the year 2013, the average population density achieved 139 inhabitants/km^2. As compared with the average population density in the Slovak Republic (110 inhabitants /km^2), the total territory is found above the average. The population number and density development on the total territory is obvious from the following table.

Table C.II.15: Population numbers and densities on the total territory for the period 2008 till 2013 (states as to 31 December)

Area [km^2]	2008		2009		2010		2011		2012		2013	
	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]	Number [1]	Density [1/km^2]
3523.12	493,269	140	494,249	140	495,286	141	489,34	139	490,285	139	490,984	139

C.II.11.1.3. Population Age Structure

In order to identify the population age structure, the population is divided into three economic age groups:

- pre-productive age group – children and adolescents at the age from 0 to 14 years,
- productive age group – inhabitants at the age from 15 to 64 years,
- post-productive age group – inhabitants older than 65 years.

In the years 2010 till 2011, the Statistical Office of the Slovak Republic changed the methodology of population classification into age groups. While in the years 2008 till 2010 the productive age definition was 15 to 59 years for men and 15 to 54 years for women, since the year 2011 the productive age has been defined in the uniform manner: 15 to 64 years. There was no change in the pre-productive age definition (0 to 14 years), the above described change also applies to the post-

productive age definition (the continuation from the productive age). Therefore, the data prior to the year 2011 is calculated so that it corresponds to methodological procedures used after the year 2011.

Concerned Territory

While the pre-productive population share was stagnating, the older post-productive population share was increasing, especially in case of women, and the productive population share was decreasing on the concerned territory during the period from 2008 to 2013. That development represents a longer-term population ageing, while 8- and higher percentage share of 65-year and older people is the essential criterion to designate a population as ageing. See the following table for the concerned territory population age structure by economic groups during the period from 2008 till 2013.

Table C.II.16: Population age structure on the concerned territory by age groups during the period from 2008 till 2013 (as to 21 December)

Year	Total population [1]	Economic age groups					
		Population by age groups [1]			Structure [%]		
		pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years	pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years
2008	54,067	7,238	38,960	7,869	13.39	72.06	14.55
2009	54,141	7,207	38,915	8,019	13.31	71.88	14.81
2010	54,286	7,234	38,844	8,208	13.33	71.55	15.12
2011	53,282	7,092	37,773	8,417	13.31	70.89	15.80
2012	53,382	7,119	37,609	8,654	13.34	70.45	16.21
2013	53,523	7,208	37,462	8,853	13.47	69.99	16.54

Further Territory

The same population development, i.e., the population ageing, occurred on the further territory during the period from 2008 till 2013. The share of the productive group of men and women was decreasing and the share of the older population group of 65+ years was increasing. At the same time, a slight decrease occurred in the share of children of up to 14 years. The population age structure on the further territory by economic groups during the period from 2008 till 2013 is obvious from the following table.

Table C.II.17: Population age structure on the further territory by economic groups for the period from 2008 till 2013 (as to 31 December)

Year	Total population [1]	Economic age groups					
		Population by age groups [1]			Structure [%]		
		pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years	pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years
2008	439,202	60,966	321,748	56,488	13.88	73.26	12.86
2009	440,108	60,312	322,171	57,625	13.70	73.20	13.09
2010	441,000	60,181	322,178	58,641	13.65	73.06	13.30
2011	436,552	59,876	316,532	60,144	13.72	72.51	13.78
2012	436,903	59,919	315,310	61,674	13.71	72.17	14.12
2013	437,461	60,188	313,430	63,843	13.76	71.65	14.59

Total Territory

During the period from 2008 till 2013, the share of productive group of women and men was decreasing on the total territory and the share of the group of men and women older than 65 years was increasing. At the same time, a slight decrease occurred in the share of children of up to 14 years. The population age structure on the total territory by economic groups during the period from 2008 till 2013 is obvious from the following table.

Table C.II.18: Population age structure on the total territory by economic groups for the period from 2008 till 2013 (as to 31 December)

Year	Total population [1]	Economic age groups					
		Population by age groups [1]			Structure [%]		
		pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years	pre-productive age 0 to 14 years	productive age 15 to 64 years	post-productive age 65+ years
2008	493,269	68,204	360,708	64,357	13.83	73.13	13.05
2009	494,249	67,519	361,086	65,644	13.66	73.06	13.28
2010	495,286	67,415	361,022	66,849	13.61	72.89	13.50
2011	489,834	66,968	354,305	68,561	13.67	72.33	14.00
2012	490,285	67,038	352,919	70,328	13.67	71.98	14.34
2013	490,984	67,396	350,892	72,696	13.73	71.47	14.81

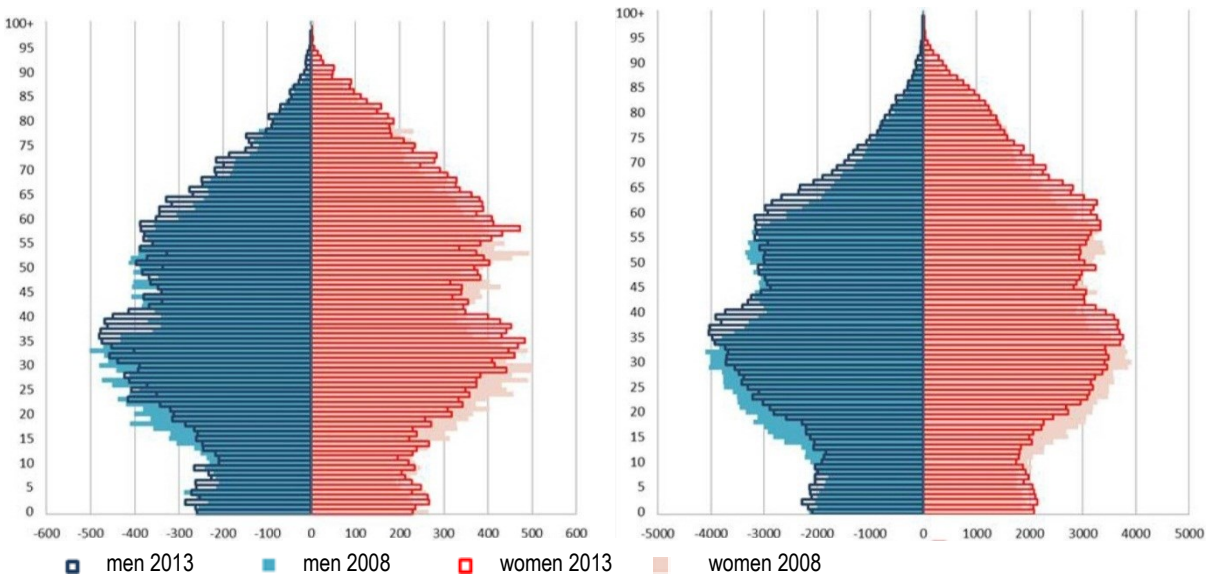
Population Age Structure Development

Based on shares of pre-productive, productive and post-productive age groups, the population development trends on the concerned and further territories document an identical progress of intensive population ageing during the period from 2008 till 2013. The population living in the NJZ area represents a regressive population type where the post-productive component of older citizens prevails over the children, the pre-productive component. The population ageing trend in the NJZ area follows the nationwide population development, the population is ageing on the long-term basis.

The population ageing process is also proved by the Ageing Index expressing the number of persons at the post-productive age (65+ years) accounting for 100 persons at the pre-productive age (0 to 14 years). In the year 2013, the Ageing Index achieved the level of 122.8 % on the concerned territory and 106 % on the further territory. During the period from 2008 till 2013, the Ageing Index was gradually increasing on both the concerned and further territories whereby, on the concerned territory, 109 older persons accounted for 100 children in the year 2008 and 123 older persons in the year 2013 and, on the further territory, 93 older persons accounted for 100 children in the year 2008 and 106 older persons in the year 2013. Pronounced differences in the Ageing Index levels between male and female populations were recorded whereby a higher share of older female population (65+ years) was observed on the concerned territory. In the year 2013, the children's component was prevailing in the male population on both the concerned and further territories.

Population age structures on both the concerned and further territories are presented by gender in the following figures in 2008-to-2013 comparisons.

Figure C.II.24: Age structures on the concerned territory (left) and the further territory (right) in 2008-to-2013 comparison



C.II.11.2. Public health Condition

C.II.11.2.1. Methodological Data

C.II.11.2.1.1. Health Indicators

Public health condition information is processed on principles of health indicator calculations, analyses of their states and trends, broad comparisons with selected areas, surrounding and remote districts, as well as separate comparisons within the residence size. All the health indicators are calculated from databases of deaths, births, abortions and age structures of municipalities within various time spans of years from 1993 till 2012. The evaluation is based on data obtained by means of the Information Service of the Statistical Office of the Slovak Republic (ŠÚ SR). 27 indicators were selected for the evaluation (see the following table) and their complete set describes the population condition from different viewing angles. Thus, it is possible to determine with a certain accuracy how much the relevant indicator is independent in the given place and at the given time, or how much it is affected by other facts (e. g., by the population age structure, site attractiveness or regional conventions).

In principle, the indicators are divided into direct ones describing a particular condition (e. g., the relative death rate (mortality) due to malignant tumours), and auxiliary ones explaining causes that affected the levels of the direct indicators (e. g., the share of older inhabitants).

The Report [John M. Last: A Dictionary of Epidemiology, Oxford University Press, 2001] is used as the basic methodological reference. Other possibly used methodologies (life expectancy calculations and age-standardized indicators) are referred to for individual indicators.

Table C.II.19: List of demographically-health indicators and brief descriptions of their calculation methodologies

Order	Indicator name		Unit	Calculation method	Environment	Social status	Environment attractiveness	Subjective factors	Unaffected indicators
1	Reproductive health	Birth rate	per mille	1,000 x number of children born alive / number of resident inhabitants	X	X	X	X	X
2		Low birth weight children share	percentage	100 x number of children with birth weight up to 2500 g /number of childbirths	X	X		X	
3		Total abortion rate	percentage	100 x number of all kinds of abortion / number of childbirths	X	X		X	
4		Spontaneous abortion rate	percentage	100 x number of spontaneous abortions / (sum of all childbirths and abortions)	X	X		X	
5	Demography	0 to 14 years inhabitants share	percentage	100 x number of children at the age from 0 to 14 years / number of all inhabitants		X	X		X
6		15 to 64 years inhabitants share	percentage	100 x number of inhabitants at the age from 15 to 64 years / number of all inhabitants		X	X		X
7		65 and more years inhabitants share	percentage	100 x number of inhabitants at the age of 65 years and more / number of all inhabitants		X	X		X
8		85 and more years inhabitants share	percentage	100 x number of inhabitants at the age of 85 years and more / number of all inhabitants	X	X			X
9	Life expectancy	Life expectancy on birth	years	Calculation in compliance with a special methodology, counting at the age of 0	X	X			X
10		Life expectancy at the age of 45 years	years	Calculation in compliance with a special methodology, counting at the age from 40 to 49 years	X	X		X	
11		Life expectancy at the age of 65 years	years	Calculation in compliance with a special methodology, counting at the age from 60 to 69 years	X	X		X	
12	Indices	Natural growth index	index	1,000 x (number of children born alive less number of deceased persons) / number of resident inhabitants			X		
13		Total growth index	index	1,000 x (number of inhabitants as to 31.12			X		

Order	Indicator name		Unit	Calculation method	Environment	Social status	Environment attractiveness	Subjective factors	Unaffected indicators
				less number of inhabitants as to 31.12. last year) / number of resident inhabitants					
14		Migration balance index	index	1,000 x (total population growth less natural growth) / number of resident inhabitants			X		
15		Ageing index	percentage	100 x number of inhabitants at the age of 65 years and more / number of children at the age from 0 to 14 years					X
16	General death rate (mortality)	Gross death rate (mortality)	per mille	1,000 x number of deceased persons / number of resident inhabitants	X	X	X	X	
17		Age Standardized Mortality Ratio (SMR)	percentage	Calculation in compliance with a special methodology, all inhabitants, all deceased persons in 10 groups	X	X	X	X	X
18		Premature death share	percentage	100 x number of deceased persons at the age from 1 to 69 years / number of all deaths	X	X	X	X	
19		Potential Years of Life Lost (PYLL) per 100,000 inhabitants	years	100,000 x sum of potential years of life lost for deceased persons within 1 to 69 / number of resident inhabitants	X	X	X	X	
20	Death rate (mortality) causes	Relative death rate (mortality) - C00 to C97	per 100,000	100,000 x number of persons deceased due to mentioned diagnoses / number of resident inhabitants	X	X	X	X	
21		Standardized Mortality Ratio (SMR) C00 to C97	percentage	Calculation in compliance with a special methodology, all inhabitants, all persons deceased due to the given diagnoses	X	X	X	X	X
22		Relative death rate (mortality) - C15-C26	per 100,000	100,000 x number of persons deceased due the given diagnoses / number of resident inhabitants	X	X	X	X	
23		Relative death rate (mortality) - C30-C39	per 100,000	100,000 x number of persons deceased due the given diagnoses / number of resident inhabitants	X	X	X	X	
24		Relative death rate (mortality) - C81-C86	per 100,000	100,000 x number of persons deceased due the given diagnoses / number of resident inhabitants	X	X	X	X	
25		Relative death rate (mortality) - C91 to C95	per 100,000	100,000 x number of persons deceased due the given diagnoses / number of resident inhabitants	X	X	X	X	
26		Relative death rate (mortality) – I00 to I99	per 100,000	100,000 x number of persons deceased due the given diagnoses / number of resident inhabitants	X	X	X	X	
27		Standardized Mortality Ratio (SMR) - I00 to I99	percentage	Calculation in compliance with a special methodology, all inhabitants, all persons deceased due to the given diagnoses	X	X	X	X	X

Causes of deaths are coded in compliance with the International Classification of Diseases (MKCH). C00 to C97 are codes for all malignant tumours, codes C15 to C26 refer to tumours of digestive bodies, codes C30 to C39 are related to tumours of breathing and internal chest bodies, codes C81 to C96 represent tumours of blood production bodies and the lymphatic system, codes C91 to C95 refer to leukaemia. Codes I00 to I99 refer to cardiovascular causes. PYLL means potential years of life lost. SMR stands for the indirectly age standardized mortality ratio.

The indicators that, in compliance with references, are connected with direct actions of the environment are marked in the *Environment* column. Descriptive indicators were exempted from the group expressing population numbers and migration, except for the share of the population at the age of 85 years and more – the high age is directly connected with a quality environment.

The indicators that depend to a larger extent on finance and education are marked in the *Social and economic status* column.

The *Environment attractiveness* criterion is an attempt to distinguish interesting areas. In a certain manner, it is a different expression of the social status. This criterion shows itself, e. g., looking at growth indices.

Subjective factors are the most important and the worst-to-describe factors for the health indicators. The factors may affect health at the most, but they can only be intercepted in the form of variability among areas, or uncertainty in prognoses.

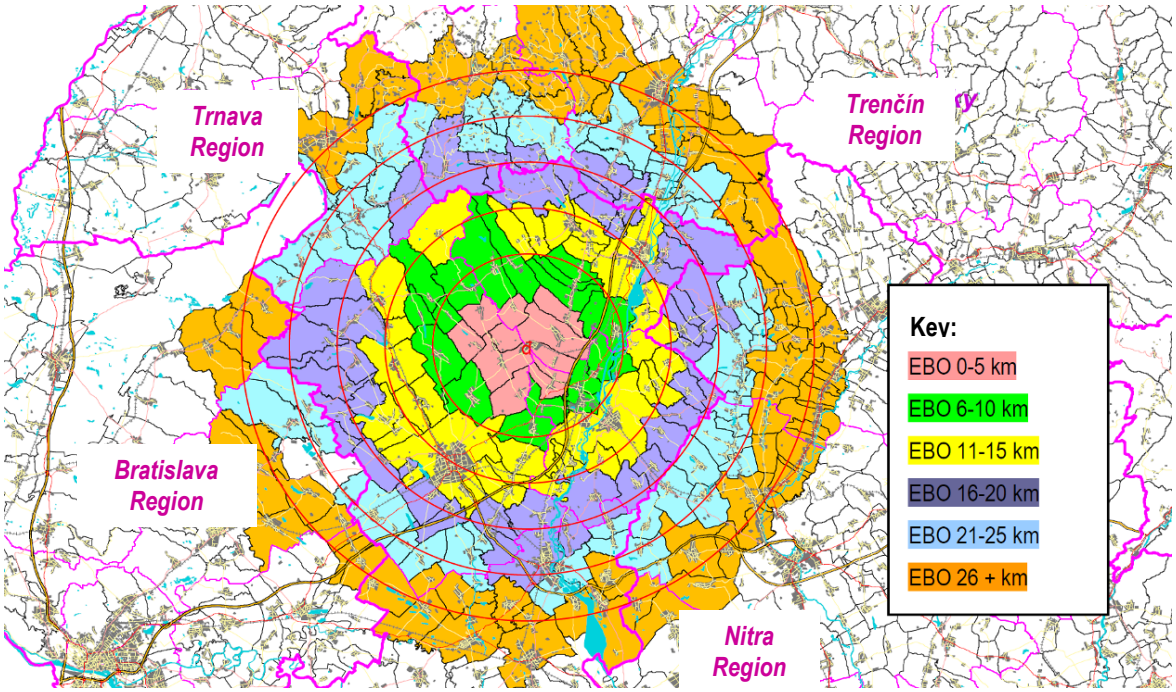
The group designated as *Unaffected by previous factors* includes standardized calculations, age structures and some other basic facts.

All the indicators were subjected to the multidimensional fuzzy c-cluster analysis, looking for similar states and similar trends on the level of 80 %, providing their exact descriptions and associating similar areas to a single cluster. The incorporation into a single cluster is, at the same time, a confirmation of a statistically significant distinction from another cluster. The conjunction of results for individual sites makes it possible to estimate the situation in the EBO surroundings. If the difference between some of EBO sites and the wide surroundings were evidentiary, this would be the reason to consider the possibility of impact on the population and public health due to the construction, operation or decommissioning of facilities in Jaslovské Bohunice.

C.II.11.2.1.2. Assessment Areas

The centre of the EBO site is the basic assessment point. Zones are circumscribed around this centre in intervals of 5 km (as far as the distance of about 30 km) where real cadastral areas of municipalities are found. The classification of the municipality in the relevant distance zone is defined by the fact that the major part of the built-up cadastral area is situated within the given distance.

Figure C.II.25: Classification of municipalities within monitored areas



The numerical state or trend itself identified for one area does not say anything. One does not know whether it is a good or bad state. That is why, all-embracing comparisons within the whole Slovakia from seven points of view were selected. On the whole, Slovakia was divided into 97 separated areas due to seven selection procedures.

Table C.II.20: Selection of territories for separate calculations of indicators

Selection procedure number	Territory selection	Limitation	Selection criterion	Total number of groups in the given area
1	Group of municipalities á 5 km from EBO (or one group of municipalities 0 to 30 km from EBO), see figure above	All municipalities in the selection	Km from the EBO centre: 0 to 5, 6 to 10, 11 to 15, 16 to 20, 21 to 25, 26 to 30 (or 0 to 30 separately in the sum)	6 groups (or 1 group in the sum)
2	Selection of municipalities within a comparative study	Municipalities with up to 5000 inhabitants only	EBO+15 km, Surveillance Group 1, Surveillance Group 2	3 groups
3	Group of municipalities by the number of inhabitants	All municipalities in SR in the selection	Up to 500 inhabitants, 501 to 1000, 1001 to 5000, 5001 to 20000, 20001 to 50000, 50001 and more	7 groups
4	Districts of SR	All municipalities in the selection, except for Bratislava and Košice	All municipalities in individual districts, except for Bratislava and Košice	70 districts
5	Cities of Bratislava and Košice	Those cities only	Sum of districts 101 to 105 and 802 to 805	2 cities
6	Regions of the Slovak Republic	All municipalities in the Slovak Republic by region	Sum of all municipalities in individual regions of SR	8 regions
7	Slovak Republic	None	Sum of all municipalities in the Slovak Republic	1 state

The whole area within 30 km around EBO is included in the form of 'EBO+30 km'. Values identified for Trnava and Nitra regions are attached to this area as a contrast; the prevailing majority of municipalities belong to those regions. The population living on the whole 30-km territory around EBO is very similar to that living in Bratislava. That is why, the city of Bratislava is considered separately in all analyses, too. The nationwide value is referential.

Municipalities are divided into six size groups in compliance with the number of resident inhabitants. Thus, the usual division is reduced in a certain manner in order to imitate the demographical situation around EBO. Municipalities with higher numbers of inhabitants prevail in the EBO surroundings – 14 municipalities (out of the total of 229) with less than 300 inhabitants are situated within 30 km from EBO whereby 13 other municipalities house more than 5,000 inhabitants.

The most detailed analysis is made for the area within 15 km around EBO (EBO+15). All municipalities with more than 5,000 resident inhabitants are excluded from this group of municipalities; the data is taken from average values for the period from 2000 till 2004, i. e., for the central section of the monitored period (1993 till 2012), or, they are directly officially designated as towns. They are towns of Trnava, Hlohovec, Leopoldov, Piešťany and Vrbové. Those towns are only monitored within their 5-km zones and within the whole group of 229 municipalities in the EBO+30 surroundings.

Beside a group of EBO+15 municipalities situated within the distance of 15 km and modified in such a manner, two similar surveillance groups of municipalities are set up that are situated reliably outside the 30-km zone around power plants (i. e., reliably beyond reach of EBO and EMO), but situated in a relative vicinity, in order to maintain, to as large extent as possible, similarities in geological, climatic, demographical and social-economic conditions. They are designated as Surveillance Group (towards Bratislava, in Districts of Pezinok, Senec and Dunajská Streda) and Surveillance Group 2 (towards the border with Hungary, in Districts of Komárno and Nové Zámky).

The total 90 municipalities are considered in the surveillance groups. In order to ensure the comparability, towns are excluded, too (Pezinok, Senec, Ivanka pri Dunaji, Šaľa, Hurbanovo, Kolárovo, Nesvady and Komárno).

C.II.11.2.2. Results of Health Indicators Assessment

C.II.11.2.2.1. Reproductive Health

Four indicators were assessed – the birth rate, the low birth weight children share, the abortion rate and the spontaneous abortion rate. All of them express both the quantity and quality of the latest generation. Those indicators are connected with possible environmental effects, a lower birth rate, more prematurely born children, more abortions and especially more spontaneous abortions are rather expected in a contaminated terrain.

In the monitored years, the average *birth rate* in Slovakia achieved 10.65 children born alive per 1000 inhabitants annually. Year-on-year differences amounted from 9.45 to 13.73. The highest birth rate was in Námestovo District (15.02 to 24.64, the

average being 17.57), the lowest one was in Myjava District (6.72 to 11.30, average of 8.23). A decrease in the birth rate occurred by approximately one third, on the nationwide scale. The EBO+15 km birth rate is similar to that in surrounding areas, it is rather low (7.16 to 12.57, average of 9.22). The highest birth rate, in comparison with a very large area, was achieved in the closest zone within 5 km (EBO+5 km, 10.59). When comparing three territories (EBO+15, Surveillance Group 1 and Surveillance Group 2), the birth rates are almost identical in the long term – 9.16 in Surveillance Group 1 and 9.13 in Surveillance Group 2. There is no difference between them. EBO+30 km area approaches to EBO+15 km values (9.32). In the long term, no impacts of EBO site nuclear facilities on this parameter are monitored, neither as for the state, nor as for the trend.

The *low birth weight children share* (less than 2500 g) in the number of all new-born children is a vicarious term for prematurely born children. The average nationwide value achieved 7.52 % (ranging from 7.04 to 7.91 % annually) in the monitored years. Average values of 5.56 % were achieved within the EBO+30 km area. The lowest values of all the selections and for the whole time period were achieved by the zone within 5 km around EBO (EBO+5 km), namely the average value of 4.16 % (ranging from 1.01 to 5.43 % annually). The highest values were achieved in Gelnica District (10.98 % to 14.76 %, average of 13.25 %). The state is stable on the nationwide scale, there is no significant increase or decrease. The EBO surroundings are in a good state in the long term, values similar to the wide area of the north-western Slovakia are reported, the share of prematurely born children was one of the lowest in Slovakia for the whole time period. Comparisons of the three areas brought similar results. EBO+15 km (4.59 %) and Surveillance Group 1 (5.34 %) are good, while Surveillance Group 2 (8.22 %) is rather worse. EBO cannot be seen on the background of surrounding municipalities at all, the indicator values are excellent, as well as in the whole surroundings. Prematurely born children are not a problem of the western Slovakia. No negative impact of EBO site nuclear facilities on this parameter exists.

The *abortion rate* amounted on an average to 45.79 % of abortions nationwide in the monitored years (annually 32.96 % to 62.18 %). The lowest values were registered in Námestovo District (12.15 % to 17.45 %, average of 14.51 %), the highest ones in Banská Bystrica District (42.32 % to 107.94 %, average of 70.25 %). A substantial decrease of values in time was registered as low as less than a half of the initial level. This indicator is very fluctuating and highly variable, from both the territorial and time points of view. EBO+15 km area is conspicuous, it is classified in the cluster with a long-term low abortion rate of 29.10 % which is not usual in the given locality. The situation in EBO+5 km area is equally good (29.27 %). Further areas beyond 25 km are the same as their surrounding districts. EBO+30 km area shows the value of 44.41 % and approaches the nationwide average value. Comparisons of the three areas were clearly in favour of EBO+15 km. Both the surveillance groups show higher values – Surveillance Group 1: 41.11 % and Surveillance Group 2: 57.81 %. No negative impact of EBO on the abortion rate can be identified.

The *spontaneous abortion rate* achieved on an average 6.28 % of spontaneous abortions out of all conceptions nationwide in the monitored years (annually 5.62 % to 6.84 %). The best result was achieved by Piešťany District closely followed by EBO+5 km showing an average of 2.99 %. The worst situation was identified in Levoča District reporting the average of 9.84 %. The EBO surroundings along with Piešťany District (the whole district belongs there) are the best in Slovakia in the long-term. The lowest share of spontaneous abortions appears there. The compared areas are different from each other. EBO+15 km is classified in an exclusively low (good) cluster (4.21 %), as well as Surveillance Group 1 (4.68 %). Surveillance Group 2 is classified in a higher – worse – cluster (6.22 %). EBO+30 km shows on an average 5.46 % of spontaneous abortions. No negative impact of EBO on the spontaneous abortion rate can be identified.

None of the four analysed birth rate and abortion rate indicators was not, and is not either, damaged by the existence of nuclear facilities on the EBO site. Whatever distance they are viewed from, the whole EBO surroundings are either the same as a wide area, or better, or even (as for the especially sensitive spontaneous abortion rate) the best in Slovakia.

C.II.11.2.2.2. Demography

At present, Slovakia recognizes the division into the pre-productive age from 0 to 14 years, productive age from 15 to 64 years and post-productive, or older, age from 65 years One more age category was introduced for the purposes of the present assessment, i. e., 85 years and more, as a longevity indicator, i. e., a population and environment quality indicator. Shares of population at certain ages were calculated as a simple percentage of the whole population. The first three components make up 100 %, the age category of 85+ is in addition to 100 % (it is a share of the whole only).

The average share of children at the age from 0 to 14 years was 18.39 % of the whole population of Slovakia in the period from 1993 till 2012. The trend was clearly decreasing, but approximately in the year 2008 it stopped and has been stagnating since. The EBO surroundings are similar to the surveillance group (16.84 % for EBO+15 km, 17.87 % for

Surveillance Group 1 and 16.00 % for Surveillance Group 2). EBO+30 km (16.82 %) is very similar to EBO+15 km. There are more children within the distance of 5 km from EBO (18.60 %) than in further areas.

The number of inhabitants at the productive age (from 15 to 64 years) had been increasing in Slovakia till 2008. A stagnation or even decrease has occurred approximately since 2008. The average percentage of population at the age from 15 to 64 years is 69.94 % in Slovakia. The trend of the productive population share in the EBO surroundings was increasing, as well as in the widespread area of the whole western half of Slovakia. The average percentage of population at the age from 15 to 64 years is 71.35 % in the EBO+15 km area. During recent years, it has already begun to stagnate or decrease. EBO+15 km is similar to its surveillance groups – the average percentage of the mentioned population is 71.62 % for Surveillance Group 1 and 70.412 % for Surveillance Group 2. In case of EBO+5 km, the percentage representation of the population at the age from 15 to 64 years is slightly lower than in the surroundings and the whole Slovak Republic, the average being 68.5%, in case of EBO+30 km, it is the other way round, i. e., the average value is 70.56 %.

The share of older persons (65 and more years) is systematically increasing throughout the republic. The state is not balanced in the republic. The share of older persons is higher in the south of the republic, and lower in the eastern Slovakia, in Orava region and within the wider surroundings of Bratislava. The nationwide average of the population structure achieved 11.67 % in this age group. The EBO surrounding territory is situated partially in the historically higher older people share area and partially, towards Bratislava, in the lower share area. The average share of older persons achieved 11.83 % in the EBO+15 km area and even 12.90 % in the EBO+5 km area. As for the EBO+30 km area, the share of older persons achieved 12.62 %. There are differences between surveillance groups: Surveillance Group 1 shows a lower share of 10.44 %, while, on the contrary, Surveillance Group 2 shows a higher share of 13.61 %.

The share of old persons (85 years and older) is systematically increasing throughout the republic. The 20-year average was 0.92 % of the whole population. The state is not balanced in the republic. The share of old persons is higher in the south of the republic. The share is lower in the eastern Slovakia, in Orava region and within the wider surroundings of Bratislava. The EBO surrounding territory is situated partially in the historically higher old people share area and partially, towards Bratislava, in the lower share area with the average value of 1.19 %. In case of this indicator, EBO+15 km area is found between its surveillance groups. Surveillance Group 1 shows a lower percentage of old persons (0.79 %), while, on the contrary, Surveillance Group shows a higher percentage of old persons (1.23 %). There is the same trend in the EBO+5 km area as in the EBO+15 km area. The average share of old persons achieved 1.15 % in that area. The share of old persons in the EBO+30 km area (1.02 %) approaches the nationwide average value.

C.II.11.2.2.3. Life Expectancy

Life expectancy values were calculated from shortened life tables, they are uniform for both the genders. Three age periods were evaluated separately on the basis of that calculation – the life expectancy on birth, the life expectancy at the age of 45 years and the life expectancy at the age of 65 years.

The whole Slovakia is markedly divided along the North-South line. Higher expectancies and the fastest increase are present in the northern half whereby lower values and more slowly increasing trends exist in the southern half. This division is narrowed in compliance with the age progression. On the whole, the territorial age difference is quite small. The difference between the states is approximately 2 % on birth, approximately 4 % at the age of 45 years and 5.5 % at the age of 65 years.

The *life expectancy on birth:* the 16-year nationwide average value achieved 73.55 years. The analysis indicated two clusters, the northern half of Slovakia is better in the long term whereby the southern half is worse. Both the states show increasing trends. The whole EBO+30 km surroundings have a steadily higher expectancy of 74.08 years. The EBO+15 km area is classified in a well-defined low cluster with a high expectancy (74.32 years), as well as EBO+5 km (74.68 years) and EBO+30 km areas (74.08 years). Both the surveillance groups are classified in a worse cluster (lower expectancy) – 72.99 years for Surveillance Group 1 and 72.27 years for Surveillance Group 2. The theoretical life span is not shortened by the existence of EBO, in no case a shorter life is expected in that area.

The *life expectancy at the age of 45 years:* Slovakia is divided very clearly into a worse South and a better North again, but the worse part is already more extensive and is closer to the EBO site. The whole Slovakia shows a value in between (34.36 years, i. e., 45+34.36 = 79.36 years). The lowest life expectancy was identified in Krupina in the year 1998 (30.51 years), the highest one was identified in Bratislava in the year 1998 (45.78 years), i. e., the range of expectancies was from 75.51 to 90.78 years. The surroundings of EBO+15 km (35.65 years) and EBO+30 km (34.49 years) are in the good half, above the nationwide average value. EBO+5 km shows even a higher life expectancy (36.11 years). Both the

surveillance groups brought slightly worse results (34.72 years for Surveillance Group 1 and 33.89 years for Surveillance Group 2). The existence of EBO does not reduce the theoretical life span of markedly adult people either.

The *life expectancy at the age of 90 years:* At the age of 65 years, the Slovak population is in for approximately 20 more years of life, with small regional variations of up to 5 %. There are two clear halves – the northern and the southern one – in Slovakia again, the southern half being worse. The boundary of the worse state partially interferes with sites in the EBO surroundings (EBO 16 to 20 km). Average life expectancy results for EBO+15 km are 19.09 years, 19.07 years for EBO+5 km and 18.94 years for EBO+30 km surroundings. Surveillance Group 1 shows the value of 18.40 years, Surveillance Group 2 achieved the average value of 18.13 years. Even almost the whole life spent in the neighbourhood of EBO is not shortened, but it is either the same as in the wide surroundings, or longer.

C.II.11.2.2.4. Indices

Indices represent an expansion of the section on demography and life expectancy. 4 indices are introduced here characterizing the territory.

The *natural growth index* reflects a natural growth of the population without considering any migration. It is calculated as thousand times the number of children born alive less the number of deceased persons divided by the number of resident inhabitants. The result should indicate whether the municipality is growing or declining. This analysis represents a partial problem in the EBO surroundings (but also in other quickly developing industrial areas) – a municipality appears as dying out, because, actually, more people die than are born there. However, the municipality is markedly growing, people move there along with already born children that theoretically supported the growth somewhere else. The whole republic indicates a zero or rather decreasing character (0.90), the population is neither increasing, nor decreasing. Values around zero are also indicated by EBO+5 km (0.1), EBO+15 km (-1.30), EBO+30 km (-0.95), Surveillance Group 1 (-0.03) and Surveillance Group 2 (-4.17) and are below the nationwide state. However, Surveillance Group 1 (Pezinok – Senec surroundings) has already began to grow rapidly, when Bratislava expanded so much that even those distances began to be attractive.

The *total growth index* takes migration into account. Migration is quite high in some areas, it exceeds markedly the natural population growth. It is calculated as thousand times the number of inhabitants as to 31 December less the number of inhabitants as to 31 December of the preceding year divided by the number of resident inhabitants. If the natural population growth is stable or decreasing and, at the same time, the total population growth is increasing, new inhabitants are moving to the municipality. The EBO surroundings are systematically growing rather due to migration than due to childbirths. This analysis also shows that the closest EBO surroundings are attractive for people. There is a high total population growth within the distance of 10 km. At the same time, the natural population growth is low, people were moving there on a target. The total population growth index achieved 6.28 for EBO+5 km, 0.22 for EBO+30 km. EBO+15 km (-1.27) and Surveillance Group 2 (-1.56) are below the average nationwide state (0.86). Surveillance Group 2 (Pezinok - Senec surroundings, the average of 6.82) has already began to grow rapidly, when Bratislava expanded so much that even those distances began to be attractive.

The *migration balance index* is a representation of the total population growth taking migration into account. It is calculated as thousand times the total population growth less the natural growth divided by the number of resident inhabitants. Territories achieving a positive index are those where people are moving in. The other way round, territories with a negative index are those where people are moving from. The 16-year nationwide average value was 0.56. The following areas show a high migration balance index: the wide area around Bratislava, the whole area situated along the Danube River, Turčianske Teplice District, Košice Vidiek District and, quite obviously, a relatively large area around EBO, too. This has not been any systematic trend, changes and temporary stops of the expansion occurred. The closest EBO surroundings within the distance from 0 to 10 km are experiencing a systematic population influx whereby inhabitants are leaving areas at the distance from 11 to 15 km. The EBO+5 km area achieved the value of 6.27, while the EBO+15 km area is on the level of -1.47. The average value for the whole EBO+30 km area is favourable (1.16). Any moving was markedly reduced by the 2008 crisis. People obviously come to the EBO surroundings especially to find work, or possibly, some housing in the countryside. This is evident from the fact that while people are moving to areas at the distance from 0 to 10 km from EBO, other people are leaving areas at the distance from 11 to 15 km which would indicate that people are leaving Trnava town for the countryside and are not disturbed by the nearby nuclear power plant. Both the surveillance groups are above the nationwide state, as well as above the EBO+15 km state. In case of Surveillance Group 1, the migration balance index shows the attractiveness of the area (5.72). Surveillance Group 2 is also above the nationwide average and achieved 1.61.

The *ageing index* is a synthetic indicator providing the ratio of children at the age from 0 to 14 years and older persons at the age of 65 years and more. Its result is expressed in percentage. If its value is 100 %, numbers of both the age groups are the same. If it is lower than 100 %, more young people are present than old ones and vice versa. The nationwide index achieved the value of 63.48 %, EBO+15 km achieved 70.27 % and EBO+30 km even 75.04 %. All 97 monitored units have grown old, Slovakia itself by 1.9-multiple. The whole EBO surroundings are growing old relatively rapidly, the territory within 5 km is an exception again, the number of children is higher and the ageing index is lower (69.6 %) there.

C.II.11.2.2.5. General Death Rate (Mortality)

Four indicators were assessed – gross death rate (mortality), indirectly standardized mortality ratio (SMR), premature death share and Potential Years of Life Lost (PYLL) per 100,000 inhabitants.

As for both the gross death rate and indirectly standardized mortality ratio, Slovakia is divided into the better north and worse south. Both the gross death rate and age standardized mortality ratio, as well as PYLL number, are lower in the northern half. Neither the gross death rate, nor the age standardized mortality ratio have increasing trends, they remain on similar values for the whole 16 years. Both the premature death share and PYLL are decreasing within units of per cent. Both the EBO surroundings within 15 km and within 30 km are the same as the wider area or better. They were worse in **no** indicator, no indicator shows any negative impact of EBO.

The *gross death rate (mortality):* The indicator depends on the age of the population. It is calculated as a simple number of deaths per 1000 inhabitants of the given population per a unit of time, usually per year. Neither the age, nor the gender of deceased persons is taken into consideration. Thus, this gives advantage to 'older' areas or areas with lower numbers of children. That is why, this indicator should always be interconnected with the age structure analysis, or possibly be assessed in a pair with the age standardized mortality ratio. The average 16-year value of Slovakia as a whole equals to 9.82. The nationwide trend is neutral, it is neither increasing, nor decreasing. During the analysed 16 years, the minimum value of the indicator was achieved in Tvrdošín District (average of 6.68), while the maximum value shows Medzilaborce District (average of 13.23). The nationwide span is more than a multiple of 2. The EBO+15 km area indicates the average value of 10.06 for the whole time period, EBO+5 km shows 10.49 and the whole EBO+30 km 10.1 deaths per 1000 inhabitants annually. The EBO+15 km area shows a higher death rate than Surveillance Group 1 (8.88), but it is lower than that of Surveillance Group 2 (14.04).

The *SMR – indirectly age standardized mortality ratio:* The indicator is an indispensable complement to the gross death rate. Its principle eliminates the age of the population and takes the death age into consideration. The nationwide state is 100 % for the whole time period, regardless of real values. Other areas are calculated as a percentage ratio. There is a north-to-south polarization into the better north and the worse south which confirms the nationwide division in relation to the gross death rate. For the whole time period, the highest state has been in Krupina District where it exceeded the nationwide level on an average by 23 %, with the top in the year 2002 – by 36 %, while the lowest state was recorded in the city of Bratislava (83.51 %). The minimum state was achieved in the EBO+5 km area (72.24 %) in the year 1997. The EBO surroundings within 15 km slightly improve the position of the territory and are definitely good with a low state. The average 16-year value achieved 97.52 % in the EBO+15 km area and 97.88 % in the EBO+30 km area, i. e., both the areas were below the standard value that means better. The comparative surveillance groups are demonstrably worse. Surveillance Group 1 achieved the value of 105.94 % and Surveillance Group 2 achieved 109.76%. The EBO existence does not affect the standardized general mortality ratio negatively.

The *premature death rate:* Premature deaths are a marked indicator of environmental effects. For the purpose of premature death rate assessment, the value of 70 years is selected as a limit. Children of up to 1 year of age are not included in the premature death calculations. It is supposed that a death within the first year of life is probably a termination of progress of a complicated degree of a development malfunction incompatible with life in our geographical conditions. No previous division into a better and worse half of the Slovak Republic can be seen here. The premature death rate percentage is spatially similar throughout Slovakia in the long term. The only continuous broader strip of a good state stretches from the North to the South and includes wide surroundings of both the nuclear power plants, Bohunice and Mochovce The average premature death rate percentage was 41.62 % in Slovakia, it was decreasing from 45 % (1993) to 39.95 % in the year 2008. The EBO+30 km site showed an average percentage of 39.93 % and it was decreasing from 43 % to 37 %. The EBO+5 km site brought even better results, the premature death rate was only 35.96 % there. The EBO+15 km site was the best in comparison with its surveillance groups, it indicated an average percentage of 38.41 %, while Surveillance Group 1

achieved 45.18 % and Surveillance Group 2 41.63 %. The EBO existence does not have any negative impact on the premature death rate level.

The premature death rate expressed by means of PYLL - Potential Years of Life Lost: This indicator reflects the timeliness of premature deaths. A simple percentage only registers the fact that it happened, while PYLL expresses, in the mediated manner, how much sooner the premature deaths happened. The Slovak Republic is divided into two parts – to northern and the southern one – while the south is worse and the north is better. The average number of PYLL per 100,000 inhabitants in Slovakia was 5,655 for 16 years, with the minimum of 2,953 in the EBO surroundings within 5 km and with the maximum of 8,121 in Brezno District in the year 1993. PYLL indicator is usually also calculated per a single premature death and then the dispersion of the minimum average age on death ranges from 53.17 years (Kežmarok District) to 57.68 years (EBO+5 km surroundings). The EBO+15 km area belongs to the better part in the long term (5,503 years), and it remains in that part even in comparison with its surveillance groups that are demonstrably worse (Surveillance Group 1 – 6,450 years, Surveillance Group 2 – 7,171 years). The PYLL indicator value of 5,449 was achieved in the EBO+30 km area, i. e., it was better than in the Slovak Republic. The EBO surroundings are in a good state, with an extremely good state within the closest distance; the PYLL value was very low (4,663 years) in the EBO+5 km area.

C.II.11.2.2.6. Death Rate Causes

Causes of deaths are coded in the same manner as diseases using the International Classification of Diseases (MKCH). During the analysed time period, two revisions were in force. Since the year 1994, Revision 10 has been in force in Slovakia, however, the year 1993 was covered by Revision 9. It can be seen from databases that the change was not implemented in a uniform manner in all regions. That is why, e. g., it is only possible to assess leukaemia since the year 1995, the preceding years are not uniform.

Two spheres were selected for the analyses – malignant tumours as a methodically standard basis for each nuclear facility, and cardiovascular causes that are a replacement diagnosis for all uncertainties. Those two groups are closely connected with each other and they complement each other. The following death causes are monitored:

The whole group of malignant tumours coded C00 to C97 as a relative value, as well as an indirectly age standardized value. The following tumours are assessed separately out of the whole group:

- malignant tumours of digestive bodies (codes C15 to C26),
- malignant tumours od breathing and intra-chest bodies (C30 to C39),
- malignant tumours of blood production bodies and the lymphatic system (C81 to C96),
- leukaemia (C91 to C95).

The whole group of circulation system diseases (cardiovascular diseases), coded I00 to I99; they are both relatively and indirectly age standardized as SMR, too.

The *malignant tumours death rate (C00 to C97):* Malignant tumours are the second most frequent cause of deaths in Slovakia after cardiovascular diseases, and the markedly first cause that is usually and generally connected with environmental effects. All deaths due to diagnoses C00 to C97 in compliance with MKCH, Revision 10 (or 140 to 208, in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis. The basic relative rate of death due to malignant tumours is processed as a number of deaths due to malignant tumours in the given population per 100,000 of its members per one calendar year. Neither the age, nor the gender of the deceased persons are monitored. During last 16 years, the average mortality due to malignant tumours was 213.82 deaths per 100,000 inhabitants per one calendar year in Slovakia. The value is increasing proportionally to the population ageing, approximately by 1 case per 100,000 inhabitants per year. However, considering the age of the population, the increase disappears, there is no trend and the whole Slovakia also appears similar. It can be stated that the death rate due to tumours is copying the population age structure, results in no special situations anywhere and is, basically, not increasing.

The state in the EBO surroundings looks similar and does not differ from surrounding areas. If the EBO+15 km area (259.44 cases) is compared with Surveillance Groups 1 and 2 (236.82 cases for Surveillance Group 1, or 289.74 cases for Surveillance Group 2), EBO is found between them from the relative death rate point of view (Surveillance Group 1 is better and Surveillance Group 2 is worse). The value for the EBO+5 km area is also similar to the EBO+15 km area (255.44 cases), the EBO+30 km area is slightly better (234.61 cases). All the compared territories together are included in the worse (higher) cluster, as compared with the nationwide trend. This problem is obviously stronger than any local

environmental effects and it cannot be related to power plants. It is not possible to trace the impact of the operation history on this health indicator.

The i*ndirectly age standardized mortality ratio due to malignant tumours (SMR C00 to C97):* It is a complement to the relative death rate due to malignant tumours. The age on death is slightly considered. The Slovak Republic as a whole was taken as a standard. Slovakia, as a standard, achieves the value of 100 % every year, regardless of what absolute values are processed. The studied population is either relatively better than Slovakia (it is below 100 % then), or it is worse (more than 100 %). Ten age groups were used. Comparisons are made whether the studied population is dying out due to malignant tumours in the same age ratio as the standard population. The calculation methodology in compliance with [Epidemiology, The Logic of Modern Medicine, Milos Jenicek, Montreal, Epimed, 1995] was applied. In case of a too small population, some age groups are not filled up and the result is often not reliable. This results in great year-on-year fluctuations even for quite a large population. The fuzzy cluster analysis did not come to a solid result for this indicator, more or less, it dealt with the whole Slovakia as similar, whatever division was taken into account. Local year-on-year fluctuations are great, trends are chaotic. It definitely cannot be said that numbers of malignant tumours are growing, though only somewhere, if they are assessed from the age of the deceased point of view. Numbers of deaths are increasing proportionally to the population ageing. The smaller territory is studied, the less reliable the result is. Considering the age on death, the whole Slovakia is almost the same, both in the state and in the trend. It can be concluded that in case of the age standardization of death rate due to malignant tumours, a long-term balanced stability exists in Slovakia, without any clearly changed territories.

All three surveillance areas (EBO+15 km, Surveillance Groups 1 and 2) show a higher age standardized mortality ratio due to malignant tumours, i. e., above 100 %. All of them were classified as indistinct, rather worse than better. Values in all of them exceed the Slovak standard. The same situation also exists in the EBO+5 km area (110.3 %). This state has a more extensive coverage than the monitored areas, a similar state exists in all surrounding districts. The EBO+15 km surroundings have a lower age standardized mortality ratio due to malignant tumours (105.71 %) than the surveillance areas (107.66 % for Surveillance Group 1 and 109.74 % for Surveillance Group 2). The EBO+30 km area is the best of all the compared areas (103.37 %), however, this value is still above the nationwide average. The lowest age standardized mortality ratio was identified in large towns, it is so-so in small municipalities and it is high in medium-size municipalities.

The *relative death rate due to malignant tumours of digestive bodies (C15 to C26):* The basic relative death rate due to malignant tumours of digestive bodies is processed as a sum of deaths due to these malignant tumours in the given population per 100,000 of its members and per one calendar year. Neither the age, nor the gender of the deceased persons is considered. All deaths due to diagnoses C15 to C26 in compliance with MKCH, Revision 10 (or 150 to 159 in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis.

The territory of Slovakia is quite polarized and differences are relatively great. The 16-year nationwide calculation brought the result – 76.59 deaths per 100,000 inhabitants per year. 65,980 inhabitants died of this kind of tumours in Slovakia for this time period (approximately 4,124 annually). The nationwide trends are systematically decreasing. The EBO surroundings belong to the worse cluster, except for annular areas with towns of Trnava, Piešťany, Hlohovec and Vrbové which are 'good'.

The whole EBO+15 km area along with the surveillance groups are localized on a continuous territory with a worse state. RBO+15 km shows a higher relative frequency than Surveillance Group 1 and a lower one than Surveillance Group 2. The values are as follows: EBO+15 km – 94.95 deaths per 100,000 inhabitants annually, Surveillance Group 1 achieved on an average 81.12 deaths per 100,000 inhabitants annually and Surveillance Group 2 showed 110.87 deaths per 100,000 inhabitants annually. The EBO+5 km area indicated an average relative death rate of 100.86 deaths per 100,000 inhabitants annually, while the EBO+30 km area showed 85.71 deaths per 100,000 inhabitants annually. All small Slovak municipalities are included in the worse cluster, it is a problem of the countryside, or rather a problem of age and, globally, of the whole Trnava and Nitra Self-Governing Regions where the EBO area belongs territorially. Malignant tumours of digestive bodies are a domain of small municipalities in Slovakia. Their rate of occurrence in the small municipalities is as much as by 60 % higher than in greater towns.

The *relative death rate due to malignant tumours of breathing and intra-chest bodies (C30 to C39):* The basic relative death rate due to malignant tumours of breathing and intra-chest bodies is calculated as a number of deaths due to these malignant tumours in the given population per 100,000 of its members per one calendar year. Neither the age, nor the gender of the deceased persons is considered. All deaths due to diagnoses C30 to C39 in compliance with MKCH, Revision

10 (or 160 to 165 in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis.

The 16-year nationwide calculation brought the result – 44.7 deaths per 100,000 inhabitants per year. 38,505 inhabitants died of this kind of tumours in Slovakia for this time period (approximately 2,400 annually). Approximately the same holds true that was said about the age standardized mortality rate, there are no markedly different areas in Slovakia. All areas in Slovakia are rather similar and it seems that this kind of tumours is retreating nationwide. The EBO+30 km area indicated 48.53 deaths per 100,000 inhabitants annually. The best state was recorded in the EBO+5 km circle where the value has approached the nationwide average value (46.71 deaths per 100,000 inhabitants annually for C30-C39).

In case of the EBO+5 km area, it was identified how much one-year data is changing in both the absolute and relative versions if a small number of people is analysed. 11,000 people lived on an average in that territory and the number of deaths due to lung cancer was 2 to 9 cases annually. The values mean relatively 18.46 - 89.48 cases per 100,000 inhabitants. It is a very unstable piece of data without any statistical classification. It is only areas 11 to 15 and the whole EBO area that are sufficiently large for stable trends.

Comparisons of the three areas showed no differences. All three areas (EBO+15 km: 54.22 deaths, Surveillance Group 1: 54.16 deaths, Surveillance Groups 2: 62.35 deaths per 100,000 inhabitants annually) are similar to each other, all of them overreach the worse cluster in the final sum. After all, just as in case of the wide surroundings, it is not a problem of EBO, all the small Slovak municipalities are included in the worse cluster, it is a problem of the countryside, or rather of the age.

The *relative death rate due to malignant tumours of the lymphatic, blood production and related tissues (C81 to C96):* Two views of leukaemia were included in the analysis – both the whole group C81 to C96 and as subgroup C91 to C95. Thus, two indicators were analysed at the same time. Too variable results were obtained from separate analyses of each indicator apart. Comparisons of the two indicators only brought a clearer view of the areas where those diseases are more frequent and where they are less frequent.

The basic relative death rate due to malignant tumours of the lymphatic, blood production and related tissues (C81 to C96) is calculated as a number of deaths due to these malignant tumours in the given population per 100,000 of its members per one calendar year. Neither the age, nor the gender of the deceased persons is considered. All deaths due to diagnoses C81 to C96 in compliance with MKCH, Revision 10 (or 200 to 208 in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis. Everything in this selection that is related to blood and lymph is included in the calculations. Both blood and lymph should be sensitive to the ionizing radiation.

The 16-year nationwide calculation brought the result – 13.17 deaths per 100,000 inhabitants per year. 11,341 inhabitants died of this kind of tumours in Slovakia for this time period (514 to 763 annually). All areas in Slovakia are analytically similar, everything is variable and the trend is fractionalized. Neither the EBO surroundings, nor their surveillance areas are beside this unclear classification. It cannot be spoken about any describable territorial differences. Everything is similar, without any increasing tendencies, with great year-on-year fluctuations. Small numbers are in question.

For the EBO 0-to-5 km area, the one-year data is very variable, both in the absolute and relative versions, if small numbers of people are available. 11,000 people used to live on this territory on an average, the number of deaths due to the flood production system cancer ranged from 0 to 5 cases a year, while three 'zero years' occurred. This means relatively 0.00 to 48.69 cases per 100,000 inhabitants. It is a very unstable piece of data, without any statistical classification. The whole time period is only interesting where it can be stated that the 16-year calculation result is 18 deaths per 100,000 inhabitants for the EBO+5 km area annually. The situation in the EBO+30 km area is similar to the whole Slovakia – 14.24 deaths due to the mentioned diagnoses per 100,000 inhabitants annually.

Comparisons of areas brought no differences. All three areas are similar to each other, all of them overreach the worse cluster in the final sum. Considering the 16-year sum, the EBO+15km area (15.43 deaths due to the mentioned diagnoses per 100,000 inhabitants annually) ranks in the middle between the surveillance groups: Surveillance Group 1 showed 14.24 and Surveillance Group 2 - 16.02 cases per 100,000 inhabitants annually. Again, the whole wide surroundings are

similar, it is not a problem of EBO, but of the countryside itself. No extraordinary situation has developed in the EBO surroundings.

The relative death rate due to leukaemia (C91 to C95) is calculated as a sum of deaths due to those malignant tumours in the given population per 10,000 of its members per one calendar year. Neither the age, nor the gender of the deceased persons is considered. All deaths due to diagnoses C91 to C95 in compliance with MKCH, Revision 10 (or 200 to 208 in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis. In this case, all the analyses begin with the year 1995, because years 1993 and 1994 are distinctively marked by the recoding of the catalogue of diseases.

This only kind of malignant proliferation is directly connected with the leukaemia. The 14-year nationwide calculation brought the result of 2.91 deaths due to the given diagnoses per 100,000 inhabitants annually. 2,196 inhabitants died in Slovakia due to this kind of tumours for this time period (137 to 184 annually). The diagnosis is rare, few cases are available for analytical solutions even nationwide. The whole Slovakia is similar in its variability, neither territorial, nor time excesses occurred anywhere. It was even impossible to factorize the territory into various clusters and assessments are similar everywhere from both the state and trend points of view. Both the EBO surroundings and their surveillance areas are a part of this unclear classification. Everything is similar and without any increasing tendencies, with great year-on-year fluctuations. In this case, even 5 cases mean a great fluctuation. The EBO+30 km area indicated 3.15 deaths due to the mentioned diagnoses per 100,000 inhabitants annually. In case of the EBO+5 km area, the one-year data is very variable in both the absolute and relative versions if a small number of people is analysed. 11,000 people lived on an average in that territory and the number of deaths due to leukaemia was only 4 cases for all those years, while eleven 'zero years' occurred. The values mean relatively 0.00 to 18.84 cases per 100,000 inhabitants. When comparing the relative situations, the 14-year calculation for the EBO+5 km area (2.71 deaths per 100,000 inhabitants annually) turned out to be better than the nationwide state.

Comparisons of the areas (EBO+15 km, Surveillance Groups 1 and 2) showed no differences. The death rate achieved 3.17 cases per 100,000 inhabitants annually for EBO+15 km, 2.91 cases for Surveillance Group 1 and 3.86 cases for Surveillance Group 2. All three areas are similar to each other, all of them overreach the worse cluster in the final sum. The 14-year projection shows that the EBO+15 km area ranks in the middle between the surveillance groups. Surveillance Group 2 (Komárno surroundings) where there is no special industry, not even nuclear, is the worst.

Deaths of leukaemia, death age assessments: Numbers of inhabitants in age groups by five years are the basis, while the first five-year group is divided into two subgroups – children at the age of zero, i.e., up to one year, and children at the age from one to four years. It was only the sum that was analysed, because there are few leukaemia cases, fortunately, and one-year analyses are chaotic. Relative values bring a zero in one year, while a high figure in another, and neither of them means anything but using small numbers. If, however, the mortality due to leukaemia is assessed according to the age, a new point of view is obtained. The mortality begins to increase sharply at the age of approximately 50 years and it achieves even 9 times the average value. This disease is a problem of old people with the maximum at the age of 80 years and more. There are two maximum values for the EBO+15 km area, at the age from 70 to 74 years and then at the age from 80 to 84 years.

The relative death rate due to cardiovascular causes (I00 to I99): The basic relative death rate due to circulation system diseases, or cardiovascular causes, is calculated as a sum of deaths due to those reasons in the given population per 100,000 of its members per one calendar year. Neither the age, nor the gender of the deceased persons is considered. All deaths due to diagnoses I00 to I99 in compliance with MKCH, Revision 10 (or 390 to 459 in compliance with Revision 9) that were recorded in Slovakia by the Statistical Office of the Slovak Republic during the period from 1993 till 2008 were included in the analysis. This kind of death causes is the most frequent one in Slovakia in the long term. It is usually closely connected with the age.

The 16-year nationwide calculation brought the result – 530.29 deaths per 100,000 inhabitants per year. 456,782 inhabitants died of cardiovascular causes in Slovakia for this time period (27,096 to 29,729 annually. The nationwide trends are slightly decreasing.

The EBO surroundings belong to the worse, or possibly to the rather worse cluster, except for the annular area including towns of Trnava, Piešťany, Hlohovec and Vrbové where the situation is good. The EBO+30 km area indicated 553.60 deaths per 100,000 inhabitants annually. As compared with the surveillance groups, the EBO+15 km area is in the middle (618.86 deaths per 100,000 inhabitants annually), i. e., its relative death rate is higher than in Surveillance Group 1 (559.78 deaths) and lower than in Surveillance Group 2 (742.79 deaths). Both the EBO+15 km area and Surveillance Group 2 are classified in the worse cluster, the Senec surroundings are classified as indistinct, rather good. The EBO+5 km area is also classified in the worse cluster (592 deaths per 100,000 inhabitants annually). All small Slovak municipalities are classified in the worse cluster, it is a marked problem of the countryside. It is likely that those disproportions are connected with the age structure. Small municipalities are generally older and the share of children is lower there. Comparisons of relative mortality due to cardiovascular causes by the municipality size are actually significant. They give the greatest difference among individual indicators. The small municipalities show more than twice the mortality of larger towns.

This indicator is extraordinarily bound to the age. Thanks to this fact, it is only an informative indicator, auxiliary to the gross death rate it copies.

The *indirectly age standardized mortality due to cardiovascular causes (SMR I00 to I99):* The calculation methodology in compliance with [Epidemiology, The Logic of Modern Medicine, Milos Jenicek, Montreal, Epimed, 1995] was applied. The age standardization reduces differences among sites caused by ratios of age groups within the population. It assigns a higher weight to deaths at younger ages and slightly reduces the significance of higher ages.

On the basis of the applied methodology, the monitored site is compared with Slovakia as a standard, while Slovakia represents 100 % every year. Other areas are expressed as percentage of the nationwide state.

The whole south of Slovakia indicates a high state, Záhorie, Orava and Kysuce areas, as well. The north is gradually better by 10 to 20 %. Slightly more inhabitants live in the better group, thanks to cities of Bratislava and Košice representing 9 districts altogether. Four positive extremes occurred in that analysis, an extraordinarily low standardized mortality ratio (SMR) due to circulation system diseases was identified in Bratislava and in Liptovský Mikuláš, Dolný Kubín and Trenčín Districts. Extraordinary high SMR values were identified in Krupina, Revúca and Snina Districts.

The EBO area is markedly older than the Slovak population as a whole and, that is why, the death rate is naturally higher there, especially due to cardiovascular causes. If the age standardization is used, the cardiovascular mortality in the EBO+15 km area (95.23 %) does not even achieve the nationwide level (100 %). The whole EBO surroundings are classified in the better cluster that has been below the nationwide level all the time. The whole EBO surroundings are the best among surveillance groups (Surveillance Group 1 – 150.21 %, Surveillance Group 2 – 106.93 %), they show the lowest value of this SMR type out of this whole trinity and, statistically, they are demonstrably better. The whole EBO+30 km area is below the nationwide level (i.e. it is better), namely 96.41 %. The same situation has developed in the EBO+5 km area where the average value achieved 96.49 %.

C.II.11.2.3. Summary of Results

The EBO site within the distance of 15 km (EBO+15 km) was monitored to the deepest detail and it was proved that the site does not differ principally from its two surveillance areas (designated as Surveillance Group 1 and Surveillance Group 2) that cannot be physically affected by nuclear facilities on the EBO site. Besides, EBO + 5 km and EBO+30 km areas were monitored in detail.

From the methodological point of view, the classification in another cluster during the cluster analysis calculation for the particular indicator is considered as a difference. As long as the EBO+15 km area is classified in the same cluster as its surveillance areas, all the areas are considered as similar – not differing for that indicator. If it was identified that the EBO+15 km area was classified in a cluster different from its 2 surveillance areas, an analysis of potential causes was performed and values of the relevant indicator were compared with values of the same indicator within a wider region of the western Slovakia, or possibly with other defined areas (e. g., the north, the south, the countryside), as well, and with the nationwide average value.

Within 27 monitored demographically-health indicators, all three compared areas (the EBO+15 area, Surveillance Group 1 and Surveillance Group 2) were classified 10 times as having equal results, EBO+15 km along with one of the surveillance

groups showed equal results 8 times, while the other surveillance group was different from them, and 9 times happened that each of the groups was different. None of the indicators ever achieved any extraordinary value, all the time it has been spoken about values that are average, or better than average, within the western Slovakia.

To sum up, a high expected age in all age categories, a low share of prematurely born children, a low spontaneous abortion rate, a low total age standardized mortality ratio and rather higher mortality due to malignant tumours exists around EBO+15 in the long term. Similar situations have developed in the EBO+30 area, as well as in both regions where the EBO area belongs. A similar state within each indicator is always related to a much larger territory that the wide assessed EBO area. Neither the closely monitored leukaemia, nor the whole category of blood production body tumours at all are and were higher in the EBO surroundings and elsewhere. Those indicators could not be analysed demonstrably even within the Slovak Republic, thanks to huge year-on-year and local variability, values were obtained with trends consistent with totally non-demonstrable analyses.

As for mortality, the closest surroundings within 20 km is completely classified in the better cluster with lower mortality values in both the basic groups. Any difference only appears from 21 km and further. It has not been identified that, so far, EBO would have any impact on a change in health indicators of the population living in its surroundings. EBO does not cause a higher mortality due to either malignant tumours or cardiovascular causes in its surroundings. Thus, no corrective or protective measures are necessary.

The following table brings a brief summary of results. In addition to the territory around EBO, many other territorial selections were monitored, however, two selections were principal. A group of municipalities without towns was formed, situated within the distance of 15 km (EBO+15 km). The group was studied and, in relation to it, two similar surveillance groups of municipalities were formed that are situated in the relative mutual vicinity and found in similar geological-climatic-economic conditions (Surveillance Group 1 towards Bratislava, in Districts of Pezinok, Senec and Dunajská Streda) and Surveillance Group 2 towards the border with Hungary, in Districts of Komárno and Nové Zámky), but reliably beyond reach of EBO and EMO. The whole area within 30 km around EBO is included as EBO+30 km and values obtained for Trnava and Nitra Self-Governing Regions are given as a contrast to the EBO+30 km area that predominantly extends in those regions. The nationwide value serves as a reference.

Table C.II.21: Summary values of indicators

	Indicator	Number of years in analysis	Comparison of 3 areas			Wide territorial comparison			Slovak Republic	Desired state	Real state EBO+15 km
			EBO+15 km	Surveillance Group 1	Surveillance Group 2	EBO+30 km	Trnava Self-Governing Region	Nitra Self-Government Region			
1	Birth rate	16	9.22	9.16	9.13	9.32	9.56	9.25	10.65	Rather higher	Low, as everywhere around
2	Low birth weight children share	16	4.59	5.34	8.22	5.56	5.93	6.86	7.52	Low	Low, good
3	Total abortion rate	16	29.10	41.11	57.81	45.41	49.06	53.21	45.79	Low	Low, good
4	Spontaneous abortion rate	16	4.21	4.68	6.22	5.46	5.68	6.27	6.28	Low	Low, good
5	0 to 14 years inhabitants share	20	16.82	17.87	16.00	16.82	17.12	16.70	18.39	Rather higher	Low, as everywhere around
6	15 to 64 years inhabitants share	20	71.35	71.62	70.41	70.56	71.15	70.34	69.94	High	High, good
7	65 and more years inhabitants share	20	11.83	10.44	13.61	12.62	11.72	12.98	11.67	----	Information only
8	85 and more years inhabitants share	20	1.19	0.79	1.23	1.02	0.98	1.05	0.92	----	Information only
9	Life expectancy on birth	16	74.32	72.99	72.27	74.08	73.52	73.08	73.55	High	High, good
10	Life expectancy at the age of 45 years	16	35.65	34.72	33.89	34.49	35.18	33.54	34.36	High	High, good
11	Life expectancy at the age of 65 years	16	19.09	18.40	18.13	18.94	18.48	18.35	18.80	High	High, good
12	Natural growth index	16	-1.30	-0.03	-4.17	-0.95	-0.41	-2.00	-0.90	Rather higher	Low, as everywhere around
13	Total growth index	16	-1.27	6.82	-1.56	0.22	1.40	-1.30	-0.86	Rather higher	Low, as everywhere around
14	Migration balance index	16	-1.47	5.72	1.61	1.16	1.81	0.70	0.56	---	Informative value
15	Ageing index	16	70.27	58.46	85.08	75.04	68.48	77.73	63.48	---	Informative value
16	Gross death rate (mortality)	16	10.06	8.88	14.04	10.1	9.77	11.41	9.82	Low	Higher, as everywhere around
17	Age Standardized Mortality Ratio (SMR)	16	97.52	105.94	109.76	97.88	102.28	104.82	100.00	Low	Low, good
18	Premature death share	16	38.41	45.18	41.63	39.93	42.05	40.67	41.62	Low	Low, good
19	PYLL per 100,000 inhabitants	16	5,503	6,450	7,171	5,449	5,665	6,073	5,655	Low	Low, good
20	Relative death rate - C00 to C97	16	259.44	236.82	289.74	234.61	232.12	253.65	213.82	Low	Rather higher, as everywhere around
21	Standardized mortality ratio C00-C97	16	105.71	106.99	109.74	103.37	107.66	109.35	100.00	Low	Higher, as everywhere around

	Indicator	Number of years in analysis	Comparison of 3 areas			Wide territorial comparison			Slovak Republic	Desired state	Real state EBO+15 km
			EBO+15 km	Surveillance Group 1	Surveillance Group 2	EBO+30 km	Trnava Self-Governing Region	Nitra Self-Government Region			
22	Relative death rate (mortality) - C15-C26	16	94.95	81.12	110.87	85.71	82.62	94.21	76.59	Low	Higher, as everywhere around
23	Relative death rate (mortality) - C30-C39	16	54.22	54.16	62.35	48.53	50.26	51.63	44.70	Low	Higher, as everywhere around
24	Relative death rate (mortality) - C81-C86	14	15.43	14.24	16.02	14.24	13.55	14.53	13.17	Low	Higher, as everywhere around
25	Relative death rate (mortality) - C91 to C95	14	3.17	2.91	3.86	3.15	3.00	3.36	2.91	Low	Rather higher, as everywhere around
26	Relative death rate (mortality) - I00 to I99	16	618.86	559.78	742.79	553.60	534.89	601.78	530.29	Low	Higher, as everywhere around
27	Standardized Mortality Ratio - I00 to I99	16	95.23	105.21	106.93	96.41	101.22	101.87	100.00	Low	Low, good

C.II.11.3. Population Social and Economic Status

In the year 2013, 2,715,300 economically active inhabitants lived in the Slovak Republic out of the total of 5,415,949 inhabitants. The economic activity rate achieved 59.3 % in 2013, which is a value on the level of the year 2008, and the unemployment rate amounted to 14.2 %, which is by 48 % higher unemployment rate than in the year 2008.

Municipalities situated on the concerned territory of the NJZ belong to the Trnava Self-Governing Region that is among productive agricultural regions of the Slovak Republic and, at the same time, it is also noted for a varied industry branch structure. Car making, electronic and power engineering industries hold significant positions. In the year 2013, 298,200 economically active inhabitants lived in the Trnava Self-Governing Region out of the total of 557,608. The 298,200 economically active inhabitants included 261,800 employed people (which is by 6 % less than in the year 2008) and 36,400 unemployed people (which is by 99 % more than in the year 2008). The unemployment rate achieved 12.2 % in the Trnava Self-Governing Region in the year 2013 (which is by 97 % more than in the year 2008).

Economic Activity

The following tables express economic activity of the population and rates of economic activity, employment and unemployment in comparisons between the years 2008 and 2013 (in compliance with ŠÚ SR).

Table C.II.22: Economic activity of the population for years 2008 and 2013 (states as to 31 December)

Territory	Economically active population [thous. persons]			Employed [thous. persons]			Unemployed [thous. persons]		
	2008	2013	index 2013/2008	2008	2013	index 2013/2008	2008	2013	index 2013/2008
SR	2,691.2	2,715.3	1.01	2,433.8	2,329.3	0.96	257.5	386.0	1.50
BSK	345.9	336.6	0.97	333.4	315.3	0.95	12.4	21.4	1.73
TTSK	296.9	298.2	1.00	278.6	261.8	0.94	18.3	36.4	1.99
TSK	299.3	291.0	0.97	285.5	263.4	0.92	13.9	27.6	1.99
NSK	360.5	345.0	0.96	328.7	299.6	0.91	31.7	45.5	1.44

Table C.II.23: Rates of economic activity, employment and unemployment for years 2008 and 2013 (states as to 31 December)

Territory	Economic activity rate [%]			Employment rate for the 15+ group [%]			Employment rate for the group from 15 to 64 [%]			Unemployment rate [%]		
	2008	2013	index 2013/2008	2008	2013	index 2013/2008	2008	2013	index 2013/2008	2008	2013	index 2013/2008
SR	59.4	59.3	1.00	53.7	50.9	0.95	62.3	59.9	0.96	9.6	14.2	1.48
BSK	65.3	64.2	0.98	62.9	60.1	0.96	72.1	70.6	0.98	3.6	6.4	1.78
TTSK	62.5	62.2	1.00	58.7	54.6	0.93	68.0	64.5	0.95	6.2	12.2	1.97
TSK	58.2	56.6	0.97	55.5	51.2	0.92	65.0	61.1	0.94	4.7	9.5	2.02
NSK	59.5	57.9	0.97	54.3	50.3	0.93	64.1	60.3	0.94	8.8	13.2	1.50

Economic Dependency Ratio

It is possible to consider the economic dependency ratio (see the following table, on the basis of data provided by ŠÚ SR) as an indicator of the level of economic and social conditions in the region. It reflects the burden to the population able to work (economically active population) imposed by dependent persons and, thus, represents a ratio of the economically non-active component of the population to the economically active component of the population, The economic dependency ratio value is an expression of the number of economically dependent persons (the group of children at the age from 0 to 14 years and the group of older inhabitants over 65 years old) accounting for 100 economically active inhabitants (the productive group of population at the age from 15 to 64 years).

Table C.II.24: Economic dependency ratio for the period from 2008 till 2013 (states as to 31 December)

Territory	IEZ – number of dependent persons per 100 inhabitants of the productive age					
	2008	2009	2010	2011	2012	2013
Concerned territory	38.78	39.13	39.75	41.06	41.94	42.87
Further territory	36.50	36.61	36.88	37.92	38.56	39.57
Total territory	36.75	36.88	37.19	38.25	38.92	39.92

Based on the above given IEZ data, it is possible to gradually increase the burden to the economically active population by the dependent population on the concerned territory and in the further area during the assessed time period from 2008 till 2013. The increase in the economic dependency on the assessed territory is a sign of the population ageing, i. e. the increasing of the share of older population included in the post-productive group and the stagnation of the pre-productive age group. At the same time, the number of productive population decreased on the assessed territory during the time period from 2008 till 2013. In compliance with the economic dependency ratio, 43 dependent persons accounted for 100 productive age inhabitants in municipalities on the concerned territory in the year 2013 and by 3 persons less (i. e., 40) on the further territory. The number of economically dependent persons living on the concerned territory was higher than on the further territory during the time period from 2008 till 2013.

The increasing share of older post-productive inhabitants and the stagnating share of the pre-productive group of children lead to the increase in the economic dependency of the active population and to the economic unbalance between expenses and earnings. On the other hand, real assumptions of appropriate life conditions, good social and health care in the given NJZ region are a positive feature of the population ageing and extension of life.

Education

The achieved population education level is assessed in compliance with the permanent address of persons in districts of the concerned territory - Hlohovec, Piešťany, Trnava, on the basis of results of the Population, Houses and Apartments Census made in the year 2011 (the Statistical Office of the Slovak Republic).

Table C.II.25: Education level achieved by the population in the year 2011 (states as to 21 May)

	ISCED 1		ISCED 2		ISCED 3		ISCED 4		ISCED 5		ISCED 6		TOTAL SR
	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER
Slovak Republic	808,490	15.0%	1,244,038	23.1%	1,515,973	28.1%	80,616	1.5%	707,326	13.1%	40,642	0.8%	**5,397,036**
Trnava Self-Governing Region	91,604	16.5%	146,900	26.5%	151,438	27.3%	8,319	1.5%	60,974	11.0%	2,809	0.5%	**554,741**
Galanta District	18,290	19.5%	25,915	27.7%	24,499	26.2%	1,432	1.5%	9,192	9.8%	356	0.4%	**93,594**
Senica District	10,538	17.4%	17,389	28.7%	16,110	26.6%	608	1.0%	5,353	8.8%	181	0.3%	**60,504**
Trnava District	17,139	13.3%	32,102	25.0%	36,037	28.0%	1,739	1.4%	17,372	13.5%	939	0.7%	**128,567**
Hlohovec District	6,936	15.2%	12,285	26.8%	12,821	28.0%	527	1.2%	4,799	10.5%	258	0.6%	**45,761**
Piešťany District	8,340	13.2%	15,073	23.9%	19,999	31.7%	1,150	1.8%	8,041	12.7%	430	0.7%	**63,152**
Nitra Self-Governing Region	117,124	17.0%	177,688	25.8%	189,285	27.4%	9,744	1.4%	78,721	11.4%	4,027	0.6%	**689,867**

	ISCED 1		ISCED 2		ISCED 3		ISCED 4		ISCED 5		ISCED 6		TOTAL SR
	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER
Nitra District	22,112	13.9%	39,219	24.6%	43,194	27.1%	2,070	1.3%	24,551	15.4%	1,908	1.2%	**159,143**
Šaľa District	9,248	17.4%	13,656	25.6%	15,008	28.2%	827	1.6%	5,505	10.3%	177	0.3%	**53,286**
Topoľčany District	11,287	15.6%	20,450	28.3%	20,067	27.8%	1,007	1.4%	7,683	10.6%	277	0.4%	**72,257**
Trenčín Self-Governing Region	76,829	12.9%	160,043	26.9%	176,852	29.8%	8,281	1.4%	72,085	12.1%	2,245	0.4%	**594,328**
Myjava District	4,056	14.7%	7,266	26.4%	8,387	30.5%	406	1.5%	3,409	12.4%	108	0.4%	**27,531**
Nové Mesto nad Váhom District	8,474	13.5%	17,499	27.9%	18,694	29.8%	810	1.3%	6,745	10.8%	253	0.4%	**62,707**
Bratislava Self-Governing Region	57,546	9.6%	103,157	17.1%	179,323	29.8%	13,110	2.2%	143,227	23.8%	14,451	2.4%	**602,436**
Malacky District	10,593	15.7%	16,891	25.1%	17,808	26.4%	904	1.3%	9,171	13.6%	711	1.1%	**67,376**
Senec District	8,172	12.3%	12,568	19.0%	17,508	26.4%	1,079	1.6%	12,276	18.5%	2,042	3.1%	**66,265**
Pezinok District	6,253	10.9%	12,146	21.1%	16,922	29.4%	975	1.7%	10,340	18.0%	692	1.2%	**57,567**

SOURCE: Statistical Office of the Slovak Republic, DATAcube database. Population, Houses and Apartments Census made in the year 2011

Key: ISCED 1 – primary education
ISCED 2 – lower secondary education
ISCED 3 – higher secondary education
ISCED 4 – post-secondary non-tertiary education
ISCED 5 – 1st degree of tertiary education
ISCED 6 – 2nd degree tertiary education

Total SR – gives the total number of inhabitants as to 21 May 2011 in the given area, i. e., number of population with an achieved education degree of ISCED1-ISCED6 , population without any formal education, with an unidentified degree of achieved education (for persons at the age of 16 years and more) and with the non-applicable classification of the achieved education (persons younger than 16 years).

% - expression of the percentage for the given education level, in the relevant area to the total number of population in the given year.

The education trend related to the economically active population (at the age from 15 to 64 years) for the time period from 2008 till 2012 is presented in the following table (in compliance with ŠÚ SR). When comparing the education achieved by the economically active population from 15 years of age in the Trnava Self-Governing Region, it is obvious that the complete secondary education (complete secondary apprentice education including the school-leaving examination + complete secondary vocational education + complete secondary grammar education + higher professional education) is prevailing. Along with the lower secondary education, it accounts for approximately 80 % of the whole achieved education. This trend is similar to that in the Self-Governing Regions of Nitra and Trenčín. The other way round, the Bratislava Self-Governing Region indicates much higher percentage of university education, namely 2.5 times as high as in TTSK.

Table C.II.26: Education achieved by the economically active population for the time period from 2008 till 2012

Territory	Year	Basic 1)		Lower secondary 2)		Complete secondary 3)		University 4)		Total
		[1]	%	[1]	%	[1]	%	[1]	%	[1]
BSK	2008	17,600	5.09	72,200	20.87	157,000	45.38	99,200	28.67	346,000
	2009	13,600	3.90	70,700	20.30	157,500	45.22	106,500	30.58	348,300
	2010	14,500	4.23	63,000	18.39	148,700	43.42	116,300	33.96	342,500
	2011	15,200	4.56	53,500	16.05	143,400	43.02	121,200	36.36	333,300
	2012	10,900	3.22	55,200	16.33	149,100	44.11	122,800	36.33	338,000
NSK	2008	23,900	6.63	147,400	40.89	149,600	41.50	39,600	10.98	360,500
	2009	25,300	7.21	142,300	40.54	141,100	40.20	42,300	12.05	351,000
	2010	22,300	6.33	141,700	40.21	146,800	41.66	41,600	11.80	352,400
	2011	17,900	5.23	139,700	40.85	137,100	40.09	47,300	13.83	342,000
	2012	18,100	5.23	133,900	38.69	141,700	40.94	52,400	15.14	346,100
TSK	2008	12,900	4.31	122,900	41.06	120,800	40.36	42,700	14.27	299,300
	2009	10,100	3.42	124,200	42.12	120,800	40.96	39,800	13.50	294,900
	2010	9,000	2.99	115,100	38.20	128,300	42.58	48,900	16.23	301,300
	2011	9,900	3.37	112,400	38.26	126,600	43.09	44,900	15.28	293,800
	2012	9,600	3.28	112,700	38.49	123,000	42.01	47,500	16.22	292,800
TTSK	2008	16,900	5.69	100,700	33.93	145,400	48.99	33,800	11.39	296,800
	2009	13,200	4.39	106,900	35.53	139,100	46.23	41,700	13.86	300,900
	2010	14,100	4.64	113,300	37.26	131,300	43.18	45,400	14.93	304,100
	2011	14,100	4.80	101,600	34.60	130,100	44.31	47,800	16.28	293,600
	2012	15,400	5.21	111,400	37.66	130,300	44.05	38,700	13.08	295,800
SR	2008	181,800	6.76	928,200	34.49	1,179,800	43.84	401,400	14.92	2,691,200
	2009	159,000	5.91	924,100	34.35	1,181,900	43.94	425,000	15.80	2,690,000
	2010	164,000	6.06	911,700	33.68	1,154,200	42.64	476,700	17.61	2,706,600
	2011	157,600	5.88	878,700	32.79	1,155,300	43.11	488,400	18.22	2,680,000
	2012	158,400	5.85	895,900	33.10	1,152,000	42.56	500,200	18.48	2,706,500

1) basic education and no education
2) apprentice and secondary vocational education without the school leaving examination
3) complete secondary apprentice education including the school leaving examination + complete secondary vocational education + complete secondary general education + higher professional education
4) university education degree 1 to 3

Numbers of schools and school facilities operated in Hlohovec, Piešťany and Trnava Districts (where the concerned territory belongs) and in the Self-Governing Regions - BSK, NSK, TSK a TTSK (where the total territory belongs) are presented in the following table. The data is taken from the Register of Schools and School Facilities sponsored by the Institute of Educational System Information and Prognoses.

Table C.II.27: Operated schools and school facilities

Territory	Kindergar-tens	Basic schools	Basic schools of arts	Secondary schools (all)	Secondary grammar schools	Secondary vocational schools	Conserva-tories	Apprentice centres	Universities
Hlohovec District	17	18	1	4	1	3	0	0	0
Piešťany District	27	23	2	10	3	7	0	0	0
Trnava District	52	38	7	18	5	12	1	1	2
TTSK	259	226	27	71	23	47	1	1	2
TSK	246	195	41	64	20	44	0	2	3
NSK	386	297	28	93	27	64	2	0	2
BSK	208	156	41	111	45	62	4	4	13

C.II.11.4. Public Opinion

Public opinion data is also included in the population data.

The latest public opinion poll on nuclear power engineering was made in the Slovak Republic by NMS Market Research SR company in December 2013. The total of 470 coincidentally selected respondents older than 18 years answered the questions. Based on the poll, answers provided by three equally numerous groups of population were evaluated. The first group included respondents of municipalities situated within the distance of 10 km from the EBO site (158 persons), the second one was made up of inhabitants living in municipalities situated in the wider surroundings beyond 10 km (154 persons) and the third group involved inhabitants of larger towns (158 persons).

The public opinion poll organized in the year 2013 confirmed the development trend of public attitudes to nuclear power engineering that was evaluated based on results of polls implemented by MARKANT Agency in 2010 and 2008. The 2010 poll was performed using a sample of 803 respondents selected from the population of Slovakia over 18 years, out of which 250 respondents came directly from the Jaslovské Bohunice region. The 2008 poll was implemented using a sample of 1,035 respondents selected from the population of the whole Slovakia over 18 years. The poll also addressed 322 respondents directly from the Jaslovské Bohunice region.

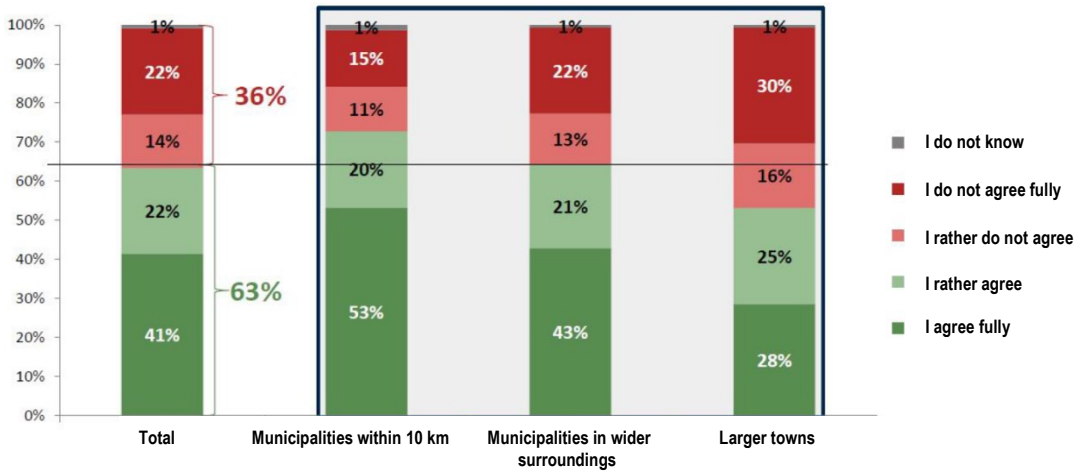
The 2013 public opinion poll examined attitudes of respondents to the following areas in relation to nuclear power engineering:

- the NJZ construction,
- the provision of stable electric power supply,
- electric power prices, dependency on imports,
- safety with regard to the surroundings,
- environment pollution,
- advantages for the region and population.

NJZ Construction

Almost two thirds of polled persons (63 %) agreed to the construction of the NJZ in the year 2013. As compared with other respondents, the consent was more frequently expressed by inhabitants living in municipalities within the distance of 10 km from the NJZ (73 %). With regard to 2010 and 2008 polls, the share of views consonant with the NJZ construction has increased. In the year 2010, 60 % of the Jaslovské Bohunice region inhabitants agreed to the NJZ construction which was by 13 % more than in the year 2008 (47 %). In the year 2010, 62 % inhabitants nationwide expressed their consent to the NJZ construction, which was an increase by 13 % with regard to the year 2008 (49 %).

Figure C.II.26: Rate of consent to the construction of the NJZ in Jaslovské Bohunice



Source: Quantitative public opinion poll 'Attitudes to Nuclear Power Engineering' (NMS Market research SR, 2013)

Provision of Stable Electric Power Supply

In the year 2013, 92 % of polled respondents agreed to the statement that a nuclear power plant provides stable electric power supply, while 95 % of respondents living in the close surroundings within the distance of 10 km from the NJZ agreed to this statement. With regard to the year 2010, an increase in the consent expressed to this statement was registered, while in the year 2010, 76 % of polled Slovaks and 79 % of Jaslovské Bohunice region inhabitants expressed their consent.

Electric Power Prices, Dependency on Imports

In the year 2013, a marked majority of polled persons (82 %) agreed to the statement that nuclear power engineering contributes to stable prices of electric power.

Moreover, 71 % of respondents agreed to the statement that a nuclear power plant reduces the dependency on oil and gas imports. Those statements were not evaluated in public opinion polls performed in years 2010 and 2008.

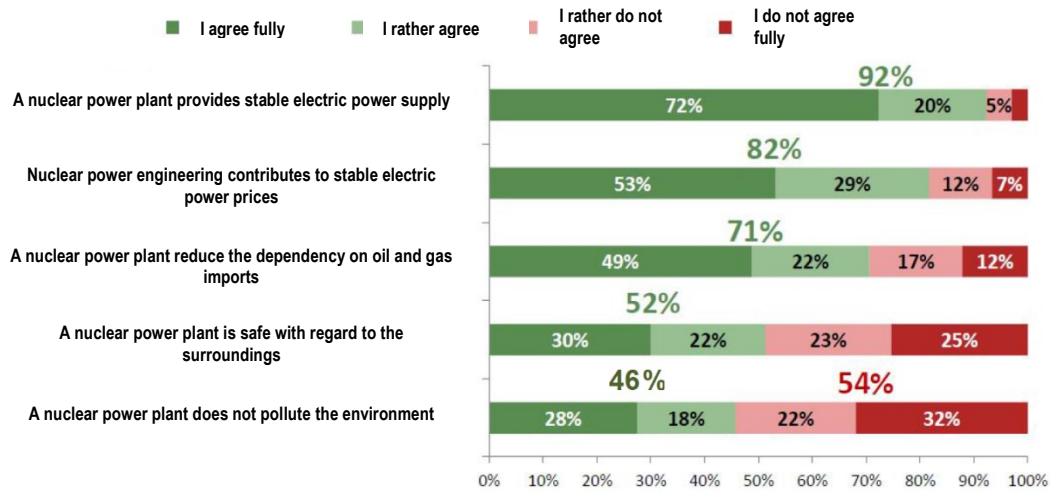
Safety with Regard to the Surroundings

In the year 2013, approximately one half (52 %) of polled respondents agreed to the mentioned statement, in case of inhabitants living within the distance of 10 km from the NJZ, the share was even slightly higher (60 %). In 2010, the rate of agreement to the 'safety with regard to the surroundings' question by respondents from the Jaslovské Bohunice region was 50 % and it was 43 % in the year 2008. In case of the nationwide population, the increase in the consent was a little bit lower – from 35 % in 2008 to 38 % in 2010.

Environment Pollution

In the year 2013, 46 % of polled respondents agreed to the statement that a nuclear power plant does not pollute the environment. In the year 2013, the consent to this statement was expressed by even higher share of polled respondents living in the close surroundings within the distance of 10 km from the NJZ, namely 54 %. In the year 2010, 51 % of Jaslovské Bohunice region inhabitants expressed their consent to the statement and 55 % of those inhabitants in the year 2008. In case of the nationwide population, 54 % of respondents agreed to this statement in both the years 2010 and 2008.

Figure C.II.27: Rate of consent to statements on nuclear power plants



Source: Quantitative public opinion poll 'Attitudes to Nuclear Power Engineering' (NMS Market research SR, 2013

Advantages for the Region and Population

In the year 2013, 58 % of respondents agreed to the statement that the presence of a nuclear power plant in the region brings some advantages for the inhabitants of the region, while even 64 % of respondents living within the distance of 10 km from the NJZ agreed to this statement. In opinion of the majority of respondents from the year 2013, the NJZ construction in Jaslovské Bohunice will definitely or rather positively affect the employment rate (91 %), the overall development of the region (76 %) and the development of municipalities in cadastral areas of which the power plant will be constructed (74 %).

Approximately a half of the polled is convinced of a positive impact of the NJZ on social services (51 %) and on the health care (47 %).

A significant shift with regard to the preceding opinion poll can be observed in case of this view from the year 2013 of advantages resulting from the presence of a nuclear power plant in the region. In the year 2010, a half of the respondents agreed that the presence of a nuclear power plant in the region brings advantages for its inhabitants. Those advantages were perceived the most often in the form of an increase in the employment rate (58 %), the overall region development (37 %), the development of a particular municipality where the nuclear power plant will be in operation (45 %), a positive impact on the living standard (32 %), a positive impact on the health care area (27 %) and on the social development area (19 %).

More than a half of respondents (58 %) from the region agree to the opinion that the construction of the NJZ in the region will bring advantages for its inhabitants, the most often in the form of an increase in the employment rate and the development of the given region.

C.II.11.5. Infrastructure

C.II.11.5.1. Transport Infrastructure

All basic types of transport are provided on both the concerned and wider territories of interest: road, railway, air and water transport.

Road transport: The basic road skeleton on the wider territory of interest in Districts of Trnava, Hlohovec and Piešťany includes state roads of local, regional or trans-regional significance. The road communication network available throughout the local area (delimited by the radius of 10 km) consists of class II and III roads to a significant extent. Class II roads are mainly significant for the transport among regions and districts, while they lead, to a prevailing extent, through residential areas of municipalities situated on their routes. The transport serviceability of the territory is provided by means of a relatively dense network of class III roads carrying out the function of servicing communications for residential agglomerations and providing transport connections among them, outside class II road routes. A single class I road is routed through the assessed territory, while its transport significance is being gradually replaced with D1 motorway. The motorway is a significant part of the communication network in the given area and provides the function of transport connections among important centres of state and trans-regional significance. No express road is routed within the space delimited by the local area.

As for transport links among the site itself and the wider communication network, class III road No. III/50415 is significant. That communication enables to use road connections from two main directions (directions from Jaslovské Bohunice or Žlkovce) and serves to the road transport of employees, as well as to the road haulage.

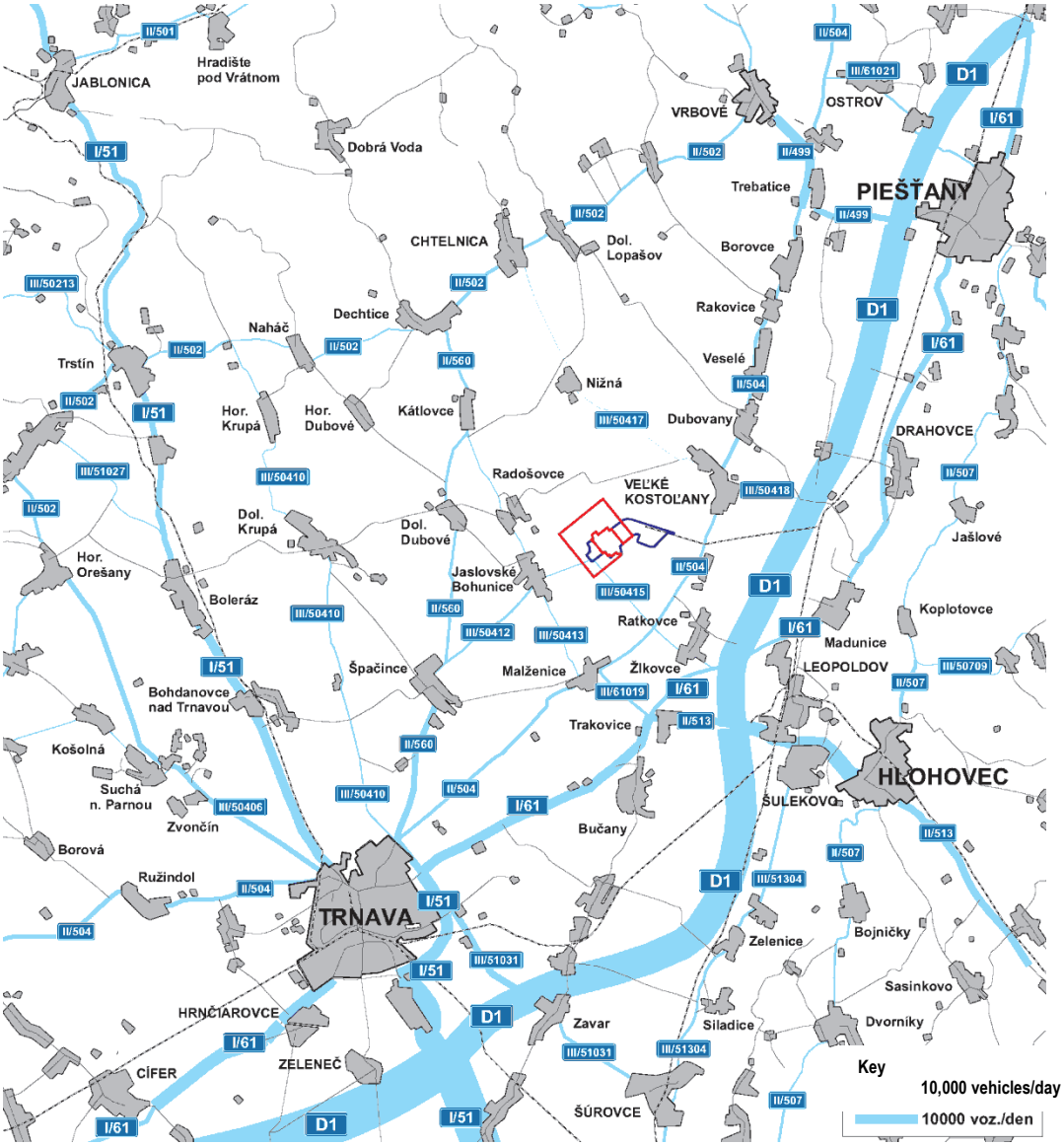
An intra-plant communication network is built in areas of the existing nuclear facilities on the site providing access to individual objects.

The average transport intensity (in compliance with the transport census of the year 2010 organized by the Slovak Road Administration (SSC)) throughout the concerned territory exceeds 3,000 vehicles per 24 hours (the road haulage share being on the level of approximately 17 to 18 %) on class II roads, and approximately 1,300 vehicles per 24 hours (the road haulage share being on the level of approximately 20 %) on class III roads. Exceptions include the road section No. III/50412 between Špačince and Jaslovské Bohunice municipalities and road section No. III/61019 between Malženice and Trakovice municipalities where the intensity exceeds 2,000 vehicles per 24 hours.

All the communications on which the car transport will run in connection with the NJZ operation have sufficient capacities and are properly equipped for the operation under consideration

The road network existing in the wider territory of interest including the transport intensity map is illustrated in the following figure.

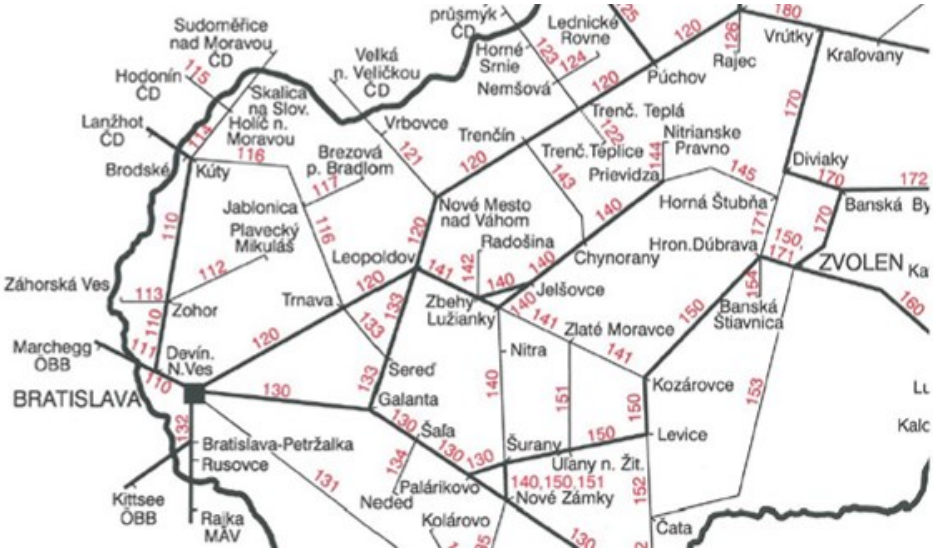
Figure C.II.28: Road network in the wider territory of interest (including the transport intensity map for the year 2010)



Railway transport:

Railway lines No. 120 Bratislava - Žilina, 133 Leopoldov - Galanta and 141 Leopoldov - Kozárovce are among significant railway lines forming the basic railway transport network of the regional area. Both passenger and haulage transport services are provided on the railway lines. Several regional lines are also routed around the assessed territory, however, they serve predominantly for the passenger transport. The following figure illustrates the whole railway transport network in the wider territory.

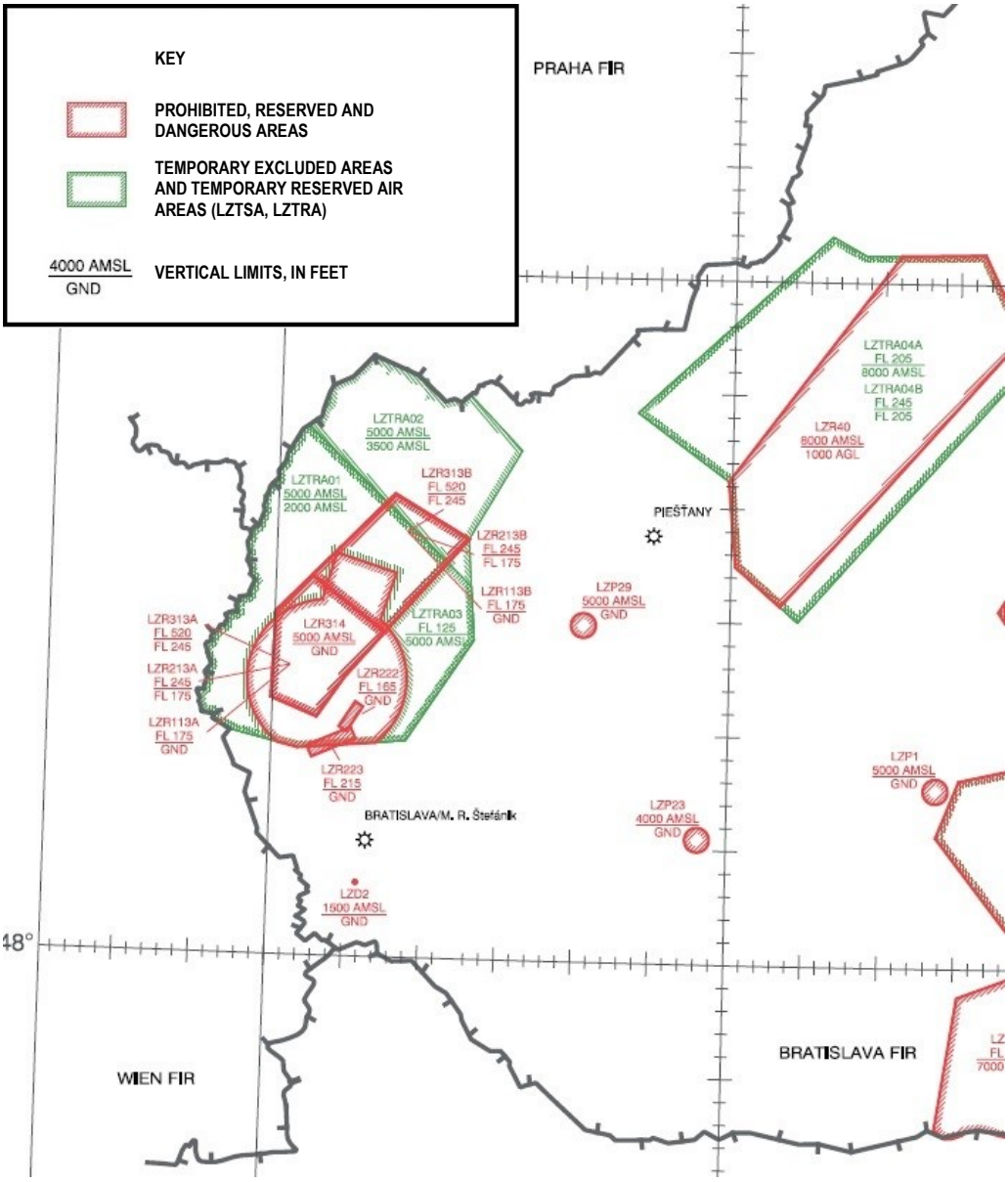
Figure C.II.29: Railway communication network



The link between the EBO site and the railway network is provided by means of a railway siding originally built for the needs of JE A1 and at present it serves for the whole power plant area. The railway siding with the length of 8.1 km is connected to railway line No. 120 Piešťany - Trnava - Bratislava in the railway station Veľké Kostoľany where a shunting track is built enabling the railway siding operation.

Air transport: Both civil and military air operations are functioning in the concerned territory. The area of existing nuclear facilities is protected from any type of air operation, namely by the Aviation Authority of the Slovak Republic - a prohibited aviation area also covering the NJZ site is proclaimed, published and supervised. The LZP29 Jaslovské Bohunice prohibited aviation area is delimited by a circular line with the radius of 2 km extending to the altitude of GND-5000 ft / 1500 m MSL. This prohibited aviation area is activated 24 hours daily.

Figure C.II.30: Prohibited and restricted aviation areas



One military airport, two international civil airports and one irregular operation airport are situated within 50 km from the NJZ.

The nearest military airport is situated at Malacky, in the vicinity of Kuchyňa municipality, at the distance of 42.5 km from the NJZ site. The nearest military air operation is carried out within restricted air areas and within a temporarily reserved air area. Those areas are situated to the North-East from the NJZ site at the distance of 25 km at least.

M. R. Štefánik International Airport in Bratislava is the largest civil airport. It is situated 49 km to the South-West from the NJZ site. With regard to the distance from the NJZ, the airport operation only concerns the use of the landing and take-off runway with the Berva input and output point. The runway is found at the distance of 13.5 km from the NJZ site.

International Airport Piešťany is situated 19 km to the North-North-East of the NJZ site. During working days (or, possibly at request), the daily operation is performed at the airport, flight services are provided and the aeroclub sports operation as well.

The national non-public airport Trenčín is situated 47 km to the North-North-East from the NJZ site. The operation period lasts from 1 May to 31 October. The airport provides the aeroclub operation using piston engine airplanes, gliders, motorized gliders and ultra-light airplanes. Moreover, irregular transport is provided, arrivals and departures by Slovak Army airplanes to and from the Aviation Repair Works situated on the airport site.

Further on, three sports airports (Trnava-Boleráz, Nitra-Janíkovce and Senica) and four agricultural airports (Nemčice, Čab, Ludanice and Veľké Ripňany) are situated within 50 km from the NJZ site.

Special aviation works occur irregularly (such as the thermovision monitoring of high-voltage overhead transmission lines, oil pipeline inspections, aerial photographing, movie flights, etc.).

Water transport: The water transport is of significance especially for the transportation of heavy and oversize components. It is feasible along the Danube River from the Black Sea to the Bratislava Harbour (and further on using the road transport network), another route utilizable at present runs along the Váh River from the Danube River to the Kráľová Waterworks site (and further on using the road transport network again).

C.II.11.5.2. Other Infrastructure

All usual technical infrastructure is available on the concerned territory, i. e., electrical transmission and distribution networks, both technological and potable water main networks, other product pipelines and telecommunication networks.

Electrical network: With regard to its electric power function, the concerned territory is characteristic of a remarkable number of electrical overhead transmission and distribution lines (including electrical stations), intended to lead out electric power from the electric power engineering facilities to the electric power supply system and to supply towns and municipalities situated in the region with electric power.

A steam-gas power plant is found at Malženice municipality (operated by E.ON, the installed capacity of approximately 430 MW_e). At present, the power plant is shut down and conserved.

Potable water: Municipalities found on the concerned territory are connected to the group water main system Veľké Orvište with additional complementary water sources. The area of nuclear facilities found on the EBO site is also supplied with water from that water main system.

Further water management systems: A water management system is built on the territory for the operation of facilities situated on the Nuclear Power Plant Jaslovské Bohunice (EBO) site.

Raw water necessary for the existing facilities is taken off from the Sĺňava Water Reservoir to the Pečeňady Pumping Plant from where it is transported to the water treatment plant on the EBO site.

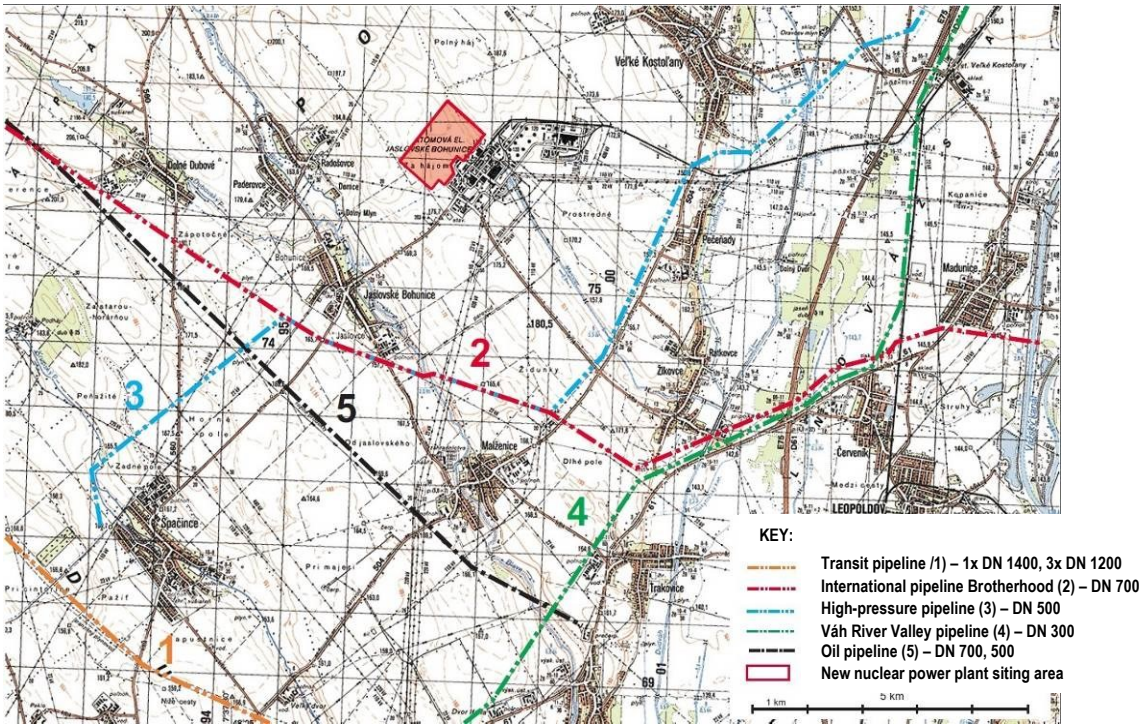
The Socoman pipeline system is the resulting waste water collector system from the EBO site. Systems of industrial waste water and sewage water drainage from the EBO site facilities are discharged into Socoman. The pipeline length as far as the estuary to the Drahovce Channel (river kilometer of 2.2) is approximately 10.8 km.

The open Manivier Channel is the resulting rain water collector system from the EBO site. Rain water drainage systems from sites of existing nuclear facilities and their surroundings are discharged into Manivier. The Manivier Channel is discharged into the Dudváh River.

Amelioration and irrigation systems are built on fields.

Gas pipelines and product pipelines: Several gas pipelines and an oil pipeline cross the concerned territory (see the following figure).

Figure C.II.31: Product pipeline routes in the NJZ surroundings



The following gas pipeline routes are found in the zone with the radius of 10 km:

- transit gas pipeline routes from the Russian Federation (RF) to western European states (route No. 1);
- international gas pipeline Brotherhood (RF - SR - CZ) (route No. 2);
- high-pressure gas pipeline route of the distribution node Špačince to Nové Mesto nad Váhom (route No. 3);
- Váh River Valley gas pipeline Bratislava - Trnava - Trenčín (route No. 4).

Routes No. 2 and 3 are the closest to the NJZ site, in the distance of approximately 2.5 to 3 km.

The gas pipelines are operated by Slovenský plynárenský priemysel (Slovak Gas Industry). The transit gas pipeline system consists of the transit gas pipeline, the interstate gas pipeline and intra-state line sections of the gas pipeline providing the gas supply to the EBO site.

The following oil pipeline routes cross the 10-km zone around the nuclear power plants:

- two parallel oil pipeline routes of DN 500 and DN 700 with the booster pumping plant in Bučany, crossing the Váh River between towns of Hlohovec and Leopoldov (route No. 5).

The oil pipeline route approaches the NJZ site the most closely – to approximately 4 km – in the section between municipalities of Jaslovské Bohunice and Špačince.

The oil pipeline is operated on the territory of the Slovak Republic by Transpetrol, j.s.c, Bratislava. Oil is transported in oil pipelines of DN500 and DN700 from the supplier organization to the Czech Republic and to the processing centre Slovnaft, j.s.c., Bratislava. The nearest booster pumping plant to the NJZ site is the booster pumping plant in Bučany, including the oil storage tanks with the capacity of 75,000 m^3. The Bučany plant is situated at the distance of 8 km to the South-South-East of the NJZ site.

Other networks: A heat supply system is built on the territory supplying towns of Trnava, Hlohovec and Leopoldov and municipality of Jaslovské Bohunice with heat from the JE V2. The system consists of elevated heating water distribution pipelines and return pipelines and transports heat from the JE V2 to heat exchanging plants in the mentioned towns and municipalities.

Further on, wire and wireless telecommunication networks (including radio and television signal transmissions), systems for the information transmission from the emergency preparedness system on the EBO site, or other infrastructure, are available on the concerned territory.

C.II.12. Cultural and Historical Monuments

12. Cultural and historical monuments and sights.

C.II.12.1. Cultural and Historical Monuments

No cultural and historical monuments and sights are found on the NJZ siting and construction area. A lot of small-scale solitaire pieces of architecture are situated on the wide territory of interest (crosses, chapels, crucifixions, statues, etc).

The concerned territory is included neither in the Register of Historical Reserves, nor in the Register of Historical Zones. No paleontological discovery site or significant geological site is found on the concerned territory or in its closest surroundings.

C.II.12.2. Tangible Assets

No tangible assets owned by natural persons are found on the NJZ siting and construction area.

A series of building objects owned by the Investor of the proposed activity (i. e., JESS company and its major shareholder, JAVYS company) is situated in the area. They are objects of auxiliary character used for clerical, storage or operational purposes and cooling towers of the JE V1 being decommissioned. Further, transport and infrastructure networks owned, or administered, by various legal bodies are found in the area.

It is supposed that some objects will be used for the NJZ construction purposes as construction site equipment, or for communication connections and electric power, fire water, potable water and gas supply.

Property relations to concerned parcels are settled separately, outside off the environment impact assessment process.

C.II.13. Archaeological Discovery Sites

13. Archaeological discovery sites.

C.II.13.1. Archaeological Discovery Sites

The following can be considered as significant archaeological discovery sites on the concerned territory:

- Jaslovské Bohunice – a recorded finding of a fluted ceramics settlement, or of a skeleton burial place of Unetice Culture from Early Bronze Age (‘Pravé pole‘ site). This territory was already populated during the Eneolith.
- Malženice – findings of a Volute Culture settlement and fluted ceramics from the Late Bronze Age and Late Iron Age culture.

Clay statuettes of women and animals were found in the wider territory of interest (Bučany municipality); the rarest statuette was named ‘Bučianska Venuša‘ (’Bučany Venus’). The Celtic burial place that was unearthed there dates back to 5th to 3rd century BC.

The mentioned sites are not in any spatial collision with the NJZ siting and construction area.

C.II.14. Paleontological and Geological Sites

14. Paleontological discovery sites and significant geological sites (e. g. rock formations, karst territories a. o.).

C.II.14.1. Paleontological and Geological Sites

No paleontological discovery sites and no significant geological sites are found in the NJZ siting and construction area and in its surroundings.

C.II.15. Environment Pollution Sources

15. Characteristics of existing environment pollution sources (e. g., noise, vibrations, radiation) and their impact on the environment.

C.II.15.1. Noise

From the noise point of view, the concerned territory can be characterized as anthropogenized. The blending of noise generated by various activities (transport, industry, agriculture) more or less corresponding to the landscape character is a characteristic feature of the territory.

The nearest protected premises of objects found in the surroundings of the assessed site are concentrated in urban areas of the surrounding municipalities (Jaslovské Bohunice, Veľké Kostoľany, Pečeňady and Radošovce). Noise measurement methods and calculation models were used for the assessment of actual noise conditions on the territory. The model calculations were performed using Cadna A software code, version 4.4, with the incorporated noise calculation for the conditions of the Slovak Republic, within the meaning of 99th Professional Regulation of the Ministry of Health Care of the Slovak Republic. The overview of localization of reference points where the noise load calculation was performed is illustrated in the following figure.

Figure C.II.32: Localization of calculation points (no scale)

Noise generated by stationary sources is analysed at reference points characterized in the following table.

Table C.II.28: Reference points for the assessment of noise generated by stationary sources

Reference point	Municipality	Reference point location
S1	Veľké Kostoľany	western edge of the municipality, southern part
S2	Veľké Kostoľany	western edge of the municipality, central part
S3	Veľké Kostoľany	western edge of the municipality, northern part
S4	Pečeňady	western edge of the municipality
S5	Jaslovské Bohunice	eastern edge of the municipality, central part
S6	Jaslovské Bohunice	eastern edge of the municipality, northern part
S7	Jaslovské Bohunice	eastern edge of the municipality, southern part
S8	Radošovce	eastern edge of the municipality, southern part
S9	Radošovce	eastern edge of the municipality, southern part

The reference points for stationary noise sources are selected in peripheral parts of municipalities oriented towards the EBO site, apart from the acoustically significant impact of transport noise sources. Calibration and verification noise measurements were made prior to the model calculation.

Results of model calculations of noise generated by stationary sources are presented in the following table.

Table C.II.29: Noise from stationary noise sources in EBO

Reference point		L_{pAeqT} [dB]			Uncertainty of prediction
designation	altitude [m]	day	evening	night	
S1	4.0	< 25.0	< 25.0	< 25.0	+ 1.8 dB
S2	4.0	< 25.0	< 25.0	< 25.0	
S3	4.0	< 25.0	< 25.0	< 25.0	
S4	4.0	< 25.0	< 25.0	< 25.0	
S5	4.0	< 25.0	< 25.0	< 25.0	
S6	4.0	< 25.0	< 25.0	< 25.0	
S7	4.0	< 25.0	< 25.0	< 25.0	
S8	4.0	< 25.0	< 25.0	< 25.0	
S9	4.0	< 25.0	< 25.0	< 25.0	

It is obvious from the assessment of impact of stationary and other sources of noise (technological sources, tertiary roads, and the like) that, under the present conditions, specified hygienic limits are not exceeded in the nearest premises protected against noise. The nearest protected built-up residential areas are found in such distances that the resulting levels of noise generated by the operation of noise sources existing on the EBO site are deeply under the limit in all monitored time period of the day (day, evening, night).

Further, an important impact on the territory is achieved by the road transport running on a class III road network and on class II roads No. 560 and 504. Those roads are routed directly through residential areas of concerned municipalities and directly affect noise conditions on the territory. In order to objectify the noise load from mobile noise sources on the concerned territory, a model calculation was used again preceded by calibration noise measurements at exposed points of the concerned territory.

Noise from transport sources was modelled at reference points characterized in the following table.

Table C.II.30: Reference points for the evaluation of noise from transport sources

Reference point	Municipality	Reference point location
D1	Veľké Kostoľany	at road II/504, in the southern part
D2	Veľké Kostoľany	at road II/504, in the central part
D3	Veľké Kostoľany	at road II/504, in SE part, in Piešťanská cesta
D4	Pečeňady	at road II/504, at the western edge
D5	Žlkovce	at road III/50415, in the western part
D6	Žlkovce	at road III/50415, in the eastern part
D7	Malženice	at road II/504, in the southern part
D8	Malženice	at road II/504, in the central part
D9	Malženice	at road III/61019
D10	Malženice	at road II/504, in the eastern part
D11	Jaslovské Bohunice	at road III/50415, in the eastern part at the entry way to the NJZ
D12	Jaslovské Bohunice	at road III/50413, in the northern part
D13	Jaslovské Bohunice	local road in the western part (Trnavská cesta)
D14	Jaslovské Bohunice	at road III/50413, in the southern part
D15	Jaslovské Bohunice - Paderovce	at road III/50413, in the central part

Reference points for transport noise sources are selected at roads running through municipalities.

Results of model calculations of noise generated by transport sources are presented in the following table.

Table C.II.31: Noise resulting from the present road transport intensity

Reference point		L_{pAeqT} [dB]			Uncertainty of prediction
designation	altitude [m]	day	evening	night	
D1	4.0	66.0	64.4	57.2	+ 1.8 dB
D2	4.0	68.6	67.0	59.8	
D3	4.0	69.0	67.4	60.2	
D4	4.0	63.5	61.9	54.9	
D5	4.0	61.9	60.3	54.5	
D6	4.0	59.8	58.2	52.6	
D7	4.0	63.7	62.1	55.2	
D8	4.0	66.7	65.1	58.0	
D9	4.0	65.7	64.1	58.3	
D10	4.0	67.6	66.0	58.9	
D11	4.0	61.5	60.0	54.3	
D12	4.0	63.1	61.5	55.8	
D13	4.0	64.4	62.8	57.1	
D14	4.0	64.3	62.7	57.0	
D15	4.0	63.0	61.4	55.6	

The transport on the railway siding routed to the EBO site is of secondary significance. However, the transportation on the line is only bound to EBO site needs and no regular services are provided.

Activities related to the focus of both the concerned territory and wider territory of interest, especially activities connected with agriculture, are additional sources of noise. However, they are activities concentrated to a relatively short time period (they last several weeks at the most), agricultural activities have not a decisive impact on the overall noise situation on the territory.

The overall noise situation on the concerned territory can be assessed as adequate to the character and the functional structure, the road transport travelling through residential areas of municipalities is a dominant noise source.

C.II.15.2. Vibrations

No significant vibration sources, i. e. especially mining activities using explosives, are found on the concerned territory.

The JE V2 operation does not cause vibrations that could affect the surroundings. Turbine generators in the power plant are installed on separately founded stands and the generated vibrations are transferred directly to the sub-soil where they are damped to insignificant values already in the immediate surroundings of their origin.

C.II.15.3. Ionizing Radiation

C.II.15.3.1. General Data on Sources of Population Exposure

Ionizing (radioactive) radiation has been a natural part of the environment already since the occurrence of life on Earth. Sources of ionizing radiation causing the exposure of human population are divided into natural and artificial ones.

Natural sources: Natural sources have the most significant share in the population exposure. The natural sources include the cosmic and cosmogenic radiation, natural radioactivity of rocks, water and air, natural radioactivity of food and natural contents of radionuclides in the human body.

The effective dose of cosmic radiation achieves approximately 0.3 mSv/year at the sea level. The effective dose increases with the rising altitude above the sea level up to 1 mSv/year at the altitude of 3,000 m. The cosmic radiation magnitude is different in different geographical latitudes. The cosmic radiation is caused by high-energy protons (90 %) and helium nuclei (10 %) arriving from space. The cosmic radiation is constant for the particular site, but it can change on a short-term basis during great solar eruptions. The cosmogenic radiation is a radiation by radionuclides produced by interactions between the cosmic radiation and nuclei of air, water and soil. Tritium (H-3) and carbon isotope C-14 are typical representatives. Tritium and carbon cause mainly internal exposure of the population in that they enter the food chain. The cosmogenic radiation exposure is considered as a part of the cosmic radiation.

The natural radioactivity of rocks, water and air is caused by radionuclides found on Earth since its origin. This group includes radionuclides - isotopes occurring in nature: U-238, U-235, Th-232 and Np-235 and, further, K-40 potassium. The natural potassium that is among major elements in the majority of Earth's crust rocks contains approximately 0.01 % of K-40 radionuclide and is contained virtually in all foodstuffs consumed by man. Sources of internal human exposure include, above all, K-40 radionuclide and radionuclides of uranium and thorium decay chains. They are found in balanced concentrations in the human organism due to continuous intake within the food chain, in water, atmospheric air and due to outlet in the form of excretion.

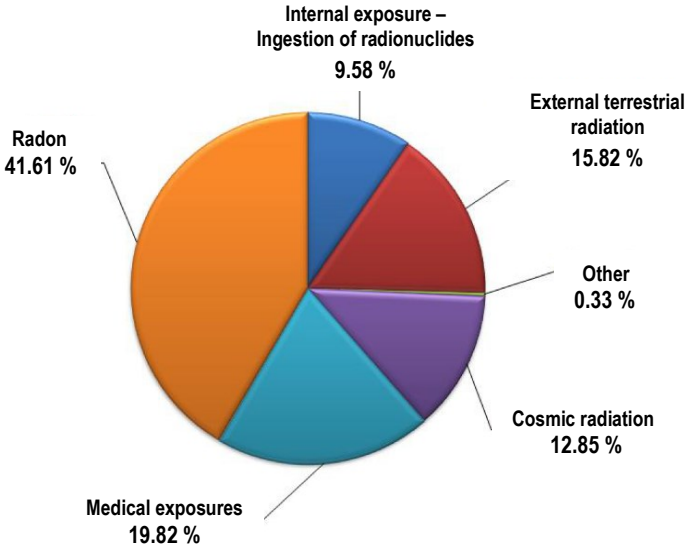
Radon (Rn-222), as a part of U-238 natural decay chains is a radioactive inert gas proceeding from the soil and building materials into buildings. Due to breathing, it passes into lungs where it causes local exposure as an α-emitter. The share of radon in the population exposure is markedly different in different regions, but it represents the most significant contribution to the population exposure from natural sources, both worldwide and under the conditions of Slovakia.

In compliance with the contemporary knowledge, (UNSCEAR 2008) the natural radiation represents almost 80 % of the average population exposure.

Artificial sources: Artificial exposure sources especially include medical radiation (X-ray devices, radiopharmaceutical preparations, etc.). Moreover, a minority share accounts for technogenic sources (use of radionuclides in consumer and other goods including the radionuclide contents in building materials), for effects of natural radionuclides contained in light ashes from thermal power plants combusting fossil fuels, for professional exposures at work and for the so-called global fallout (remnants of nuclear weapons tests and of accidents in nuclear power engineering facilities). Exposures from operation discharges from nuclear power facilities are also included.

General distribution of radiation doses to the population (in compliance with UNSCEAR 2008) is obvious from the following diagram.

Figure C.II.33: Distribution of radiation doses to the population



It is obvious that the natural exposure is fully dominant, followed by the medical exposures. It is obvious from the figure that radon in buildings and the terrestrial radiation of Earth's surface radionuclides (the surrounding terrain) are among the most significant natural radiation sources. Other contributions to the population exposure (including discharges from nuclear facilities) are of minority significance.

For comparison purposes, the following table gives average annual effective dose values from all significant natural and artificial radiation sources for years 1993 and 2008 (in compliance with UNSCEAR data).

Table C.II.32: Comparisons of contributions from individual radiation sources to the population exposure for years 1993 and 2008

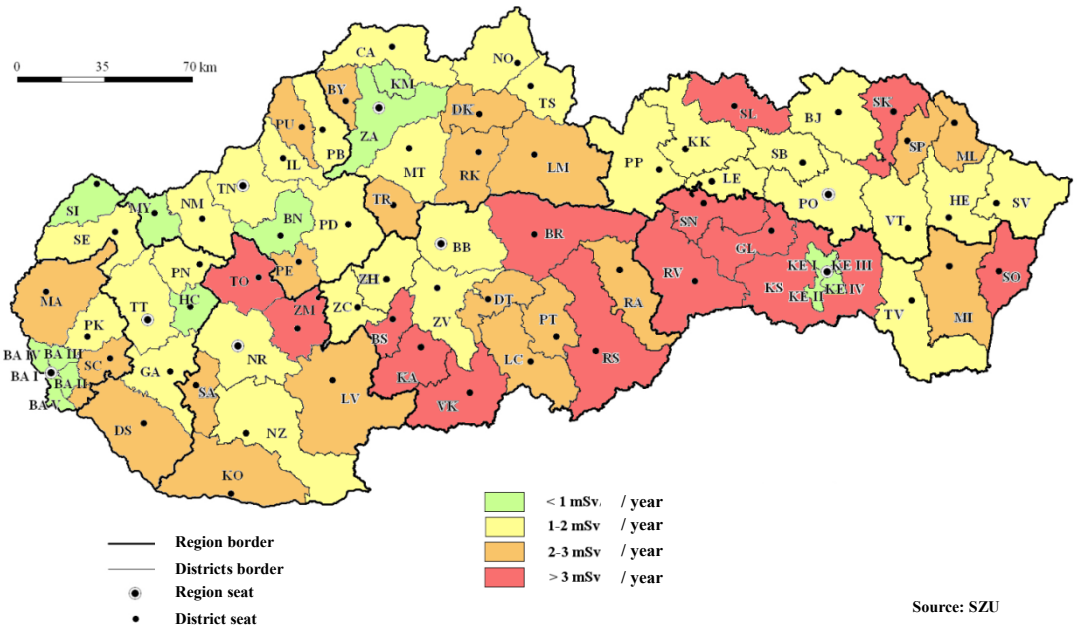
Radiation source	Year 1993		Year 2008	
	[mSv/year]	[%]	[mSv/year]	[%]
Cosmic radiation	0.39	14.50	0.39	12.85
External terrestrial radiation	0.46	17.10	0.48	15.82
Internal exposure – by ingestion of radionuclides	0.23	8.55	0.29	9.58
Radon	1.30	48.33	1.26	41.61
Other	0.01	0.37	0.01	0.33
Total of natural sources	2.39	88.85	2.43	80.18
Medical radiation sources	0.30	11.15	0.60	19.82
Total of all sources	2.69	100.00	3.03	100.00

It is obvious that the cosmic and external exposure levels, as well as the value of exposure from natural sources as a whole in the year 2008 are similar to those in 1993. Medical exposures (medical applications of ionizing radiation used for diagnostic purposes) are the most significant of artificial sources of the population radiation load. This component also represents the most progressive increase - in compliance with UNSCEAR data of 2008, it has doubled on an average with regard to the year 1993, while this dose is higher in developed countries, approximtely 2 mSv/year is quoted. On the other hand, the contribution of radon exposures in buildings has decreased slightly which can be attributed to the development of radon monitoring and to the application of anti-radon measures. Contributions of other artificial sources of the population radiation loads (including nuclear power engineering) remain insignificant. Natural radiation sources that cannot be fully eliminated represent a certain basic level of the population exposure. In compliance with the mentioned data, the average effective exposure dose to individuals in the population worldwide is on the level of approximately 2.4 mSv/year and represents the most significant contribution to the collective effective dose to the human population.

The natural radiation background under conditions existing in the Slovak Republic corresponds to those values and represents a total effective dose per inhabitant of approximately 3 mSv/year. In addition to the altitude above sea level, the total dose is mainly affected by conditions in which gaseous radon is released from the soil and bedrock into the surrounding

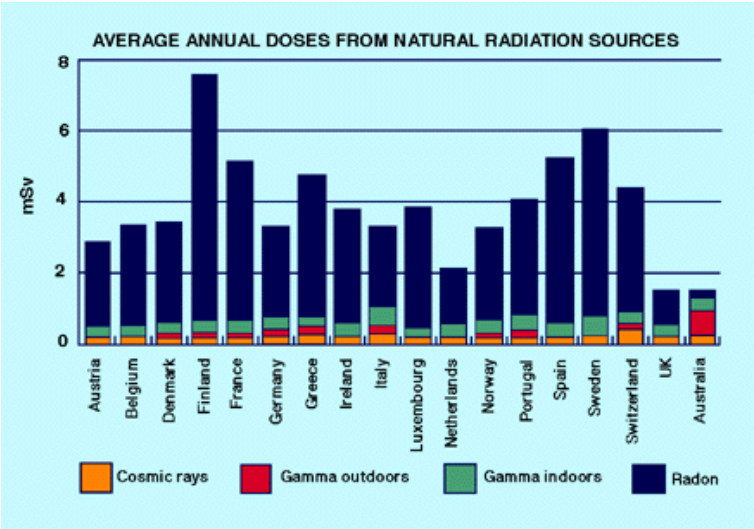
air. The average annual effective dose from the radon (and its daughter products) inhalation in residential premises for an SR inhabitant is approximately 2 mSv/year. The dose varies by regions, depending on the bedrock geological structure and properties, as obvious from the following figure.

Figure C.II.34: Average annual individual effective dose from radon inhalation in residential premises by SR districts



Natural radiation background values (caused, mainly by radon) are even higher in some European countries, as shown in the following figure (according to World Nuclear Organisation, 2015).

Figure C.II.35: Average annual effective doses per inhabitant from natural radiation sources



C.II.15.3.2. Radiation Situation on the Concerned Territory

C.II.15.3.2.1. Input Data

Basic information for the territory radiation situation assessment in relation to the existing nuclear facilities include measurements at the source, i. e., results of monitoring of their gaseous and liquid discharges, or surveillance measurements of radioactive materials, activities of which make it possible to release them from the radiation emitter

supervision measures. Exposures – effective doses to representative persons living in the surroundings of the nuclear facilities – are determined by model calculations on the basis of measured values. Results of monitoring – of measurements performed in the environment – forms information necessary for the territory radiation situation assessment. .

C.II.15.3.2.2. Emission Situation on Site

C.II.15.3.2.2.1. Assessment of Nuclear facilities Discharges on Site

At present, multiple nuclear facilities are found on the EBO site in different life cycle stages (see Chapter A.II.8.4. 'Data on Additional Installations and Proposed Facilities on Site', page 111 of the present Report).

Radioactive effluents discharged by those installations are monitored. The monitoring system serves to monitor radioactive substances discharged from the nuclear facilities (into the air, or to watercourses) and provides the supervision over the (not)exceeding of authorized effluent limits determined by regulatory bodies (by the Chief Hygiene Officer - by means of the Public Health Authority of the Slovak Republic in Bratislava, by the Nuclear Regulatory Authority of the Slovak Republic and, in case of liquid effluents, by the District Authority in Trnava, the Environment Care Department, by the Section of State Administration of Water and by selected environment protection organizations).

Gaseous effluents are monitored for reason of the provision of monitoring over the adherence to determined legislative and authorized limits and on account of the alarm annunciation of exceeding reference levels of radioactive substance discharges into the environment. The supervision over the gaseous effluents monitoring includes the supervision over the adherence to determined limits of radioactive substance discharges into the air (noble gases, aerosols and vapours – e. g., of iodine) through the ventilation stack during the operation under normal conditions and in accident states and post-accident situations and the alarm annunciation of radioactive substance discharges into the environment and the determination of activity amounts discharged into the environment through ventilation stacks during accident states. Further on, the balance (off-line) monitoring of gaseous effluents is provided on the basis of sampling and subsequent selective laboratory assessments.

Liquid effluents are monitored for reason of supervision over the adherence to determined limits and of the alarm annunciation of radioactive substance discharges. The supervision over the liquid effluents is provided by the activity monitoring of waters discharged from the EBO site. Monitoring measurements are complemented by laboratory volumetric activity measurements of radionuclides. As in case of gaseous effluents, balance values are calculated in order to calculate impacts of those effluents. Thus, it is ensured that the authorized limits will not be exceeded during the waste water discharge (in case that authorized levels of liquid effluent activities from selected surveillance tanks are exceeded, the system will ensure that the discharge is interrupted).

Results of the monitoring are evaluated on a regular basis. All kinds of radioactive substances (RAL) discharged from the nuclear facilities on the EBO site (since their commissioning till the present day) into the air and to watercourses were deeply below the determined authorized radiological limits.

Authorized amounts of radioactive substances discharged from the nuclear facilities on the EBO site into the atmosphere and hydrosphere are determined by authorized annual limits[19]. The authorized limit is determined for individual nuclear

[19] SE-EBO (JE V2): Decisions issued by ÚVZ, OOZPŽ/6774/2011 of 25 October 2011, authorizing the discharge of radioactive substances produced during the SE-EBO operation, from administrative supervision by means of their discharging into the atmosphere, Váh River and Dudváh River.

JAVYS: for JE A1: Decisions issued by ÚVZ, OOZPŽ/7119/2011 of 21 October 2011, authorizing the discharge of radioactive substances from A1 premises from administrative supervision by means of their discharging in the form of exhalations through ventilation stacks found on the A1 site into the atmosphere and in discharge waters drained to the Váh River and Dudváh River.

JAVYS: JE V1: Decisions issued by ÚVZ, OOZPŽ/3760/2011 of1 July 2011, authorizing the discahrge of radioactive substances produced due to activities related to the JE V1 decommissioning from administrative supervision by means of their discharging in the form of exhalations through ventilation stacks found on the A1 site into the atmosphere and in discharge waters drained to the Váh River and Dudváh River.

The JE A1 ventilation stack is divided into two parts (parts A and B), to which separate JE A1 objects are connected. Separate maximum authorized indicative values of effluents into the amosphere are determined for each part.

facilities as an effective dose, namely based on decisions issued by the Public Health Authority of the Slovak Republic (ÚVZ SR) authorizing radioactive substance discharges into the environment. Operators of the nuclear facilities then must ensure, in compliance with legal regulations in force, that the effective dose to the representative person from the critical population group caused by the radioactive substances discharged into the air and surface waters will not exceed the authorized radiological limits of the effective dose per an inhabitant. At present, the limits are determined for individual operators of nuclear facilities found on the Bohunice site, as follows.

Table C.II.33: Indicative effective dose values to a representative person from the population

Nuclear facility	Limit	Note
JAVYS Nuclear facility	32 µSv/year	Out of which: 20 µSv/year for JE V1 12 µSv/year for other JAVYS nuclear facilities (JE A1, TSÚ RAO, MSVP)
SE Nuclear facility	50 µSv/year	For JE V2

The sum of authorized radiological limit values (82 µSv/year) for all the nuclear facilities installed on the Bohunice site is lower, with a sufficient margin, that the limit dose for the complex of nuclear facilities in compliance with the Regulation of the Government of the Slovak Republic No. 345/2006, Coll., on Fundamental Safety Requirements for the Protection of Employees and Population from Ionizing Radiation, (250 µSv/year) and is insignificant with regard to the natural background radiation (approximately 3,000 µSv/year).

The permit issued by the Public Health Authority if the Slovak Republic (ÚVZ) to discharge radioactive substances into the environment also includes additional duties of the permit holders. The most important duties include the following:

- adhere to reference levels (record, investigation and intervention levels) determined in the form of derived daily effluents of individual gaseous exhalation components (noble gases, I-131 and a mixture of long-lived aerosols),
- monitor, or determine individual gas exhalation components and liquid effluents,
- in order to monitor and determine activities of discharged radioactive substances activity, use metrologically verified measurement systems (the so-called reserved gauges),
- announce cases when limits were exceeded to the Public Health Authority of the Slovak Republic,
- inform the Authority on activities of discharged gaseous exhalations and liquid discharges (quarterly), on annually activity balances of exhalations and discharge waters and on assessment of their impact on the population dose loads, based on a model (annually).

Maximum authorized indicative values of discharges are determined in decisions issued by to the Public Health Authority of the Slovak Republic for effluents of the most important types of radioisotopes and their groups. The indicative values are determined for directly measurable quantities that can be evaluated continually or periodically prior to the introduction of the relevant radionuclide into the environment (a typical case: the take-off and evaluation of a sample for the H-3 activity in a surveillance tank of discharge water). The non-exceeding of the indicative values is ensured by the adherence to determined radiological limits evaluated on a regular basis using calculations. The indicative values are presented in the following table.

Table C.II.34: Indicative values for activities of radionuclides discharged from the complex of nuclear facilities in Jaslovské Bohunice into the atmosphere and hydrosphere

Type of effluents			Indicative values for annual effluents					
			JAVYS					SE-EBO
Atmosphere								
Ventilation stack:			JE A1 (part A)	JE A1 (part B)	BSC	MSVP	JE V1	JE V2
Noble gases (any mixture)		[TBq/year]	-	-	-	-	-	2,000
Radioisotope I-131 (gaseous and aerosol forms)		[MBq/year]	-	-	-	-	-	65,000
Aerosols	Mixture of long-lived radionuclides	[MBq/ year]	658	141	141	300	80,000	80,000
	Strontium Sr-90		19.6	4.2	4.2		140	140
	Mixture of alpha radionuclides		6.16	1.32	1.32	-	20	20
Hydrosphere								
			JE A1 + BSC			JE V1 + MSVP		JE V2
Recipient – Váh River								
Tritium		[GBq/ year]	10,000			2,000		20,000
Corrosion and fission products		[MBq/year]	12,000			13,000		13,000
Recipient – Dudváh River								
Tritium		[GBq/year]	37			20		200
Corrosion and fission products		[MBq/ year]	120			130		130
Concentration limits (applicable to both recipients)								
Tritium		[MBq/m^3]	195					
Corrosion and fission products		[kBq/m^3]	37					

The determination of the so-called critical group of the population, or a representative person from the critical group of the population, is the basis of the assessment methodology of population exposure effects. The critical group is defined within the meaning of the Regulation of the Government of the Slovak Republic No. 345/2006, Coll., on Fundamental Safety Requirements for the Protection of Employees and Population from Ionizing Radiation, as a "model group of physical persons representing those individuals from the population who are exposed at the most from the given source and by the given exposure paths". Population exposures are evaluated by operators of individual nuclear facilities (including the verification/validation of determination of the critical group of the population – a representative person) and submitted in annual reports to relevant regulatory bodies and the public. The critical group of the population can vary for individual years (e. g., depending on the actual distribution of wind directions). Effective doses to the population living in the surrounding of the nuclear facility Jaslovské Bohunice, calculated on the basis of the total activity of radionuclides discharged into the atmosphere and hydrosphere from individual nuclear facilities on the site for recent 20 years, are presented in the following table.

Table C.II.35: Annual effective doses to a representative person from nuclear facilities on the Jaslovské Bohunice site for the period from 1994 till 2013

Year	Effective dose	Municipality (area)	Note
1994	4.03 x 10^{-7} Sv/year	Žlkovce	
1995	1.54 x 10^{-7} Sv/year	Žlkovce	
1996	4.63 x 10^{-7} Sv/year	Žlkovce	
1997	3.71 x 10^{-7} Sv/year	Žlkovce	
1998	1.64 x 10^{-7} Sv/year	Žlkovce	
1999	6.63 x 10^{-8} Sv/year	Malženice	After the termination of liquid waste technical water discharge into the Dudváh River recipient, inhabitants of municipalities become the critical group, depending on the prevailing wind direction.
2000	1.50 x 10^{-7} Sv/year	Malženice	
2001	1.80 x 10^{-7} Sv/year	Malženice	
2002	1.96 x 10^{-7} Sv/year	Malženice	
2003	7.59 x 10^{-8} Sv/year	Pečeňady	
2004	1.32 x 10^{-7} Sv/year	Pečeňady	
2005	1.19 x 10^{-7} Sv/year	Pečeňady	
2006	1.01 x 10^{-7} Sv/year	Bohunice	Individual nuclear facilities that are radiation sources participated in the maximum effective dose value as follows: EBO (JE V2): 51.24%, JAVYS: 48.76% (out of which JE V1: 48.71% and VYZ: 0.05%)
2007	2.24 x 10^{-7} Sv/year	Pečeňady	
2008	2.16 x 10^{-7} Sv/year	Pečeňady	
2009	2.07 x 10^{-7} Sv/year	Pečeňady	
2010	1.56 x 10^{-7} Sv/year	Pečeňady	
2011	SE: 1.72 x 10^{-7} Sv/year JAVYS: 4.14 x 10^{-8} Sv/year	Pečeňady Ratkovce, Žlkovce	Since the year 2011, effective doses to a representative person from the population have been calculated separately for JAVYS and for SE (JE V2)
2012	SE: 1.85 x 10^{-7} Sv/year JAVYS: 3.98 x 10^{-8} Sv/year	Pečeňady Ratkovce, Žlkovce	
2013	SE: 2.07 x 10^{-7} Sv/year JAVYS: 1.47 x 10^{-8} Sv/year	Pečeňady Ratkovce, Žlkovce	

The results show that actual effective doses achieve less than 1 % of the authorized limits determined for a representative person from the population (and, thus, they are by 4 orders lower than doses resulting from the natural radiation background).

C.II.15.3.2.2.2. Characteristics of Radioactive Substances Discharged from Existing Nuclear facilities

Discharges into the Air

The radioactive gases in the form of noble gases, aerosols and vapours (e. g., iodine vapours) produced in technological systems of the operated nuclear power plants are, after the purification by gas purification plant, discharged into the environment in the controlled manner by means of ventilation systems through ventilation stacks.

Gas-air mixture activities are significantly reduced in aerosol and iodine filter systems so that radioactive noble gases (mainly short-lived Xe-133, Xe-135 and Ar-41) prevail at the outlet from the ventilation stack of operated JE V2 reactor units. In case of decommissioned JE A1 and JE V1 and of nuclear facilities within which no fission process is running (spent nuclear fuel storage premises, or radioactive waste treatment and conditioning facilities and radioactive waste storage rooms), long-lived gaseous radionuclides (Kr-85, H-3, C-14) can only occur in gaseous exhalations.

Actual values of radioactive substance discharges for the period from 2011 till 2013 (when a decrease mainly in gaseous discharges into the atmosphere evident due to the JE V1 shutdown) are presented in the following table. It is obvious that real activity values for substances discharged into the air only achieve a fraction of the maximum authorized indicative values (single units of % for noble gases and < 1 % for other components).

Table C.II.36: Real values of discharges into the atmosphere from individual nuclear facilities on the Bohunice site for the period from 2011 till 2013

Type (group) of discharges		JAVYS		SE-EBO	Total for Bohunice nuclear facilities
		JE A1, TSÚ RAO, MSVP	JE V1	JE V2	
year 2011					
radioactive noble gases	[Bq/year]		2.06E+09 *	8.50E+12	8.50E+12
iodine (I -131)	[Bq/year]		4.23E+05 *	4.60E+05	8.83E+05
long-lived aerosols	[Bq/year]	2.63E+06	9.46E+06	5.90E+06	1.80E+07
strontium	[Bq/year]	1.58E+05	2.29E+04	6.00E+04	2.41E+05
alpha aerosols	[Bq/year]	1.55E+04	2.50E+03	2.94E+03	2.09E+04
year 2012					
radioactive noble gases	[Bq/year]		2.06E+09 *	6.03E+12	6.03E+12
iodine (I -131)	[Bq/year]		4.23E+05 *	3.80E+05	8.03E+05
long-lived aerosols	[Bq/year]	2.52E+06	2.82E+06	8.17E+06	1.35E+07
strontium	[Bq/year]	1.28E+05	1.21E+03	5.27E+04	1.82E+05
alpha aerosols	[Bq/year]	2.11E+04	2.05E+02	1.27E+03	2.26E+04
year 2013					
radioactive noble gases	[Bq/year]		2.06E+09 *	4.33E+12	4.33E+12
iodine (I -131)	[Bq/year]		4.23E+05 *	4.02E+05	8.25E+05
long-lived aerosols	[Bq/year]	2.52E+06	2.82E+06	6.19E+06	1.15E+07
strontium	[Bq/year]	1.28E+05	1.21E+03	6.84E+04	1.98E+05
alpha aerosols	[Bq/year]	2.11E+04	2.05E+02	1.63E+03	2.29E+04

* Since 20 July 2011, on the basis of a decision issued by the state regulatory body, the operator of the shutdown JE V1 is not obliged to evaluate activities of noble gases and I-131 in gaseous exhalations from the JE V1, the given value corresponds to MDAs in the JE V1 ventilation stack.

It is obvious that, after the JE V1 shutdown, the JE V2 operation has a decisive impact on the surrounding environment. The following table gives activity values for individual components of gaseous effluents discharged into the atmosphere from the JE V2 ventilation stack for the period from 2007 till 2013. Measured maximum values of effluents discharged into the atmosphere for individual isotopes ('envelope' maximum values) are presented in Chapter B.II.5. 'Radiation and Other Physical Fields' (page 137 of the present Report).

Table C.II.37: Overview of representations by individual limited radionuclides in annual discharges into the atmosphere from the JE V2 for the period from 2007 till 2013

Radionuclide		Discharged activities by individual years							Average value	% of indicative value
		2007	2008	2009	2010	2011	2012	2013		
radioactive noble gases	[TBq/year]	6.48	4.99	5.1	7.13	8.51	6.03	4.33	6.08	0.304
iodine I-131 *	[MBq/year]	0.43	0.46	0.30	0.37	0.46	0.38	0.40	0.40	0.001
sum of gamma aerosols	[MBq/year]	10.186	9.691	7.873	6.798	5.930	8.17	6.19	7.83	0.010
Sr-89+90 aerosols	[kBq/year]	177.4	124.7	87.94	63.32	59.71	52.73	68.44	90.61	0.065
Sum of alpha aerosols	[kBq/year]	25.74	11.95	21.35	5.95	2.94	1.27	1.63	10.12	0.051
tritium H-3	[GBq/year]	688.8	638.7	593.2	448.3	491.1	679.7	534.5	589.97	N/A **
sum of C-14	[GBq/year]	329.1	338.7	393.96	398.7	297.8	421.1	435.8	363.23	N/A **

* Sum of both aerosol and gaseous forms.
** No maximum indicative values are determined for gaseous effluents of H-3 and C-14.

In accordance with the data in the table above, actual values of annual activities of individual gaseous exhalation components discharged from the JE V2 are deeply below the maximum indicative values.

Discahrges into watercourses

Radioactive substance discharged with waste waters, which are in compliance with the authorized limits, are discharged from all nuclear facilities on the site via an underground pipeline channel (Socoman) into the Váh River. The Socoman Channel flows into the Drahovce Channel downstream of the Hydro Power Plant Madunice. The water is discharged in the

off-balance regime from technological circuits of the operated JE V2 reactor units, from the JE A1 and JE V1 that are being decommissioned, from radioactive waste treatment and conditioning technologies, and the purified radioactive water from purification plants and the heating steam condensate are also included. The water is discharged from the facilities into the special radioactive water purification system, then, after the purification by ion exchanger filters, it is drained into surveillance tanks and, after the analysis and acknowledgement that the maximum authorized concentrations are not exceeded, the water is discharged into the hydrosphere in a regulated manner, or it is repeatedly purified by the purification plants (if the maximum authorized concentrations are exceeded).

Regarding the volumetric activity measurements, H-3 activity is relatively easy to measure, fission and corrosion product activities are determined in laboratories where low values of Cs-134, Cs-137 can be measured; contents of other mentioned radionuclides is ranging on the determinability border or below.

The low-activity water discharged from the operated JE V2 reactor unit includes, above all, the purified off-balance water from purification plants of technological circuits and the heating steam condensate taken from evaporators in those purification plants. The water is discharged into the special waste water purification system. After the purification by ion exchanger filters, the water is drained into surveillance tanks. After the surveillance tanks are filled up, their contents is subjected to chemical and radiochemical analyses. Volumetric activities of corrosion and fission products contained in the waste water intended for the discharge must be lower than 3.7E+01 Bq/l and, in case of tritium, < 1,95E+05 Bq/l. Depending on results of monitoring measurements, the following is performed with the contents of the surveillance tanks:

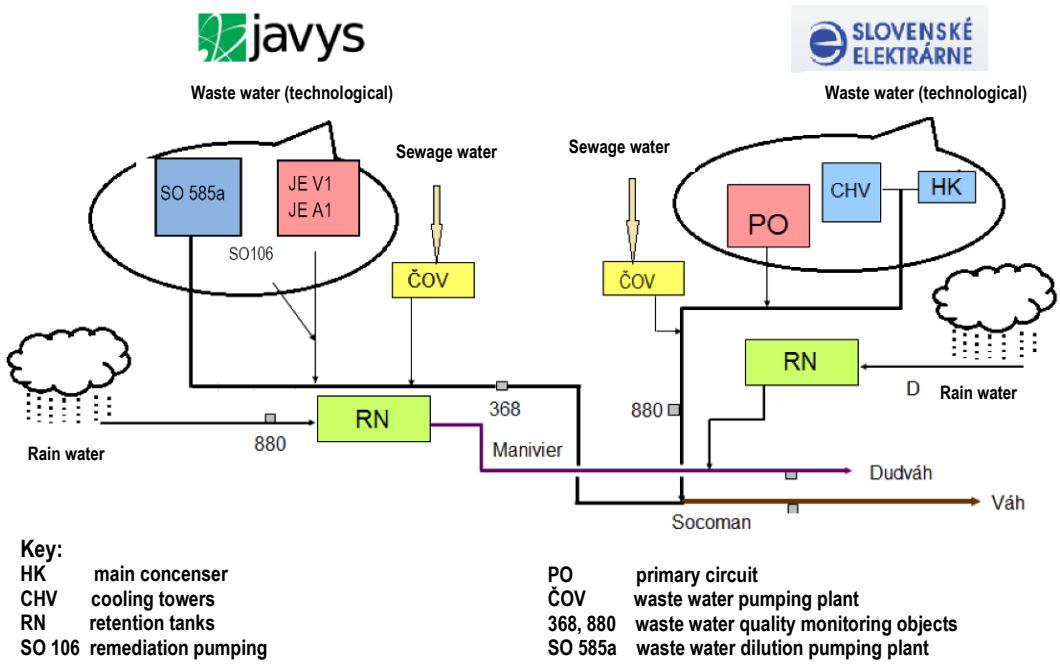
- it is repumped to pure condensate tanks for the subsequent use in the power plant,
- it is discharged to the industrial waste water collector channel – Socoman – and drained from the site as waste water,
- it is repumped to waste water tanks for the purification purposes.

The surveillance tanks are discharged in coordination with the non-active water flow rate in the resulting collector channel in order to ensure the dilution. If low-activity effluents are to be discharged, the following non-active waste water flow rate condition must be complied with: $Q \geq 375$ m^3/hour. Regarding the volume, the low-activity water discharged from the JE V2 represents approximately 60,000 m^3 annually which accounts for less than 1 % of all industrial waste water (approximately 99 % of waste water is the non-active warmed-up water from the cooling circuit). A possible exceeding of an activity limit during the low-activity waste water discharge results in an automatic shut-off of the border valve upstream of the intake to the Socoman sewer system.

Low-activity off-balance water from the operation of treatment lines in TSÚ RAO (and from lines installed in the JE A1 premises, too) and from the decommissioning of JAVYS (JE A1 and JE V1) nuclear facilities is the water that is produced, e. g., during the decontamination, bituminization, cementation processes, etc. The water is treated in the same way as the low-activity water from the JE V2 and, thus, it is purified and, after the radiochemical examination, discharged in the regulated manner as waste water to the recipient via the Socoman waste water collector. A part of effluents may be exceptionally drained from the JAVYS site via retention tanks to the Manivier Channel flowing into the Dudváh River recipient. Volumetric activity limits for effluents to the Dudváh River recipient are identical to the values determined for the Váh River recipient (1.95E+05 Bq/l for tritium and 3.7E+01 Bq/l for corrosion and fission products).

The diagram illustrating the discharge of waste and rain waters from the EBO site (JE V2 and JAVYS facilities) is presented in the following figure.

Figure C.II.36: Principal diagram of the discharge of waste and rain waters from the JE A1, JE V1 (JAVYS) and JE V2 (SE), current state



Annual discharged waste water activity values are limited in a manner similar to gaseous effluent activities. Real tritium activity values for radioactive substances discharged with the waste water to surface watercourses (the Váh River) achieve magnitudes on the level of 5 % of the maximum authorized indicative values for the JE A1 + TSÚ RAO, 25 % of the indicative values for the JE V1/MSVP and 50 % for the JE V2. The real discharged radioactive substance activity values for other corrosion and fission products are < 1 % of the authorized limits. Similar assessments hold true for effluents into the Dudváh River (if such discharges are exceptionally made).

The following tables present effluent activity values discharged into the hydrosphere from the JE V2, JE V1+MSVP and from the JE A1+TSÚ RAO. Measured maximum values of effluents discharged into the atmosphere for individual isotopes ('envelope' maximum values) are presented in Chapter B.II.5. 'Radiation and Other Physical Fields' (page 137 of the present Report).

Table C.II.38: Monitored values of liquid effluents from the JE V2 to Socoman for the period from 2003 till 2013

Year	Tritium			Corrosion and fission products		
	Indicative value	Reality	Percentage of limit	Indicative value	Reality	Percentage of limit
	[GBq/year]		[%]	[MBq/year]		[%]
2003	4.37E+04	6.21E+03	14.21	3.80E+04	3.42E+01	0.090
2004	4.37E+04	5.11E+03	11.69	3.80E+04	3.80E+01	0.100
2005	4.37E+04	6.29E+03	14.39	3.80E+04	4.18E+01	0.110
2006	4.37E+04	9.96E+03	22.79	3.80E+04	9.88E+01	0.260
2007	2.00E+04	5.52E+03	27.60	1.30E+04	1.56E+01	0.120
2008	2.00E+04	4.58E+03	22.90	1.30E+04	1.95E+01	0.150
2009	2.00E+04	1.02E+04	51.00	1.30E+04	1.56E+01	0.120
2010	2.00E+04	1.01E+04	50.50	1.30E+04	2.08E+01	0.160
2011	2.00E+04	9.53E+03	47.65	1.30E+04	2.42E+01	0.186
2012	2.00E+04	9.19E+03	45.95	1.30E+04	2.39E+01	0.184
2013	2.00E+04	9.76E+03	48.81	1.30E+04	2.50E+01	0.193

Note: Up to the year 2006, the indicative values are presented for the JE V1+V2; since the year 2007, for the JE V2 only.

During the period of parallel JE V1 and JE V2 operations, indicative values of maximum discharges into the hydrosphere had been determined for both the nuclear power plants and this state lasted until the year 2006. The limits were separated for the subsequent period (separate indicative values were determined for JE V1 and JE V2 discharges).

Tritium H-3 and corrosion and fission products (Cr-51, Mn-54, Fe-59, Co-57, Co-58, Co-60, Zn-65, Sr-89, Sr-90, Zr-95, Nb-95, Ru-103, Rh-106, Ag-110m, Sb-124, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Pu-238, Pu-239, Pu-240, Am-241) are the dominant radionuclides monitored in the JE V2 waste water. In compliance with a decision issued by the Public Health Authority of the Slovak Republic, the radionuclides are monitored for the purposes of balances and assessing the impact on the population dose load resulting from discharges into watercourses. In case that other radionuclides are also identified in the discharged radioactive substances, they will be included in the effluent balances. All radionuclides will enter the population dose load calculations whose measured activities exceed MDAs.

The dominant radionuclides contained in discharges into watercourses from other nuclear facilities on the site (decommissioned nuclear power plants A1 and V1, and other JAVYS nuclear facilities – TSÚ RAO and MSVP) monitored for those purposes, are radionuclides of similar structure, except that short half-life period radionuclides are missing and, the other way round, long half-life period radionuclides are added. A more detailed real measured radionuclide structure in both gaseous and liquid discharges from nuclear facilities of the Bohunice site is presented in Chapter B.II.5. 'Radiation and Other Physical Fields' (page 137 of the present Report).

If relatively stable levels of measured liquid radioactive substance discharge values from the JE V2 for recent years and for the period of parallel JE V1 and JE V2 operations (i. e., prior to the separation of effluent limits from both the installations) are considered, it is possible to expect balanced trends in JE V2 effluent amounts, or activities, in the future that will not differ markedly from the present period.

Table C.II.39: Monitored values of liquid effluents from the JE V1 and MSVP to Socoman for the years from 2011 to 2013

Year	Tritium			Corrosion and fission products		
	Limit	Reality	Percentage of limit	Limit	Reality	Percentage of limit
	[GBq/year]		[%]	[MBq/year]		[%]
2011	2.00E+03	5.76E+02	28.80	1.30E+04	2.27E+01	0.175
2012	2.00E+03	8.05E+00	0.403	1.30E+04	1.25E+01	0.096
2013	2.00E+03	1.22E+01	0.61	1.30E+04	1.73E+01	0.133

After both the JE V1 reactor units operation had been terminated, the liquid effluent activity markedly decreased. In the coming time period, an overall, slightly decreasing, activity trend for discharges into the hydrosphere can be expected to which the scheduled JE V1 decommissioning will mainly contribute. In case of MSVP object, a rather balanced effluent activity trend can be expected in the coming period resulting from the interim spent fuel storage facility operation character.

Table C.II.40: Monitored values of liquid effluents from the JE A1 and TSÚ RAO to Socoman for the years from 2011 to 2013

Year	Tritium			Corrosion and fission products		
	Limit	Reality	Percentage of limit	Limit	Reality	Percentage of limit
	[GBq/year]		[%]	[MBq/year]		[GBq/year]
2011	1.00E+04	3.46E+02	3.46	1.20E+04	1.02E+02	0.85
2012	1.00E+04	2.28E+02	2.289	1.20E+04	8.47E+01	0.706
2013	1.00E+04	1.10E+02	1.10	1.20E+04	7.24E+01	0.603

In the coming time period, it is possible to expect balanced trends in liquid effluent activities with regard to the continuing JE A1 decommissioning and to the TSÚ RAO treatment lines operation scheduled in the long term.

Table C.II.41: Monitored values of liquid effluents from the JE A1 to Manivier (Dudváh River) for the years from 2011 to 2013

Year	Tritium			Corrosion and fission products		
	Limit	Reality	Percentage of limit	Limit	Reality	Percentage of limit
	[GBq/year]		[%]	[MBq/year]		[GBq/year]
2011	3.70E+01	2.00E-03	0.005	1.20E+02	3.57E-01	0.298
2012	3.70E+01	1.00E-03	0.003	1.20E+02	6.04E-01	0.503
2013	3.70E+01	-	0.000	1.20E+02	-	0.000

Note: No low-activity water was discharged to the Dudváh River recipient in the year 2013.

There is a possibility for the decommissioned JE A1 to also discharge low-activity effluents via the Manivier collector channel to the Dudváh River recipient in compliance with permits in force. This applies in substantiated cases during repairs or revisions of the Socoman industrial waste water collector channel. A separate discharge consent must be issued be the regulatory body.

In the coming time period, it is possible to expect decreasing trends in low-activity liquid effluent discharge from the JE A1 to the Dudváh River (regardless of the year 2013) and no sudden significant change in the trends of active effluents production to that recipient is assumed.

On the whole, it is obvious from the above given data that tritium effluents from the JE V2 have a decisive impact on discharges to the hydrosphere. In case of corrosion and fission products, JE A1 + TSÚ RAO effluents have a dominant impact.

C.II.15.3.2.3. Emmission Situation on Site

C.II.15.3.2.3.1. Bohunice Nuclear facilities Surroundings Monitoring Systems

The monitoring of the surroundings of nuclear facilities means the monitoring of possible radionuclide occurrences in individual environment components. As long as real measured values are ranging within experimental errors on the radiation background level, it means that the impact of the nuclear facilities operation on the surroundings is insignificant. The major task of the surroundings monitoring is the observation and assessment of population exposures in the surroundings of the nuclear facilities, based on knowledge of basic parameters (such as values of dose rate or measured radionuclide activities in individual environment components) and additional parameters affecting individual exposure paths to the surrounding population. Moreover, the surroundings monitoring system serves to identify long-term trends in the radioactivity of environment components and to search for connections among the development of relevant quantities and the existence of nuclear facilities. In case of extraordinary events occurring in nuclear facilities on the site, or radiation events abroad, the monitoring system serves to indicate radiation impacts and to verify the efficiency of possible measures.

Under normal conditions, as long as individual nuclear facilities are operated in compliance with the design and both gaseous and liquid discharges are controlled in compliance with conditions specified by relevant regulatory bodies, it is only possible to determine exposures of the surrounding population exposure indirectly, using calculation models where radionuclide activities in gaseous and liquid effluents and parameters affecting the transfer of radionuclides by environment components to the surrounding population are the major input parameters.

The radiation monitoring system of the surroundings of the nuclear facilities on the Bohunice site is focused on the monitoring over the following:

- radiation characteristics by means of measuring dose rates above the ground surface and radionuclide activities in aerosols and fallouts in the low-level atmosphere layer,
- contamination of developed areas on the site and of ground surfaces in the terrain surrounding the site,
- sub-surface water in the non-saturated (i. e., not saturated with fresh ground water) geological stratum using drainage and infiltration probes in the surroundings of tanks where the potentially contaminated water is stored,
- ground water in the saturated (i. e., saturated with fresh ground water) geological stratum in both the local and regional scales,
- surface hydrological systems representing: water recipients for liquid effluents (Socoman Channel – Váh River – Kráľová Water Reservoir, or Manivier Channel – Dudváh River – Váh River for the water from the rain sewer system and for the case of extraordinary effluents), potable, irrigation and other industrial water sources,
- radionuclide occurrences in the environment components characteristic of the given site (fodder crops, vegetables, fruits, meat, milk, etc.).

The following means are used for the monitoring purposes.

Teledosimetry System

The teledosimetry system (TDS) enables to monitor the surroundings of the nuclear facilities on the Jaslovské Bohunice site automatically and continually by means of measuring and recording the following quantities:

- dose rates from the external gamma radiation,
- volumetric activities of aerosols,
- radioiodine volumetric activity and its time integral.

Measurements installed in ventilation stacks at the JE V2 (noble gases, aerosols and iodine) and JE V1 (aerosols) are also connected to the teledosimetry system (TDS).

TDS is installed in the form of three circuits. The first circuit consists of 5 fixed stations built on the EBO site itself – 3 on the JE V1 site and 2 on the JE V2 site. 24 probes are connected to E4 and E5 stations. The probes are installed on the JE V2 site fencing and are intended to measure the plume dose rates (likewise, 24 probes were also connected to stations built on the JE V1 site. The probes were installed on the JE V1 site fencing and are intended to measure the plume dose rates – they were disconnected following the JE V1 shutdown) The second circuit includes the nearest municipalities within the distance from 3 to 6 km from the nuclear facilities site with 15 fixed stations. The third circuit involves towns within the distance of up to 15 km from the nuclear facilities site, with higher concentrations of the population (Vrbové, Piešťany, Hlohovec, Trnava). The layout of the teledosimetry system monitoring points is obvious from the following figures.

Figure C.II.37: Layout of TDS JE V2 local network first circuit monitoring points

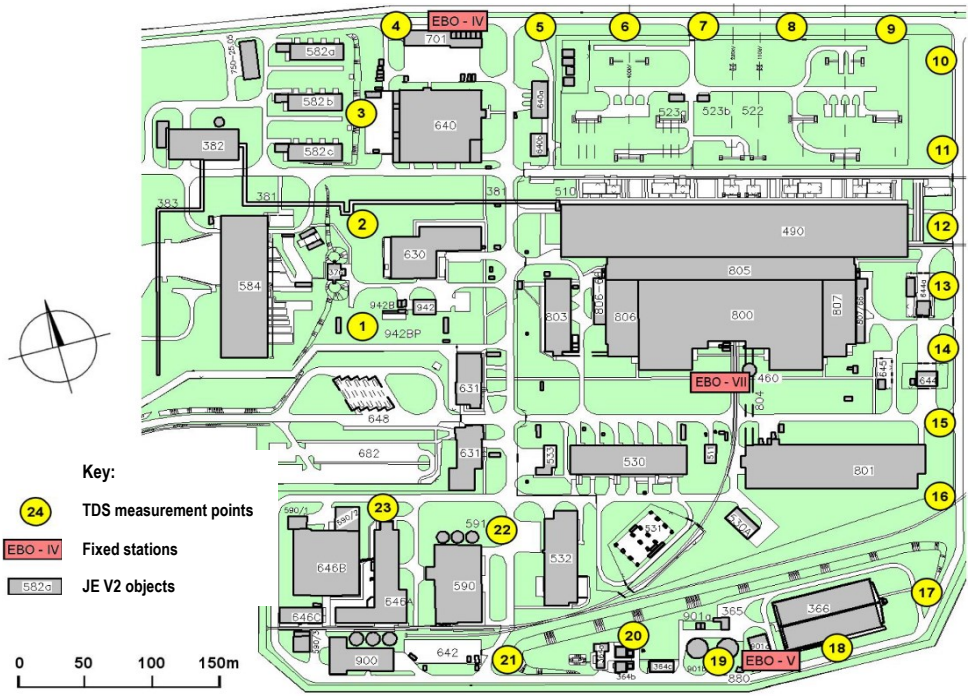
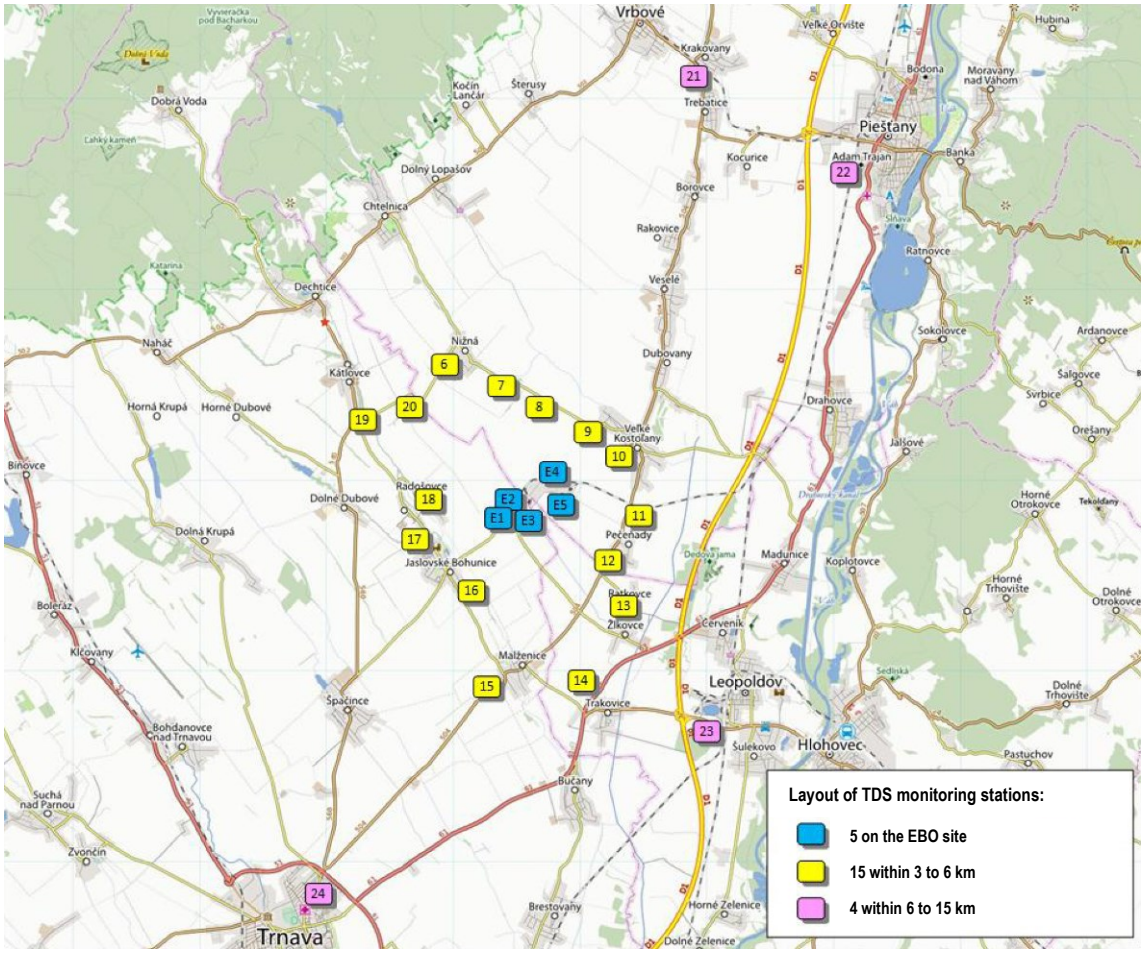


Figure C.II.38: Layout of monitoring points of three circuits of local network of TDS installed on the Bohunice nuclear facilities site



Sampling devices and devices measuring activities of aerosols and radioiodine, dose rates and $CaSO_4$-type thermoluminiscence dosimeters used to determine integral monthly doses of external radiation, as well as facilities necessary for the operation of those stations and transmissions of the measured data to the central computer of the system installed in the Environment Radiation Supervision Laboratory (LRKO) building in Trnava, are installed in the fixed stations of the teledosimetry system. The thermoluminiscence dosimeters (TLD) used to determine integral monthly doses of external radiation are installed in all the fixed TDS stations and, in addition to that, at 32 municipality authorities in the surroundings of the complex of Bohunice nuclear facilities, within the distance of 21 km.

The TDS system is administered by SE company. The basis of the existing TDS can also be used for the NJZ with the necessity to complement the first circuit and, in compliance with currently valid requirements for the monitoring system, possibly also modify other circuits, while the second and third circuits are basically convenient to the NJZ at present. The decision on the particular solution of the TDS for the NJZ will be made during the NJZ design delivery.

Mobile Monitoring Means

Mobile monitoring means serve to get further details on the radiation situation at points found in the surroundings either in compliance with the monitoring program, or on an operative basis, as necessary, the most often based on TDS measurement results. Using mobile means, it is possible to take samples, to measure dose rates from the external gamma radiation, the ground contamination by means of the so-called in-situ spectrometry, or it is possible to sample aerosols, iodine vapours in the low-level atmosphere layer, or, possibly, to deploy or collect thermolumiscence dosimeters used for the measurement of external gamma radiation doses.

Monitoring Using the Environment Sampling

The monitoring of all major environment components in the surroundings of nuclear facilities found on the EBO site is performed by the Environment Radiation Supervision Laboratory (LRKO) in Trnava that is accredited for the given activities and by regulatory bodies (the Public Health Authority of the Slovak Republic, the Ministry of Environment of the Slovak Republic). LRKO performs the monitoring in compliance with the approved EBO Nuclear facilities Surroundings Radiation Supervision Monitoring Program. In addition to LRKO, additional organizations are dealing systematically with the monitoring of radionuclide occurrences in the surroundings of nuclear facilities on the EBO site from the point of view of assessing the impact of that complex on the environment:

- EKOSUR company performs a complex monitoring of both ground and infiltration waters since the year 1997,
- The Public Health Authority of the Slovak Republic performs the monitoring of ionizing radiation dose equivalent rates, activities of aerosols in the air, radioactive fallouts and the contamination of food, potable water, mineral and surface waters and additional environment components by radioactive substances in the surroundings of nuclear facilities and nationwide,
- The Slovak Hydrometeorological Institute (SHMÚ) Bratislava, Jaslovské Bohunice observatory, performs the monitoring of climatic and meteorological parameters in the area necessary for the climatic database generation, model calculations of effluent impacts and produces prognoses of impacts caused by possible accidents; moreover, SHMÚ also performs the monitoring of surface water quality including the radiation monitoring.

Environment components characterizing individual radionuclide paths from the operation to a man (exposure paths) are supervised by means of sampling. When determining general sampling procedures, sample processing procedures and measurement conditions, everything starts from the requirement that, in case of radionuclides that are characteristic of the nuclear facilities impact assessment on the environment, their minimum detectable activities in environment samples are near to the radiation background levels. Reference "investigation"levels are determined on the basis of statistical assessments of activities showed by those radionuclides in environment samples performed over a sufficiently long time period. If the levels are exceeded, the reason for this and the relation to the existence of nuclear facilities on the site is examined. The anthropogenic radionuclides that occur in common in the radiation background (i. e., they are a part of the so-called global fallout) and that, at the same time, occur in gaseous and liquid effluents from nuclear facilities include the following: Cs-137, Sr-90, H-3, C-14 and Pu-239. The presence of those radionuclides in the radiation background also affects the total beta (Σβ) and the total alpha (Σα) activities of the radiation background. With regard to the fact that activities of the mentioned radionuclides in the global fallout are continually decreasing after nuclear weapon tests in the atmosphere were prohibited (accidents in nuclear power plants, such as Chernobyl in 1986 and Fukushima in 2011, only showed short-term impacts), activity measurements of anthropogenic radionuclides in the radiation background are becoming more and more difficult.

The following items are monitored by means of sampling on the Bohunice site:

- aerosols and fallouts in the low-level atmosphere layer,
- solids and sediments,
- individual food chain links (fodder crops, agricultural products, vegetables, fruits, meat, milk, etc.),
- potable and surface waters in water recipients Manivier, Dudváh River and Váh River (including Kráľová Water Reservoir),
- ground water in the first saturated stratum under the nuclear facilities site area, but in the wider surroundings, too.

Aerosols: Fixed dosimetry stations of the teledosimetry system.

Sampling points: EBO I-V, Jaslovce, Bohunice, Radošovce, Kátlovce I-II, Nižná I-II, Veľké Kostoľany I-III, Pečeňady I-II, Žlkovce, Malženice, Trakovice, Krakovany, Piešťany, Šulekovo, Trnava.

Measurements: a gamma spectrometric analysis after the gamma spectrometric analysis, filters taken from EBO-III and Trnava stations are processed for the radiochemical analysis for Sr-90 contents and, at the same time, the EBO-III filter is processed and analysed for the presence of alpha radionuclides. After the analyses, a part of the filters is handed over to ÚVZ Trnava where analyses for the presence of heavy metals are performed.

Fallouts: Sampling points: EBO site, Veľké Kostoľany, Bohunice, Nižná, Pečeňady, Trnava.

After the processing and gamma spectrometric analysis, the strontium analysis is performed. At the same time, the presence of alpha radionuclides is determined on the basis of EBO-III station data.

Soil: The soil pollution by radionuclides is identified by the following methods:

- in-situ gamma spectrometric method,
- dose rate measurements using ionizing chambers,
- sampling and sample laboratory analysis.

Sampling points: samples are taken at points of external TDS stations: EBO A1, V1, V2, Krakovany, Veľké Kostoľany II, Pečeňady I, Malženice, Jaslovské Bohunice, Radošovce, Kátlovce II, Nižná II, Piešťany, Šulekovo, Trnava, Žlkovce.

Analysis: individual samples are analysed gamma spectrometrically to determine gamma radionuclides (distribution along the depth) and radiochemically to determine strontium and alpha radionuclides.

The soil (terrain) pollution is identified separately for arable lands and grass plots.

Food chain links: Grass and fodder crops:

- Grass sampling points: EBO A1, EBO V1, EBO V2, Krakovany, Veľké Kostoľany, Pečeňady, Jaslovské Bohunice, Radošovce, Kátlovce, Nižná, Piešťany, Hlohovec, Trnava, Žlkovce, Malženice (the total of 15 points).
- Clover species sampling points: Jaslovské Bohunice, Žlkovce, Pečeňady, Chtelnica, Nižná, Dechtice, Bučany, Trnava, Piešťany, Hlohovec (the total of 10 points).
- Measurements: gamma spectrometric analyses of individual samples and the processing of composite samples twice a year for the presence of Sr-90 and alpha radionuclides.

Milk:

- Milk activity is identified using random samples taken from the production factory (cowshed).
- Sampling points: cowsheds of cooperative farms at Nižná, Pečeňady.
- Measurements: iodine gamma spectrometric screening and strontium determination.

Agricultural products:

- Activities of anthropogenic radionuclides in agricultural products – the plant production – are determined.
- Sampling points: with regard to agricultural conditions, sampling points are not exactly specified. The average number of sampling points is 10 for each crop, while at least 4 samples must be taken at a shorter distance from EBO than 5 km. Sampling points for other samples are expected to be distributed uniformly in all directions.
- The sampling method: after the end of vegetation period, immediately prior to the harvest, parts of products are sampled that are intended for consumption or eventually for food processing.
- The following crops that are grown on predominant areas in the EBO surroundings are under supervision: wheat, barley, corn, sugar beet, oil-seed rape. A part of capacity is reserved for crops that are not specified to a deeper detail such as: peas, root vegetables, fruits, fruiting vegetables.
- The processing method: mechanical cleaning (grains) or washing, grating, drying, homogenization (sugar beet).
- Measurements: Individual samples are gamma spectrometrically analysed and a single accumulated sample is made for each kind of crop in order to determine the strontium content.

Hydrosphere: Potable water:

- The purpose of examinations is to exert supervision over the contamination of the first ground water horizon.

- Sampling points: wells Veľké Kostoľany, Žlkovce I-II, Trakovice I-II, Kátlovce, Zelenice, Siladice, Malženice – cooperative farm, Malženice – compressor plant.
- Summary beta activities are measured for individual samples in compliance with STN 83 0523 standard, the strontium content is determined and tritium analysis is also performed.

Surface water:

- The purpose of examinations is to document the contribution of the nuclear facilities operation to the surface water radioactivity.
- Sampling points: the Dudváh River in Veľké Kostoľany, the Dudváh River in Bučany, Žlkovce Channel, the Váh River in Madunice, the Váh River in Varov Šúr.
- Individual samples are gamma spectrometrically measured, the strontium content is also determined using the liquid scintillation spectrometry.

Riverine streambed sediment:

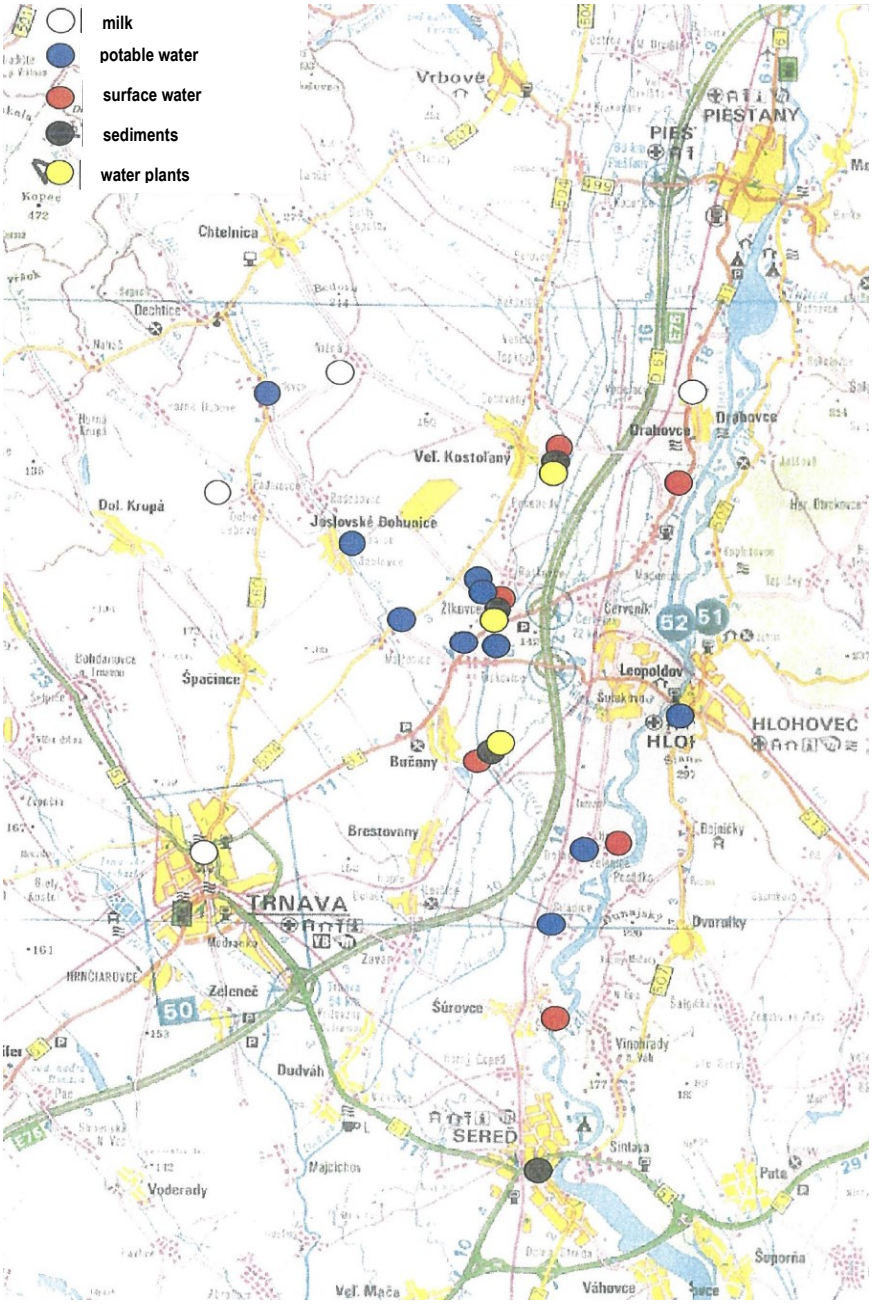
- The purpose of examinations is to obtain information on recipient streambed contamination trends due to the sedimentation from the discharged water.
- Sampling points: the Manivier Channel, the Dudváh River in Bučany, the Dudváh River in Veľké Kostoľany (reference point), the Králová Water Reservoir.
- Measurements: Individual samples are gamma spectrometrically analysed.

Water plants (pothamogeton):

- The aim is to obtain information on independent examinations of the surface water radioactivity.
- Sampling points: the Žlkovce Channel (depending on plant occurrence points), the Dudváh River in Bučany, the Dudváh River in Veľké Kostoľany.
- Measurements: Individual samples are gamma spectrometrically analysed; subsequently, analyses are performed for Sr-90 and alpha nuclides.

The following figure shows a map of milk, potable water, surface water, riverine streambed sediments and water plants (potamogeton) sampling points found in the EBO site surroundings. The reference surface water sample (i. e., not affected by the operation of nuclear facilities on the EBO site), is taken from the Madunice Channel, in the Madunice Hydro Power Plant area, upstream of the Socoman outlet object into the diversion channel.

Figure C.II.39: Layout of milk, potable water, surface water, sediments and water plants sampling points



Fish:

- The aim of examinations is to obtain information on the accumulation of radioactive substances from water in fish organisms.
- Sampling points: the Žlkovce Channel, the Dudváh River in Bučany, the Boleráz Water Reservoir – the reference point.
- Measurements: Individual samples are measured gamma spectrometrically.

Ground water:

- Radiation monitoring of drill holes are made on the nuclear facilities site. They are divided into three groups, depending on their depth, as follows:
  - dry drill holes – down to the depth of 5 m,
  - saturated drill holes – down to the depth of 15 m (hydrological collector I),

- saturated drill holes – down to the depth of 25 m (hydrological collector II).
- The purpose of the monitoring is to identify whether ground water is being polluted.
- Sampling points: radiation monitoring drill holes of the combined type, i. e., those interfering in the ground water hydrological collectors I and II.
- Measurements: tritium (H-3) volumetric activity, strontium (Sr-90) volumetric activity, volumetric activities of gamma nuclides (Co-60, Cs-134, Cs-137, K-40 a. o.), volumetric activities of alpha nuclides (Pu−239/240, Pu-238, Am-241), some selected physical-chemical characteristics (pH, total hardness, conductivity), ground water level (in case of the ground infiltration water, the presence of water itself).

If an examination level has been exceeded, all the radiation monitoring drill holes are inspected, as well as other accessible ground water sources, or, possibly, the contamination is examined on the surroundings of technological objects.

Preventive measures (the remediation pumping) in the ground water quality assurance area are implemented by means of the drawing off and subsequent discharge of ground water. The activity is performed by technological equipment making it possible to pump the ground water in the long term and to drain it in a safe manner along with other liquid effluents using the controlled dilution system in surface watercourses. The ground water condition monitoring is performed on the basis of analyses of samples taken regularly from N-3 drill hole.

C.II.15.3.2.3.2. Nationwide Radiation Monitoring

The nationwide radiation monitoring, as a part of the Early Radiation Warning System, results from legislative requirements of the Slovak Republic, especially from Act No. 355/2007, Coll., on Protection, Support and Development of Public Health, as amended, followed by the Decree of the Ministry of Health of the Slovak Republic No. 524/2007, Coll., Laying down Details of the Radiation Monitoring Network. Based on the decree, the following is to be provided by the radiation monitoring:

- the background data necessary for systematic assessment and regulation of the population exposure and for assessments of the population exposure resulting from the performance of activities leading to exposure during a normal radiation situation,
- the provision of the environment radioactive contamination data for the decision-making on the implementation and termination of interventions and limitation measures in case of a radiation hazard,
- the exposure level data to inform the population and to provide the international exchange of information on the radiation situation on the territory of the Slovak Republic.

Based on the Resolution of the Government of the Slovak Republic No. 138/1991, on the Population Protection Assurance in Case of a Radiation Accident in a Nuclear facility, the Slovak Headquarters of the Radiation Monitoring Network (SÚRMS) were established as a permanent executive component of the Radiation Accidents Commission of the Government of the Slovak Republic (KRH SR). KRH SR is a part of the Central Emergency Staff of the Slovak Republic.

Within the meaning of its Statute, SÚRMS is conferred upon the interdepartmental scope of powers and is responsible for the coordination of both the radiation situation monitoring and assessment in case of extraordinary events connected with radioactive substance discharges into the environment. Moreover, SÚRMS is responsible for the interpretation of radiation situation accident monitoring data in relation to the health protection, for the development of health risk prognoses during a nuclear facility accident and for the preparation of background documents necessary for the introduction of immediate and subsequent corrective measures throughout the territory of the Slovak Republic.

The Radiation Monitoring Network of the Slovak Republic (RMS SR) is an executive component of SÚRMS. It consists of permanent and stand-by constituents. The permanent RMS constituents include organizations, offices and institutions in the following government departments:

- the Ministry of Health of the Slovak Republic, providing 4 mobile monitoring groups, fixed monitoring systems and laboratory groups of ÚVZ SR, SZU in Bratislava, regional ÚVZ in Banská Bystrica and Košice,
- the Ministry of Interior of the Slovak Republic, providing a departmental assessment centre, a fixed monitoring system, mobile monitoring groups, 3 support control chemical laboratory groups,

- the Ministry of Defence of the Slovak Republic providing a departmental assessment group (the Centre of the Radiation, Chemical and Biological Protection of Armed Forces of the Slovak Republic (RCHBO OS SR), Trenčín), a fixed network of ARIS system, mobile monitoring groups,
- the Ministry of Environment of the Slovak Republic, providing the fixed Early Warning Network, short-, medium- and long-term meteorological prognoses,
- the Ministry of Economy of the Slovak Republic, providing, by means of the operator of both the NPP Jaslovské Bohunice and NPP Mochovce, its own monitoring centres with local radiation monitoring networks, fast EBO and EMO monitoring groups, mobile monitoring groups and 2 support laboratory groups.

The stand-by constituents of the Radiation Monitoring Network of the Slovak Republic (RMS SR) mainly include support laboratory groups in PF UK, FMFI UK, VÚVH, VUJE and Sanitary and Veterinary Service laboratories.

Radiation Monitoring Network activities are performed in the following two modes:

- the so-called "normal monitoring regime" during the normal operation when the full-area monitoring of the actual radiation situation is ensured, including both the monitoring and assessment of consequences of preceding extraordinary events,
- during the "radiation accident, or extraordinary event" connected with radionuclide discharges into the environment, or when their occurrence is suspected whether on or outside the territory of the Slovak Republic.

The data is transmitted continually from the Early Warning Network of the Ministry of Environment of the Slovak Republic via the Slovak Hydrometeorological Institute SHMÚ (including both the actual and forecasted meteorological data) to the Emergency Response Centre of the Nuclear Regulatory Authority of the Slovak Republic (CHO ÚJD SR).

The following are the quantities measured by the Early Radiation Warning Network at present:

- spatial dose equivalent rate of gamma radiation in the air in nSv/hour,
- volumetric activities of individual radionuclides determined on the basis of gamma spectrometric analyses in Bq/m^3: Be-7, Cs-137, Rn-220, Rn-222, I-131, I-132, I-133, Co-60,
- volumetric activities of artificial alpha and beta radionuclides.

In addition to the data acquired by the Early Warning Network, data from local radiation monitoring networks of JE Jaslovské Bohunice and JE Mochovce is also transmitted continually to the Emergency Response Centre of the Nuclear Regulatory Authority of the Slovak Republic (the technological data from NPP technological information systems is also transmitted, making it possible to determine or prognosticate radioactive substance discharges into the NPP surroundings during an extraordinary event, i. e., the so-called “source term“, necessary to prognosticate radiological consequences of discharges for the population living in the surroundings).

It is assumed that the same scope of measured data will also be provided from the NJZ to the Emergency Response Centre of the Nuclear Regulatory Authority of the Slovak Republic.

C.II.15.3.2.3.3. Results of Monitoring in the Surroundings

Aerosols and Fallouts

Aerosols obtained by the continual sampling within the TDS stations are measured gamma spectrometrically, in case of Cs-137 and Be-7, radiochemically in case of Sr-90 and Pu-239/240, by 24 stations (5 out of them directly on the Bohunice nuclear facilities site), with the periodicity of 14 days. Natural radionuclides, such as K-40, and the cosmogenic Be-7 are predominant in the aerosols (similarly in fallouts, too). Activities of technogenic radionuclides found in the surroundings are mostly below MDAs which are on the level of units of μBq/m^3 for Cs-137. With regard to the more selective detection method (radiochemistry), radionuclides Sr-90 and Pu-239 have lower MDAs, that is why, they are measurable in the majority of cases (on the level of tenths of μBq/m^3 for Sr-90 and on the level of thousandths of μBq/m^3 for Pu-239). Occurrences of those radionuclides in environment samples are natural, as they are a part of the global fallout. Their measurability only depends on the sensitivity (MDAs) of the applied method. It is also possible to identify exceptionally other radionuclides (above MDAs) on the EBO site that do not usually occur in the radiation background. In such cases, as this is considered as an exceeding of the investigation level, the possible source of contamination is always examined. The exceeding of the investigation level on the site itself appears most frequently in case of Cs-137, in samples of aerosols (but, exceptionally, in

fallouts, too) taken in the fixed EBO I teledosimetry system station. Earth works performed with soils contaminated by low-activity radionuclides and originating from the decommissioned JE A1 site are being most frequently identified as contamination sources (after the examination) in reports bringing results related to the monitoring in the surroundings of the EBO nuclear facilities complex. An exceptional case was recorded in late March and early April 2011 when investigation levels were exceeded in all teledosimetry system stations which was caused by a short-term passing of the contaminated air plume originating from the NPP Fukushima in Japan. Measured activities were not significant from the radiation risk assessment point of view, but the fact that they were identified reliably shows evidence that the radiation situation monitoring system in the surroundings of the complex of EBO nuclear facilities is set-up well.

The fallout radioactivity is monitored by six selected teledosimetry system stations in monthly periods. Cs-137 is measured gamma spectrometrically and Sr-90 and Pu-239/240 are measured radiochemically. Measured values (if they are higher than MDAs) fluctuate on the level of hundreds of mBq/m^2 for Cs-137, on the level of tens of mBq/m^2 for Sr-90 and on the level of units of mBq/m^2 (or less) for Pu-239/240. When measuring radionuclide activities in fallouts, such radionuclides can also exceptionally occur that are not a part of the global fallout. The causes are similar to those mentioned in case of aerosols.

Agricultural Products, Soil and Sediments

Radioactivity of milk, agricultural products, clover, grass, water plants, soils and sediments are monitored. Volumetric activities of artificial radionuclides are mostly below MDAs, or they are on the natural radiation background level. The measured Sr-90 volumetric activity in milk fluctuated on the level of up to 20 mBq/l.

The specific activity of soils is measured in depths from 0 to 5 cm and shows values of up to 20 Bq/kg for Cs-137, from 1.0 to 2.0 Bq/kg for Sr-90 and up to 200 mBq/kg for Pu-239/240. The natural K-40 activity is predominant, its specific activity varies on the level of hundreds of Bq/kg. Specific activities in off-production grass soils (K-40 and Cs-137 in different depths, maximum values around 600 Bq /kg for natural K-40 and 35 Bq/kg for Cs-137).

Sediments are measured on the following sites: Bučany – the Dudváh River, Veľké Kostoľany – the Dudváh River, Žlkovce – the Manivier Channel and Kráľová – the Water Reservoir. Considering technogenic radionuclides, the highest specific activity was identified for Cs-137 in the Bučany – Dudváh River area, its magnitude being 800 Bq/kg.

The Váh River recipient sampling point to be used for the monitoring of sediments, was selected in the section where the water flow is minimum (a weir-type storage basin) and, that is why, there is the highest probability of radionuclide accumulation in the streambed sediments. The following table shows mass activity values, measured in streambed sediment samples taken from the Kráľová Water Reservoir in the years from 2010 till 2013, in compliance with LRKO reports.

Table C.II.42: Radioactivity of the Váh River streambed sediments, sampling point at Kráľová Water Reservoir, 2010 - 2013

Nuclide		2010	2011	2012	2013
Be-7	[Bq/kg dry matter]	11.6	4.7	7.2	9.3
K-40	[Bq/kg dry matter]	473.0	424.0	363	442.0
Cs-137	[Bq/kg dry matter]	1.6	2.5	2.21	37.5
Cs-134	[Bq/kg dry matter]	0.5	0.4	0.6	0.9
Sr-90	[Bq/kg dry matter]	1.0	0.61	0.63	1.3
Pu-239/240	[mBq/kg dry matter]	143.0	95.9	100.0	34.4

The highest specific activity values were measured for K-40 natural radionuclide in all the years.

Surface Water

H-3, Cs-134 and Cs-137 activities are measured in surface waters (Dudváh River and Váh River). Values identified for the years from 2009 to 2013 were mostly below MDAs for Cs-134 and Cs-137. Measured H-3 values range from the natural background (units of Bq/l) to tens and, exceptionally, up to hundreds of Bq/l, depending on the sampling point (waste water is more diluted in the Dudváh River, or in the Váh River, than, e. g., in the Manivier Channel in Žlkovce). Natural K-40 volumetric activity in the surface water is on the level of tenths of Bq/l.

Ranges of measured values and medians (in contrast to the arithmetic average, a median is not affected by sporadic extreme values; median values are given in parentheses in the table) of radiation pollution indicators for the years from 2009

to 2013 in individual surface water sampling points (potentially affected and non-affected profiles for the complex of EBO nuclear facilities) are presented in the following tables prepared in compliance with LRKO Trnava annual reports. The results show that medians of measured values do not virtually differ for affected and non-affected profiles. Slight long-term increases with regard to the non-affected profiles are only observable in summary beta activities of samples taken from the Manivier Channel.

Table C.II.43: Measured radiation pollution indicators, the Dudváh River water, sampling point Veľké Kostoľany (non-affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 5.3 (3.7)	1.9 to 3.3 (2.65)	3.5 to 4.2 (3.85)	3.8 to 4.7 (3.95)	3.2 to 4.0 (3.7)
Potassium (K-40)	[mBq/l]	73 to 295 (110.0)	68.0 to 181.0 (110.0)	68.0 to 197.0 (100.5)	71.0 to 298.0 (118.5)	72.0 to 721.0 (113.0)
Caesium (Cs-137)	[mBq/l]	1.9 to 5.7 (5.25)	3.0 to 6.9 (5.25)	1.8 to 4.0 (3.0)	1.5 to 5.4 (2.9)	1.5 to 5.5 (2.8)
Caesium (Cs-134)	[mBq/l]	2.3 to 5.5 (4.95)	2.4 to 6.7 (4.9)	1.5 to 3.7 (2.65)	1.5 to 5.0 (2.65)	1.4 to 4.9 (2.3)
∑ β	[mBq/l]	40.0 to 175.0 (77.9)	42.5 to 172.0 (104.5)	34.7 to 157.0 (107.0)	43.8 to 182.0 (107.5)	43.6 to 170.0 (112.0)
∑ α	[mBq/l]	64.55 to 246.0 (114.5)	68.6 to 229 (118.2)	68.7 to 249.0 (120.0)	95.1 to 192.0 (115.0)	54.7 to 130.0 (88.95)

Table C.II.44: Measured radiation pollution indicators, the Dudváh River water, sampling point Bučany (affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 7.7 (3.75)	1.9 to 8.5 (3.0)	3.5 to 4.2 (3.85)	3.8 to 4.3 (3.9)	3.2 to 4.5 (3.75)
Strontium (Sr-90)	[mBq/l]	7.2 to 15.7 (9.1)	2.0 to 18.5 (7.95)	5.8 to 16.0 (8.35)	4.1 to 13.6 (7.45)	5.3 to 12.5 (7.15)
Potassium (K-40)	[mBq/l]	110.0 to 394.0 (256.0)	71.0 to 316.0 (159.0)	68.0 to 212.0 (93.0)	74.0 to 260.0 (163.0)	34.0 to 903.0 (104.5)
Caesium (Cs-137)	[mBq/l]	2.4 to 8.7 (4.6)	2.0 to 6.4 (4.85)	2.1 to 6.2 (3.7)	1.3 to 6.9 (3.55)	0.9 to 5.6 (2.95)
Caesium (Cs-134)	[mBq/l]	1.5 to 5.3 (4.05)	2.4 to 6.0 (4.9)	1.6 to 5.5 (3.7)	1.6 to 6.0 (3.45)	0.8 to 5.2 (2.75)
∑ β	[mBq/l]	29.5 to 144.0 (68.8)	45.9 to 165.0 (86.2)	45.5 to 123.0 (91.3)	50.9 to 174.0 (84.5)	57.7 to 201.0 (88.85)
∑ α	[mBq/l]	46.10 to 258.0 (108.8)	53.3 to 195.0 (98.5)	63.3 to 171.0 (122.5)	45.0 to 158.0 (86.45)	57.9 to 189.0 (88.9)

Table C.II.45: Measured radiation pollution indicators, the Manivier Channel water, sampling point Žlkovce (affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 202.6 (4.85)	2.2 to 100.2 (3.2)	3.8 to 19.0 (3.95)	3.8 to 47.8 (4.3)	3.2 to 9.8 (3.75)
Potassium (K-40)	[mBq/l]	120 to 329 (106)	120.0 to 807.0 (207.0)	75.0 to 616.0 (110)	72.0 to 523.0 (139)	70.0 to 438.0 (160)
Caesium (Cs-137)	[mBq/l]	4.5 to 11.5 (3.35)	3.1 to 11.6 (6.7)	2.9 to 6.1 (3.5)	1.9 to 7.7 (3.9)	1.2 to 6.3 (3.05)
Caesium (Cs-134)	[mBq/l]	2.3 to 5.7 (3.0)	2.6 to 5.8 (4.35)	1.7 to 5.3 (3.45)	1.9 to 6.7 (3.65)	1.5 to 6.1 (3.35)
∑ β	[mBq/l]	58.6 to 232.0 (58.9)	59.5 to 295.0 (109.3)	42.9 to 240.0 (92.0)	81.0 to 418.0 (206.5)	59.2 to 167.0 (149.0)
∑ α	[mBq/l]	54.0 to 141.0 (74.4)	43.5 to 120.0 (66.7)	39.8 to 105.0 (64.95)	37.3 to 77.3 (58.6)	21.9 to 106.0 (44.7)

Table C.II.46: Measured radiation pollution indicators, the Váh River water, sampling point Madunice (non-affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 5.3 (3.7)	1.9 to 3.3 (2.65)	3.5 to 11.8 (3.85)	3.8 to 4.3 (3.9)	3.2 to 4.0 (3.7)
Potassium (K-40)	[mBq/l]	81 to 252 (130.0)	68.0 to 204.0 (98.0)	67.0 to 120.0 (93.0)	74.0 to 9,748 (120.0)	67.0 to 903.0 (85.5)
Caesium (Cs-137)	[mBq/l]	2.8 to 7.9 (4.6)	3.1 to 7.1 (5.1)	3.0 to 5.9 (4.5)	1.6 to 7.1 (4.22)	1.4 to 7.1 (3.3)
Caesium (Cs-134)	[mBq/l]	2.4 to 5.8 (4.6)	2.7 to 5.8 (4.9)	2.7 to 5.4 (4.85)	1.6 to 6.4 (4.55)	1.4 to 6.6 (2.9)
∑ β	[mBq/l]	27.0 to 78.0 (55.65)	30.0 to 76.0 (58.7)	32.1 to 73.0 (50.5)	30.2 to 74.4 (59.0)	29.3 to 66.4 (52.05)
∑ α	[mBq/l]	40.3 to 128.0 (91.0)	28.5 to 88.5 (52.6)	22.3 to 80.3 (50.75)	36.2 to 103.0 (53.4)	23.6 to 69.5 (47.35)

Table C.II.47: Measured radiation pollution indicators, the Váh River water, sampling point Horné Zelenice (affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 62.0 (4.6)	2.4 to 10.7 (3.1)	3.5 to 4.0 (3.85)	3.8 to 32.5 (3.95)	3.4 to 16.5 (3.75)
Strontium (Sr-90)	[mBq/l]	5.9 to 11.0 (8.2)	4.1 to 26.5 (6.5)	6.1 to 16.0 (8.85)	5.4 to 10.8 (7.25)	4.9 to 9.1 (5.8)
Potassium (K-40)	[mBq/l]	86 to 158 (110.0)	71 to 143 (95.0)	67.0 to 216.0 (119.0)	67.0 to 1,183.0 (110.0)	45.0 to 257 (93.5)
Caesium (Cs-137)	[mBq/l]	2.2 to 10.0 (5.4)	1.6 to 5.7 (5.2)	1.8 to 5.8 (3.35)	1.6 to 6.9 (4.65)	0.5 to 7.6 (3.65)
Caesium (Cs-134)	[mBq/l]	4.4 to 5.6 (4.55)	1.5 to 6.1 (5.1)	0.9 to 5.5 (2.75)	1.8 to 6.2 (4.3)	0.8 to 7.4 (3.5)
∑ β	[mBq/l]	32.4 to 107.0 (55.9)	32.6 to 101.5 (57.8)	31.6 to 82.6 (51.6)	41.1 to 97.8 (61.0)	30.1 to 104.0 (62.95)
∑ α	[mBq/l]	44.0 to 136.0 (74.85)	41.8 to 102.8 (72.35)	43.2 to 84.2 (73.95)	34.8 to 69.7 (48.55)	8.5 to 86.9 (52.8)

Table C.II.48: Measured radiation pollution indicators, the Váh River water, sampling point Varov Šúr (affected profile)

Nuclide		2009	2010	2011	2012	2013
Tritium (H-3)	[Bq/l]	3.2 to 46.5 (4.15)	2.0 to 16.3 (2.8)	3.5 to 5.8 (3.85)	3.8 to 91.4 (3.95)	3.4 to 19.9 (3.75)
Potassium (K-40)	[mBq/l]	86.0 to 158.0 (106.0)	60.0 to 1,059.0 (77.0)	66.0 to 133.0 (110.0)	71.0 to 143.0 (100.0)	68.0 to 180.0 (85.5)
Caesium (Cs-137)	[mBq/l]	2.2 to 5.9 (3.35)	2.5 to 6.3 (3.4)	1.8 to 5.8 (5.3)	1.6 to 5.7 (3.95)	1.4 to 9.3 (3.65)
Caesium (Cs-134)	[mBq/l]	2.4 to 5.7 (3.0)	2.2 to 5.8 (3.75)	1.4 to 5.3 (4.9)	1.5 to 6.1 (3.8)	1.2 to 8.8 (3.5)
∑ β	[mBq/l]	40.9 to 92.0 (58.9)	36.5 to 98.0 (55.2)	34.7 to 102.0 (39.75)	32.5 to 77.4 (53.45)	26.0 to 102.0 (57.0)
∑ α	[mBq/l]	46.10 to 102.0 (74.4)	32.7 to 119.0 (67.75)	39.6 to 155.0 (54.1)	38.4 to 77.7 (63.6)	20.0 to 101.0 (50.55)

The trans-border situation is documented in the following tables describing the radiation situation in the Danube River watercourse (both non-affected and affected profiles) and the Váh River, too, (affected profile upstream of the river mouth into the Danube River). The tables are processed on the basis of SHMÚ monitoring reports and include average measured pollution values.

Table C.II.49: Measured radiation pollution indicators, the Danube River water, sampling point Hainburg, Austria (non-affected profile)

Nuclide		2010	2011	2012	2013	Regulation of the Government of the Slovak Republic No. 269/2010, Coll.
Tritium (H-3)	[Bq/l]	1.6	1.7	2.5	1.6	100
Strontium (Sr-90)	[Bq/l]	0.0063	0.0045	0.0020	0.0033	1.0
Caesium (Cs-137)	[Bq/l]	0.0097	0.0047	0.0070	0.0080	0.5

Table C.II.50: Measured radiation pollution indicators, the Danube River water, sampling point Bratislava Centre – SR (non-affected profile)

Nuclide		2010	2011	2012	2013	Regulation of the Government of the Slovak Republic No. 269/2010, Coll.
Tritium (H-3)	[Bq/l]	2.2	1.7	1.4	2.5	100
Strontium (Sr-90)	[Bq/l]	0.0040	0.0045	0.004	0.0025	1.0
Caesium (Cs-137)	[Bq/l]	0.0097	0.0047	0.0078	0.0011	0.5
Caesium (gamma spectroscop. Cs-137)	[Bq/l]	0.0070	0.0020	0.0030	0.0040	0.5

Table C.II.51: Measured radiation pollution indicators, the Váh River water, sampling point Komárno - SR (affected profile)

Nuclide		2010	2011	2012	2013	Regulation of the Government of the Slovak Republic No. 269/2010, Coll.
Tritium (H-3)	[Bq/l]	1.0	6.7	2.5	1.9	100
Strontium (Sr-90)	[Bq/l]	0.0045	0.0030	0.0040	0.0025	1.0
Caesium (Cs-137)	[Bq/l]	0.0070	0.0052	0.0044	0.0097	0.5
Caesium (gamma spectroscop., Cs-137)	[Bq/l]	0.0040	0.0020	0.0020	0.0040	0.5

Tab. C.II.52: Measured radiation pollution indicators, the Danube River water, sampling point Szob – Hungary (affected profile)

Nuclide		2010	2011	2012	2013	Regulation of the Government of the Slovak Republic No. 269/2010, Coll.
Tritium (H-3)	[Bq/l]	1.0	1.4	1.4	2.5	100
Strontium (Sr-90)	[Bq/l]	0.0040	0.0038	0.004	0.0025	1.0
Caesium (Cs-137)	[Bq/l]	0.0048	0.0037	0.0078	0.0011	0.5
Caesium (gamma spectroscop., Cs-137)	[Bq/l]	0.0050	0.0020	0.0030	0.0040	0.5

For the period from 2010 till 2013, the monitored surface water bodies were meeting surface water quality requirements in relation to radiation indicators, in compliance with the Regulation of the Government of the Slovak Republic No. 269/2010, Coll. no measurable impact on the Danube River radiation pollution parameters due to operations of nuclear facilities found on the EBO site. The Danube River parameters at sampling point Szob (Hungary) correspond to the relevant parameters measured at sampling points in Bratislava (Slovakia) and Hainburg (Austria).

Potable Water

Potable water is measured for the presence of tritium and Sr-90. Tritium volumetric activities range from units to approximately 40 Bq/l, Sr-90 volumetric activities show values of units of mBq/l. The total beta activity ranges within units of Bq/l.

Ground water

Ground water, especially the ground water found under the JE A1 site, is historically contaminated by tritium. For that reason, a separate chapter is dedicated to both the radiation situation state and development in the ground water (see below).

Dose Rate

Dose rates are continually monitored by 24 monitoring stations by means of the Bohunice nuclear facilities teledosimetry system. Values measured by the stations range from 60 to 100 nGy/hour which are common values (e. g., data obtained from dose rate measurements made in the year 2010 using thermoluminiscence dosimeters throughout the territory of the Slovak Republic by means of the Radiation Monitoring Network show an average value of 92.9 ± 11.8 nGy/hour).

C.II.15.3.2.4. Radiation Situation in Ground Water

In order to provide the radiation situation monitoring in the geological environment and ground water, a monitoring system is installed in areas of the Bohunice nuclear facilities and in their wider surroundings. A long-term (since 1990) ground water radiation situation monitoring has been performed using a network of monitoring objects in compliance with monitoring programs taking into account geological and migration characteristics of the existing or potential radioactive contamination

of the ground water. From the point of view of migration properties of individual radionuclides in the ground water (including those potentially occurring), the following order of migration capabilities – dispersion speed – is determined (the retardation coefficient value K_d [m^3/kg] is given in parentheses): H-3 (0) > Co-60 (0.002) > Sr-90 (0.02) > Cs-137 (0.5) > alpha nuclides Pu-238, Pu-239/240, Am-241.

That means that tritium H-3 is the major monitored contaminating radionuclide propagating within the geological environment in the form of the so-called tritium water and, thus, it can be transported by means of ground water flowing to relatively long distances.

In case of tritium, no legally or standardly determined value exists for ground water that would represent a common background. Tritium can also appear in ground water separately from the nuclear facility operation, due to processes running within the natural water circulation (precipitation – refilling of ground water – accumulation, etc.) and in interactions with other activities (e. g., nuclear weapon tests). The natural (i. e., natural background) value is determined in compliance with the "Instruction by the Ministry for the State Property Administration and Privatization of the Slovak Republic and the Ministry of Environment of the Slovak Republic of 15 December 1997, Reg. No. 1617/min., how to proceed to assess company commitments from the environment protection point of view in a privatization project submitted by the company within the privatization process", where the value of 3.0 Bq/l was determined for ground water as an indicator and an "A" standard characterizing phon values or approximately natural contents (or agreed values of the required sensitivity limit for analytic determinations).

The legally defined value for tritium content in potable water is specified by the Regulation of the Government of the Slovak Republic No. 354/2006, Coll., laying down Requirements for Water Intended for Human Consumption and for Supervision of Water Quality Intended for Human Consumption, namely the indicative value (IH) of 100 Bq/l.

The following facts follow from ground water radiation situation monitoring results and their summary evaluation for the year 2013 [*Kostolanský M. et. al. 2014*], as well as from comparisons with evaluations published in preceding annual reports and other related reports [*Plško et.al.2008, Benko J. & Kovács T., 2011*]:

1. The JE A1 is the major real and large-area source of contamination of the geological environment in the area of Bohunice nuclear facilities which is a consequence of historical radioactive media leakage from technological equipment (designed and installed in compliance with approaches applied from 1950s till 1960s) to the sub-soil. Volumetric activities in the geological environment below the JE A1 site fluctuate, with the maximum value of up to 10^5 Bq/l. In compliance with the monitoring results, the further direction of the contamination dispersion into the Bohunice nuclear facility surroundings is virtually identical to the direction of ground water flow.

   The unfavourable site ground water radiation situation is purposefully resolved by the implementation of remediation measures (the remediation pumping). Thus, the contaminated ground water is removed from the geological environment and residual contamination movements beyond the site are hindered. With regard to the delimited complex source on the JE A1 site, the remediation pumping efficiency exceeded 88 % at the end of the year 2013. Therefore, up to 12 % of the activity continue to flow on in the ground water flow direction through the reference monitoring profile (a profile situated in front of the site border in the ground water flow direction, between S6A and JB-36 drill holes). Pumping intensity levels were as follows as to the end of the year 2013: ~2.2 kBq/s for tritium and ~0.14 Bq/s for Co-60. Maximum tritium volumetric activity values in the area closely outside the site (the first part of the contamination plume originating from the JE A1 site) achieve levels of up to 79 Bq/l (JB-12 drill hole) and less than 12 Bq/l in the front of that part of the cloud (JB-4 drill hole). Due to the natural convection and dispersion along the line of JB-45 - JB-46 drill holes, maximum tritium volumetric activity values in the second part of the plume originating from the JE A1 site achieve the level of up to 203 Bq/l (JB-46 drill hole). The tritium contamination transported to areas of municipalities is low (Malženice – up to 37 Bq/l, Žlkovce – up to 40 Bq/l, the edge of Jaslovské Bohunice municipality – up to 203 Bq/l).

2. As for the JAVYS site, tritium was identified on the JE V1 site, specifically in the area surrounding building 800 (JB-43 drill hole, approximately of the order of 100 Bq/l). Values of up to 149 Bq/l are achieved (JB-3 drill hole) closely outside the JE V1 site (the building 800 surroundings being the probable source). Multiple survey works were performed on the territory in question to clarify the mentioned situation. It is possible to state, on the basis of identified data and model calculations, that the ground water contamination source originates from leaking technological systems of the power plant being decommissioned, above all, from those installed in building 800 of the JE V1.

3. The radiation situation in the SE area (the JE V2 site) is favourable, except for the situation around RK-80 drill hole. In the year 2013, tritium volumetric activity values of up to the level of ~60 Bq/l were measured in that drill hole. Moreover, tritium values slightly above the MDA level (i. e., 4 Bq/l) were measured in ground water found in the surroundings of RK-82, JB-40, JB-41 drill holes and, in addition, in RK-90B in 2nd quarter and in RK-81 and RK-90C in 3rd quarter. The origin and source of that radionuclide in ground water is found in the JE V2 sewer systems area (the JE V2 rain sewer system and SO 366 retention tanks). The ground water is not polluted in the remaining part of the JE V2 site territory, or sporadically measured tritium volumetric activity values achieve insignificant levels slightly above MDA.

   From the tritium areal distribution point of view, the area closely surrounding JB-18 drill hole is specific. Tritium volumetric activity occurrences in ground water in the area closely surrounding that drill hole have been registered since the year 2011 and maximum values of up to 73 Bq/l were measured. The JE V2 sewer systems area (or the sewer system route from the JE V2 site to its mouth into the surface Manivier Channel) is the source and origin of this tritium.

4. Assessments specified in paragraphs 1 to 3 hold true for the hydrological collector I ground water. On the basis of results obtained from the hydrological collector II ground water monitoring, the ground water can be considered as non-contaminated.

5. The ground water in the remaining part of the monitored territory are radioactively non-contaminated (10 Bq/l), except for the ground water in the vicinity of the Dudváh River (it is a result of the historical infiltration of the contaminated Dudváh River surface water into the ground water due to historical discharges of low-activity waste water from the Bohunice nuclear facilities via the Manivier recipient into the Dudváh River: TKS-1 drill hole (activity of 5 Bq/l), while the volumetric activity level is gradually fading away, as compared with historical measured results, down to the natural background level. Moreover, in 3rd quarter of 2013, activities of 25 Bq/l, with the maximum of 158 Bq/l, were measured in the ground water from SK-6 drill hole (1st quarter of 2013) in the vicinity of the Socoman outlet object into the Drahovce Channel, i. e., in the SK object (virtually surface water).

6. The radiation situation on the territories of Hlohovec water source and utilized water sources (wells) in the Leopoldov area is favourable. Tritium volumetric activities in ground water monitored in water sources (wells and drill holes) in both 1st and 2nd quarters of 2013 were on the level of up to 10.0 Bq/l (wells of the Hlohovec water source and monitoring objects of that water source – drill holes designated PxH). The level of 10 Bq/l was exceeded in 3rd quarter of 2013 in S-1, S-2 and S-3 wells of the Hlohovec water source, the maximum value being on the level of 12.6 Bq/l, and, moreover, in four monitoring objects of that water source (PxH drill holes) where a maximum value was measured on the level of 11.3 Bq/l. In 4th quarter of 2013, the tritium volumetric activity level of 10 Bq/l was only exceeded in one well of the Hlohovec water source, namely in S-3 (the tritium volumetric activity value: 10,9 Bq/l). To compare, the tritium volumetric activity level was up to 12.0 Bq/l on the territory in question in the preceding year 2012. The infiltration of the Drahovce Channel surface water (waste water is discharged from the Bohunice nuclear facilities to the channel in question) into the surrounding ground water becomes evident.

7. Tritium volumetric activity values did not exceed the limit (indication) value of 100 Bq/l. The tritium volumetric activities of ground water in water sources (wells and drill holes) are monitored on the level of up to 15 Bq/l (wells of the Hlohovec water source and monitoring objects of that water source).

8. The fact that, as compared with recent years, significant radiation situation improvements can be observed, is an important item of the long-term time development trend of tritium volumetric activities in the area of the nearest municipalities in the surroundings of the Bohunice nuclear facilities site. That is to say, the long-term operation of JE A1 site corrective measures (ground water remediation pumping) caused the disruption of the main contamination release cloud originating from the main source (the JE A1 site) into two parts. The contamination dispersion to the further territory in the ground water flow direction has been hindered, or even stopped in the first part, on the area side, and it is assumed that the front of this plume will be gradually transferred towards the source (the JE A1 site). As for the second part of the plume which is not affected by the remediation pumping any more at present, it is assumed that tritium volumetric activities will be slowly decreasing up to the natural background level due to the natural convection (the dilution using clear non-contaminated water), dispersion and radioactive decay. Another significant improvement was recorded in the area upstream of Malženice and Žlkovce municipalities where the levels of tritium volumetric activities have been decreased down to insignificant values achieving the natural background level, because waste water discharges into the Manivier recipient were reduced and the Socoman Channel was also sealed up directly in Žlkovce

municipality. If the JE A1 site remediation pumping is in permanent operation, then such a development is also assumed in the area of the south-eastern edge of Jaslovské Bohunice municipality in future.

9. Activities of other natural radionuclides, in addition to tritium, have not been identified in the ground water outside the site of Bohunice nuclear facilities.

10. In connection with the present state in ground water on the studied territory, the 2011 report [*Kostolanský et.al. 2012*] contained the risk analysis update. The following results from its conclusions:
    - Tritium radionuclide (H-3) is the determining substance causing the pollution of the territory of interest (outside the borders of the site of Bohunice nuclear facilities) and representing a potential radiation risk.
    - Pollution dispersion risk calculations were performed for the given territory and using the knowledge of pollution. The calculations showed that the actual scope of pollution would be extending without remediation measures, while there is an assumption of its further dispersion with the ground water beyond the site of Bohunice nuclear facilities.
    - Based on the calculations and for considered exposure paths (possible use of contaminated ground water from local sources by the population for drinking and irrigation purposes, or for the feeding of farm animals, too – meat and milk consumption), it followed that the risk in the studied area is acceptable if ground water tritium volumetric activities in the surroundings of the Bohunice nuclear facilities do not exceed the level of 500 Bq/l, while a tighter requirement was adopted for the JAVYS site border to achieve the level of 100 Bq/l by means of the remediation pumping in future.
    - Thanks to the implementation of the long-term ground water remediation pumping that has been in operation on the JE A1 site (the main source of the propagating tritium contamination) in object 106 (N-3 drill hole) since 2000, the ground water contamination dispersion beyond the source site is being reduced in the long-term development period. Due to the installation of the remediation pumping system in question, a significant active protective element has come into existence providing the ground water quality protection on site.

Both the monitoring system and interpretation of results obtained from the monitoring of the existing radiation situation (as to the year 2013) are obvious from the following figures.

Figure C.II.40: Radiation situation (tritium volumetric activities) on the site of the Bohunice nuclear facilities

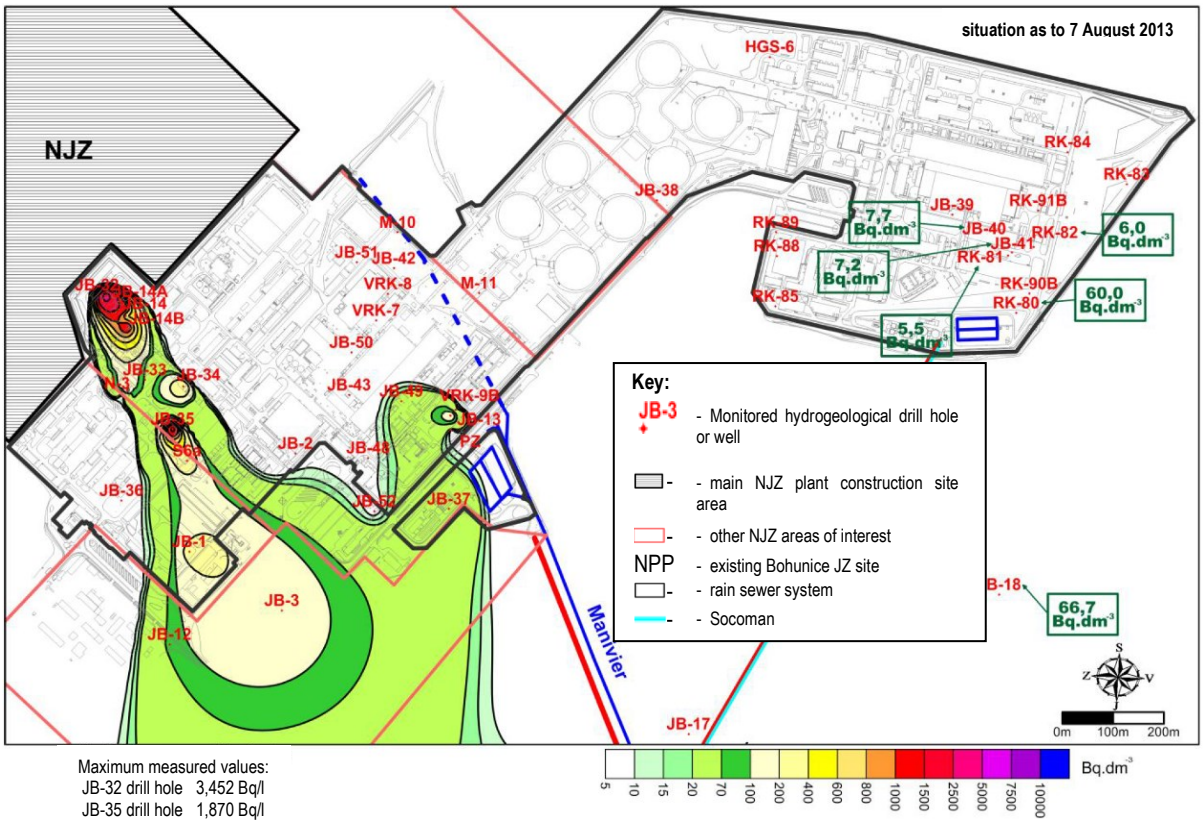
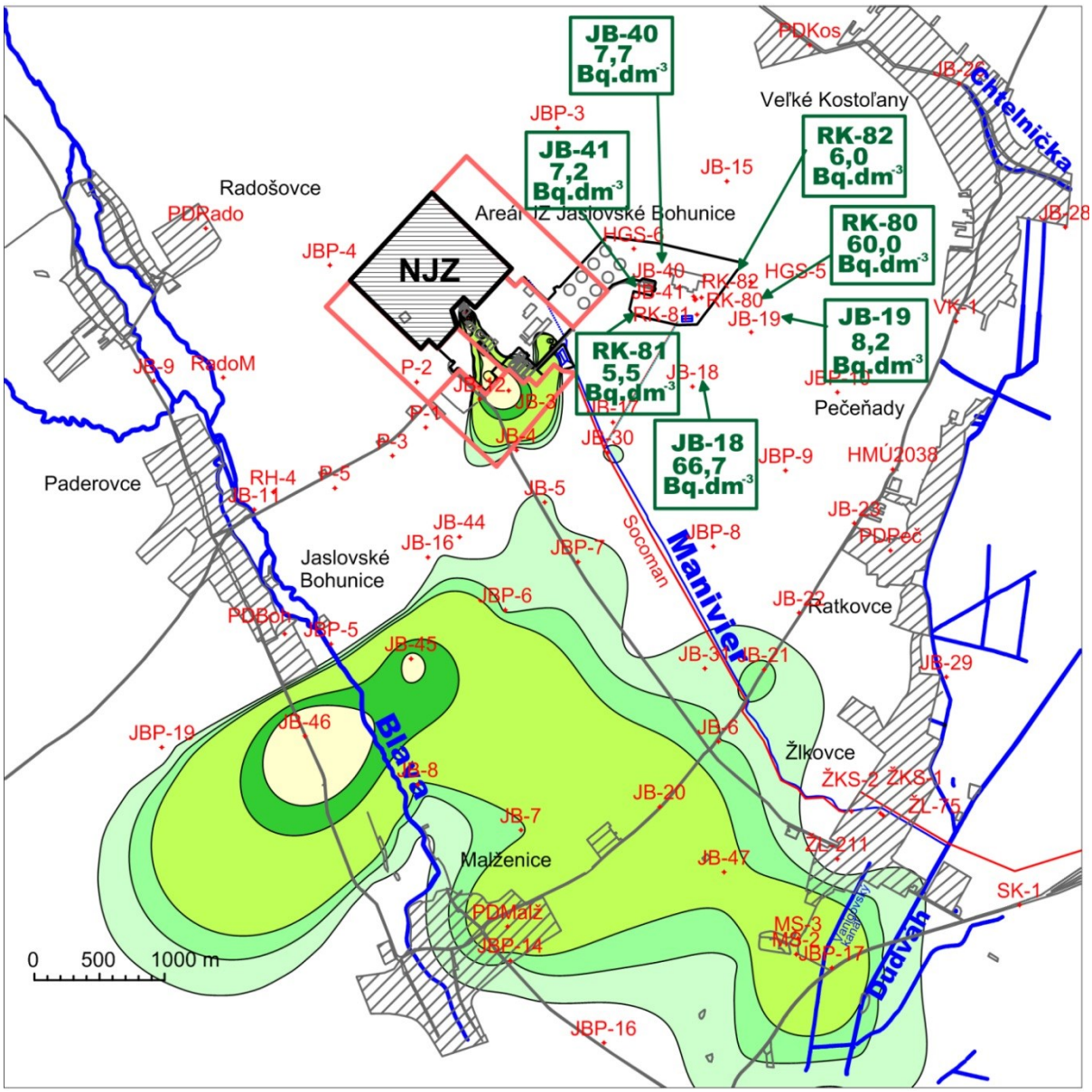


Figure C.II.41: Radiation situation (tritium volumetric activities) on the wider territory around the site of the Bohunice nuclear facilities

situation as to 7 August 2013



Key:

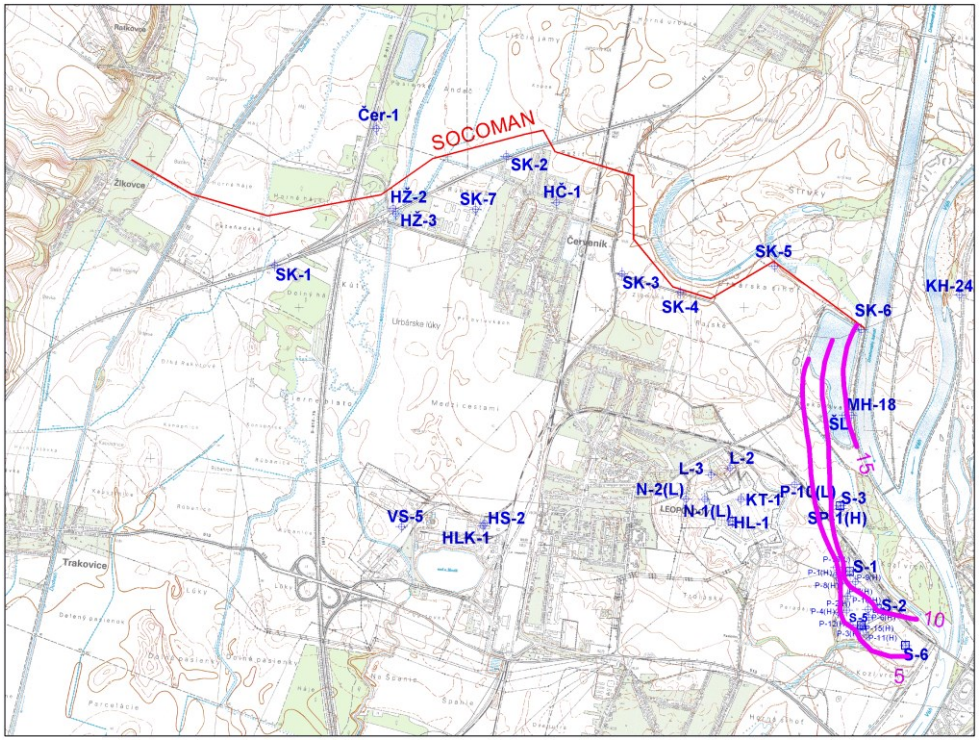
Maximum measured values: JB-32 drill hole 3,452 Bq/l

Tritium volumetric activity [Bq/l]

JB-3 - functional drill hole, well

- main New nuclear power plant construction site area
- other new NPP areas of interest
- existing site of Bohunice JZ site

Figure C.II.42: Radiation situation (tritium volumetric activities) on the Socoman – Drahovce Channel - Váh River territory



Key:

- S-6 - pumped (not pumped) well
- P-11 - hydrological monitoring drill hole
- Socoman – EBO waste channel
- 15 - tritium activity isoline [Bq/l]

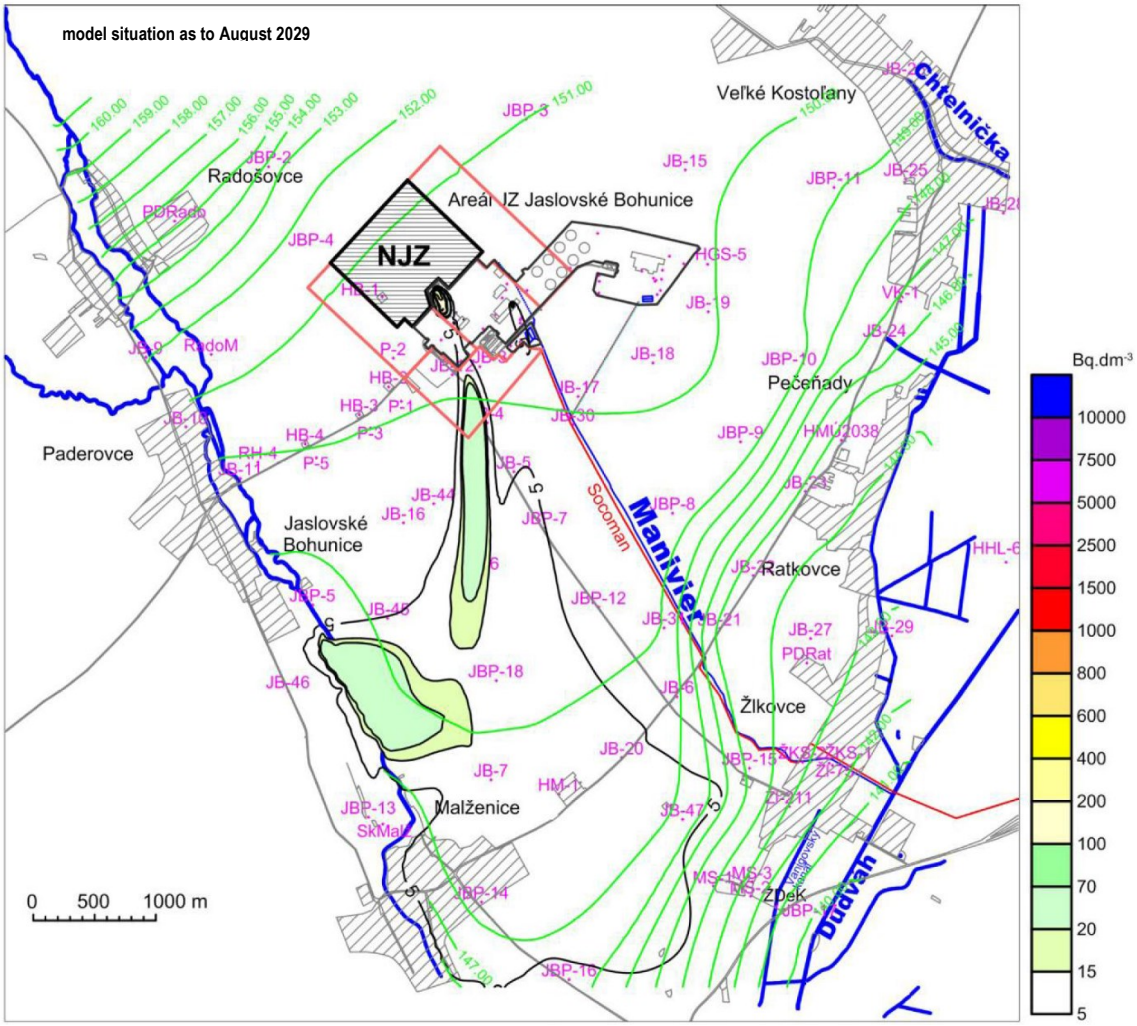
In order to determine the future state in the NJZ construction and operation time periods, a model prognosis was compiled for the radiation situation (tritium volumetric activity) development in ground water (a hydraulic model – MODFLOW software code and a transport model – MT3D software code). The main NJZ construction site area localization precedes the localization of the existing tritium contamination cloud considering the flow direction (i. e., it is found upstream of the existing cloud), while the technical infrastructure area is localized in the ground water flow direction (i. e., it is found downstream of the existing cloud).

It follows from the compiled model prognoses of tritium contamination dispersion in ground water from sources found on adjacent JAVYS sites (JE A1 and JE V1) that):

1. Tritium found in ground water can in no case affect the main NJZ construction site area (i. e., the area where the Main Reactor Building (HVB)) of the NJZ will be built).
2. Tritium levels in ground water in the area, where the NJZ technical infrastructure will be situated, will be affected by leakage sources on the JE A1 site whereby the contamination will achieve the level of several 100 Bq/l (maximum up to 700 Bq/l) as to the year 2029 and it will decrease to phon values as to the year 2089.
3. Tritium volumetric activities will achieve values of up to 100 Bq/l as to the year 2029 and the contamination will decrease to phon values as to the year 2089.
4. Sources found on the JE V1 site will not virtually affect the ground water contamination during the whole NJZ operation period.

The radiation situation (tritium volumetric activities) on the territory originating from sources found on the JE A1 and JE V1 sites, with the standard operation of the ground water remediation pumping system, as to the year 2029 (the assumed beginning of the NJZ operation) is obvious from the following figure.

Figure C.II.43: Model radiation situation (tritium volumetric activities) on the wide territory around the site of Bohunice nuclear facilities in 2029



Key:

- model conjunction of contamination
- model tritium contamination isoline [Bq/l]
- hydrogeological drill hole, well
- model ground water level isoline [m above sea level]
- main New nuclear power plant construction site area
- other new NPP areas of interest
- existing site of Bohunice JZ site

C.II.15.4. Additional Physical and Biological Characteristics

It can be reasonably expected that non-ionizing radiation levels (i. e., magnetic or electric fields in the surroundings of electric equipment) in publicly accessible areas meet the required limits. Electric power generating objects and equipment themselves (generators, transformers, switchyards) are situated within closed compartments off the publicly accessible areas. It is only overhead electric transmission lines ensuring the power output or reserve power supply that cross the publicly accessible areas, however, they are of standard construction corresponding to design and safety requirements for that type of installation.

No additional significant physical or biological characteristics of the concerned territory are specified.

C.II.16. Complex Assessment of Contemporary Environmental Problems

16. Complex assessment of contemporary environmental problems.

The overall environment quality on the concerned territory is formed by mutual relations among anthropogenic and natural environment components whereby the anthropogenic function (industry, agriculture, housing) is historically dominating. Considering this context, the state of the territory corresponds to its character.

Taking more significant problems into account, it is necessary to mention the following:

- 'old' ecological load (ground water pollution with tritium) – the load does not cause a significant risk and is being remediated successfully,
- low biological diversity resulting from the dominating agricultural and industrial functions of the territory (extensive areas of agricultural land and industrial sites) – however, an ecological stability skeleton exists on the territory, biological functions of the territory are not completely suppressed which is also witnessed by the presence of protected areas on both the national and Community levels,
- significant presence of anthropogenic elements in the landscape character as a result of the EBO industrial site including massive bulky operation objects and the related infrastructure,
- impact of transport on residential areas of municipalities (noise, air) resulting from the historical routing of roads through centres of municipalities.

Those problems are not limiting for the utilization of the territory.

C.II.17. Overall Environment Quality

17. Overall environment quality – the synthesis of both positive and negative factors (e. g., the rock environment vulnerability, relief sensitivity, surface and ground water sensitivity, soil sensitivity, air sensitivity, sensitivity of fauna and flora and their biotopes, sensitivity of comfort factors and human life quality).

The proposed activity is to be situated on the territory related to the site of Jaslovské Bohunice nuclear facilities (EBO), i. e., on the territory utilized intensively for industrial activities.

The state of environment on the concerned territory is defined by the following four factors:

- industrial function,
- agricultural function,
- housing function, and
- natural function.

Those four functions are consolidated on the territory in the long term and their relations are clearly delimited. Thus, they are not sources of significant collisions.

Industrial function is represented by the electric power generation on the EBO site and related activities and infrastructure. Due to the operation (or decommissioning) of the existing nuclear facilities on the EBO site, neither the environment, nor the public health are damaged. All the outputs into the environment are monitored and they range within limits in the long term established by relevant legal regulations and/or relevant authorities. Authorized limits of effective exposure doses are adhered to reliably in the radiation area. At the same time, the 'old' ecological load of the territory (ground water pollution with tritium) is being gradually successfully remediated. That is why, the electric power generation does not significantly affect the environment quality. There is an exception – undeniable impacts of power plant objects, other related objects and infrastructure on aesthetic qualities of the territory (i. e., impacts on the landscape character) that are subjugated by both the acknowledged technical character and size scales of the objects at the near sight.

Agricultural function makes use of useful soil, terrain and climatic conditions of the territory. With regard to this fact, the majority of the territory is predominantly and intensively used for agricultural purposes.

Housing function is concentrated to urban areas of municipalities with a sufficient distance from the EBO site. Necessary infrastructure is available in the municipalities (supply, power engineering, communication and transport links) including services. Health, social and economic conditions are favourable for the population and, from many points of view, they are better than in other areas of the Slovak Republic.

Natural function is limited by extensive areas of intensive agricultural activities and industrial production (the EBO site) as well. Thus, it is formed, above all, by agricoenoses poor in species, with occasional occurrences of ecologically more valuable segments made up predominantly of line accompaniments of watercourses and roads. In spite of this fact, special protected areas are also found on the territory (protected sites, a natural reserve), Natura 2000 sites (protected bird areas, Community importance areas) and additional nature and landscape conservation elements (significant marshlands, territorial ecological stability system elements) making up a basis of ecological stability of the territory.

As follows from the mentioned data, the overall environment quality on the territory is favourable. It is formed by mutual relations among anthropogenic and natural components of the environment whereby the anthropogenic function (industry, agriculture, housing) is historically dominating. Therefore, the territory is not (when complying with legitimate nature conservation interests) significantly vulnerable or sensitive to anthropogenic interventions. Thus, the new load resulting from the NJZ will not enter a vulnerable environment. The vulnerability is understood as sensitivity to changes affected by natural and anthropogenic factors and it is used in the environment impact assessment process when the ecological tolerability is assessed, i. e., the capacity of the territory to tolerate a certain load without any disruption of its structural links.

The following scale is used for the sensitivity assessment of the concerned territory:

- critically vulnerable environment,
- medium vulnerable environment,
- slightly vulnerable environment.

Rock Environment Vulnerability

The rock environment vulnerability is defined as a rock environment sensitivity rate to the action of vulnerability factors. The following are the classification criteria: the rock sensitivity in connection with the assessed activity, the assumed intensity of activity effects to the rack environment and the possibility to redevelop undesirable phenomena by means of a technical solution. The rock environment vulnerability classification is assessed in compliance with STN 44 3705 standard ‘Assessments of Rock Sensitivity and Rock Environment Vulnerability‘.

Two facially different sedimentary systems (or lithotypes) will be situated within the reach of the supposed building structures within the perspective construction site: a system of fine-grained soils in the overlying stratum of gravels (loess, loess clays and alluvial clays) and a system of fluvial gravels and sands. In general, the fine-grained sediments would be assessed as critically vulnerable (possible collapsing of loess soils, possibility to heave up or swell up in case of fine-grained soils, potential for liquefication) and gravels as medium vulnerable.

The virtually whole volume of the body of fine-grained sediments will be removed from the Main Reactor Building area and replaced with improved foundation soils. The deep foundations (feet of stilts) will be put in the underlying whole made up of gravels and sands. With regard to geotechnical characteristics of soils in the system of gravels and sands, the impact on this environment due to the loading by the new structure will be minimum.

Relief Sensitivity

The relief of the concerned territory shows a minimum division and declivity rate. The NJZ siting and construction area is situated on a plain territory, or, possibly, on a slightly wavy territory. From the susceptibility to land-slides point of view, the concerned territory can be classified as slightly endangered, no land-slides were recorded. From the exogenic processes point of view, the wind erosion can be classified as higher to high, as the territory provides an open and predominantly plain

relief with a large-area utilization mode and without a more intensive outplanting of windbreaks that would partially eliminate this undesirable phenomenon. With regard to the relief character, the majority of agricultural lands situated on the wider territory of interest are not endangered due to water erosion, or its intensity is only very low.

Ground Water and Surface Water Sensitivity

The ground water in hydrological collector I (the NJZ area as far as the Dudváh River flood plain: 15 to 40 m under the ground; The Váh River flood plain, the section from the Drahovce Channel to the confluence with the Váh River: 1 to 3 m under the ground) is affected by multiple factors in the surroundings – existing plants, waste water discharges into the surface water and their subsequent infiltration into the ground water and, e. g., intensive agriculture with the use of fertilizers and their penetration into the ground water. However, possible ground water pollutions are of local character without any remote dispersion and are only transported for units of kilometers. Moreover, with regard to the extensive and detailed monitoring of the area and the possibility of using individual monitoring drill holes for the remediation pumping, the whole area is monitored to a very deep detail and possible pollutions can be remediated. In case of this type of collector (a connected collector found in an attainable depth), remediation activities are very efficient.

Thus, hydrological collector I is historically affected and there is some susceptibility to further impacts. The collector can be assessed as a collector with a slightly deteriorated ground water quality, however, the situation at potable water take-off points is favourable and does not restrict the population. With regard to the efficiency of remediation measures, the capability to eliminate anthropogenic activities, and with regard to natural self-regulation processes running within the hydrological collector, hydrological collector I can be considered as medium vulnerable.

The connection of hydrological collectors I and II is not possible on the site (note: see Chapter C.II.6.2. ‘Ground Water‘for the specifications of hydrological collectors I and II). With regard to the fact that hydrological collector II is protected from both the overlaying and underlying strata by isolators (impermeable clays) and also with respect to its in-depth position (48 to 58 m under the ground), hydrological collector II can be classified as a good quality collector without any further possible impacts and with a slight vulnerability.

The Váh River catchment area water quality is especially affected by point pollution sources (industrial and municipal waste waters) as the Váh River Valley (Považie) is among the most developed industrial areas in Slovakia. The influence resulting from a marked regulation of the main watercourse is not negligible either, as a system of waterworks and channels is built thereon.

Soil Sensitivity

Despite the fact that the concerned territory is distinguished by a high degree of agricultural activities, it is among areas with the least contaminated soils nationwide, as far as agriculture inflicted pollution is concerned. Soils in the concerned territory are slightly susceptible to acidification, the soil acidification by local sources shows itself to a minimum extent. In relation to the risk of plant production contamination with metals, the soils are assessed on the medium risk level, with the predominantly high and, to a less extent, medium resistance to the intoxication by the acid group of risky metals, and with the low to medium resistance to the intoxication by the alkaline group of risky metals. Soils on the concerned territory are distinguished by their predominantly high retention capacity and medium permeability. Based on these characteristics, the soils can be assessed as slightly vulnerable.

Air Sensitivity

The NJZ site itself and its surroundings are among the less loaded territories nationwide from the air pollution point of view. Thanks to favourable orographic and climatic conditions, the territory has good circulation, as a result of which emitted pollutants are dispersed to a sufficient extent. In addition to the remote transfer of pollutants, the air quality is especially affected by emissions from large industrial sources found on the studied territory. The air vulnerability can be assessed on the medium level.

Sensitivity of Fauna, Flora and Ecosystems

The proposed project is situated in a landscape dominated by soils utilized in large areas for agricultural purposes, there is a lack of forest woody vegetation, non-original plant species appear and anthropogenic social-economic elements are present there. Ecostabilization elements are represented on the territory of interest to a minimum extent, the landscape shows a low ecological stability coefficient. The whole concerned territory can be assessed as a territory of low biological diversity.

Anthropogenic interventions that were made there in the past resulted in the liquidation of the free greenery, valuable biotopes perished due to reclamation and amelioration Works. Natural and near-to-natural communities are absent on the territory. Communities and biotopes of Community or national importance are already markedly modified at present, they are exposed to intensive anthropization effects. Greenery areas on a territory are significant ecostabilization and aesthetic elements in the landscape and fauna shelters, but such elements are markedly absent throughout the concerned territory The NJZ siting and construction area will not directly interfere with any small-area or large-area protected territory of the national system of protected territories. Within the meaning of Act No. 543/2002, Coll., on the Nature and Landscape Conservation, as amended, degree 1 of protection applies there. From the fauna, flora and ecosystems point of view, the territory sensitivity can be assessed as low to medium.

Sensitivity of Comfort Factors and Human Life Quality

The proposed activity is situated on the territory where a series of nuclear facilities has been operated for a long time and the relation between the population living on the concerned territory and nuclear power engineering is thus consolidated in the long term. It follows from results of performed opinion polls that, on one hand, the safe operation of nuclear facilities and social and economic benefits thanks to the nuclear facilities are perceived positively, on the other hand, a part of the population in the region shows a certain anxiety about unfavourable impacts on the environment that are not specified more closely. From the point of view of the concerned public health assessment, health state indicators (demographical structure, reproductive health, death rate, sickness rate, etc.) do not statistically and significantly differ from average values for the population of the Slovak Republic and a series of indicators are even better. The territory sensitivity can be assessed as medium.

C.II.18. Assessment of Expected Territory Development if the Proposed Activity is not Implemented

18. Assessment of expected territory development if the proposed activity is not implemented.

The nuclear power installations and related facilities are operated on the concerned territory in the long term. All their necessary infrastructural links are established. It can be expected that this power engineering function of the territory will remain maintained even after the operation of the existing power sources is terminated, regardless of whether the proposed activity is implemented or not. It is just the availability of necessary areas and infrastructural and operational links that makes the site a first-rank place for the siting of new power sources. Thus, from the environmental point of view, this represents a rational and optimum solution consisting in the use of the ready and equipped territory.

If the proposed activity was not implemented, the use of the territory for another power source would be the real and probable scenario. With regard to the site capacity, it would probably be a power source comparable (in both the character and capacity) with the source that is the subject of the proposed activity. That is why, in case of this scenario, there would not be significant changes in the development of the concerned territory if the proposed activity was implemented or not.

If the proposed activity was not implemented, a complete resignation from the power engineering use of the territory would be the other extreme scenario. However, even in case of this scenario, further pressure to use the territory for other purposes (that would naturally bring relevant impacts, too) cannot be excluded. However, it is extremely unlikely that any anthropogenic utilization of the concerned territory will be completely refrained from (and it will be returned to the natural environment) and this would not be rational from the multi-branch environmental point of view either

C.II.19. Compliance with the Land Use Plan Documentation

19. Compliance between the proposed activity and the land use plan documentation in force.

The proposed activity is in compliance with the relevant land use plan documentation as follows:

- Territorial Development Conception of the Slovak Republic,
- Trnava Self-Governing Region Land Use Plan documentation,
- Land use plan documentation of concerned municipalities.

The Territorial Development Conception of the Slovak Republic (update of 2011) is a document that is the starting point of the nationwide land use policy of the Slovak Republic.

The following provision is stipulated in the mandatory part of the Territorial Development Conception: "To ensure territorial conditions for the construction of new electric power and heat generation facilities and their related structures, including the assurance of territorial preparations, construction and completion of national electric transmission lines and facilities used for the electric power transmission, the construction of additional international connections in connection with the liberalization of power engineering in compliance with the Power Safety Strategy of the Slovak Republic."

This also applies to the NJZ construction project, as it is one of priorities of the Power Safety Strategy of the Slovak Republic. Territorial conditions for the Source construction and the construction of its related facilities are established within the preparations of the Trnava Self-Governing Region Land Use Plan.

Trnava Self-Governing Region (TTSK) Land Use Plan that entered into force on 19 January 2015 is a document determining the TTSK proceeding from the planned construction activity point of view.

The NJZ construction is included in the mentioned plan for the period from 2015 till 2035, namely in the area situated in the North-West part of the existing Jaslovské Bohunice power plant site. That position is the most appropriate for the NJZ siting from the point of view of meeting the conditions established by the Atomic Act, i. e., considering the impacts on the environment, connections to the infrastructure, water sources, use of qualified staff and their social welfare. 65 hectares should be reserved for that purpose and 135 hectares more for the construction site equipment. The TTSK Land Use Plan document also refers to new overhead transmission lines and a switchyard that will enable to connect the NJZ to the electric power supply system, as well as to raw water intake pipelines and waste and rain waters drainage pipelines.

The establishment of land use planning conditions for the possible construction of the NJZ and facilities related to its perspective operation on the Jaslovské Bohunice site is included among significant development areas and areas of special interest of the regional significance in the TTSK Land Use Plan which delimit the framework of elements for the lower levels of land use plan documents.

The state of the land use plan documents in concerned municipalities are summarized in the following table.

Table C.II.53: List of land use plan documents of concerned municipalities

Region	District	Municipality	Land use plan / amendments
Trnava	Trnava	Jaslovské Bohunice	ÚPN-O of 2008, Amendments No. 2/2013 in force at present. Both the text and graphical parts only apply to the present EBO site. The NJZ will be considered within the land use plan update under preparations (in compliance with the TTSK Land Use Plan Document).
		Malženice	ÚPN-O of 2008, no amendments.
		Radošovce	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Dolné Dubové	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Kátlovce	ÚPN-O of 2005.
		Špačince	ÚPN-O of 2004, Amendment No. 1/2011.
	Hlohovec	Ratkovce	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Žlkovce	ÚPN-Oof 2004, Amendment No. 1/2011.
		Červeník	ÚPN-O of 2007, Amendment No. 3/2013 in force at present.
		Trakovice	ÚPN-O of 2007, Amendment No. 1/2008.
		Madunice	ÚPN-O of 2005, Amendment No. ZaD č. 2/2012 in force at present.
	Piešťany	Nižná	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Pečeňady	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Veľké Kostoľany	ÚPN-O of 2007, Amendment No. 1/2008 in force at present. The text part does not deal with the present EBO site. The EBO size is included in the Veľké Kostoľany wider relations cadastral documentation. The proposed NJZ construction is not dealt with in the current land use plan.
		Dubovany	ÚPN-O of 2010. The text part states that the municipality is situated in the Jaslovské Bohunice NPP zone of protection. The proposed NJZ construction is not dealt with in the current land use plan.
		Drahovce	ÚPN-O of 2005, Amendment No. 5/2014 in force at present.
		Dolný Lopašov	The municipality population is below 2,000.That is why, it is not obliged to keep a land use plan so far.
		Chtelnica	ÚPN-O of 2005, Amendment No. 3/2014 in force at present.
		Piešťany	ÚPN-SÚ of 1998, Amendment No. 11/2013 in force at present.

The NJZ is not mentioned in land use plans of the concerned municipalities at present, as the superior TTSK Land Use Plan has only entered into force recently (19 January 2015). However, land use plans of the municipalities will be aligned with the superior land use plan document in compliance with common land use planning procedures and, thus, the NJZ will be gradually included.

C.III. Environment Impact Assessment Including Health

III. Assessment of assumed impacts of the proposed activity on the environment including health and the estimate of their significance (assumed direct, indirect, secondary, cumulative, synergic impacts and impacts initiated during the construction and implementation).

C.III.1. Population Impacts

1. Population impacts – number of inhabitants affected by impacts of the proposed activity in concerned municipalities, health risks, social and economic consequences and connections, disruptions of comfort and life quality, acceptability of the activity for the concerned municipalities (e. g., on the basis of opinion positions and comments provided by the concerned municipalities on the basis of sociological surveys, among inhabitants of the concerned municipalities), and other impacts.

C.III.1.1. Health Impacts and Risks

C.III.1.1.1. Methodological Introduction

The health risk assessment method is applied in order to prevent and minimize health risks for people resulting from various sources. The method is used during the process of authorized limits determination for harmful pollutants in the environment. However, at the same time, the method represents the only way how to assess the population exposure to harmful factors for which no limits are determined from the health protection point of view. This method, however, makes it possible to obtain more detailed information on possible impacts on the public health and comfort than by means of simple comparisons with applicable legislative limits, even on the harmful pollutants for which obligatory limits are established by legislative procedures.

The health risk assessment starts from the assumption that a certain health damage risk rate always exists under certain conditions and it is not possible to avoid that. The risk can be minimized, however, it cannot be eliminated. Thus, the achievement of a zero health risk is virtually impossible from the methodology point of view and is not necessarily an achievable target. However, the risk must be minimized to as reasonable rate as possible, from the point of view of health and environmental risks.

A methodology based on procedures developed by US EPA Agency is used at present to estimate health risks. The procedures are further developed and enhanced. Methods and results of epidemiological studies are also used more and more. The risk assessment in the Slovak Republic is delimited formally and factually by the Methodological Instruction of the Ministry of Environment of the Slovak Republic of 22 October 1998, No. 623/98-2, on Risk Assessment and Management Procedures.

The health risk estimate is performed in the following four successive steps:

- Risk Identification,
- Evaluation of Dose - Response Relationship,
- Exposure Characterization,
- Risk Characterization.

The steps can be summarized as follows:

Risk Identification: The purpose of this step is to identify relevant harmful pollutants and factors the concerned population is exposed to and get a summary of evidence on their undesirable effects to man, based on available data. The objective is to identify whether and under which circumstances the monitored agents can be dangerous for the human health.

Evaluation of Dose - Response Relationship: This step describes quantitatively the relationship between a dose from the given harmful substance and the rate of its effect to the organism. This quantification off the Dose – Response is a prerequisite for the subsequent estimate of the risk rate. In this case, the risk represents a mathematical probability that health can be damaged, a sickness or even death can occur. In case of harmful chemical and physical pollutants, two basic kinds of action are considered at the beginning, as for the type of health effects – threshold and non-threshold effects:

- Harmful pollutants with the threshold effect are assumed not to have any negative effect up to a certain level (a threshold). Increasing effects can then be expected above this limit, depending on the magnitude of exposure. This group includes a majority of toxic substances and the so-called deterministic effects of ionizing radiation.
- As for harmful pollutants with the non-threshold effect, no dose level that is still safe can be specified (a certain unfavourable effect is conservatively assumed already from the lowest doses) and the Dose-to-Response function is expressed by means of an indicator characterizing the risk potential rate of the given harmful pollutant. This group includes a majority of carcinogenic substances and the so-called stochastic effects of ionizing radiation[20].

Exposure Characterization: The exposure characterization includes a qualitative expression of the contact between the characterized factor and the organism and a quantitative expression of the intensity of that effect. The objective is to obtain information in which possible exposure paths, to what extent and in which number the population is exposed to the effects of the characterized harmful pollutant. The objective is **not** to characterize only an average exposed individual, but also real cases of persons with the highest exposures. For that purpose, the most struck groups of the population are therefore identified, whether due to the increased vulnerability, or due to the increased exposure (the so-called critical groups of the population).

Risk Characterization: The Risk Characterization is the final step in the whole risk assessment process integrating information obtained in the preceding steps. The probability that a human organism will suffer some of possible damages is defined qualitatively and quantitatively.

- The HI (Hazard Index) is calculated for harmful pollutants with the threshold effect, i. e., the ratio of the assumed exposure to the still exposure that is still below the threshold. If HI is less than 1, the effect of the given harmful pollutant is negligible.
- In case of harmful pollutants with the non-threshold effect, the evaluated information includes the resulting number by which the number of health damage cases increased in the population of exposed people. The acceptable risk is usually of the order of E-06 (i. e., 1 case per 1 million exposed people), lower levels (E-05, or E-04) are sometimes accepted. Attributive risk indicators are used for some harmful pollutants (a forecast of the increase in number of cases related to health consequences in exposed people) with the use of relations described in epidemiological studies.

C.III.1.1.2. Radiation Impacts

From the point of view of assumed the NJZ impacts on the population and public health, it is possible to consider ionizing radiation impact as the most intensively monitored. Radioactivity, i. e., a natural of artificially induced ability of some unstable atom nuclei to transform spontaneously and release energy in the form of radiation, is the physical base for the generation of ionizing radiation.

During the ionizing radiation action, the absorption of an amount of energy by an atom or molecule and its use for the ionization of the same or another atom or molecule is the primary event. This results in the origination of free negatively charged electrons and positively charged ions. The negatively or positively charged ions are characterized by instability and higher reactivity and, during interactions with other substances, they are able to induce chemical or electrostatic changes in them. This can bring serious consequences to living tissues where the production of ions and free radicals of chemical bonds is disrupted and, thus, cells are damaged.

[20] A specific situation is related to noise, because its effects are considered as non-threshold within the audibility band. Thus, the determination of quantitative relations between exposure and effects for an average sensitive group of population becomes the output.

The *absorbed dose* is the basic quantity of exposure. It is defined as a ratio of the absorbed energy of radiation and the mass of the material where the energy was absorbed. The absorbed dose unit is gray (Gy), its dimension is J/kg.

However, particular mechanisms of radiation-to-mass interactions are specific for each type of radiation. The effect depends on the type of radiation (α radiation, β radiation, γ radiation, neutron radiation), i. e.., on the energy, mass and charge of particles or photons. Some types of radiation (γ photons, β electrons) ionize sparsely and, that is why, they are not so efficient as other types of radiation (α particles, neutrons) that ionize more densely and, that is why, they are able to cause more damage in the exposed mass. The type of radiation by which the dose is caused is taken into account in the form of the so-called *radiation weight factor*, expressing the efficiency of individual types of radiation. The radiation weight factor magnitude ranges from 1 (for photons) to 20 (for α particles).The *equivalent dose* is then the quantity taking into account the efficiency of radiation. The equivalent dose is defined as a product of the radiation weight factor and the absorbed dose. The equivalent dose unit is Sievert (Sv).

However, different human body organs have different sensitivities to radiation effects. Therefore, the equivalent dose does not speak anything about the risk that can arise from radiation (e. g., exposure of gonads has a different effect from, e. g., skin exposure with the same dose). For that reason, the so-called *tissue weight factor* is included in the assessment expressing the sensitivity of individual organs to exposure. The tissue weight factor magnitude ranges from 0.01 (skin) to 0.20 (gonads) whereby the sum of all weight factors for all organs in the whole human body equals to 1. The *effective dose* is then used for the risk calculation. It is defined as a sum of products of the tissue weight factor and the equivalent dose (for all exposed organs). The effective dose unit is sievert (Sv) again.

All exposure data given in the present Report are expressed in the form of effective dose values[21]. The increment of effective dose per a time unit is expressed as the *effective dose rate* (Sievert per time is the unit, e. g., Sv/s), the total received effective dose is then expressed in the form of the *effective dose* or *committed effective dose* per time (e. g., the annual effective dose in Sv/year or the lifetime effective dose in Sv/70 years and the like). Sievert is a relatively great unit, its thousandths (milisievert, mSv, 1.10^{-3} Sv, 1E-03 Sv) or millionths (microsievert, μSv, 1.10^{-6}, 1E-06 Sv) are used for practical reasons.

Ionizing radiation effects are divided into the following, from the human organism point of view:

- deterministic effects when the effect occurs regularly after a certain dose has been received, and
- stochastic effects when the probability of damage rises with the increasing dose.

Deterministic effects: They are effects occurring as a result of death or loss of the mitotic capability for a large number of exposed cells. They are effects resulting in direct damage of tissues (e. g., skin radiation damage, fertility damage, chronic radiodermatitis, crystalline lens damage, acute exposure sickness). They occur as a result of high doses. They are threshold effects, they only appear after a certain threshold dose is exceeded and their seriousness increases with the increasing dose. Frequently, but not always, they are of acute character and occur shortly after the exposure.

Stochastic effects: Those effects are induced by changes in the genetic information of exposed cells and are characteristic of the formation of malignant tumours and hereditary damage. On the basis of a generally accepted opinion, they are considered as non-threshold. As the dose is increasing, not the damage seriousness, but the probability that serious damage occurs in the exposed population is increasing. Stochastic effects are delayed in time, they only become evident after a certain time period from the exposure (frequently, after many years).

When assessing potential NJZ effects this Report is only focused on the stochastic effects, with regard to very low doses.

A recommended functional radiation protection system is based on the assumption that, in case of low doses (approximately below 100 mSv), a given increase in a dose results in a directly proportional increment of probability that tumour diseases or hereditary effects occur due to radiation. This approach, generally known as " Linear and Non-Threshold Dose – Response Model " is conservative (i. e., the risk is rather overvalued) and even though it remains a scientifically acceptable basic component in the practical radiation protection system, biological/epidemiological information that would unambiguously verified the hypothesis supporting this model cannot be unambiguously proved.

[21] Except for cases when equivalent dose data is used for a relevant organ (e. g., in the emergency exposure area).

For that reason, a view is held in case of health effects induced by low doses that it is not appropriate for the purpose of health measures planning to calculate a hypothetic number of cases related to tumour or hereditary diseases that could be caused by very low radiation doses striking large numbers of people over a very long time period. Instead, the ICRP[22] Commission processed and published – in its Report No. 103 (2007) – on the basis of the latest scientific knowledge, coefficients used for the estimate of the so-called health detriment. The "overall health damage" that appeared in an exposed group of people and in their descendants due to a group exposure to a radiation source is considered a health detriment. It is a multidimensional term. The following stochastic quantities are its basic components: the probability of induced fatal new formation, the weighted probability of serious hereditary consequences and the life reduction due to the damage. The hereditary damage transferred into children is also included in there by ICRP, although it was not proved in case of man. This is done for cautiousness, with regard to the fact that convincing evidence exist in that area in case of experimental animals.

The following table gives health detriment estimate coefficients in compliance with ICRP.

Table C.III.1: Nominal risk coefficients of health detriment estimates for stochastic effects of low radiation doses (ICRP, 2007)

Exposed population	Risk coefficient [10^{-2} Sv^{-1}]		
	New formations	Hereditary effects	Total
Total	5.5	0.2	5.7
Adults	4.1	0.1	4.2

Note: The risk coefficient is of a probabilistic character whereby the risk coefficient value expressed in units of 10^{-2} Sv^{-1} means a probable number of health detriment per 100 persons exposed by the individual effective dose of 1 Sv.

Analyses performed in thisReport include thoroughly applied conservative assessments for the total population using the risk coefficient of 5.7 x 10^{-2} Sv^{-1} (0.057 Sv^{-1}).

When assessing the exposure, we start from the assumption that nuclear facilities slightly increase dose loads in the surrounding environment during operation due to residual traces of radionuclides discharged in gaseous and liquid effluents. The effluents become a part of the ecosystem and their radioactive components are subsequently received by the population in various dispersion routes. Individuals in the population can be irradiated internally, when radioactive substances enter the organism, especially by breathing (inhalation), ingestion, or externally, e. g., during a stay in the environment. Those impacts will act in a concurrent effect of the NJZ along with the nuclear facilities existing on the site during their life cycles (operation, decommissioning).

The calculation of radiological consequences induced by radioactive effluents under the NJZ normal operation conditions, namely in the concurrent effect along with the operation of other nuclear facilities on the site (JE V2, JAVYS facilities), as well, is presented in Chapter C.III.16.3. 'Ionizing Radiation Impacts' (page 325 of the Report). Relevant methodological data is presented there, too.

Cumulative lifetime loads (50 years for an adult, 70 years if the children's age is taken into account), i. e., lifetime committed effective doses from inhalation and ingestion and effective doses from external exposure are presented in the following tables for all assessed zones (i. e. for combinations of all assessed directions and distances). The layout of the assessed zones is obvious from Chapter C.III.16.3. 'Ionizing Radiation Impacts' (page 325 of the present Report), zones extending to foreign territories are indicated by the grey background colouring.

[22] ICRP (International Commission on Radiological Protection) is an independent non-governmental organization founded in the year 1928. It processes systematically new scientific knowledge from radiology and uses it to update preventive recommendations for the protection against ionizing radiation related risks (both artificially produced and natural ionizing radiation). ICRP interconnects the most significant worldwide experts in that area and enjoys a high international authority in that branch. All international standards and national regulation activities in the radiation protection branch are based on ICRP recommendations.

Table C.III.2: Lifetime individual effective doses from the NJZ+JE V2+JAVYS effluents (50 years – an adult man)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime individual effective dose [Sv/50 years]					
S	1.38E-05	2.21E-05	1.81E-05	1.26E-05	8.60E-06	6.05E-06
SSV	7.95E-06	1.20E-05	1.00E-05	7.30E-06	5.20E-06	3.72E-06
SV	5.50E-06	7.75E-06	6.60E-06	4.85E-06	3.47E-06	2.51E-06
VSV	7.05E-06	1.09E-05	8.70E-06	6.10E-06	4.21E-06	2.99E-06
V	2.31E-05	4.40E-05	3.27E-05	2.12E-05	1.38E-05	9.35E-06
VJV	2.79E-05	5.90E-05	4.22E-05	2.60E-05	1.61E-05	8.40E-05
JV	3.14E-05	6.50E-05	4.51E-05	2.74E-05	1.69E-05	8.45E-05
JJV	2.43E-05	3.86E-05	2.88E-05	1.94E-05	1.33E-05	9.45E-06
J	5.35E-05	7.90E-05	6.35E-05	4.49E-05	3.16E-05	2.27E-05
JJZ	1.56E-05	2.49E-05	1.95E-05	1.35E-05	9.40E-06	6.70E-06
JZ	5.05E-06	7.15E-06	6.40E-06	4.99E-06	3.68E-06	2.71E-06
ZJZ	5.25E-06	6.25E-06	5.95E-06	4.85E-06	3.75E-06	2.83E-06
Z	2.01E-05	3.32E-05	2.78E-05	1.98E-05	1.38E-05	9.75E-06
ZSZ	2.17E-05	4.34E-05	3.27E-05	2.13E-05	1.40E-05	9.60E-06
SZ	1.91E-05	3.50E-05	2.59E-05	1.67E-05	1.08E-05	7.35E-06
SSZ	1.56E-05	2.57E-05	1.87E-05	1.23E-05	8.05E-06	5.50E-06
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime individual effective dose [Sv/50 years]					
S	3.24E-06	1.73E-06	9.00E-07	4.79E-07	2.96E-07	2.00E-07
SSV	2.02E-06	1.07E-06	5.50E-07	2.91E-07	1.78E-07	1.20E-07
SV	1.40E-06	7.60E-07	3.97E-07	2.08E-07	1.25E-07	8.25E-08
VSV	1.65E-06	8.90E-07	4.66E-07	2.46E-07	1.50E-07	1.00E-07
V	4.75E-06	2.45E-06	1.27E-06	6.90E-07	4.40E-07	3.06E-07
VJV	5.20E-06	2.68E-06	1.41E-06	7.80E-07	5.05E-07	3.58E-07
JV	7.85E-05	2.73E-06	1.43E-06	7.90E-07	5.15E-07	4.95E-06
JJV	7.85E-05	7.60E-05	7.45E-05	7.40E-05	7.35E-05	4.90E-06
J	1.23E-05	6.45E-06	3.33E-06	1.79E-06	1.12E-06	7.65E-07
JJZ	3.63E-06	1.93E-06	1.00E-06	5.35E-07	3.36E-07	2.29E-07
JZ	1.50E-06	8.05E-07	4.16E-07	2.18E-07	1.32E-07	8.70E-08
ZJZ	1.61E-06	8.70E-07	4.45E-07	2.29E-07	1.37E-07	8.85E-08
Z	5.20E-06	2.73E-06	1.41E-06	7.55E-07	4.68E-07	3.18E-07
ZSZ	4.94E-06	2.57E-06	1.33E-06	7.25E-07	4.61E-07	3.20E-07
SZ	3.80E-06	2.00E-06	1.05E-06	5.70E-07	3.61E-07	2.50E-07
SSZ	2.86E-06	1.51E-06	7.90E-07	4.29E-07	2.72E-07	1.88E-07

Table C.III.3: Lifetime individual effective doses from the NJZ+JE V2+JAVYS effluents (70 years – considering the children's age)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime individual effective dose [Sv/70 years]					
S	1.93E-05	3.09E-05	2.53E-05	1.76E-05	1.20E-05	8.47E-06
SSV	1.11E-05	1.67E-05	1.40E-05	1.02E-05	7.28E-06	5.21E-06
SV	7.70E-06	1.09E-05	9.24E-06	6.79E-06	4.85E-06	3.51E-06
VSV	9.87E-06	1.53E-05	1.22E-05	8.54E-06	5.89E-06	4.19E-06
V	3.23E-05	6.15E-05	4.57E-05	2.97E-05	1.93E-05	1.31E-05
VJV	3.91E-05	8.26E-05	5.91E-05	3.63E-05	2.25E-05	1.18E-04
JV	4.40E-05	9.10E-05	6.31E-05	3.83E-05	2.37E-05	1.18E-04
JJV	3.40E-05	5.40E-05	4.03E-05	2.71E-05	1.86E-05	1.32E-05
J	7.49E-05	1.11E-04	8.89E-05	6.28E-05	4.42E-05	3.18E-05
JJZ	2.18E-05	3.49E-05	2.72E-05	1.88E-05	1.32E-05	9.38E-06
JZ	7.07E-06	1.00E-05	8.96E-06	6.98E-06	5.15E-06	3.79E-06
ZJZ	7.35E-06	8.75E-06	8.33E-06	6.79E-06	5.24E-06	3.96E-06
Z	2.81E-05	4.64E-05	3.89E-05	2.77E-05	1.93E-05	1.37E-05
ZSZ	3.04E-05	6.07E-05	4.58E-05	2.98E-05	1.96E-05	1.34E-05
SZ	2.67E-05	4.90E-05	3.62E-05	2.33E-05	1.51E-05	1.03E-05
SSZ	2.18E-05	3.59E-05	2.61E-05	1.72E-05	1.13E-05	7.70E-06
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime individual effective dose [Sv/70 years]					
S	4.53E-06	2.42E-06	1.26E-06	6.71E-07	4.14E-07	2.80E-07
SSV	2.82E-06	1.49E-06	7.70E-07	4.07E-07	2.49E-07	1.67E-07
SV	1.95E-06	1.06E-06	5.56E-07	2.91E-07	1.75E-07	1.16E-07
VSV	2.30E-06	1.25E-06	6.52E-07	3.44E-07	2.09E-07	1.40E-07
V	6.64E-06	3.43E-06	1.78E-06	9.66E-07	6.15E-07	4.28E-07
VJV	7.28E-06	3.75E-06	1.97E-06	1.09E-06	7.07E-07	5.01E-07
JV	1.10E-04	3.82E-06	2.00E-06	1.11E-06	7.21E-07	6.92E-06
JJV	1.10E-04	1.06E-04	1.04E-04	1.04E-04	1.03E-04	6.86E-06
J	1.72E-05	9.03E-06	4.66E-06	2.51E-06	1.57E-06	1.07E-06
JJZ	5.08E-06	2.70E-06	1.40E-06	7.49E-07	4.70E-07	3.20E-07
JZ	2.10E-06	1.13E-06	5.82E-07	3.05E-07	1.84E-07	1.22E-07
ZJZ	2.25E-06	1.22E-06	6.23E-07	3.21E-07	1.91E-07	1.24E-07
Z	7.28E-06	3.82E-06	1.97E-06	1.06E-06	6.55E-07	4.45E-07
ZSZ	6.92E-06	3.59E-06	1.86E-06	1.02E-06	6.45E-07	4.48E-07
SZ	5.31E-06	2.80E-06	1.47E-06	7.98E-07	5.05E-07	3.50E-07
SSZ	4.00E-06	2.11E-06	1.11E-06	6.00E-07	3.80E-07	2.63E-07

In compliance with ICRP recommendations, the total sums of committed effective doses from inhalation and ingestion and of effective doses from external exposure for 50 (or 70) years multiplied by the risk coefficient of 0.057 Sv^{-1}. Results are presented in the following tables.

Table C.III.4: Lifetime risk resulting from effluents from the NJZ+JE V2+JAVYS (adults)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime health detriment risk [-]					
S	7.87E-07	1.26E-06	1.03E-06	7.18E-07	4.90E-07	3.45E-07
SSV	4.53E-07	6.81E-07	5.70E-07	4.16E-07	2.96E-07	2.12E-07
SV	3.14E-07	4.42E-07	3.76E-07	2.76E-07	1.98E-07	1.43E-07
VSV	4.02E-07	6.21E-07	4.96E-07	3.48E-07	2.40E-07	1.70E-07
V	1.32E-06	2.51E-06	1.86E-06	1.21E-06	7.87E-07	5.33E-07
VJV	1.59E-06	3.36E-06	2.41E-06	1.48E-06	9.18E-07	4.79E-06
JV	1.79E-06	3.71E-06	2.57E-06	1.56E-06	9.63E-07	4.82E-06
JJV	1.39E-06	2.20E-06	1.64E-06	1.10E-06	7.58E-07	5.39E-07
J	3.05E-06	4.50E-06	3.62E-06	2.56E-06	1.80E-06	1.29E-06
JJZ	8.89E-07	1.42E-06	1.11E-06	7.67E-07	5.36E-07	3.82E-07
JZ	2.88E-07	4.08E-07	3.65E-07	2.84E-07	2.10E-07	1.54E-07
ZJZ	2.99E-07	3.56E-07	3.39E-07	2.76E-07	2.13E-07	1.61E-07
Z	1.15E-06	1.89E-06	1.58E-06	1.13E-06	7.84E-07	5.56E-07
ZSZ	1.24E-06	2.47E-06	1.86E-06	1.21E-06	7.98E-07	5.47E-07
SZ	1.09E-06	2.00E-06	1.47E-06	9.49E-07	6.16E-07	4.19E-07
SSZ	8.86E-07	1.46E-06	1.06E-06	6.98E-07	4.59E-07	3.14E-07
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime health detriment risk [-]					
S	1.84E-07	9.83E-08	5.13E-08	2.73E-08	1.69E-08	1.14E-08
SSV	1.15E-07	6.07E-08	3.14E-08	1.66E-08	1.01E-08	6.81E-09
SV	7.95E-08	4.33E-08	2.26E-08	1.18E-08	7.13E-09	4.70E-09
VSV	9.38E-08	5.07E-08	2.65E-08	1.40E-08	8.52E-09	5.70E-09
V	2.70E-07	1.40E-07	7.24E-08	3.93E-08	2.51E-08	1.74E-08
VJV	2.96E-07	1.53E-07	8.04E-08	4.45E-08	2.88E-08	2.04E-08
JV	4.47E-06	1.56E-07	8.12E-08	4.50E-08	2.94E-08	2.82E-07
JJV	4.47E-06	4.33E-06	4.25E-06	4.22E-06	4.19E-06	2.79E-07
J	6.98E-07	3.68E-07	1.90E-07	1.02E-07	6.38E-08	4.36E-08
JJZ	2.07E-07	1.10E-07	5.70E-08	3.05E-08	1.91E-08	1.30E-08
JZ	8.55E-08	4.59E-08	2.37E-08	1.24E-08	7.50E-09	4.96E-09
ZJZ	9.18E-08	4.96E-08	2.54E-08	1.31E-08	7.78E-09	5.04E-09
Z	2.96E-07	1.55E-07	8.04E-08	4.30E-08	2.67E-08	1.81E-08
ZSZ	2.82E-07	1.46E-07	7.58E-08	4.13E-08	2.62E-08	1.82E-08
SZ	2.16E-07	1.14E-07	5.99E-08	3.25E-08	2.06E-08	1.43E-08
SSZ	1.63E-07	8.58E-08	4.50E-08	2.44E-08	1.55E-08	1.07E-08

Table C.III.5: Lifetime risk resulting from effluents from the NJZ+JE V2+JAVYS (children)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime health detriment risk [-]					
S	1.10E-06	1.76E-06	1.44E-06	1.01E-06	6.86E-07	4.83E-07
SSV	6.34E-07	9.54E-07	7.98E-07	5.83E-07	4.15E-07	2.97E-07
SV	4.39E-07	6.18E-07	5.27E-07	3.87E-07	2.77E-07	2.00E-07
VSV	5.63E-07	8.70E-07	6.94E-07	4.87E-07	3.36E-07	2.39E-07
V	1.84E-06	3.51E-06	2.61E-06	1.69E-06	1.10E-06	7.46E-07
VJV	2.23E-06	4.71E-06	3.37E-06	2.07E-06	1.28E-06	6.70E-06
JV	2.51E-06	5.19E-06	3.59E-06	2.18E-06	1.35E-06	6.74E-06
JJV	1.94E-06	3.08E-06	2.29E-06	1.54E-06	1.06E-06	7.54E-07
J	4.27E-06	6.30E-06	5.07E-06	3.58E-06	2.52E-06	1.81E-06
JJZ	1.24E-06	1.99E-06	1.55E-06	1.07E-06	7.50E-07	5.35E-07
JZ	4.03E-07	5.71E-07	5.11E-07	3.98E-07	2.94E-07	2.16E-07
ZJZ	4.19E-07	4.99E-07	4.75E-07	3.87E-07	2.99E-07	2.26E-07
Z	1.60E-06	2.65E-06	2.22E-06	1.58E-06	1.10E-06	7.78E-07
ZSZ	1.73E-06	3.46E-06	2.61E-06	1.70E-06	1.12E-06	7.66E-07
SZ	1.52E-06	2.79E-06	2.06E-06	1.33E-06	8.62E-07	5.87E-07
SSZ	1.24E-06	2.05E-06	1.49E-06	9.78E-07	6.42E-07	4.39E-07
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime health detriment risk [-]					
S	2.58E-07	1.38E-07	7.18E-08	3.82E-08	2.36E-08	1.60E-08
SSV	1.61E-07	8.50E-08	4.39E-08	2.32E-08	1.42E-08	9.54E-09
SV	1.11E-07	6.06E-08	3.17E-08	1.66E-08	9.98E-09	6.58E-09
VSV	1.31E-07	7.10E-08	3.71E-08	1.96E-08	1.19E-08	7.98E-09
V	3.79E-07	1.96E-07	1.01E-07	5.51E-08	3.51E-08	2.44E-08
VJV	4.15E-07	2.14E-07	1.13E-07	6.22E-08	4.03E-08	2.86E-08
JV	6.26E-06	2.18E-07	1.14E-07	6.30E-08	4.11E-08	3.95E-07
JJV	6.26E-06	6.06E-06	5.95E-06	5.91E-06	5.87E-06	3.91E-07
J	9.78E-07	5.15E-07	2.66E-07	1.43E-07	8.94E-08	6.10E-08
JJZ	2.90E-07	1.54E-07	7.98E-08	4.27E-08	2.68E-08	1.82E-08
JZ	1.20E-07	6.42E-08	3.32E-08	1.74E-08	1.05E-08	6.94E-09
ZJZ	1.28E-07	6.94E-08	3.55E-08	1.83E-08	1.09E-08	7.06E-09
Z	4.15E-07	2.17E-07	1.13E-07	6.02E-08	3.73E-08	2.54E-08
ZSZ	3.94E-07	2.05E-07	1.06E-07	5.79E-08	3.67E-08	2.55E-08
SZ	3.03E-07	1.60E-07	8.38E-08	4.55E-08	2.88E-08	2.00E-08
SSZ	2.28E-07	1.20E-07	6.30E-08	3.42E-08	2.17E-08	1.50E-08

It is obvious from the results that the health detriment risk from effluents discharged from the NJZ and other nuclear facilities on the site is of the order of E-06 and lower in all the zones. Thus, it reliably complies with the strictest internationally recognized criteria. Considering a very conservative approach, the highest risk results from zone No. 78 (the geographical direction JV (South-East), distance of 7 to 10 km), namely it is of the order of E-06. The highest risk from abroad results from zone No. 96 (the Váh River estuary into the Danube River (Hungary), the geographical direction JJV (South-South-East), distance of 90 to 110 km) where values of the order of E-07 are achieved. This value is by 1 to 2 orders lower in the other trans-border zones.

Besides, it is necessary to take into consideration that the NJZ background design documents, as well as their evaluation procedures, are conservative and considerably overestimated. Therefore, it can be assumed with a high probability rate that both the loads and the resulting health detriment probability will be much lower than described above.

Comparisons with radiation background impacts can also provide an interesting view of the population radiation load. An average effective dose from natural sources in the Slovak republic was approximately 3 mSv/year. Medical applications, especially diagnostics, increase the dose to the population by another approximately 1.7 mSv/year. If the mentioned background values are summed up, the total average value is obtained that is higher by 3 orders than values calculated for nuclear facilities on the site. Thus, it is obvious that health effects induced by the nuclear facilities, including the NJZ, will also be only tiny fractions of effects caused by the natural background and by the background conditioned on other artificial sources.

C.III.1.1.3. Non-Radiation Impacts

C.III.1.1.3.1. Chemical Harmful Pollutants

NO_2, solid substances of PM_{10} and $PM_{2.5}$ fractions, CO, benzene and benzo(a)pyrene are among decisive emitted chemical harmful pollutants that can cause unfavourable impacts on human health.

Nitrogen dioxide (NO_2): From the health point of view, nitrogen dioxide is the most significant of nitrogen oxides and is among the most intensively monitored harmful pollutants. Effects of higher NO_2 concentration to the human organism are chronic, on one hand, and acute, on the other hand. Acute effects to the human health were observed in the form of impacts on lungs functions and the reactivity of air passages that should not be induced at values of 200 µg/m^3 (the recommended 1-hour concentration). Further, a series of studies quantifies the relation between the effects of long-term NO_2 exposure and respiratory problem occurrences, however, based on a revised recommendation by WHO, long-term imission NO_2 concentrations designated as probable indicators suggesting the presence of a whole spectrum of pollutants. As no reliable quantitative Dose-Response relations are available, in case of chronic effects of this harmful pollutant, it is recommended to assess a complex risk on the basis of relations specified for solid substances (PM_{10} or $PM_{2.5}$ fractions). The indicative value for average annual nitrogen dioxide concentrations presented in actual WHO documents is 40 µg/m^3.

Suspended particles PM_{10} and $PM_{2,5}$: Suspended particles irritate the mucous membrane of air passages, they can cause changes in both the morphology and function of the ciliary epithelium, increase the sputum production and decrease self-cleaning capabilities of the respiratory system. The changes facilitate occurrences of infections. Recurrences of acute inflammation diseases can lead to occurrences of chronic bronchitis and chronic obstructive pulmonary disease with the subsequent overloading of the right atrium of heart and blood circulation failures. The effect of a short-term increased concentration of suspended particles of PM_{10} fraction becomes evident in the form of strengthened asthma symptoms and of increased overall sickness and death rates. Great attention is constantly paid to health effects of suspended particles, nevertheless, the threshold concentration that would be effect-free has not been identified so far. The finest suspended particle fraction $PM_{2.5}$ is considered as the most significant from the health effects point of view, a significant share in which accounts for the secondary production of particles due to chemical reactions of originally gaseous substances in the air, such as nitrogen dioxide and sulphur dioxide. Observed effects of long-term exposures to PM_{10} fraction particles are also stated for average annual concentrations lower than 30 µg/m^3. Epidemiological studies indicate that the life expectancy in areas with high imission loads can be by more than a year shorter, as compared with low load areas. Besides, this life expectancy reduction begins to express itself, already starting from average annual fine particle concentrations of 10 µg/m^3. The WHO experts' report on REVIHAAP Project (2013) states, based on new knowledge, a recommendation to continue the usage of the assessment methodology from the Clean Air for Europe program. It is recommended to consider primarily the following indicators of attributive death and sickness rates for the purposes of PM exposure health risk assessment: the total or specific death rate, potential years of life lost, the sucker death rate, children's bronchitis symptoms, chronic bronchitis – adults, asthma attacks for all age categories, cardiovascular and respiratory hospitalizations for all age categories, urgent doctor's visits due to asthma (or other respiratory problems) and cardiovascular diseases for all age categories and restricted activity days – adult people.

Carbon monoxide (CO): Acute poisoning symptoms are the major described CO effect. CO can induce cardiovascular and neurological failures in lower concentrations, its perinatal effect was proved. Several indicative values are specified by WHO for short-term CO concentrations (e. g, the 8-hour concentration value that is determined on the level of 10,000 µg/m^3). However, in case of carbon monoxide, these result in reversible effects and prominent experts in the risk assessment branch consider the

assessment of that harmful pollutant as afield. The fact that background concentrations of carbon monoxide only vary around 3.5 % of the WHO indicative value is another reason why that harmful pollutant was not assessed further. The contribution itself from reviewed sources is then by two or more orders lower, hence, it is completely insignificant from the point of view of possible impacts on the public health.

Benzene: In case of a long-term exposure, benzene shows haematotoxical, genotoxical, immunotoxical and carcinogenic effects. With regard to this fact, benzene was classified in group 1 among proven human carcinogens by the International Agency for Research of Cancer, IARC. WHO recommends to use the carcinogenic risk unit, UCR, of 6 x 10^{-6} µg/m^3 for the derivation of the limit benzene concentration in the air. UCR represents a geometrical average of values derived by means of various models from the updated epidemiological study covering the professionally exposed population.

Benzo (a) pyrene: Benzo(a)pyrene (BaP) is a typical representative of polycyclic amorphous hydrocarbons that have toxic, mutagenic or carcinogenic properties. From the IARC carcinogenity classification point of view, BaP is classified in group 2A – suspected carcinogen and it is also a substance that is most frequently used in the form of a limit or a recommended value. The unit of carcinogenic risk UCR equals to 8.7 x 10^{-5} at the benzo(a)pyrene exposure concentration of 1 ng/m^3.

Calculated changes in imission characteristics caused by the proposed project and presented in Chapter C.III.4. 'Impacts on Air' (page 289 of the present Report) are an input to the next risk assessment stage within the exposure estimate. Those changes in concentrations of selected harmful pollutants are subsequently assessed in relation to the emission background of the site (see Chapter C.II.5. 'Air', page 160 of the present Report).

From the short-term exposure point of view, the situation can be considered as health satisfactory (i. e., determined legislative limits are reliably complied with). An estimate of health risks resulting from long-term exposures to chemical substances is then a much more essential characteristic. Moreover, chronic effects assessment methods are designed under the assumption that a greater part of the short-term impacts on health is also included.

A gradual decrease in imission concentrations on the territory is assumed in case of nitrogen dioxide in perspective years due to improving emission factors of fuel combustion in operated vehicles. Thus, if the risk assessment was based on that harmful pollutant, the conclusion would include adequate improvements of health characteristics with regard to the current state. Calculations made for solid substances result in conclusions that, from the health effects point of view, the expected impact of the NJZ operation in the assessed area will be quantitatively insignificant in comparison with the impact without the NJZ implementation; thus, it will cause neither any premature death rate, nor new chronic bronchitis occurrences, nor any deterioration of cardiovascular or respiratory diseases that would require hospitalizations. The benzene and benzo(a)pyrene lifetime carcinogenic risks of tumour disease occurrences are on the acceptable border in the order of E-07 and lower in both the current and perspective states. With regard to the number of the concerned population, the values are completely insignificant again. The risk will not be changed significantly due to the NJZ implementation and, thus, it will remain on the order of acceptable level. The real impact on health of the concerned inhabitants will therefore be quantitatively inapprehensible from the air pollution point of view.

C.III.1.1.3.2. Noise

Unfavourable noise effects to the human health are generally defined as morphological or functional changes in the organism leading to the deterioration of its functions, to the reduction of its stress compensation capacity or to the increase in its perceptivity to other unfavourable environmental impacts. Considering a certain simplification, long-term unfavourable noise impacts on human health can be divided into specific effects becoming evident at the equivalent acoustic pressure level above 85 to 90 dB and resulting in ear analyser function failures, and into non-specific (outside the ear) effects when functions of various systems in the organism are affected. With regard to the fact that it is a non-threshold harmful factor, the non-specific noise effects manifest themselves virtually within the whole range of noise intensity.

Auditory apparatus damage, impacts on cardiovascular and immunity system and negative sleep failures are considered as sufficiently proved on the current knowledge level. Impacts on the hormonal system, on biochemical functions, foetal development, mental health or human performance are not proved, i. e., the evidence is restricted. When making

recommendations for limit noise values in the environment, it starts from the current knowledge of negative noise impacts on sleep disturbances at night time, on vocal communications, on annoyance, feelings of crabbedness and discomfort (WHO).

When making quantitative estimates of the annoying and disturbing noise, it starts from conclusions drawn from a meta-analysis of foreign epidemiological studies. It is necessary to draw attention to the fact that those relations only apply to individual types of transport (air, road and railway), because no relevant background data on noise exposure from stationary sources is available so far. In this case, it starts from a piece of knowledge that daily disturbing effects are also partially conditioned on nightly levels, that is why, the noise indicator L_{dn} (day-night), or L_{dvn} (day-evening-night), is used in the relation integrating daily, evening and nightly noises and converts them into a common denominator of the road noise. The main purpose of those relations is the possibility to predict the probable response of the concerned population depending on the noise exposure rate. At present, this model is recommended to assess the annoyance of the population with noise in European Union countries.

Relations applying to the annoyance are derived for three annoyance levels related to the theoretical 100-degree scale of annoyance intensity:

LA (Little Annoyed): First degree of annoyance including all persons that are at least “little annoyed“, i. e., it includes all the annoyed persons of all three degrees (percentage of people affected from 28th degree on the scale from 0 to 100).

A (Annoyed): Second degree of annoyance including persons that are at least “medium annoyed“, i. e., all the medium and highly annoyed persons (annoyance from 50th degree on the scale).

HA (Highly Annoyed): Third degree including persons with marked annoyance feelings, i. e., only highly annoyed persons (marked annoyance feelings from 72th degree on the 100-degree annoyance intensity scale).

Equally, as in case of annoyance relations, three degrees of disturbing effects are derived for the noise disturbances during sleep and related to the theoretical 100-degree disturbing effect intensity scale:

LSD (Lowly Sleep Disturbed): Disturbances from 28th degree on the scale (i. e., at least "low disturbances").

SD (Sleep Disturbed): Disturbances from 50th degree on the intensity scale.

HSD (Highly Sleep Disturbed): Disturbance degree from 72nd point on the 100-degree disturbance intensity scale.

Calculated changes in the noise load caused by the impact of the intended project implementation and presented in Chapter C.III.16.1. ‘Noise Impacts‘ (page 319 of the present Report) are an input to the risk assessment within the exposure estimate.

In case of the majority of residential objects situated closest to the NJZ, equivalent noise levels produced during the operation of stationary noise sources within the NJZ are both below legislative limits and below threshold values of possible noise effects to the public health. In compliance with WHO recommendations, the nightly equivalent noise level should not exceed 45 dB in the surroundings of the houses (a noise level decrease of up to 15 dB is assumed during the external noise transfer into a room through a partially open window). This assumption will then be complied with in all the closest objects, and the noise load in those areas can therefore be considered as acceptable from the health point of view.

The transport noise level is above threshold levels of proved effects of the noise load in the present state due to transits by vehicles on considered transport routes leading through built-up residential areas.

In order to assess the local population disturbance rate, probable percentages of the population were therefore calculated that will be annoyed by the transport noise along roads to a certain extent (see the following table for individual reference points where the noise load was modelled. The localization of the reference points is illustrated in Chapter C.II.15.1 ‘Noise’ on page 227).

Table C.III.6: Population annoyance rate due to transport noise for the operation period

Reference point	Percentage share of population annoyed by transport noise by day [%]								
	Current state			Zero state without the NJZ			State including the NJZ		
	LA	A	HA	LA	A	HA	LA	A	HA
D1	64.5	40.2	37.7	66.2	42.0	40.0	66.2	42.0	40.0
D2	70.2	46.5	46.4	71.7	48.2	48.9	71.9	48.4	49.2
D3	71.1	47.5	47.8	72.6	49.3	50.4	72.7	49.4	50.6
D4	59.0	34.9	30.6	60.7	36.4	32.6	60.7	36.4	32.6
D5	56.4	32.5	27.6	57.8	33.7	29.2	60.5	36.3	32.4
D6	51.8	28.5	22.9	53.2	29.7	24.2	55.9	32.0	27.1
D7	59.6	35.4	31.3	61.2	37.0	33.3	61.2	37.0	33.3
D8	66.2	42.0	40.0	67.7	43.6	42.3	67.8	43.7	42.4
D9	65.0	40.8	38.4	66.2	42.0	40.1	66.2	42.0	40.1
D10	68.1	44.1	43.0	69.7	45.8	45.4	69.8	46.0	45.6
D11	55.8	31.9	26.9	57.2	33.2	28.5	57.5	33.5	28.9
D12	59.3	35.1	30.9	60.5	36.2	32.3	60.5	36.3	32.4
D13	62.2	37.9	34.5	63.8	39.5	36.6	63.9	39.6	36.8
D14	62.0	37.7	34.2	63.0	38.7	35.6	63.1	38.8	35.7
D15	58.9	34.8	30.5	60.1	35.9	31.9	60.2	35.9	32.0

Note: LA – low annoyance, A – medium to high annoyance, HA – high annoyance

It is necessary to note that a certain share of exposed persons is also disturbed on the level of WHO recommended threshold values. That share of the population is increased at the assessed reference points, namely in both the current and zero states without any participation of the transport related to the NJZ operation. This state will only be affected by the contribution itself of the NJZ operation necessitated transport to a very slight extent. The share of disturbed inhabitants will be increased by approximately from 0.1 to 0.3 %, the increase being only in Žlkovce municipality by maximum of 3 %.

For the night time, the disturbance rate is assessed on the basis of nightly noise levels. Percentages of the population affected by individual sleep disturbance degrees at the selected reference points and for all calculation states are presented in the following table.

Table C.III.7: Population sleep disturbance rate due to transport noise for the operation period

Reference point	Percentage share of population disturbed while sleeping at night [%]								
	Current state			Zero state without the NJZ			State including the NJZ		
	LSD	SD	HSD	LSD	SD	HSD	LSD	SD	HSD
D1	36.1	19.8	9.4	37.2	20.7	9.9	37.2	20.7	9.9
D2	39.8	22.7	11.1	40.8	23.5	11.7	41.0	23.6	11.7
D3	40.4	23.2	11.4	41.4	24.0	12.0	41.5	24.1	12.0
D4	32.9	17.5	7.9	33.9	18.2	8.4	33.9	18.2	8.4
D5	32.4	17.1	7.7	33.2	17.7	8.1	34.3	18.5	8.5
D6	29.9	15.3	6.7	30.7	15.8	7.0	31.7	16.6	7.4
D7	33.3	17.8	8.1	34.3	18.5	8.5	34.3	18.5	8.5
D8	37.2	20.7	9.9	38.2	21.4	10.4	38.2	21.4	10.4
D9	37.6	21.0	10.1	38.5	21.7	10.5	38.5	21.7	10.5
D10	38.5	21.7	10.5	39.5	22.5	11.0	39.5	22.5	11.0
D11	32.1	16.9	7.6	32.9	17.5	7.9	33.1	17.6	8.0
D12	34.2	18.4	8.5	34.8	18.9	8.8	34.8	18.9	8.8
D13	35.9	19.7	9.3	36.9	20.5	9.8	36.9	20.5	9.8
D14	35.8	19.6	9.2	36.4	20.0	9.5	36.5	20.1	9.6
D15	33.9	18.2	8.4	34.6	18.7	8.7	34.7	18.8	8.7

Note: LSD – low sleep disturbance, SD – sleep disturbance, HSD – high sleep disturbance

It also holds true for nightly sleep disturbances that a certain share of exposed persons is also disturbed on the level of WHO recommended threshold values. The disturbed population share is considerably affected by the existing motor vehicle transport. This state will only be affected by the contribution itself of the NJZ operation necessitated transport to a quite

insignificant extent again. The share of disturbed inhabitants will be increased by approximately up to 0.1 %, the increase being only in Žlkovce municipality by maximum of approximately 1 %.

Those extremely low increments will be unrecognizable by human senses on the majority of sites. Moreover, the changes vary around uncertainty levels of both measurements and calculations whereby it will not be possible to diagnose eventual changes in health effects (in case of low numbers of concerned inhabitants) in any ways.

For the given reasons, the noise induced by the future NJZ operation can be considered as acceptable from the health point of view. Any implementation of relevant counter noise measures can only be considered in the most impacted site, during the passage through Žlkovce municipality. This can be approached after road transport noise measurements are made; it is recommended to make them during the NJZ operation period.

C.III.1.2. Psychological Impacts

The proposed activity will be performed on the territory where a series of nuclear facilities have been operated for a long time. It can be said that the relation between the population of the concerned territory and nuclear power engineering is consolidated thereby in the long term and will probably not be affected to a significant extent by the implementation of the proposed activity.

It follows from results of opinion polls performed (see Chapter C.II.11.4. 'Public Opinion', page 218 of the present Report) that, on one hand, safe operation of nuclear facilities and social and economic benefits of the nuclear facilities are perceived positively and, on the other hand, a part of the population living in the region shows some concerns about unfavourable impacts on the environment that are not specified to a deeper detail. Those attitudes, or their development trends, will probably not be changed after the implementation of the proposed activity.

Measures suggested in Chapter C.IV. 'Impacts Mitigation Measures' (page 409 of the present Report) should also contribute to the reduction of impacts of those potential concerns. The measures are aimed to ensure contacts among the proposing company and surrounding municipalities and the public in the areas of providing information on the course of preparations, implementation and operation of the project and on its potential impacts on the surroundings, including operative responses to raised incentives and questions.

C.III.1.3. Social and Economic Impacts

The project implementation will have a significant impact from the points of view of local, regional and national economy and employment rate. It will support the economic development of the whole region and represents an assumption for the prosperity improvement due to the expected increase in the social product generation. During all stages, from the preparation work stage to the construction and operation stages, the project will affect the regional labour market significantly, ensure social securities, financial income and the self-fulfilment perspective for the employees.

New job opportunities will be generated due to the NJZ construction and there is an assumption of an increase in the employment rate. An increased social product generation is assumed due to the increase in the number of economically active staff members. In addition to that, the project will bring a gain for the scientific-technical development of Slovak companies that will acquire experience with state-of-the-art processes and technologies during their construction work. They will be able to master them and become more competitive when competing for orders in the perspective power engineering sector in foreign countries.

In addition to the increase in the employment rate, the project will also contribute to the development of municipalities situated in the EBO vicinity thanks to the construction of apartment and family houses and the development of transport infrastructure and civic amenities necessitated by population movements in the form of either commuting, or using temporary or permanent accommodation by the NJZ staff members. The influx of new young experts in the nuclear power engineering branch could bring new dynamics to the region and contribute to the improvement of its attractiveness from the point of view of investors from higher added value branches.

It is a typical expression of such significant projects that the essential part of economic impacts will show indirectly, or it will be directed outside the implementation site. Some of the socioeconomic impacts will have a more extensive territorial influence on the Western Slovakia and the whole Slovak Republic, or possibly, abroad. Slovak construction companies, as well as Slovak producers and suppliers of building materials and structures throughout the Slovak Republic could find their

employment on the NJZ construction. Support to the education and qualified training is assumed for both the NJZ staff members and contractors during its supposed 60-year operation.

Employment Rate Impact

The NJZ implementation will positively impact especially the increase in the regional employment rate and, thus, the living standard improvement in the region. Sufficient labour force numbers from different branches and of qualification degrees will have to be ensured during all the project phases.

The NJZ implementation will keep the continuity in employment rate of narrowly specialized labour force that, in case that the NJZ was not implemented on the site, would lose their jobs after the JE V2 reactor units shutdown which would lead to both societal and social consequences, as well as to the loss of know-how developed over many years.

The conservative estimate of number of construction staff members amounts up to 3,000 people during the NJZ construction. The estimate of labour force number is on the level of approximately 650 people for the planned 60-year NJZ operation period. The number of staff will be increased by another 1,000 contractor employees during the outage period. The number of staff in the installations existing on the site varies about the level of up to around 2,650 staff members (out of which JAVYS: approximately 800 permanent staff members and 450 contractor staff, SE: approximately 1,300 permanent staff members and 100 contractor staff members). The total number of staff members on the EBO site during the period of concurrent run of operations covering all the existing installations and the NJZ will be approximately 3,300 persons.

The production of new job opportunities in branches of production, processing and transport of building materials and structures, and consumer goods and food, as well, will also be a significant economic impact of the NJZ construction. It is also possible to assume an increase in the employment rate in the service sector related to the mentioned branches of economic activities.

The subsequent termination of the NJZ operation after 60 years will, of course, affect operation staff members who will be gradually sacked. It is assumed that after a requalification period a part of the sacked staff members will be of use for newly established job positions in relation to specific decommissioning activities.

Impact on the State of the Population

The NJZ implementation requires neither permanent nor temporary evacuation of population living in any municipality.

It is assumed that the population will be increased by operation staff members with their families, but other inhabitants will also move into new residential structures. A positive increase in the share of economically active and productive group of the population is assumed. Equally, the increase in variable population numbers in relation to the construction can express itself in the form of higher numbers of born children and of positive population growth which can lead to a change in the regressive population type on the NJZ territory of interest into the progressive population type.

Service Development Impact

Due to the assumed increase in the number of population by the construction staff and their family members, there is an assumption of an increased demand for and consumption of food and population material support products. Expected increased requirements for storage premises and their construction are related thereto which represents a prerequisite of the good population supply and, on the whole, a positive impact of the construction. Higher requirements for the provision of all kinds of services are also assumed which can express itself positively in the form of establishing new job positions and increasing the employment rate in local companies and organizations.

Impact on Accommodation Capacity Construction

The increase in the employment rate and population movements including either the commuters, or those using temporary or permanent accommodation in the NJZ region results in an assumption that new apartment and family houses will be built, as well as the demand for the purchase of accommodation and housing real estate will increase, with the impact on real estate prices in the region. The construction of new residential structures represents increased economic expenses, however, the social impact can be assessed as positive.

Infrastructure Impact

On the whole, the NJZ implementation will require a plenty of new infrastructural objects and facilities, in addition to the NJZ construction itself. Above all, they will be repairs and reconstructions of roads, the construction of new underground services, water intake and drainage routes, a new 400 kV system transformer station, a trans-shipment station for oversize river transport freights in the Váhovce municipality cadastre (Kráľová Waterworks), the construction of worker accommodation capacities and the like, which should show a positive social impact on the development in that region.

Positive changes in the demographical development, an increase in the productive population group share and the children and youth share will express themselves in the form of increased financial investments in the corresponding infrastructure and of social requirements (kindergartens, schools, children allowances, expenses on health care, catering, qualifications).

Educational System and Education Impact

With regard to the assumed 60-year operation of the NJZ, a long-term requirement will arise for the provision of professional education to potential future staff members in different branches and education degrees. An increase in the demand for highly qualified experts in the nuclear power engineering area, but also in related technical areas, is assumed. At the same time, it will be necessary to ensure the necessary training and qualification improvements for staff members of the NJZ and contractor companies during the operation period.

C.III.1.4. Infrastructure Impacts

C.III.1.4.1. Transport Infrastructure Impacts

Both the existing and expected transport loads of roads on the concerned territory are presented in the following table where expected transport loads necessitated by the NJZ (a contribution by the NJZ) are given along with the forecasted basic transport intensities as well as prognosis for the operation period without the considered the NJZ implementation (zero state).

Intensities of the existing transport related to other facilities are already included in the background (zero) state data. It is necessary to note that in the period beyond the year 2025, a further decrease in the background transport intensity is expected in relation to the JE V1 decommissioning completion process and similar assumptions can also be applied to the JE A1 decommissioning process. However, this decrease will be little significant, on the whole, and it is even not considered in the model scenario. Thus, all transport demands were taken into consideration to a sufficiently conservative extent and they represent a cumulative transport load that can occur on the site in the given time period. It is also necessary to note that intentions in the transport infrastructure construction area are not included in the model which would express itself in the form of a more favourable transport situation with a high probability.

Table C.III.8: Transport intensities on road network on the concerned territory without and with the NJZ

Road No.	Section	Zero state [vehicles / 24 hours]	The NJZ contribution [vehicles / 24 hours]	Total [vehicles / 24 hours]	Change
61	Trnava - Trakovice	14,840	113	14,953	+ 0.8 %
61	Trakovice - crossroads 50415	6,639	296	6,935	+ 4.5 %
61	Križovatka 50415 (Žlkovce) - D1 crossroads	6,639	152	6,791	+ 2.3 %
504	Trnava - Malženice	4,373	58	4,431	+ 1.3 %
504	Malženice – 50415 crossroads	4,373	106	4,479	+ 2.4 %
504	Križovatka 50415 - Veľké Kostoľany	4,373	14	4,387	+ 0.3 %
513	Trakovice - D1 crossroads	10,304	177	10,481	+ 1.7 %
560	Trnava - Špačince	9,160	58	9,218	+ 0.6 %
560	50413 crossroads - Dechtice	3,718	22	3,740	+ 0.6 %
504012	Špačince - Jaslovské Bohunice	3,330	64	3,394	+ 1.9 %
504013	Malženice - Jaslovské Bohunice	1,570	21	1,591	+ 1.3 %
504013	Jaslovské Bohunice - Kátlovce	1,569	22	1,591	+ 1.4 %
504015	I/61 crossroads (Žlkovce) - II/504 crossroads	1,313	388	1,701	+ 29.6 %
504015	I/504 crossroads – the NJZ	1,542	432	1,974	+ 28.0 %
504015	The NJZ - Jaslovské Bohunice	1,542	113	1,655	+ 7.3 %
61019	Malženice - Trakovice	3,494	42	3,536	+ 1.2 %

Note: The communication network scheme on the concerned territory where the mentioned sections are obvious is presented in Chapter C.II.11.5.1. 'Transport infrastructure', page 220 of the present Report.

As obvious, the most striking increase in the number of vehicles will occur on road No. III/504015 representing the only road connection to the site for both passenger and freight transports. The road transport intensity in the 'II/504 crossroads – the NJZ' section of this road will be increased by approximately 432 vehicles per day (out of which approximately 100 trucks), i. e., by approximately +28 %. The section (I/61 crossroads (Žlkovce) - II/504 crossroads) of road No. III/504015 will see the most striking percentage increase which, however, is caused by lower initial transport intensity. Increases of the order of percentage units are expected within the related communication network where the transport will be distributed in multiple directions, while intensity increases will be insignificant on higher class roads.

The mentioned transport intensities, or their changes, do not have a significant impact on the capacity of communications or on their construction-technical state.

In case of railway transport, the impact necessitated by the use of railway transport can be described as insignificant, the capacity of the railway connection to the site has more than a sufficient margin. Impacts on the other transport infrastructure of the concerned territory (air, water, cycling or pedestrian transport) do not occur virtually.

The impact of the total transport load necessitated by the NJZ during its operation period can therefore be considered as little significant from the transport point of view.

C.III.1.4.2. Other Infrastructure Impacts

In addition to the networks themselves necessary for the operation of the proposed activity (the electric power output, reserve power supply, water management system connection), its implementation will not have any further impact on the infrastructure of the territory. Possible changes in the concerned infrastructural network will be reinstated, or returned to the state required by their administration authorities. During the construction period, the supply of towns and municipalities with electric power and other media (water, gas or other) will be maintained.

C.III.1.5. Impacts during Construction and Operation Termination Periods

C.III.1.5.1. Impacts on Public Health during Construction and Operation Termination Periods

C.III.1.5.1.1. Radiation Impacts

During the NJZ preparation and construction periods, the nuclear facilities currently existing on the site will be in operation. The NJZ construction will not have any impact on their discharges, there will be therefore no change in their (insignificant) impacts on the population on the concerned territory and on the public health either.

No additional radiation impacts on the population will occur during the operation termination period, as compared with the operation period.

C.III.1.5.1.2. Chemical Harmful Pollutants

It is possible to assume that primary emissions will be occurring from construction machine engines and from the necessitated transport, but, above all, secondary emissions of dust particles will be occurring as a result of activities performed on the site during the preparation and construction periods. From the point of view of average annual concentrations of all the monitored harmful pollutants, insignificant contributions are achieved in the surroundings of residential areas; considering their sums with background concentrations, the imission loads achieve levels deeply below legislative limits. From this point of view, both the impacts of earthmoving and construction activities and impacts of the necessitated vehicle transport can be considered as acceptable for health. Moreover, the impacts are restricted in time, therefore, no long-term actions by emissions of selected harmful pollutants are assumed. For that reason, this Report is especially focused on short-term exposure effects within the risk assessment for this time period.

In case of nitrogen dioxide, the contribution by construction activities performed (fuel combustion by construction mechanisms) can be a significant short-term impact that will achieve up to approximately 6 μg/m^3 at the nearest residential objects. The possibility of exceeding the emission limit is excluded, NO_2 concentrations are therefore acceptable.

In case of PM_{10} fraction solid substances, an increase in maximum daily concentrations is assumed due to preparatory and construction Works, caused especially by secondary emissions (handling powder material, dust raised during earthmoving and excavation works due to wind blasts and due to movements of vehicles, etc.) This increase will achieve approximately 30 µg/m^3 at the nearest residential objects. These are only transient cases that can only occur under particularly unfavourable meteorological conditions. Nevertheless, there is a reason, however, to consider the strengthening of counter dust measures (the sprinkling of construction site areas during long rain free time periods, the cleaning of vehicles before they leave the construction site, etc.) The increase in maximum hourly concentrations in the surroundings of transport routes is expected in the order of units of µg/m^3. From the point of view of keeping health effects within acceptable levels, it is desirable to take counter dust measures (e. g., against material pouring during rides and regular maintenance of roadway surfaces) during intensive transport demand periods under unfavourable meteorological conditions on those sites as well.

As for impacts during the operation termination period, it can be expected that demolition work impacts will be comparable with construction work impacts. In this case, therefore, impacts of activities performed during this stage can be considered as acceptable from the health point of view.

C.III.1.5.1.3. Noise

Like in the operation phase, equivalent noise levels produced by the operation of stationary and other noise sources (excavation and earthmoving works, construction mechanisms, etc.) and found below legislative limits and below threshold values of possible noise effects to the public health can also be expected at the nearest residential objects during preparation and construction periods. The noise loads in those sites can therefore be considered as satisfactory from the point of view of the action of the noise to the public health.

It will be the vehicle transport again, led through residential areas on considered transport routes, whose effects to the population will be the most significant even during the construction site preparation and construction periods. In order to assess the local population disturbance rate, probable percentage shares of the population living along roads were calculated therefore using the noise descriptor L_{dvn} again who will be annoyed by the transport noise to a certain extent. The disturbance rate was not assessed for the night time as the night transport is not considered for that period.

Table C.III.9: Population disturbance rate by the transport noise for the preparation period

Reference point	Percentage share of population disturbed by transport noise [%]								
	Current state			Zero state without the NJZ			State including the NJZ		
	LA	A	HA	LA	A	HA	LA	A	HA
D1	64.5	40.2	37.7	65.3	41.0	38.7	67.9	43.8	42.6
D2	70.2	46.5	46.4	71.0	47.3	47.6	73.6	50.5	52.2
D3	71.1	47.5	47.8	71.7	48.2	48.9	74.4	51.5	53.7
D4	59.0	34.9	30.6	61.0	36.7	33.0	63.5	39.2	36.2
D5	56.4	32.5	27.6	57.1	33.1	28.4	63.7	39.4	36.5
D6	51.8	28.5	22.9	52.5	29.1	23.6	58.9	34.7	30.5
D7	59.6	35.4	31.3	60.4	36.2	32.3	60.4	36.2	32.3
D8	66.2	42.0	40.0	66.8	42.7	41.0	66.8	42.7	41.0
D9	65.0	40.8	38.4	65.6	41.3	39.1	65.6	41.3	39.1
D10	68.1	44.1	43.0	68.9	44.9	44.1	68.9	44.9	44.1
D11	55.8	31.9	26.9	56.5	32.5	27.7	56.5	32.5	27.7
D12	59.3	35.1	30.9	59.8	35.6	31.6	59.8	35.6	31.6
D13	62.2	37.9	34.5	63.1	38.8	35.7	63.1	38.8	35.7
D14	62.0	37.7	34.2	62.5	38.2	34.9	62.5	38.2	34.9
D15	58.9	34.8	30.5	59.5	35.3	31.2	59.5	35.3	31.2

Note: LA – low annoyance, A – medium to high annoyance, HA – high annoyance

Table C.III.10: Population disturbance rate by the transport noise for the construction period

Reference point	Percentage share of population disturbed by transport noise [%]								
	Current state			Zero state without the NJZ			State with the NJZ		
	LA	A	HA	LA	A	HA	LA	A	HA
D1	64.5	40.2	37.7	65.7	41.5	39.3	65.7	41.5	39.3
D2	70.2	46.5	46.4	71.4	47.8	48.3	71.5	47.9	48.4
D3	71.1	47.5	47.8	72.3	48.9	49.9	72.3	48.9	49.9
D4	59.0	34.9	30.6	61.4	37.2	33.6	61.5	37.2	33.7
D5	56.4	32.5	27.6	57.6	33.5	28.9	64.1	39.9	37.1
D6	51.8	28.5	22.9	53.0	29.5	24.0	59.4	35.2	31.0
D7	59.6	35.4	31.3	60.9	36.6	32.8	61.5	37.2	33.6
D8	66.2	42.0	40.0	67.3	43.1	41.6	68.0	43.9	42.7
D9	65.0	40.8	38.4	65.9	41.7	39.6	66.0	41.8	39.7
D10	68.1	44.1	43.0	69.4	45.5	44.9	70.0	46.2	45.9
D11	55.8	31.9	26.9	56.8	32.8	28.0	60.1	35.9	31.9
D12	59.3	35.1	30.9	60.2	35.9	32.0	61.1	36.8	33.1
D13	62.2	37.9	34.5	63.4	39.1	36.1	64.1	39.8	37.1
D14	62.0	37.7	34.2	62.8	38.5	35.3	62.9	38.6	35.4
D15	58.9	34.8	30.5	59.8	35.6	31.5	60.7	36.5	32.7

Note: LA – low annoyance, A – medium to high annoyance, HA – high annoyance

It is obvious from the results that a certain share of the population is disturbed in both the current state and in the zero state without the participation of the transport related to the NJZ preparation or construction periods. The state will only be slightly affected by the contribution itself of the NJZ preparation and construction periods necessitated transport. The share of disturbed people living in the most affected site – Žlkovce municipality – will increase by approximately single values of percentage. Recognizable changes can also be expected in municipalities of Jaslovské Bohunice, Pečeňady, or Veľké Kostoľany. However, changes assessed in this manner cannot be expected on all sites simultaneously. The transport model was designed namely so that it considers the possibility of transporting the same materials from all theoretically possible sources so that transport intensities will be significantly overlapped. The real loads of the assessed territory will be much lower during the assessed periods. For that reason, the operative noise load monitoring is proposed for the preparation and construction periods that will reflect real noise loads depending on really selected transport routes. Based on this monitoring, it will be possible to determine the sites where it would be appropriate to take individual measures leading to the noise load reduction on those sites. By means of those measures (e. g., the vehicle speed reduction, etc.), will be then possible to achieve values that will be recognizable by human senses, as compared with either the current or zero states. Thus, this expected future state can be considered as acceptable from the health point of view if the conditions will be complied with.

As far as noise impacts during the operation termination period are concerned, it can be expected that impacts of demolition and dismantling works will be comparable with impacts of construction and assembly works. Thus, no significant changes with regard to the assessment conclusions drawn above can be expected in this case either.

C.III.1.5.2. Impacts on Infrastructure during the Construction and Operation Termination Periods

The NJZ implementation will require especially to ensure the transportation of materials necessary for the construction. It is further assumed for the most intensive construction period that approximately 3,000 staff members will be working on the construction whereby considerations are made to accommodate 400 staff members directly at the construction area. The rest of 2,600 staff members will be accommodated in municipalities and towns within the wider territory of interest. Based on determined transport routes, a transportation model was developed in which the transport was considered not only on priority roads, but the use of alternative routes was also thought about. In order to ensure the transport of materials, the model is developed so that it takes into account possibilities of transporting the same materials from different possible sources. Due to the transport model development in the described manner, transport intensities will be overlapped. The model developed in this manner makes it possible to review the transport network in case of the highest possible load when a great part of the materials is transported on a single route.

On the basis of the model developed in this manner, the highest increase in the transport intensity will occur in the 'II/504 crossroads – NJZ' road section No. III/50415 during the NJZ construction period. The passenger transport intensity will

increase by 1,310 passenger cars daily and the freight transport intensity will increase by approximately 360 heavy vehicles daily. It follows from the comparison between the transport intensity on the mentioned section and the perspective transport intensity for the given period that the percentage of the average daily transport intensity will increase by approximately +112 % in the given section. The most striking percentage increase in the transport intensity (approximately by +120 %) will occur in the 'I/61 crossroads (Žlkovce) - II/504 crossroads' section. However, the increase in the transport intensity in that section caused by the NJZ construction will achieve maximum of 1,165 passenger vehicles daily and 342 heavy vehicles daily. The higher percentage increase in that section is affected by the low initial transport intensity. Increases in the order of units (exceptionally tens) of percentage are expected in the related communication network where the transport will be distributed in multiple directions.

Potentially, during the perspective period, it is possible to consider cumulative impacts with regard to stage 2 of the Nuclear Power Plant V1 Jaslovské Bohunice decommissioning when it will be possible to think about additional demands for the transportation. However, the demands will not mean any additional increases in the transport intensity, because their cumulative effects along with the most intensive activities related to the NJZ implementation are not assumed.

It follows from results of assessing impacts on the communication network made by means of HDM-4 software code that increases in the transport intensity will not cause any direct change in variable parameters of roadways due to increased transport demands during the construction period. The loss of the bearing capacity due to the loading during the construction period will only express itself in the form of a more intensive accumulation of damage in the later years of the roadway lifetime. However, it will require neither repairs, nor any increase in expenses for the road administration authority. However, in order to improve both the quality and safety of the transport, partial modifications are considered for existing roads and road network objects in the concerned region prior to the NJZ construction itself. The modifications will include repairs of insufficient quality road sections in order to avoid their complete degradation, reconstructions of bridge objects found in the insufficient state, partial modifications of selected crossroads to improve their transport situations, construction of cycling routes running in parallel with major staff transport routes, safety improvement measures in municipalities situated in the vicinity of the NJZ, etc. Repairs to be performed after the construction completion will include repairs of roadway sections on roads disrupted due to the increased transport loads. A detailed scope of proposed repairs will be determined prior to the NJZ implementation, based on the mapping of the state of roads, diagnostics and surveys of roadway structures.

With regard to the transportation technology and distances of sources, considerations are made to transport lime and cement by railway. The transport will be routed by railway line No. 120 Bratislava – Žilina to which the EBO railway siding is connected. The free capacity of line No. 120 will make it possible to include trains transporting materials (lime, cement) to EBO without any capacity or organizational problems; the same holds true for the EBO railway siding.

In connection with the transport of oversize and heavy components, it will be necessary to adapt both properties and parameters of roads included in the concerned routes. The transport of such components is a matter of several units of transport, however, using a great number of operational measures (whose provision can be demanding). Thus, it is of maximum advantage to use the water route along courses of the Danube and Váh Rivers. No construction modifications will be necessary in case of material transports along the Danube River water route. The water route parameters are sufficient for the transport of components. The transport will not need to be adapted to the variable water level during the year. The transport along the Váh River water route is only possible in a restricted mode. With regard to the supposed volume of transported oversize components (in units of pieces) and to the character of supposed modifications along the existing transport infrastructure, the impacts can be considered as little significant, on the whole.

The same transport provision system is expected for the transport during the operation termination period as during the operation, or construction periods. Expected impacts will be therefore on the level of impacts resulting from the operation or construction periods described above.

C.III.2. Impacts on Rock Environment

2. Impacts on the rock environment, mineral raw materials, geodynamic phenomena and geomorphological conditions.

C.III.2.1. Impacts on Rock Environment

Foundation soils were verified on the site intended for the NJZ construction using drill holes made down to the depth of 50 m under the ground. The studied profile covers the zone of the assumed imposed load reach even for construction objects of extreme parameters. The foundation soil profile consists of the loess complex, flood plain clays, fluvial and fluvial-limnic gravels and sands and bedrock limnic clays. The studied profile interferes in sediments of Holocene to Upper Pannonian.

Fluvial gravels (upper varied gravel complex of strata) with geotechnical parameters appropriate for the bearing of in-depth foundations are especially perspective foundation soils for demanding construction objects in the given profile. The mentioned gravel soils are found within the technical reach of standard piling technologies. The central part of the perspective construction site appears as the most appropriate area for the construction where, based on work performed, interfaces of characteristic strata do not show any anomalies and are layered virtually in the horizontal direction. The ground water does not indicate any properties aggressive to concrete, but it can act aggressively to steel bodies (structural elements) within the foundation soils.

No anomalies or other facts differing from the original assumptions resulting from the complex assessment of the preceding construction sites found on the EBO site have been identified by means of survey activities in the geological structure of the bedrock. At the same time, no facts have been identified during the given stage of work excluding or essentially obstructing the NJZ implementation. The previous uses of the site do not include such processes that could modify properties of the foundation soils, or form anomalies in the geological structure. In compliance with results brought by geological work and within the meaning of the IAEA Safety Guide NS-G-3.6 (Article 3.1), the site is preliminarily assessed as construction site of type 2.

Loess complex soils show a specific property – collapsing – that, however, was not confirmed using a set of studied samples. The collapsing was identified sporadically using samples taken from the current EBO site and, therefore, it must be assessed in detail during the subsequent stages of engineering-geological and geotechnical surveys. The summary interpretation of results brought by geotechnical tests made on soils taken from the NJZ site does not indicate any presence of collapsing in the loess. Sporadic results of some collapsing tests indicate a possible indistinctive heaving of soils. No indicia were identified indicating any possibilities of liquefaction occurrences, either for gravel and sand horizon soils, or for loess and loess clays.

The basic geophysical survey of the perspective NJZ site was also performed within a geological task in compliance with requirements for input data necessary for the seismic hazard assessment and with regard to specific requirements stated in IAEA safety guides (NS-G-3.6). In compliance with the interpretation of measurements, a geophysical model of the NJZ site geological structure was developed and, especially, speed and elastic parameters of the studied environments were specified as inputs to seismic hazard calculations.

Based on the results obtained, it can be stated that the geological structure of the perspective NJZ site consists of a series of Upper Pannonian to Holocene sediments with sub-horizontal plan-parallel planar interfaces, without anomalous modifications in the structure and without indicia of fault interfaces within the reach of measurements. A tectonic fault was registered in the Neogenic bedrock whereby the assumption that activities had faded-out in the Pliocene period was confirmed. No indicia were identified for the presence of faults in the Quarter sediments horizon under the perspective NJZ site or its immediate surroundings. All lithofacial interfaces that were registered within the reach of survey works are unambiguously of the erosion (non-tectonic) character. In compliance with analyses performed, there is an assumption that the character of the sedimentation in the Volkov complex of strata was affected during the Upper Pannonian to Pliocene periods by changes in the bedrock surface grade line that could be of the tectonic origin. During the Pliocene to Early Pleistocene periods, the sedimentation conditions were without significant changes, i. e., the fluvial gravels and sands environment correlated with the Kolárovo complex of strata is distinguished by markedly lower facial variability on the given territory. At the same time, no indicia were identified for the presence of potentially active faults within the wider territory of

the perspective NJZ site (capable faults), within the meaning of Chapter No. 8 of the IAEA Safety Guide SSG-9 [*Šujan et al. 2012a*].

The NJZ implementation has a minimum impact on the rock environment. Excavations of the subsoil to place foundation structures is the direct impact without any further consequences for its quality. The impact is only restricted to the construction site. During the operation period, neither the integrity nor quality of the rock environment will be affected.

C.III.2.2. Impacts on Mineral Raw Materials

No economically significant mineral raw material deposits are found in the surroundings of the NJZ site. Thus, neither registered, nor potential mineral raw material resources will be affected.

C.III.2.3. Impacts on Geodynamic and Geomorphological Phenomena

The NJZ construction site is stable and there is no assumption of landslides or other expressions of instability under usual construction procedures. Considering geodynamic phenomena, the loess collapsing is not excluded on the site, although results of geological activities performed so far do not indicate any presence of the mentioned phenomenon. The collapsing potential must be assessed in detail during the detailed construction site survey stage and foundation technologies must take the identified facts into account. Similarly, the analysis of the foundation soil liquefaction potential under a seismic load must be complemented during the detailed construction site survey stage. In compliance with results of the orientation engineering-geological survey stage [*Šujan et al. 2012a*], the preliminary assessment did not indicate any presence of soils for which the liquefaction could be assumed.

C.III.2.4. Impacts during the Construction and Operation Termination Periods

During the construction period, it will be necessary to consider properties of fine-grained soils of the loess complex (or possibly of the alluvial clays complex) when performing earthmoving work. Walls of temporary excavations must maintain inclinations (stepping) determined on the basis of stability calculations, or the excavations must be fitted with appropriate types of lagging.

The construction implementation will be connected with a certain volume of earthmoving work. With regard to the calculated level of the possible seismic load, foundation alternatives include bedrock improvements, or its replacement as deep as the gravelly sediments level (to the depth of approximately 20 m).

The intended project implementation will affect neither the soil stability, nor the increased soil erosion. The construction will be performed on an even ground with the installed rain water drainage system. The areas of the ground that will not be developed will be protected against erosion by either paved roads or landscape gardening on other areas.

It can be expected that foundations of objects will remain preserved on the territory during the period after the operation termination, no additional impacts on the rock environment, natural sources, geological or paleontological monuments are assumed.

C.III.3. Impacts on Climatic Conditions

3. Impacts on climatic conditions.

C.III.3.1. Impacts on Climatic Conditions

The processed data from the period from 1981 till 2010 the increased dynamics of the climatic system is typical, conditioned on anthropogenic impacts and its trend is heading towards the climate warm-up. The trend shows itself not only worldwide, but also in the regional scale. At the same time, in compliance with the Report of 2007 prepared by the Intergovernmental Panel on Climatic Change (IPCC), the number of extreme meteorological phenomena occurrences is increasing. A similar trend in the climatic system development (unaffected by the NJZ) can also be expected in the concerned area in the coming period.

Heat and water emissions from the NJZ operation could potentially lead to the following climatic impacts:

- increased average air moisture and temperature in the ground (low-level) layer;
- cloud production from water vapours discharged from cooling towers and, thus, the shortened sunshine duration;
- increased precipitation amounts, more frequent occurrences of stronger ground fogs, icing and glazed frost.

In order to assess possible impacts, actual available meteorological data was used. Results related to the assessed period obtained by means of CT-Plume/EBO model were used especially to assess the impact of the new cooling tower on the moisture, temperature and plume shadow.

Considering the current situation and taking into account the proposed scope of activities to be performed during the NJZ implementation, it is assumed that this kind of impacts should be of minimum and only of local significance that, moreover, will not represent any measurable change within the long-term site monitoring. In the majority of cases, the changes will be less marked than the climatic changes that will occur during more extreme years. The impacts will gradually fully disappear with the increasing distance from the NJZ.

C.III.3.1.1. Impact on Change in Temperature and Moisture

As compared with the impact of the existing JE V2 cooling towers system (CHV 1-4 system), the extended cooling towers system – JE V2 + NJZ (CHV 1-5 system) will bring an enlarged area corresponding to the given value of the characteristic and occurrences of higher air temperature and moisture values.

Values of the maximum average increase in air temperature are very low, differences in values between the two cooling tower systems are in the order of hundredths of °C, while differences in maximum daily values of the increase in the air temperature are on the level of tenths of °C. Maximum values of difference in the average increase in air moisture achieve the order of 10^{-3} g/kg (or the order of 0.001 % to 0.01 % of common relative moisture values) and values of difference in daily maximum increases achieve the order of 10^{-2} g/kg (or the order of 0.01 % to 0.1 % of common relative moisture values).

The negligible difference in the increases in the climatic characteristics results from the generally little impact of plumes produced by cooling towers on ground values and from the greater height achieved by plumes produced by the NJZ cooling tower as a part of CHV 1-5 system. The higher plume affects ground air temperature and moisture values to a less extent. Thus, the NJZ impact on air temperature and moisture values can be considered as insignificant, below the level of measurability using operational methods.

C.III.3.1.2. Impact on Precipitation Conditions in the Surroundings

The air flow from the new cooling tower will carry water droplets into the surrounding atmosphere that can fall to the ground surface along with droplets produced by condensing water vapours in the plume and, thus, amounts of atmospheric precipitation can theoretically be increased. It can be assumed that, with regard to droplet sizes (50 to 300 micrometers), their prevailing majority will evaporate before they fall to the ground. Such precipitation can therefore occur virtually only in cold weather and under high air moisture. The maximum precipitation usually occurs in the distance of 2- to 4-multiple of the cooling tower height whereby the annual total precipitation produced in this manner does not exceed 20 mm. Thus, the impact of the NJZ implementation is considered as insignificant from the point of view of increasing the total precipitation and, with regard to the density of precipitation measurement network installed in the surroundings of the NJZ site, it will not be possible to objectively identify this impact.

C.III.3.1.3. Impact on the Ground Fog Production

Water vapour emission from cooling towers can lead not only to the visible plume production, but also to the production of ground (low-level) fog, namely due to both the aerodynamic entrainment of the plume down to the ground and the direct water vapour transmission from the cooling towers to the ground layer of air with the subsequent condensation. However, the ground fog production can be considered as insignificant, based on preceding conclusions.

The plume aerodynamic entrainment processes were studied in aerodynamic tunnels and, as a result, the possibility of any contact between the visible plume and the ground surface was excluded already from the cooling tower height exceeding 80 m. Observations of plumes produced by 120-meter cooling towers in Jaslovské Bohunice showed that, in case of a very

strong wind, they descend by the maximum of 30 to 40 m due to their aerodynamic entrainment. After they leave the cooling tower mouth, a gradual condensation of water vapours appears and, therefore, latent heat is released and this acts as a massive lifting force. The aerodynamic entrainment can therefore be almost excluded as the mechanism leading to the production of ground fog.

C.III.3.1.4. Impacts on Extreme Meteorological Conditions on Site

The NJZ will not have any virtually measurable and identifiable impact on any extreme meteorological conditions on the site. Slight increases in temperature and moisture in the NJZ surroundings can have a certain shading effect against extremely high and low temperatures. This effect is already considered in data progressions consisting of maximum and minimum temperature values, based on which the extreme values were determined for the site. The JE V1 (2 x 440 MW_e) had been in operation till the end of 2008, concurrently along with the JE V2. The more than 20-year-long concurrent run of the JE V1 and JE V2 operations covers the decisive time period of the analysed meteorological progressions. The concurrent run of the JE V1 and JE V2 operations is conservatively considered to last 20 years, after the JE V2 operation termination, the thermal load of the atmosphere due to the JE V2 operation will be lower than during the concurrent run of the JE V1 and JE V2 operations.

C.III.3.1.5. Impact on the Change in Shading by the Visible Plume

The area with the largest relative shading by the plume is restricted to a narrow surroundings of the EBO site for both the systems (CHV 1-4 and CHV 1-5). During the transition to the CHV1-5 system, an insignificant increase in the shadowed area extent will occur. Thus, this is a reverse impact by the high plumes in comparison with their impact on air temperature and moisture values.

In order to assess the shading, it is necessary to take into account that both the shading characteristics and their statistical processing are intentionally focused on the least favourable situations. The list includes situations when the visible plume represents an obstacle to the sunshine and, at the same time, it is assumed that the overcast sky is excluded (from 8/10 to 10/10 of the sky is covered with clouds). However, the probability that such situations will occur is not high. It is also necessary to realize that shadows of plumes hovering over the cooling towers system are projected into the surroundings of the system and, at the same time, that the shading by the plume does not automatically mean the reduction or significant impact on the sunshine reaching the affected areas.

In order to consider the impact of cloudiness coverage a little better for the calculation of plume shading, an assumption is used that if the sky is clear (0/10 of the sky is covered with clouds), the plume is the only source of the shading, if the sky is overcast (from 8/10 to 10/10 of the sky is covered with clouds), the shading is only provided by the clouds and for all the other cloudiness coverage values (from 1/10 to 7/10 of the sky is covered with clouds), both the plume and cloudiness participate in the shading. The resulting difference between the new CH1-5 system and the original CH1-4 system in the number of hours individual points are overshadowed confirms that the new cooling tower will only affect the nearest power plant surroundings. The highest difference is 44 hours for the period of 5 years which corresponds to 1.54 % of the period with the Sun above the horizon. Of course, values of the difference to be determined for residential areas of the surrounding municipalities are even lower.

For the area outside the immediate surroundings of the cooling towers, it can be expected that, with regard to the Sun movements on the sky and to the wind direction variability, the overshadowed area position is significantly changing in time and, that is why, the impact of the shading (including the impact on the Earth ground temperature) will be negligible.

C.III.3.1.6. Impact on Other Climatic Characteristics

An insignificant impact is assumed from the other climatic characteristics point of view that will not represent any measurable change during the long-term monitoring of the site. In the majority of cases, the changes will be less marked than the climatic changes that will occur during more extreme years. The impacts will gradually fully disappear with the increasing distance from the NJZ.

C.III.3.2. Impacts during Construction and Operation Termination Periods

Impacts on climatic characteristics are excluded during the construction or operation termination periods.

C.III.4. Impacts on Air

4. Impacts on the air (e. g., amounts and concentrations of emissions and imissions).

C.III.4.1. Impacts on Air Quality

The NJZ, as well as each nuclear power plant, will not be a significant source of air polluting emissions.

Stand-by diesel generators (or combustion turbines) and the stand-by boiler house will be stationary non-radiation sources of air pollution, however, they will not be permanently operated sources. They will only be operated during stand-by power supply tests (or during exceptional operation periods of those facilities), namely during a limited number days per year, with the assumed time of approximately 100 hours/year. Results obtained from pollutant concentration calculations are presented in the following table.

Table C.III.11: Air pollution values at reference points - stationary sources, operation period

Pollutant		NO_2		CO	PM_{10}	
Averaging time period		1-hour	1 year	8-hours	24- hours	1 year
Number	Municipality	Concentration [µg/m^3]				
R1	Jaslovské Bohunice	18.62	0.0014	33.69	8.98	0.00064
R2	Radošovce	18.88	0.0009	34.20	9.14	0.00040
R3	Dolné Dubové	16.40	0.0006	23.20	6.18	0.00022
R4	Kátlovce	15.79	0.0010	21.51	5.68	0.00034
R5	Malženice	15.18	0.0016	19.89	5.26	0.00054
R6	Žlkovce	14.95	0.0017	19.22	5.06	0.00057
R7	Pečeňady	16.95	0.0014	25.53	6.72	0.00055
R8	Veľké Kostoľany	18.02	0.0008	30.01	7.93	0.00032
R9	Nižná	17.15	0.0011	27.16	7.12	0.00045

With regard to the number of operation hours per year, the contribution by the new stationary sources included in the NJZ to annual concentrations of NO_2 and PM_{10} will be negligible (thousandths of µg/m3). Suspended particles PM_{10}, will only achieve increased concentrations in relation to limit values (up to approximately 18 % of the legislative limit), namely in a short-term mode. Such values can only be achieved under the most unfavourable dispersion conditions and in concurrence with tests of all diesel generators which, in fact, will not happen. The impact of those sources on the air pollution can be considered as insignificant.

The vehicle transport on transportation routes will be another contributor to the air pollution (whether the staff transport or the transport of material and components necessary for the NJZ operation). The highest increase in the transport load is expected on road No. III/504015 in the direction from the NJZ to crossroads with road No. II/504 and, subsequently, towards Žlkovce in the direction to crossroads with road No. I/61. The transport load will subsequently be born mainly by road No. I/61, demands for other road network and, thus, pollutant concentrations in the surroundings will be essentially lower.

Under the influence of the natural increase in transport intensities (including the NJZ operation impact), it is possible to state that, in relation to NO_2, CO and benzene, the imission load will be rather decreasing in comparison with the current state, namely due to the forecasted decrease in unit emissions from engine vehicles in the future years. A slight increase is expected for benzo(a)pyrene and $PM_{2,5}$, and a more significant increase is expected for PM_{10}, namely in the short-term mode. Contributions to the average annual PM_{10} and $PM_{2,5}$ concentrations caused by the increase in the transport intensity due to the NJZ operation will achieve the order of tenths of µg/m^3, contributions to the maximum daily PM_{10} concentration will then achieve the order of units of µg/m^3, both of them along approach routes. Those concentrations were calculated for unfavourable time periods represented by aggravated dispersion conditions and for the winter period (when the PM_{10} repeated suspension share is the highest due to the winter road maintenance).

With regard to the imission load level on the territory it can be judged that the stationary pollution sources, including the transport necessitated by the NJZ operation, will not change the territory load in a significant manner, it is expected that imission limits determined by the legislative for all the monitored pollutants will be reliably complied with.

From the power plant operation point of view, the nuclear power is among the almost zero greenhouse gas producers. They are only emitted directly in small amounts during periodical tests of auxiliary equipment such as stand-by diesel generators, the boiler house, etc. However, the greatest share in the greenhouse gas emissions is held by fuel acquisition and conditioning during the whole life cycle. In compliance with the latest studies (e. g., WNA: Energy Analysis of Power Systems, (2014), Warner E. S., Heath, G. A.: Life Cycle Greenhouse Gas Emissions of Nuclear Electricity Generation Systematic Review and Harmonization (2012), US NREL: Life Cycle Greenhouse Gas Emissions from Electricity Generation (2013)), the greenhouse gas emissions produced during the whole nuclear power plant life cycle range from 1.8 to 48 tCO_{2-e}/GWh. Based on comparisons among greenhouse gas emissions produced by individual power sources, it is therefore obvious that the nuclear power ranks side by side among renewable power sources (hydro power plants 0.35 to 60 tCO_{2-e}/GWh, wind power plants 7.9 to 30 tCO_{2-e}/GWh and solar power plants 14t o 200 tCO_{2-e}/GWh) and produces several times lower emissions that fossil power sources (brown coal power plants up to 1700 tCO_{2-e}/GWh, black coal power plants 879 to 985 tCO_{2-e}/GWh and gas power plants 290 to 930 tCO_{2-e}/GWh). Thus, the nuclear power also plays a very significant role from the point of view the commitment undertaken by EÚ members states to reduce CO_2 emissions by 20 % of the 1990 level by the year 2020 and of other long-term targets aiming towards almost complete elimination of CO_2 emissions.

C.III.4.2. Impacts during Construction and Operation Termination Periods

During those phases, emission sources will mainly include ground shaping activities in areas of the main construction site and the construction site equipment and transport running on surrounding roads. The earthmoving work can be considered as the dominating impact affecting unfavourably the surroundings whereby suspended PM_{10} and $PM_{2,5}$ particles will be the determining substances for the assessment of impacts on the public health. Above all, the secondary dustiness induced by movements of trucks and construction mechanisms on the dried roadway surface and on polluted roads during dry periods, will be their source. Construction machines and vehicles moving around the construction site will also be emission sources of solid substances, they will produce emissions from the engine fuel combustion. It follows from the assessment that the most unfavourable state will be represented by gross ground shaping activities in the areas of the main construction site and the construction site equipment that can be done in concurrence with demolitions and other activities producing solid pollutants. The maximum 24-hour PM_{10} contribution value is bound to the construction site area and it is decreasing with the distance. Values and concentrations at reference points in the nearest residential areas are presented in the following table.

Table C.III.12: Values of PM air pollution at reference points – construction (gross ground shaping activities in areas of the main construction site and the construction site equipment)

Pollutant		PM_{10}		$PM_{2,5}$
Averaging time period		24-hours	1 year	8-hour
Number	Municipality	Concentration [µg/m³]		
R1	Jaslovské Bohunice	28.73	0.53	0.18
R2	Radošovce	26.63	0.29	0.10
R3	Dolné Dubové	12.03	0.10	0.04
R4	Kátlovce	11.26	0.15	0.05
R5	Malženice	13.93	0.27	0.09
R6	Žlkovce	11.48	0.26	0.09
R7	Pečeňady	13.27	0.23	0.08
R8	Veľké Kostoľany	16.50	0.14	0.05
R9	Nižná	18.30	0.18	0.06

The maximum contribution to 24-hour PM_{10} concentrations out of reference points situated in surrounding municipalities is achieved in Jaslovské Bohunice municipality with 28.7 µg/m³, representing 57.4 % of the limit. If the background concentration is added, there is an assumption that the daily PM_{10} concentration limit will be exceeded in Jaslovské Bohunice and Radošovce municipalities under aggravated dispersion conditions. Under common dispersion conditions occurring on the site, the limit will not be exceeded even when the background concentration is taken into account. With regard to the authorized limit exceeding tolerance for 35 days, however, it can be assumed that hygienic conditions will not

be violated from the public health point of view (there is a margin of approximately 20 days in relation to the assumed reference value – days of the exceeded limit).

During the gross ground grading activities on the construction site, contributions to the average annual PM_{10} concentration in surrounding municipalities will be ranging from 0.3 to 0.5 µg/m^3, i. e., on the levels from 0.8 to 1.3 % of the limit; in case of $PM_{2,5}$, the values will be ranging from 0.1 to 0.2 µg/m^3, i. e., on the levels from 0.4 to 0.8 % of the limit. Any possibility of exceeding the imission limit is excluded in case of average annual concentrations.

In addition to the dominating impact of dustiness during the NJZ preparation and construction stages, impacts of NO_2, CO, benzene and benzo(a)pyrene produced due to engine fuel combustion were also assessed, namely for the gross ground shaping activities period when movements of trucks and construction mechanisms around the construction site area and on tertiary roads are the most intensive. It follows from the assessments that the contribution to the imission situation on the territory resulting from emissions by construction mechanisms is very low. Maximum values of 1-hour NO_2 concentrations achieved in the centre of the activities represent 1.2 % of the limit, concentrations of the other pollutants are negligible in relation to the limits. The nearest municipalities will not be virtually concerned by impacts of NO_2 emissions resulting from activities performed on the construction site, in case of 1-hour NO_2 concentration, the maximum values will achieve 0.06 µg/m^3, which is 0.03 % of the limit, in the nearest municipalities.

The presented results hold true for the calculation related to atmosphere stability class C and speed class 1 which represents an unfavourable scenario that can occur in the given area in a limited number of days. Based on a check calculation for atmosphere stability class D that occurs in the area the most frequently, values in the centre of the activities approximately a half of the magnitude.

During the construction period itself, volumes of earthmoving work and movements by mechanisms on an uncovered soil will be essentially lower than during the construction site preparation stage and, thus, the impact on the dustiness production will be by one order lower during that time period. The imission limit value was not exceeded at reference points for the contribution to the 24-hour PM_{10} concentration. The highest calculated contributions to the average annual PM_{10} and $PM_{2,5}$ concentrations in the surrounding municipalities vary on the level of hundredths of the limit value.

During the construction period, the transport intensity will also be increased due to the construction staff members transportation and demands for the transport of building, structural, or waste materials. Road No. III/504015, the NJZ – Žlkovce, will be the busiest road. The transport load will be subsequently distributed between road No. II/504 (towards Trnava, above all) and road No. I/61. The section of road No. III/504015, the direction from the NJZ to Jaslovské Bohunice, will be essentially less loaded. The transport beyond Jaslovské Bohunice will be divided into two directions: to Kátlovce, with the predominance of freight traffic, and to Špačince, with the predominance of passenger traffic. As compared with the current state, it can be stated again that the NO_2, CO and benzene imission loads will be decreasing in the perspective state by virtue of the forecasted decrease in engine vehicle emission factors. Pollutants including benzo(a)pyrene and suspended substances will be an exception: for the perspective state, the transport intensity increase will also mean an increase in the imission load due to the secondary dustiness that, however, will remain below the imission limit with a sufficient margin.

It follows from the above mentioned facts that the impact of the construction period will be bound to the construction area itself and its nearest surroundings. The impact will be of common character, i. e., its scope will be common for the construction period and will be restricted to a period of several years. From the significance point of view, it can be said that the air pollution will not mean any essential deterioration during the construction period.

With regard to the fact that emissions resulting from both the transport and accompanying activities performed on the site during the operation termination period will not exceed emissions produced during the construction period, similar insignificant impacts are therefore expected for the operation termination and decommissioning periods as well.

C.III.5. Impacts on Water Conditions

5. Impacts on water conditions (e. g., quality, modes, drainage conditions, supplies).

C.III.5.1. Impacts on Surface Water

It can be assumed that the impact of the NJZ on surface water will result from the pumping of raw water (the Váh River – the

Sĺňava Waterworks Reservoir), from the discharge of waste water (the Váh River – the diversion channel) and rainwater (the Dudváh River). This impact will act in a concurrent effect along with the concurrent operation of other nuclear facilities on the Jaslovské Bohunice site (JE V2, JAVYS) that are using the same water sources and the same recipients as well.

C.III.5.1.1. Impact on Quantitative Characteristics

Quantitative characteristics will be affected by the raw water take-off from the Váh River (the Sĺňava Waterworks Reservoir) and by the discharge of waste water to the Váh River (The Drahovce – Madunice Diversion Channel), or of rain water to the Dudváh River.

Approximately steady water take-offs are expected for the NJZ for the operation period, with the assumption of a slight increase in the take-off due to climatic changes during the NJZ lifetime (IPCC SRES A2 climatic scenario is considered conservatively, assuming an increase in average annual temperature by 3.95 °C, i. e., to 14.4 °C, by the end of the century). The same assumption also applies to other nuclear facility on the site.

Assumed water take-offs for the NJZ and the other installations on the site are presented in the following table.

Table C.III.13: Average current and average annual raw water take-offs

Year	NJZ		Existing nuclear facilities on the EBO site		Total	
	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]
2029	1.42	45,000,000	0.93	30,000,000	2.35	75,000,000
2045	1.45	46,000,000	0.72	23,000,000	2.17	69,000,000
2085	1.52	48,000,000	---	---	1.52	48,000,000

A permit to take off 2.54 m³/s of water from the Sĺňava Water Reservoir is in force at present (District Environment Authority Nitra, reg. No. OÚŽP-97/1994-4/Ču of 26 April 1994)[23]. This value will not be exceeded even after the NJZ is commissioned. EBO site take-offs (including the NJZ) will therefore not cause any need for a change in the Drahovce – Madunice Waterworks handling regulations, namely if the potential impact of the climatic change is taken into account. On the contrary, water take-offs for nuclear facilities operated by JAVYS company will be gradually decreasing during the coming period (before the year 2045) due to the terminating of operations. The JE V2 water take-off will also be gradually decreasing for the same reason after the year 2045 at the latest. In the year 2085, the NJZ will be the only consumer.

The amount of discharged waste water will be proportional to the amount of taken-off raw water and, taking into account the amount of evaporated water and drifted droplets from the cooling tower, the condensation in the cooling circuit, water consumption and the amount of purified sewage water.

Assumed discharges of waste water from the NJZ and from the other installations on the site are presented in the following table.

Table C.III.14: Average current and average annual discharges of waste water

Year	NJZ		Existing nuclear facilities on the EBO site		Total	
	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]
2029	0.25	8,000,000	0.19	6,100,000	0.44	14,100,000
2045	0.26	8,200,000	0.15	4,700,000	0.41	12,900,000
2085	0.27	8,500,000	---	---	0.27	8,500,000

The following permits are in force at present governing waste water discharges from the nuclear facilities existing on the site via the Socoman Collector Channel:

- for JAVYS company: Decision No. OU-TT-OSŽP2-2013/00026/GI of 18 October 2013, allowing to discharge the following amounts: 12,096 m³/day and, thus, 4,415,040 m³/year,

[23] In the year 2012, consultations were held with the Slovak Water Management Company, š.p., OZ Piešťany, that is authorized to permit an increase in the raw water take-off up to 5.0 m³/s.

- for SE EBO V2: Decision No. KÚŽP-1/2006/00271/Fr of 14 July 2006, allowing to discharge the following amounts: 9,936 m³/day and, thus, 3,626,640 m³/year.

In common, it is therefore permitted to discharge 8,041,680 m³/year from the existing installations.

Water decrements (the difference between amounts of taken-off and discharged water determined especially by the evaporation in the cooling tower) are presented in the following table.

Table C.III.15: Differences between average current and average annual raw water take-offs and waste water discharges

Year	NJZ		Existing nuclear facilities on the EBO site		Total	
	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]	immediate [m³/s]	annual [m³/year]
2029	1.17	37,000,000	0.74	23,900,000	1.91	60,900,000
2045	1.19	37,800,000	0.57	18,300,000	1.76	56,100,000
2085	1.25	39,500,000	---	---	1.25	39,500,000

Water decrements on the level of up to 1.25 m³/s (NJZ), or up to 1.91 m³/s (NJZ along with the other installations on the site) are not significant from the point of view of the Váh River flow rate (Q_a = 140.121 m³/s, the average for the preceding 35 years Q_r ranges from 100 to 160 m³/s).

As for rain water drained to the Dudváh River recipient, its average amounts of up to approximately 102,000 m³/year (NJZ), or of up to approximately 432,000 m³/year (NJZ along with the other installations on the site) will not significantly affect hydrological conditions on the territory. The recipient capacity is sufficient, the rain water drainage system is equipped with torrential rain water retaining tanks.

C.III.5.1.2. Impact on Qualitative Characteristics

Non-radiation qualitative characteristics will be affected by waste and rain water discharges from the NJZ, namely in a cumulative effect along with waste and rain waters from other nuclear facilities on the EBO site.

Purified industrial and sewage waste waters from the NJZ will be discharged independently of the existing systems by means of a new sewer collector channel to the Váh River recipient (the Drahovce – Madunice Diversion Channel). Rain water discharges from the NJZ will be performed independently of the existing systems by means of a new sewer collector channel to the Dudváh River recipient.

Waste and rain waters are discharged from the existing nuclear facilities on the site in a similar manner. Purified waste water is discharged by means of the existing Socoman Sewer Collector Channel to the Váh River recipient (the Drahovce – Madunice Diversion Channel), rain water is discharged by means of the existing Manivier Channel to the Dudváh River recipient.

The qualitative impact on non-radiation characteristics[24] if surface water can express itself in the following parameters:

- warm-up,
- conventional pollution,
- rain water discharge.

The following facts result from the analysis of those impacts.

Warm-up

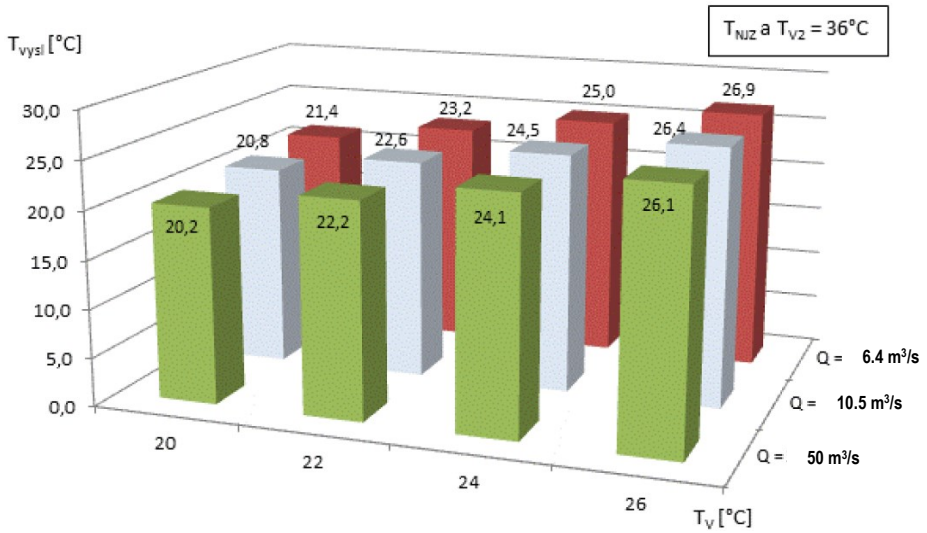
In order to assess the impact on the recipient temperature, a model calculation has been made taking into account consequences of the discharging of warmed-up waste water from the NJZ, namely in a concurrent effect along with the discharging of warmed-up waste water from the other nuclear facilities on the site (whereby the JE V2 operation is significant from that point of view). With regard to the conservative approach, the following combination of initial conditions was analysed:

[24] Radiation impacts are assessed in Chapter C.III.16.3. 'Ionizing Radiation Impacts' (page 325 of the present Report).

- diversion channel flow rate: Q_V = 6.40 (minimum guaranteed flow rate), 10.5 and 50.0 m³/s,
- water temperature from the Sĺňava Water Reservoir: T_V = 20, 22, 24 and 26 °C,
- waste water flow rate from the NJZ: Q_{NJZ} = 0.27 m³/s,
- waste water flow rate from the JE V2: Q_{V2} = 0.14 m³/s,
- waste water temperature from both the NJZ and JE V2: T_{NJZ} = T_{V2} = 33, 34, 35 and 36 °C.

Results corresponding to the most favourable combination: T_{NJZ} = T_{V2} = 36 °C are presented in the following table.

Figure C.III.1: Impact of waste water discharges from the NJZ and JE V2 on the resulting water temperature in the Drahovce Channel



The diagram shows that even in case of the most unfavourable conditions (the minimum flow rate and increased temperature in the Váh River in combination with the maximum flow rate and temperature of waste water from the NJZ and JE V2), the water temperature limit value downstream of the mixing zone of the Drahovce Diversion Channel will not be achieved (the limit value is determined by the actual District Authority Trnava Decision No. OU-TT-OSŽP2-2013/00026/Gl of the year 2013: 28 °C).

The thermal impact on the Váh River (downstream of the confluence with the diversion channel) will be even significantly lower, with regard to the fact that the long-term average annual flow rate represents Q_a = 140.121 m³/s (the annual average for the preceding 35 years Q_r ranges from 100 to 160 m³/s). This corresponds to the temperature difference lower than 0.1 °C.

Conventional Pollution

Waste water containing conventional (chemical) pollution comes from the following water management plants:

- the cooling towers blow-down system, waste waters from the demineralization system, from the sand filters and screens washing system, neutralized aggressive water, safety overflows on tanks, etc.,
- oil-polluted water from facilities where handling oil substances is a common practice (compressor plants, diesel generator plants diesel generator oil management systems, diesel oil management systems, garages, etc.): after the purification, the water will be returned to the water treatment system to be used for operational purposes (however, it is not excluded either that, after the quality inspection, the water will be discharged to the waste water system),
- sewage water that, after the purification and quality inspection, will be discharged to the waste water collector channel.

Expected emission concentration indicators of the NJZ waste water pollution and their comparisons with emission limits applicable to the JE V2 and with surface water limits (specified by the Regulation of the Government of the Slovak Republic (NV) No. 269/2010, Coll., Laying down Requirements for the Achievement of Good Water Conditions) are presented in the following table.

Table C.III.16: Concentration emission indicators of the NJZ waste water pollution

Indicator	Average concentration in the NJZ waste water	Maximum concentration in the NJZ waste water	Limit in compliance with the current JE V2 permit	Limit for power plant waste water in compliance with NV 269/2010	Imission limit for surface water in compliance with NV 269/2010
[mg/l]					
biological oxygen demand (BSK_5)	2.14	2.655	8	*	7
chromate chemical oxygen demand ($CHSK_{cr}$)	16.19	21.870	30	40	35
insoluble substances (NL)	10.12	11.097	20	40	---
soluble substances (RL)	725.68	809.376	1,200	1,000	900
ammonia nitrogen ($N\text{-}NH_4^+$)	0.20	0.279	4	*	1
nitrates (NO_3^-)	40.20	46.655	80	*	5
sulphates (SO_4^{2-})	210.18	257.436	350	*	250
chlorides (Cl^-)	72.69	88.015	180	*	200
non-polar extractable substances (NEL)	0.10	0.121	0.35	1	0.1
total phosphorus ($P_{celk.}$)	0.17	0.218	1.5	*	0.4
ferrum (Fe)	0.12	0.197	2	*	2
hydrazine hydrate (N_2H_4)	0.02	0.021	2	4	---
detergents (PAL)	0.11	0.139	0.5	*	---
[-]					
acidity, alkalinity (pH)	6 - 9	6 - 9	6 - 9	6 - 9	---

* ... these indicators are not specified by the legislative for power plant waste water

The following tables present maximum daily and average annual mass emission indicators for the NJZ waste water specified for the years 2029, 2045 and 2085 (taking into account the IPCC SRES A2 conservative climatic scenario).

Table C.III.17: Assumed maximum daily mass emission indicators for the NJZ waste water

Indicator	Maximum concentration in the NJZ waste water [mg/l]	Maximum daily amount of the NJZ waste water [m^3/day]			Maximum daily mass pollution from the NJZ [kg/day]		
		2029	2045	2085	2029	2045	2085
biological oxygen demand (BSK_5)	2.655	27,648	28,252	29,549	73.39	75.00	78.44
chromate chemical oxygen demand ($CHSK_{cr}$)	21.870	27,648	28,252	29,549	604.65	617.86	646.23
insoluble substances (NL)	11.097	27,648	28,252	29,549	306.81	313.51	327.90
soluble substances (RL)	809.376	27,648	28,252	29,549	22,377.62	22,866.48	23,916.24
ammonia nitrogen ($N\text{-}NH_4^+$)	0.279	27,648	28,252	29,549	7.71	7.88	8.24
nitrates (NO_3^-)	46.655	27,648	28,252	29,549	1,289.90	1,318.08	1,378.60
sulphates (SO_4^{2-})	257.436	27,648	28,252	29,549	7,117.60	7,273.09	7,606.99
chlorides (Cl^-)	88.015	27,648	28,252	29,549	2,433.44	2,486.60	2,600.76
non-polar extractable substances (NEL)	0.121	27,648	28,252	29,549	3.35	3.42	3.58
total phosphorus ($P_{celk.}$)	0.218	27,648	28,252	29,549	6.03	6.16	6.45
ferrum (Fe)	0.197	27,648	28,252	29,549	5.45	5.56	5.82
hydrazine hydrate (N_2H_4)	0.021	27,648	28,252	29,549	0.59	0.60	0.63
detergents (PAL)	0.139	27,648	28,252	29,549	3.85	3.94	4.12

Table C.III.18: Assumed average annual mass emission indicators for the NJZ waste water

Indicator	Average concentration in the NJZ waste water [mg/l]	Average annual amount of the NJZ waste water [thousands of m³/year]			Average annual mass pollution from the NJZ [t/year]		
		2029	2045	2085	2029	2045	2085
biological oxygen demand (BSK_5)	2.14	7,954	8,168	8,578	17.00	17.45	18.33
chromate chemical oxygen demand ($CHSK_{cr}$)	16.19	7,954	8,168	8,578	128.74	132.21	138.84
insoluble substances (NL)	10.12	7,954	8,168	8,578	80.52	82.68	86.83
soluble substances (RL)	725.68	7,954	8,168	8,578	5,772.03	5,927.33	6,224.86
ammonia nitrogen ($N\text{-}NH_4^+$)	0.20	7,954	8,168	8,578	1.58	1.63	1.71
nitrates (NO_3^-)	40.20	7,954	8,168	8,578	319.76	328.37	344.85
sulphates (SO_4^{2-})	210.18	7,954	8,168	8,578	1,671.80	1,716.78	1,802.96
chlorides (Cl^-)	72.69	7,954	8,168	8,578	578.17	593.73	623.53
non-polar extractable substances (NEL)	0.10	7,954	8,168	8,578	0.80	0.83	0.87
total phosphorus ($P_{celk.}$)	0.17	7,954	8,168	8,578	1.38	1.41	1.49
ferrum (Fe)	0.12	7,954	8,168	8,578	0.92	0.94	0.99
hydrazine hydrate (N_2H_4)	0.02	7,954	8,168	8,578	0.16	0.16	0.17
detergents (PAL)	0.11	7,954	8,168	8,578	0.88	0.90	0.94

The following table presents assumed maximum mass emission indicators for other nuclear facilities on the site. A part of those installations will be in their decommissioning stage, however, with regard to the conservative approach, maximum possible pollution contributions from those installations are taken into account along with the NJZ operation contribution.

Table C.III.19: Assumed maximum daily mass emission indicators for waste water from other nuclear facilities on the site

Indicator	Maximum daily mass pollution from JE A1, JE V1 and TSÚ RAO [kg/day]	Maximum daily mass pollution from JE V2 [kg/day]	Total maximum daily mass pollution [kg/day]
biological oxygen demand (BSK_5)	96.77	79.49	176.26
chromate chemical oxygen demand ($CHSK_{cr}$)	362.88	298.08	660.96
insoluble substances (NL)	241.92	198.72	440.64
soluble substances (RL)	12,096.00	11,23.20	24,019.20
ammonia nitrogen ($N\text{-}NH_4^+$)	48.38	39.74	88.12
nitrates (NO_3^-)	604.80	794.88	1 399.68
sulphates (SO_4^{2-})	1,814.40	3,477.60	5,292.00
chlorides (Cl^-)	1,209.60	1,788.48	2,998.08
non-polar extractable substances (NEL)	4.23	3.48	7.71
total phosphorus ($P_{celk.}$)	24.19	14.90	39.09
ferrum (Fe)	24.19	19.87	44.06
hydrazine hydrate (N_2H_4)	-	19.87	19.87
detergents (PAL)	6.04	4.97	11.01

The resulting Váh River water pollution due to waste water discharges from the NJZ and from other nuclear facilities on the site and comparisons between calculated values and imission limits for surface water in compliance with the applicable legislative are presented in the following tables.

The resulting concentration of pollutants in the watercourse is calculated from contributions by all nuclear facilities on the site for the considered minimum flow rate of Q_{mind} = 7.046 m³/s in the Váh River and Q_{zar} = 6.4 m³/s in the diversion channel. The sum of those values represents approximately (after a conservative reduction) a 7-day average of the 100-year minimum flow rate in the Váh River (Šaľa profile), in compliance with the Slovak Hydrometeorological Institute data. The data is related to the years 2029, 2045, 2085 (taking into account the SRES A2 conservative climatic scenario)[25].

[25] Maximum possible pollution from other nuclear facilities on the site (JE V2, NPP A1, JE V1 and TSÚ RAO) is based on annual limits for waste water discharges, it will therefore not be modified in the year 2045 due to climatic changes.

Table C.III.20: Comparisons of contributions to the pollution from the NJZ and from other nuclear facilities on the site with actual imission limits (year 2029)

Indicator	Maximum daily mass pollution from the NJZ [kg/day]	Maximum daily mass pollution from JE A1, JE V1 and TSÚ RAO [kg/day]	Maximum daily mass pollution from JE V2 [kg/day]	Resulting imission concentration of pollution in the Váh River [mg/l]	Imission limit for surface water in compliance with NV 269/2010 [mg/l]
biological oxygen demand (BSK_5)	73.39	96.77	79.49	0.415	7
chromate chemical oxygen demand ($CHSK_{cr}$)	604.65	362.88	298.08	2.106	35
insoluble substances (NL)	306.81	241.92	198.72	1.244	---
soluble substances (RL)	22,377.62	12,096.00	11,923.20	77.211	900
ammonia nitrogen ($N\text{-}NH_4^+$)	7.71	48.38	39.74	0.159	1
nitrates (NO_3^-)	1,289.90	604.80	794.88	4.476	5
sulphates (SO_4^{2-})	7,117.60	1,814.40	3,477.60	20.651	250
chlorides (Cl^-)	2,433.44	1,209.60	1,788.48	9.039	200
non-polar extractable substances (NEL)	3.35	4.23	3.48	0.018	0.1
total phosphorus ($P_{celk.}$)	6.03	24.19	14.90	0.075	0.4
ferrum (Fe)	5.45	24.19	19.87	0.082	2
hydrazine hydrate (N_2H_4)	0.59	-	19.87	0.034	---
detergents (PAL)	3.85	6.04	4.97	0.025	---

Tab. C.III.21: Comparisons of contributions to the pollution from the NJZ and from other nuclear facilities on the site with actual imission limits (year 2045)

Indicator	Maximum daily mass pollution from the NJZ [kg/day]	Maximum daily mass pollution from JE A1, JE V1 and TSÚ RAO [kg/day]	Maximum daily mass pollution from JE V2 [kg/day]	Resulting imission concentration of pollution in the Váh River [mg/l]	Imission limit for surface water in compliance with NV 269/2010 [mg/l]
biological oxygen demand (BSK_5)	75.00	96.77	79.49	0.418	7
chromate chemical oxygen demand ($CHSK_{cr}$)	617.86	362.88	298.08	2.128	35
insoluble substances (NL)	313.51	241.92	198.72	1.255	---
soluble substances (RL)	22,866.48	12,096.00	11,923.20	78.024	900
ammonia nitrogen ($N\text{-}NH_4^+$)	7.88	48.38	39.74	0.160	1
nitrates (NO_3^-)	1,318.08	604.80	794.88	4.523	5
sulphates (SO_4^{2-})	7,273.09	1,814.40	3,477.60	20.910	250
chlorides (Cl^-)	2,486.60	1,209.60	1,788.48	9.127	200
non-polar extractable substances (NEL)	3.42	4.23	3.48	0.019	0.1
total phosphorus ($P_{celk.}$)	6.16	24.19	14.90	0.075	0.4
ferrum (Fe)	5.56	24.19	19.87	0.083	2
hydrazine hydrate (N_2H_4)	0.60	-	19.87	0.034	---
detergents (PAL)	3.94	6.04	4.97	0.025	---

Table C.III.22: Comparisons of contributions to the pollution from the NJZ and from other nuclear facilities on the site with actual imission limits (year 2085)

Indicator	Maximum daily mass pollution from the NJZ [kg/day]	Maximum daily mass pollution from JE A1, JE V1 and TSÚ RAO [kg/day]	Maximum daily mass pollution from JE V2 [kg/day]	Resulting imission concentration of pollution in the Váh River [mg/l]	Imission limit for surface water in compliance with NV 269/2010 [mg/l]
biological oxygen demand (BSK_5)	78.44	-	-	0.131	7
chromate chemical oxygen demand ($CHSK_{cr}$)	646.23	-	-	1.075	35
insoluble substances (NL)	327.90	-	-	0.546	---
soluble substances (RL)	23,916.24	-	-	39.800	900
ammonia nitrogen ($N\text{-}NH_4^+$)	8.24	-	-	0.014	1
nitrates (NO_3^-)	1,378.60	-	-	2.294	5
sulphates (SO_4^{2-})	7,606.99	-	-	12.659	250
chlorides (Cl^-)	2,600.76	-	-	4.328	200
non-polar extractable substances (NEL)	3.58	-	-	0.006	0.1
total phosphorus ($P_{celk.}$)	6.45	-	-	0.011	0.4
ferrum (Fe)	5.82	-	-	0.010	2
hydrazine hydrate (N_2H_4)	0.63	-	-	0.001	---
detergents (PAL)	4.12	-	-	0.007	---

It follows from the data that even in the most unfavourable and conservatively considered case (a concurrent impact of all nuclear facilities on the site, climatic changes are taken into consideration and the minimum Váh River flow rate), the limits specified by the Regulation of the Government of the Slovak Republic (NV) No. 269/2010, Coll., Laying down Requirements for the Achievement of Good Water Conditions) will be complied with. The limit value will be only approached to a more significant extent by the 'nitrates (NO_3^-)' indicator, other indicators will be complied with significant margins.

The Váh River pollution situation will be therefore acceptable even after the scheduled NJZ commissioning. A high long-term Váh River flow rate (Piešťany profile: Q_a = 139.9 m³/s, Hlohovec profile: Q_a = 140.1 m³/s) is a significant fact. In fact, the expected Váh River pollution will therefore be several times as low as in the most unfavourable and conservatively considered case of the minimum flow rate.

As for the Váh River water quality development, imission values indicators assessed by the Hlohovec monitoring station are maintained on a stable level in the long term, without more significant deviations which can also be expected in the future. This is substantiated by the Slovak Water Management Company, š.p., using a statement that there is no assumption of more significant industrial production development in the future that would produce a more significant amount of polluted waste water to the Váh River watercourse. The NJZ contribution will therefore not enter the qualitatively changed aquatic environment.

Starting from results obtained by analyses performed, and also based on experience gained during the operation of nuclear units so far(concurrent operations of JE V1 and V2 in the recent time period), no significant negative impact by the NJZ on surface water qualitative characteristics is expected.

Rain Water Discharges

The NJZ rain water will be drained to the Dudváh River recipient. The rain water sewer system will be equipped with retention tanks and an impounding reservoir to catch torrential rains, the recipient quantitative characteristics (flow rates) will not be affected to a significant extent. As rain water is not considered as waste water (its quality has not been changed), it will contribute to the recipient water quality improvement. In case of thorough inspections and prevention of drained rain water pollution, a slight Dudváh River recipient water quality improvement can therefore be expected. A similar (rather positive) contribution can also be expected from other nuclear facilities on the site.

C.III.5.2. Impacts on Ground Water (Non-Radiation)

Three nuclear sources of different construction and operation technology development degrees have been built on the Jaslovské Bohunice site. At present they are in different life cycle stages as follows: the normal operation (JE V2) and the

operation termination stage (JE A1, JE V1). No risky impacts on the physical-chemical and biological quality of ground water on the site expressed themselves in any stage (construction, operation, decommissioning), which is a consequence of the geological structure of the subsoil. For the mentioned reason, a non-significant impact by the NJZ on both the mode and physical-chemical and biological quality of ground water is expected within the hydrological collector I and no impact within the hydrological collector II at all.

Any potential impact on ground water would therefore occur only due to a non-assumed and highly improbable failure in operational technology systems, or in waste water treatment and drainage systems. In order to avoid such failures, the NJZ design will be equipped with adequate technical solutions (double-bottomed tanks, retention tanks, regular technology tightness inspections, parameter measurements and alarm annunciation of their changes), despite their very low probabilities.

The NJZ will not have any impact on water sources or zones of protection around ground water sources.

NJZ operation impacts on the ground water radiation situation are described in Chapter C.III.16.3. 'Ionizing Radiation Impacts' (page 325 of the present Report and subsequent pages).

C.III.5.3. Impacts during the Construction and Operation Termination Periods

Based on the current knowledge on the NJZ design, there are two variants of possible solution how to prepare the Main Reactor Building foundations.

- the subsoil improvement using a gravel sand cushion where a part of soils with less favourable properties (loess) is replaced with the gravel sand;
- the subsoil improvement using piles bearing in the gravel layer whereby the piles are interconnected in their upper parts by a reinforced concrete slab.

The first alternative leaves a part of loess to function as an isolator which is favourable from the ground water quality protection point of view. This implies a minimum or no impact during the construction.

The other alternative is less favourable from the ground water quality protection point of view, because the piles will reach approximately 2 meters below the ground water level which can potentially cause (in case of a technological discipline violation during their installation) a local non-radiation contamination. The installation of the piles requires neither any special interventions in the saturated stratum, nor any ground water pumping-off. The piles will be manufactured in compliance with current standards whereby no geological environment contamination is assumed on the construction site. It must be ensured by the piles installation technology that any contamination occurrence (mainly oil substances) of the receiving geological environment is avoided, otherwise, such an accident must be removed. The geological environment quality must be inspected on the construction site during the construction period.

The other NJZ objects will be built in the non-saturated loess geological stratum environment, i. e., above the ground water level with the preservation of a part of loess to function as an isolator.

Moreover, the following potential risk factors come into consideration, just as in case of all constructions of industrial character:

- the freight road transport (within a wider region, too) and operations by construction mechanisms – a standard risk of pollution by oil products in case of accidents,
- a high number of workers on the construction, i. e., increased demands for the sewage water purification and drainage – a standard risk of biological pollution in case that the sewer systems are disrupted.

Those risk factors are eliminated using commonly available means, i. e., based on the quality of mechanisms and sewer systems and using building inspections. A large amount of existing monitoring objects (drill holes) are found in the surroundings of the construction site. Their mode monitoring will also be performed during the NJZ construction. The monitoring system will ensure that any possible contamination leakage will be captured early. The drill holes of the existing monitoring system are equipped (that means drill holes including their installed equipment) as remediation drill holes, it is therefore possible, in case of any contamination identification, to apply immediate remediation measures to remove it.

There is therefore a high assumption that the NJZ construction (even in case that the Main Reactor Building will be founded using piles) will not have a significant impact on the ground water quality within the hydrological collector I and will have no impact on the ground water quality within the hydrological collector II.

The same impact on the geological environment is assumed during the NJZ operation termination period as during the operation period, i. e., a minimum to no impact on the ground water quality within the hydrological collector I and no impact on the hydrological collector II. The above mentioned potential risk factors only come into consideration, they will also be treated in a similar way.

C.III.6. Impacts on Soil

6. Impact on soil (e. g., utilization methods, contamination, soil erosion).

C.III.6.1. Impacts on Soil

The permanent land use will be the most significant impact of the proposed construction; in case of a conservative approach, the land use will achieve a maximum value of 46 hectares. The most essential part of the land use will relate to agricultural land, they will be predominantly high land capability soils. The soil horizon will be removed during the construction and used in an appropriate way for the final landscaping of the construction site later on.

None of the concerned lots is a part of any forest land (LP).

Raw water intake pipeline routes and waste or rain water drainage pipeline routes will be implemented under the ground without significant demands for the permanent land use. Overhead transmission lines only require land uses for the pole foundation feet. This land use will be little significant.

The construction site is situated on a plain or slightly undulating ground. The concerned territory is endangered neither by landslides, nor by undermining. No change will occur in the current state at that area due to the implementation of the proposed activity. No significant impact on the soil erosion and stability is therefore assumed after the rain water drainage from roofs is ensured and handling areas are hardened. The soil stability will be disrupted neither due to the NJZ construction, nor due to its operation and concerned soils will not be eroded.

The current soil quality state in the near EBO surroundings is a subject of regular monitoring. It follows from results obtained so far that no impact by the power plant operation on the soil can be proved at monitored points in the power plant surroundings. The operation of the proposed activity does not assume a significant supply of allogenic substances in the soil environment either and, thus, the pollution of soils.

C.III.6.2. Impacts during the Operation and Operation Termination Periods

During the construction period, it will be necessary to exempt the soil that will be used for the construction site equipment, from the agricultural land resources. In case of a conservative approach, this area will extend on up to 37 hectares. The arable land overburden will be removed from the construction site equipment area and stored on protected dumping grounds and used for the land reclamation after the construction work is completed. Impacts induced during the construction period will be significant (the areas are relatively extensive), however, they will be temporary and after the construction work is completed, the areas will be reclaimed and returned to their original purposes.

The soil contamination is only possible during the construction work period in accident situations with low probability related to construction and transport mechanisms such as leaks of oil substances, hydraulic oils, etc. If such accident states occur, everything will proceed in compliance with the relevant emergency water protection plan, or emergency transport order. In case that a free soil is contaminated by an oil substance, the soil will be disposed as dangerous waste in compliance with relevant legislative procedures.

In connection with the operation termination, no additional land use is assumed.

C.III.7. Impacts on Fauna, Flora and their Biotopes

7. Impacts on fauna, flora and their biotopes (e. g., protected, rare, endangered species and their biotopes, animal migration corridors, vegetation and animal health state, etc.).

C.III.7.1. Impacts on Fauna, Flora and their Biotopes

C.III.7.1.1. Impacts on Fauna

Potential impacts on fauna include the following:

The permanent land use (loss) and changes in original biotopes on the concerned territory. It corresponds spatially to the permanent land use site (the NJZ location). Common species of vertebrates and insects were only identified on that site, they are bound predominantly to biotopes of agricultural coenoses and human residences and their occurrences and structure are affected significantly by human economic activities. The proposed activity should therefore not cause more significant loss and fragmentation of reproductive habitats, and any reduction of species variety and numbers of animals on the wider territory. The loss of a part of food (hunting) biotopes can represent a certain problem, especially for some species of predators (Common Buzzard, Stannel, more rarely Jerfalcon). The loss will be compensated by replacement natural hunting biotopes in the NJZ surroundings.

Changes in microclimatic conditions, impacts of noise and imission loads during the NJZ operation (including the concurrent run along with the other installations on the site). Those factors can be assumed as negligible, of only local significance and bound exclusively to the NJZ site, or its immediate surroundings. No sites significant from the point of view of occurrences of protected, rare, endangered, or ecologically significant fauna species are found within that space.

Animal collisions (birds, or possibly bats) with higher constructions. With regard to the fact that birds migrate through the concerned territory in wide fronts without more markedly delimited migration corridors, collisions can only occur exceptionally (especially, under aggravated weather conditions or at night). The analysis of birds' flight levels on the NJZ site shows that almost 50 % of birds were flying at lower altitudes than 50 m above the ground which increases the risk of collisions especially with overhead electric transmission lines (they are "thin" and, thus, poorly visible). However, the rate of this impact will probably not be significant, because they are only short sections of the lines. As for possible impacts induced by the temperature of air mass emitted by the cooling tower, the values commonly vary around 30 °C (and never exceed 50 °C), which does not represent any risk for the flying birds, or bats. The overhead transmission line collision risk can be reduced using signalling, warning or visualization elements.

Impacts on migration corridors are little significant with regard to the fact that animals migrate through the concerned territory without more markedly delimited migration corridors and, in case of amphibians and reptiles, no migration corridors were identified on the territory. A significant birds' migration corridor was identified on the concerned territory – the Sĺňava Water Reservoir – and a trans-regional biological corridor – the Váh River – in which the proposed activity will only interfere at its edge (in the form of the raw water take-off object and the waste water discharge object). Impacts on the mentioned birds' migration corridor during the NJZ operation period, as well as during the concurrent run of operations, are virtually excluded.

Impacts on hydrobiological characteristics of recipients: the take-off object that will supply the NJZ with raw water is localized in the vicinity of the existing take-off object, on the Sĺňava Water Reservoir bank. During the operation of the existing take-off object on the bank of the Sĺňava Water Reservoir, no negative impacts have been recorded that would affect the Sĺňava Water Reservoir fauna. The take-off object is situated under the water level and is secured in such a manner that no unnecessary fish

kills will occur. On the basis of the mentioned, there is an assumption that the scope of the proposed object operation will not exceed the current level of impacts during the concurrent run of operations. If take-off amount limits are complied with, as well as if conditions to maintain biological flow rates in the Váh River (at the Drahovce Weir point) and in the Drahovce Channel are met, there is no assumption that hydrobiological characteristics and populations of water and water-bound animals (vertebrates and invertebrates) living at and in the Sĺňava Water Reservoir and at and in the Váh River will be disturbed during the water take-off.

The Sĺňava Water Reservoir is of significance for water birds. The nidification is especially concentrated on the "Bird Island" situated in the distance of approximately 1.1 km from the proposed take-off object. During the operation of the facility, including the concurrent run of operations, no more significant impacts on avifauna and ichthyofauna populations are assumed in the near surroundings.

In case of average water conditions, the discharged waste water will not represent a significant contribution that would unfavourably affect the hydrobiology of the watercourse and, on the other hand, in cases of significant water decreases in the Drahovce Channel, the discharged waste water will improve the unfavourable flow rate conditions, and if specified chemical pollution limits are complied with, the discharges will not represent any risk for water animals of the recipients.

It follows from calculated chemical pollution indicators that specified imission limits will not be exceeded during the concurrent run of the NJZ operation and operations of the other installations on the EBO site. The imission indicator limits can even not be exceeded in case that the minimum flow rate has been achieved in the Váh River. An approach of imission concentrations to the limit values is only assumed for NO_3^- parameter, namely under the most unfavourable conditions only. With regard to the fact that the discharges are made into flowing watercourses on the territory, the accompanying phenomenon of that process, i. e., the strengthening of eutrophication processes, is negligible.

If limits of discharged amounts and limits of discharged industrial waste water are complied with, there is no assumption that surface water qualitative parameters will be aggravated and populations of water animals and plants (including the phytoplankton) in the recipients will be affected.

Based on the calculation model, it is likely that during the concurrent run of operations, changes in waste water temperature will not represent such values that would, even under the most unfavourable conditions, affect significantly both the composition and state of water animal and plant populations (including invertebrates and phytoplankton) in the Váh River. With regard to the fact that the waste water is discharged into flowing watercourses, there is an assumption of more favourable temperature conditions than in case of stagnant water.

Rain waste water coming from the existing EBO installations is directed to retention tanks by means of a collector pipeline and drained from there to the Manivier Channel and flow out to the Dudváh River. There is no assumption that the Dudváh River water quality will be aggravated due to the discharged rain water during the concurrent run of operations. With regard to the fact that the Dudváh River flow rates depend on irrigation take-offs to a significant extent, the flow rates can be slightly improved by the discharged rain water. Animals, including the macrophytic vegetation and phytoplankton, bound to the Dudváh River water environment are adapted to changes in flow rates and to fluctuations in oxygen and organic substance contents. Species sensitive to those changes do not appear in the watercourses under the mentioned conditions.

The low-activity pollution (i. e., containing tritium, corrosion and fission products) waste water discharges are made in coordination with non-active water flow rates in the resulting collector channel, due to the waste water dilution. Actual valid limit values were not exceeded by the monitored indicators. During the concurrent run of operations and if specified low-activity substance concentration limits are complied with, there is no assumption that water animal populations in the recipients will be affected.

C.III.7.1.2. Impacts on Flora and Biotopes

The permanent land use will be the most significant impact on the flora and biotopes. The tree and shrub vegetation will probably be removed completely throughout the NJZ siting and construction site, on locations No. 25, 26 and 27 (see the site delimitation in Chapter C.II.7.2.2. 'Flora', on page 182 of the present Report). The exact extent in which trees and shrubs will be clear-felled can only be implemented after the future NJZ site has been localized geodetically. In case of permanent land uses, the changes will be irreversible. Areas of temporary land use will be reclaimed after the construction completion, a part of those areas will be sown with grass and shrub and tree vegetation will be planted on the other part.

Permanent land uses will be made during the construction of the raw water take-off object, the booster pumping plant and other service objects and feet of overhead transmission line poles. They are localized predominantly on agricultural arable land areas, without any tree and shrub vegetation. In case of the booster pumping plant, if the object is localized appropriately, possible tree and shrub vegetation seizures can be minimized.

Impacts of microclimatic changes induced by the NJZ operation (including the concurrent run of operations along with the other installations on the site of operations) are not significant. They are bound exclusively to the immediate surroundings of the site, no negative impacts on the structure of plant communities are assumed. Impacts of raw water take-offs and waste water discharges, as well as impacts of underground pipelines channels themselves on the states and structure of plant communities, as well as on the states of biotopes are not assumed.

C.III.7.2. Impacts during the Construction and Operation Termination Periods

The following can be stated in relation to impacts on animals during the construction period:

Works to be performed on the main construction site related to a temporary land use and to disturbances of original biotopes in the surroundings (the construction site equipment, stock-piles, building material storehouses, roads used for construction purposes, installation of underground pipelines), to the aggravation of life and productive conditions of organisms (air pollution by exhalations, by increased dustiness, by surface water pollution, etc.) These animal disturbances and their temporary moving out from the concerned territory (noise, vibrations, movements of construction mechanisms) can be considered as less significant, with regard to the character and scope of work, as well as to the representation of species on the territory. The majority of species is used to man and his activities including the vehicle transport, noise and movements of persons so that increased construction activities should not affect their occurrences within the wider surroundings of the construction in a more significant manner. In case of more sensitive species such as Waterbuck, Imperial Eagle, Marsh Harrier, Tawny Owl or Red-Backed Shrike, a temporary withdrawal or avoidance of places situated in the immediate surroundings of the construction can only occur. After the work is completed and in case of reclaiming the biotopes, their repeated return is assumed.

Works related to the installation of the underground pipeline (the raw water supply from the Sĺňava Waterworks Reservoir, the waste or rain water drainage into the Váh or Dudváh River recipients) can potentially affect especially occurrences of animals and their reproductive success. Common species of vertebrates and insects bound to agricultural coenoses and line vegetation growing along country lanes only occur in the corridor with the installed pipeline supplying raw water from the Sĺňava Waterworks Reservoir whereby their occurrences and representation depend markedly on species of crops grown and on agricultural management methods. For that reason, the pipeline installation impact can be considered as temporary and if the concerned areas are reclaimed, the impact is considered as less significant. With regard to the scope of work and the line character of the construction, those impacts should only have a local influence. Similarly, the impact of the installation in the corridor of waste or rain water drainage pipelines can be considered as temporary and less significant. In case of that work, however, it is necessary to draw attention to a strict adherence to construction and safety standards, including the avoidance of any intervention in the surrounding environment (beyond the working zone), namely in sites of the Madunice Grove and CHA Malé Vážky that are among significant animal biotopes on the concerned territory. The work

related to the pipeline installation will also interfere in the forest complex of the Madunice Grove, it can be fragmented further and a temporary barrier can be formed against animals during the excavation work. However, after the installation, the capacity of the territory will be restored again or maintained. The pipeline installation can have a potential impact with the local influence on protected species. Water and water-bound protected species could be endangered, namely in case that accident situations with low probability occur (due to leakage of oil substances with the subsequent water quality aggravation). This applies especially to the protected species that live and reproduce in water permanently such as Dytiscus latissimus, Northern Crested Newt, Bullfrogs (Agile Frog, Edible Frog, Marsh Frog), Ringed Snake and Eurasian Water Shrew. Those accident states can be prevented by adhering to work discipline rules and inspecting the technical state of construction machinery.

Impacts on animal migration corridors during the construction period are little significant with regard to the fact that the animals (higher vertebrates, birds) migrate through the concerned territory without more markedly delimited migration corridors and, in case of amphibians and reptiles, no migration corridors were identified on the territory that could be endangered by the construction. The significant birds' migration corridor was identified on the concerned territory – the Sĺňava Water Reservoir – and the trans-regional biological corridor – the Váh River – in which the proposed activity will only interfere at its edge in the form of the raw water take-off object and the waste water discharge object. The construction period of those objects will be relatively short – several months, the construction will be of a local character, and bound exclusively to the construction site and, therefore, without more significant impacts on the birds' migration corridor.

Negative impacts on hydrobiological characteristics of the Váh River, Dudváh River and Sĺňava Water Reservoir could only occur in cases of accident leakage of operating liquids from the construction machinery. If the construction discipline rules are adhered to and the construction technology and machinery are maintained in good technical states, there is no assumption that the surface water quality will be aggravated and populations of water and water-bound animal species will be endangered.

The following can be stated in relation to potential negative impacts on the flora and biotopes during the construction period:

In case of works to be performed on the construction site (the main construction site, the construction site equipment, working stripes along raw and waste water pipeline route corridors) the vegetation will be completely removed. In case of the working stripes, it will be possible to reduce the extent to which trees and shrubs will be felled by the appropriate pipeline route localization. During the more advanced design preparation stage, when the pipeline route will be localized geodetically, it will be possible to determine exactly the extent of felling and specify the social value of the woody plants. Temporary land uses represent reversible changes and after the construction completion it will be possible to plant the shrubby vegetation on the felled-out areas again. The replacement planting should be implemented on the basis of local woody plant species.

In case of the waste water pipeline routing, a biotope of the Community importance will be affected Ls1.2 'Oak-Elm-Ash Lowland Alluvial Forests', site No. 31 – see the site delimitation in Chapter C.II.7.2.2. 'Flora', page 182 of the present Report). If the pipeline is routed appropriately, it will be possible to reduce the biotope seizure and the total extent of felling. A seizure of a part of the biotope will not lead to its disruption or degradation, as it is found on the territory in a sufficient extent. In case of species included in the Red List of Ferns and Seed Plants of Slovakia - Lily of the Valley *(Convallaria majalis)* (almost endangered species) and Summer Snowflake *(Leucojum aestivum)* (vulnerable species) – those species are wide-spread throughout the forest stand and the implementation of the intended project will not cause that the whole populations of the mentioned species will be endangered. The changes will be reversible, as after the construction work completion the ground will be shaped and the biotope can be partially reclaimed. It will be necessary to pay increased attention to possible occurrences of invasive plant species in order to avoid their dispersion to the non-damaged parts of the biotope.

The waste water pipeline route is designed to cross site No. 23 (see the site delimitation in Chapter C.II.7.2.2. 'Flora', page 182 of the present Report) where Lk10 'High Sedge Vegetation' biotope (the nationwide

interest biotope) was identified. If the route is appropriately designed to line the south edge of the site, it will be possible to avoid completely the mentioned biotope. If, based on the technical design, the pipeline is laid under channels and watercourses, there is no assumption that their water regimes will be disrupted.

It will be necessary to pay attention to areas disrupted by the construction, to their sensitive remediation, to the implementation of replacement planting and to measures aimed at the removal of identified invasive species in order to avoid their propagation to adjacent areas.

During the construction work period, it will be necessary to use the network of local roads, country lanes, to minimize construction machinery transits, to avoid any unnecessary felling and damage to trees and shrubs due to the construction machinery transits. In cases that construction activities and construction machinery transits are made in the close vicinity of shrubs and trees, it will be necessary to secure those plants against damage using boarding. Areas damaged by the construction machinery will be remediated after the construction work completion and, where possible, replacement planting will be implemented in order to avoid possible propagation of invasive plants on uncovered areas. Stock-piles, soil dumps and plant depots will be localized so that no unnecessary arable land uses occur and tree and shrub vegetation is removed.

As for impacts on the fauna, flora and biotopes during the operation termination period, a reasonable assumption is possible that they will not exceed the above described impacts induced during the construction period.

C.III.8. Impacts on Landscape

8. Impacts on the landscape – landscape structure and utilization, landscape character.

C.III.8.1. Impacts on Landscape

C.III.8.1.1. Impacts on Landscape Structure and Ecological Stability

Due to the NJZ construction, new anthropogenic objects will arise in the landscape that will affect the landscape structure. They will include NJZ objects themselves (including the dominating object – the cooling tower) and the overhead transmission line to the electric station. It is necessary to emphasize, in context with other activities running and scheduled on the existing EBO site (and, thus, the concurring impacts in the area), that changes will occur in connection with demolitions of construction objects on the EBO site (including four existing cooling towers) in the near future. Some of the existing anthropogenic landscape elements will therefore disappear physically and the physical utilization of the territory will also be changed due to subsequent ground shaping activities. It is necessary to assess impacts of the new constructed objects on the landscape in the context of the whole EBO site that is perceived as a complex site within the landscape structure. Despite the accumulation of impacts on the landscape with other activities performed on the EBO site, it is not assumed that they will be significant, namely in spite of the fact that both the land use will be made and the way of functional utilization of the territory applied hitherto will be changed due to the cooling tower construction. The impact on the landscape structure is considered as little significant.

There is no assumption that the assessed activity will cause any essential change in the ecological stability of the concerned territory. The ecological stability on the concerned territory is already on a low level at present, and is maintained on the basis of human interventions. The concerned territory is found in the equilibrium state designated as the so-called tertiary homeostasis – the ecologically balanced state is formed by the concurrence of natural processes and human activities whereby the significant impact of the human activities is evident.

C.III.8.1.2. Visual Landscape Assessment – Landscape Face

It follows from the character of the proposed intended project that both the impact of nuclear facilities on the Jaslovské Bohunice site after the NJZ construction completion and the JE V1 dismantling (i. e., the NJZ + JE A1 + JE V2 configuration) and the impact of the existing EBO configuration (i. e., the JE A1 + JE V1 + JE V2 configuration) are assessed whereby it has followed from some methodological experiments and from previous assessments of similar intended projects that, considering a series of both bulkier and relatively smaller constructions found within the assessed site, objects higher than

30 m, and out of them, above all, dominating objects, i. e., cooling towers, reactor buildings and turbine halls are only of significance for the landscape character assessment.

Poles providing the electric power output and the reserve power supply (overhead transmission lines) representing a little different problem, considering the scale, as compared with the preceding constructions, are a specific group of objects with the height over 30 m. While the "block" objects included in the intended project are able to affect the territory visually as far as the distance of tens of kilometers, the impact of the electric power output is only a local matter related to the immediate surroundings of the power plant complex, i. e., the territory where a dense network of similar overhead transmission lines is already situated at present and that is unambiguously dominated by massive blocks of cooling towers, reactor buildings and turbine halls, As follows from the preceding assessment of similar intended projects as well, the visual impact of the electric power output lines can be considered as insignificant in that context.

Steam plumes hovering above cooling towers are also an element participating in visual effects within the landscape. From the visual point of view, the plumes are a highly variable element (now and then, they are not developed either at all). Considering rugged territories that are rather closed at the sight, even high plumes do not extend notably the visibility sphere of the assessed construction in any way. Above all, the power plant visibility sphere is improved in a more striking way by plumes in plainer parts of the territory with wide panoramic spaces and free distant horizons. In such cases, the plumes only represent a little unusual type of clouds, they rather only draw attention to the existence of a power plant, otherwise invisible, beyond the horizon than affect visual landscape characteristics on the concerned territory. Thus, the steam plumes above cooling towers are a temporary element, with a variable extent, and close to natural phenomena (cloudiness) due to their character and expression.

The maximum theoretical visibility sphere of the construction was determined, based on a graphical analysis of the digital terrain model within the distance of 120 km around the assessed site, and a visual impact model was developed for the NJZ implementation (the target state) and without it (the present state). On the basis of results obtained, a territory of interest was defined that is to be assessed. The area is of an approximately triangle shape, its apices being Bratislava (Devín) - Trenčín - Nové Zámky (Palárikovo), with the total area of 5,309 km^2. The following aspects were then assessed within the territory specified in such a manner:

- the scope and rate (intensity) of the total visual impact on the monitored territory in its present state and in the target configuration after the NJZ construction completion;
- comparisons between the total extent (area) of the power plant complex visibility in its present state and in the target configuration after the NJZ construction completion;
- comparisons between intensities (significances) of the power plant complex visual impact in its present state and in the target configuration after the NJZ construction completion;
- the intended project impact on the face of the concerned landscape.

With regard to the fact that the NJZ area continues spatially the existing complex of nuclear facilities on the Jaslovské Bohunice site with the concurrent (or pushed forward in time) JE V1 demolition, the assessment is understood, to a considerable extent, as a difference analysis between the actual and target states. The assessment results can be summarized into the following paragraphs:

- 1,247 km^2 out of the territory of interest with the area of 5,309 km^2 are visually affected by the existing EBO configuration, i. e., 23.5 % of the total area; 1,472 km^2 will be visually affected by the target EBO + NJZ configuration, i. e., 27.7 % of the total area.
- For both the assessed configurations, areas of significant or higher impacts induced by the construction are concentrated within a circle of approximately 20 km from the site, or to a territory approximately corresponding to the orographic sub-units of the Trnava Hilly Country (Trnavská pahorkatina) and the Lower-Váh River Flood Plain (Dolnovážská niva) with only border overhangs to further (contact) geomorphological units.
- The increase in the visually affected area after the NJZ construction completion (225 km^2, i. e., 4.2 % of the total area of the territory of interest) can be assessed as little significant on the whole – more marked increment areas and zones only appear at distances of more than 20 km where the impact induced by both the existing and target configurations of the power plant complex predominantly insignificant.
- The change in the visual impact intensity of the power plant complex after the NJZ construction completion can be assessed as little significant to insignificant – the visual impact of the power plant complex will remain on the same level as up to now on 71.2 % of visually affected areas, it will be increased (however, at distances longer than 20 km from the site, above all) on further 19 %, but it will be decreased at the same time on approximately 9.5 % of visually

affected areas, in this case at distances within 20 km altogether (the greater visibility reach of the 180-m-high NJZ cooling tower will express itself at longer distances, while the "disappearance" of the JE V1 site and its four cooling towers will be more striking from shorter distances, from the monitored point of view).

- The intended project will affect more significantly the lowland agricultural landscape with a very low variability of the landscape character, with the dominance of large-area blocks of arable land, with a marked application of the technizing landscape layer and a very restricted visual share of ecostabilization landscape elements.
- None of the basic landscape character values, i. e., significant landscape elements, protected areas, natural and cultural-historical landmarks of the landscape, historically valuable units, areas and objects, harmonic scales and harmonic relations will be visually degraded or intolerably affected by the NJZ on the concerned territory. A very significant impact on the landscape scale consisting in the construction of the new industrial dominant – the NJZ cooling tower – is the maximum identified impact on one of the mentioned values. The cooling tower surpasses by 55 m the existing EBO skyline and, thus, increases the overall markedness of the power plant complex in the landscape character.

Considering the mentioned facts and results of detailed assessments, it is therefore possible to assess the impact of the intended NJZ project on the Jaslovské Bohunice site on the landscape character of the territory of interest, or on its central part, as significant to determining (depending on the monitoring distance), with a slightly to medium negative impact defined, above all, by the technizing character of the construction and dimensions of its dominating objects. However, it follows from the difference analysis results that a similar impact on the delimited territory is already induced by the existing EBO configuration.

With regard to the actual state on the Jaslovské Bohunice site with nuclear facilities, it is therefore possible to also specify the assessed intended project as the NJZ construction in the existing complex with the concurrent JE V1 demolition. With the reference to the difference analysis results, the impact of the intended project, defined in such a manner, on the delimited territory of interest can then be assessed as little significant to insignificant with a slightly negative to indifferent (neutral) expression.

The impact induced by the intended project is restricted on the territory of the Slovak Republic from the landscape point of view, trans-border impacts can be considered as completely insignificant.

C.III.8.1.3. Shading of Surrounding Residential Areas

The shading of surrounding residential areas by nuclear power plants found on the Jaslovské Bohunice site after the NJZ construction completion and the review of significance of possible changes in that impact in comparison with the current state were specified separately within the assessment of the impact on the landscape.

A series of residential areas is situated in the relevant area of shading within approximately 5 km around the Jaslovské Bohunice nuclear facilities site. For the purposes of this assessment, they were represented by reference points that were then assessed in deeper detail. The reference points were established so that each potentially overshadowed residential area within the wider concerned territory, including isolated houses, weekend cottage settlements, i. e., the northern part of Jaslovské Bohunice, a part of Paderovce, Domce settlement, Dolné Dubové, the edge of Kátlovce, the western part of Pečeňady, Veľké Kostoľany, Dubovany and the Oravcov mlyn isolated house, is covered by at least one reference point.

Other residential areas situated in the wider surroundings of the site are found either at distances beyond the possible more significant reach of the monitored phenomenon and the impact of their shading will not exceed an insignificant level (residential areas beyond the border of 5 km away from EBO), or outside the overshadowed area (Nižná, Žlkovce, Malženice, the southern part of Jaslovské Bohunice), or possibly, they are hidden behind the terrain relief (Ratkovce, the eastern part of Pečeňady, the south-eastern part of Veľké Kostoľany).

Based on the calculated time relations, the impact of shading by the dominating construction objects can be mostly considered as insignificant for both the considered configurations (the existing JE A1 + JE V1 + JE V2, the proposed NJZ + JE A1 + JE V2), it will only rise to the little significance level at the reference points representing the nearest residential areas to the power plants overshadowed in summer months (Jaslovské Bohunice, Domce and Pečeňady).

The total change in shading time relations (the difference between the target configuration and the existing configuration) can be either positive or negative in the assessed case – the reconfiguration of the site of nuclear facilities consists not only in the NJZ construction (an increase in the shading), but, at the same time, also in the dismantling of the JE V1 and its four

cooling towers (a decrease in the shading). The shading assessment was performed for 23 reference points representing built-up areas of municipalities on the concerned territory, with the following results:

- Decreases in the total shading will occur in 8 reference points whereby the decreases at the eastern edge of Jaslovské Bohunice, at the southern edge of Pečeňady and at the western edge of Pečeňady can only be assessed as little significant. The decreases at the other reference points, i. e., at the western edge of Jaslovské Bohunice, at the northern edge of Pečeňady, at the southern edge of Veľké Kostoľany, in the south-western part of Veľké Kostoľany and in Oravcov mlyn, are non-essential.
- Increases in the shading can be expected at the remaining 15 reference points, however, at 3 points (the north-eastern and north-western edges of Jaslovské Bohunice municipality, the south-eastern edge of Domce settlement), the increases can only be assessed as little significant again, while increases in the remaining reference points can be considered as insignificant, namely including two points (the north-western edge of Veľké Kostoľany municipality and the western edge of Dubovany municipality) situated beyond the shading reach of the existing EBO site and that will only be overshadowed by NJZ objects.

The impact of the shading of the surrounding residential areas by nuclear facilities found on the Jaslovské Bohunice site can therefore be assessed, on the whole, as little significant (locally) to insignificant (predominantly) in both the monitored aspects (absolute time relations and a relative change with regard to the actual state).

C.III.8.1.4. Visualizations

Visualizations are made from multiple views as background materials for the assessment of impact of the proposed activity on the landscape character, for visual comparisons between the existing configuration (without the NJZ) and the target configuration (including the NJZ).

Figure C.III.2: View from Radošovce municipality (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.3: View from Bohunice (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.4: View from Jaslovce (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.5: View from Žlkovce municipality (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.6: View from Veľké Kostoľany (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.7: View from above Nižná municipality (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.8: View from below Nižná municipality (the existing state without the NJZ, the target state with the NJZ)

Figure C.III.9: View from Pečeňady (the existing state without the NJZ, the target state with the NJZ)

The overall view of both the NJZ and EBO sites is visualized in the following figure, the photograph was taken from the Slovak Hydrometeorological Institute meteorological tower.

Figure C.III.10: The overall view of the NJZ and EBO sites

C.III.8.1.5. Impacts on Recreational Utilization and Throughput of Landscape

The EBO site was devoted to the economic-power-engineering utilization already in the past. Other activities that could be performed on the concerned territory are limited just in relation to this prioritized landscape potential. Thus, the housing, recreation, conservation and many other potentials are secondary throughout the contact space.

With regard to the little rugged relief and climatic conditions, the landscape around the contemporary EBO site is utilized predominantly for agricultural purposes. The large-area block management system is applied which is the second significant limiting potential on the concerned territory suppressing the territory attractiveness from the recreational utilization point of view. However, within the meaning of the short-term recreation (especially for residential area inhabitants on the concerned territory), the road network existing throughout both the concerned and wider territories can be used for cycling (e. g., cycling route No. 2203 built in Jaslovské Bohunice cadastral area with the length of 5.6 km is registered).

The development of recreational activities is also limited by the nearby 'Špačinsko-nižnianske polia' ('Špacince-Nižná Fields') CHVÚ to a certain extent. Activities supporting recreation that would restrict survival and reproduction conditions of the Jerfalcon protected species (the Community importance bird) are not desirable on this territory.

It follows from the mentioned facts that the NJZ impact on the landscape recreational utilization and capacity almost equals to zero, with regard to the mentioned facts, i. e, no change occurs, as compared with the current state.

C.III.8.2. Impacts during the Construction and Operation Termination Period

Impacts on the landscape structure, landscape character, stability and protection during the construction of new objects will be of variable character and will gradually converge to the above described state. Other impacts will also be present during the construction period in relation to construction work (construction site equipment objects, soil stock-piles, uncovered ground surface, construction machinery presence and movements, or other). On the whole, the impacts are little significant and temporary, from the landscape point of view.

The NJZ rate of impact during the operation termination period depends on the procedure in compliance with which the operation will be terminated. Generally, it is possible to expect that the impact rate will rather recede along with the dismantling of objects.

C.III.9. Impacts on Protected Areas

9. Impacts on protected areas and their zones of protection [e. g., proposed protected bird areas, areas of Community importance, European Ecological Network (Natura 2000), national parks, protected countryside areas, protected water management areas].

C.III.9.1. Impacts on Natural Science Protected Areas

C.III.9.1.1. Impacts on Protected Areas of the National System

The NJZ siting and construction area will not interfere directly in any small-area or large-area territory of the national system of protected areas. Within the meaning of Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended, degree 1 of protection applies there (general nature conservation applicable to the Slovak Republic territory).

Impacts by the NJZ on protected areas during its operation period (as well as during the concurrent run of operations along with the other installations on the EBO site) can be considered as virtually excluded, with regard to their distances (CHA Dedova jama is the nearest territory to the NJZ siting and construction area, namely at the distance of approximately 4.9 km).

The raw water take-off object will be localized on the Sĺňava Water Reservoir bank - CHA Sĺňava. No impacts on the protected area are assumed during the common operation of the take-off object (the subject of protection – the protection of water birds an aquatic biocoenoses for scientific-research purposes).

The industrial waste water corridor route is led at the distance of approximately 150 to 300 m (depending on the localization of the pipeline system within the delimited corridor) to the South of CHA Dedova jama and in the vicinity of the southern edge of CHA Malé Vážky (the proposed route of the new pipeline will lead to the South of the existing pipeline, i. e, the new pipeline will be laid at a greater distance than 100 m from the CHA border). The pipeline will be laid in the ground and will not be a source of any phenomena that could affect negatively the protected area and endanger the subject of protection in any way.

C.III.9.1.2. Impacts on Protected Areas of the European System

The following two territories included in the European Ecological Network (Natura 2000) were identified on the concerned territory:

- SKCHVU026 Sĺňava, and
- SKCHVU054 Špačinsko-nižnianske polia (Špačine-Nižná Fields).

SKCHVU026 Sĺňava: The protected bird area (CHVÚ) is situated at the distance of approximately 11.4 km to the North-East of the NJZ site. It represents an important nidification site for water and water-bound birds, as well as a stop on the birds' migration route represented by the Váh River.

Due to the proposed activity implementation, as well as due to its operation and operation termination, the CHVÚ Sĺňava functions will not be affected in any way. The proposed water management infrastructure will be led under the ground surface and the NJZ construction itself will not be in contact with the area. The proposed activity implementation will not represent any direct seizure of biotopes and territories dedicated to species that are the subjects of CHVÚ protection, there is an assumption of their conservation in their original states.

The localization of the raw water take-off object is proposed on the Sĺňava Water Reservoir edge, i. e., this will be the point of contact with the CHVÚ territory. During the NJZ operation period (as well as during the concurrent run of operations along with other installations), the take-off object will not produce significant disturbing effects (noise, dust, light, or other) that could affect the CHVÚ itself and the subject of its protection. The water take-off will not have any negative impact, neither a level drop, nor a change in the present Sĺňava Water Reservoir water management mode will occur.

SKCHVU054 Špačinsko-nižnianske polia: The CHVÚ border is situated at the distance of approximately 100 m to the North of the proposed construction site equipment area, approximately 250 m from the main construction site area and approximately 1,000 m from the proposed cooling tower localization.

No direct impacts of the NJZ operation (as well as of the concurrent run of operations along with other installations) on CHVÚ are assumed. The new overhead transmission line can have an indirect negative impact, it can represent an obstacle to Jerfalcon flights under poor visibility conditions and there is a collision hazard. As it is only a short section of line not interfering in CHVÚ area, the rate of that impact cannot be considered as significant.

Other protected areas included in the Natura 2000 system are situated at a sufficient distance from the assessed NJZ elements and no negative impacts on the subject of their protection are assumed.

The assessment of impacts on the integrity of territories included in the Natura 2000 system is only concentrated on the assessment of impacts on the integrity of CHVÚ Sĺňava that will be affected at its edge by the localization of the raw water take-off object. With regard to the fact that the intended project only interferes in the CHVÚ border at a single point, there is no assumption that it would have any impact on a change in important ecological functions, on a significant reduction of biotopes of the species that are the subject of protection, on a reduction of the site diversity, on the site/biotope fragmentation, on a loss or reduction of key characteristics which the subject of protection depends on, or on the achieving of the protection objectives. Based on this assessment, it can be stated that the proposed activity will not interfere in the CHVÚ Sĺňava integrity at all, i. e., no new partition (fragmentation) of the territory will occur. The CHVÚ Špačinsko-nižnianske polia will not be affected, from the integrity point of view, at all.

The Natura 2000 system coherence will be affected neither by the proposed activity implementation, nor by its operation and operation termination in any way. The NJZ construction itself will not be in contact, either directly or indirectly, with any Natura 2000 territories, will not represent any obstacle on migration routes and will not disturb their continuity. The proposed water management infrastructure will be led under the ground surface. For those reasons, the coherence of the Natura 2000 system and of individual species populations and types of biotopes communicating among individual territories will not be disrupted. With regard to ecological demands, action radius, territories and migration abilities of individual species, biotopes of which are the subject of protection on Natura 2000 territories, it can be stated that the construction and operation of the proposed activity will preserve spatial interconnections of the Natura 2000 system and will not have any negative impact on the coherence of the Natura 2000 territories.

C.III.9.1.3. Impacts on Other Nature Conservation Elements

The assessed activity will not interfere directly in a significant landscape element (VKP), or in any other nature conservation elements localized on the concerned territory. With regard to the sufficient distance between the NJZ siting and construction area and the raw and waste water corridor route from other nature conservation elements, the probability of either direct or

indirect negative impacts during the NJZ operation period equals to zero.

The proposed raw water take-off object is localized at the edge of the Sĺňava Water Reservoir that is included in the List of Regional Significance Marshlands. The water take-off will not have any negative impact on the marshland, neither a level drop, nor a change in the present Sĺňava Water Reservoir water management mode.

There is no assumption that water regime of other marshlands situated on the concerned territory, or the state of biotopes and animal populations living therein will be affected negatively during the NJZ operation period.

The impact of changes in microclimatic conditions (moisture, daily course of temperatures, changes in the sun light exposure of areas) in connection with the shading by objects and by the steam plume can be considered as negligible and only of local significance and bound exclusively to the immediate surroundings of the nuclear facilities site. For the mentioned reasons, no negative impacts of the mentioned changes on the protected areas, as well as on other nature conservation elements, are assumed.

C.III.9.2. Impacts on Protected Water Management Areas

The NJZ project will not have any direct impact on protected water management areas.

The protection of the sensitive area where the project will be situated (and which includes the whole territory of the Slovak Republic) will be ensured on the basis of limit values of waste water pollution indicators for waste waters that will be discharged into surface waters, in compliance with the Regulation of the Government of the Slovak Republic No. 269/2010, Coll., Laying down Requirements for the Achievement of Good Water Conditions, as amended.

The NJZ project will not have any impact on vulnerable areas. Its subject will not include the use of the territory for agricultural purposes, it will therefore not affect nitrate concentrations.

C.III.9.3. Impacts on Other Protected Areas

Impacts on other protected areas are excluded.

C.III.9.4. Impacts during Construction and Operation Termination Periods

The NJZ siting and construction areas (the main construction site, the construction site equipment, working stripes along raw and waste water pipeline route corridors) do not interfere directly in any protected area included in the national system of protected areas, in any protected area included in the European Ecological Network (Natura 2000), and in any pother nature conservation elements (protected trees, marshlands, etc.). Within the meaning of Act No. 543/2002, Coll., on Nature and Landscape Conservation, as amended, degree 1 of protection applies there.

The protected raw water take-off object is localized at the edge of the Sĺňava Water Reservoir (CHA, CHVÚ, regionally significant marshland), interventions will be made to the bank part of the reservoir during the construction work. It will be necessary to perform the work off the nesting period, the technical states of the machinery and equipment will have to be inspected strictly and, thus, possible leakage of oil substances will have to be avoided. If technical measures and work discipline rules are adhered to, neither any water quality aggravation, nor any negative impacts on the water reservoir biotopes are assumed. Noise, dust and light emissions can be assumed during the construction period. Non-point and line sources will be mainly the emission sources during the take-off object and underground pipeline construction. Short-term pollutions during the construction will be in question and low-level air layers will be mainly affected. Their unfavourable impacts can be minimized by means of determining an appropriate construction period off the nesting period.

The proposed activity will not interfere directly in the CHVÚ Špačinsko-nižnianske polia. During the construction period, no indirect impacts on Jerfalcon nidification sites and biotope in CHVÚ are assumed. They are distant sufficiently from the construction in question so that their quality will not be aggravated. Temporary construction areas (building stocks, plant depots), as well as the construction itself, will not represent any restriction of Jerfalcon food possibilities outside the CHVÚ either, as there is a plenitude of additional similar areas there. Similarly, no Jerfalcon disturbances are assumed at its breeding places during the construction work either. The "lowland" Jerfalcon populations are adaptable to the human presence and they do not even mind the vehicle transport, noise, or increased movements of persons. Jerfalcons are nesting even in cities in many counties. They are only more sensitive to direct disturbances (movements, the forest

management work within 100 m from the nest) during the mating, egg-laying and incubation period lasting from March till April. However, this is not assumed in case of the activity in question.

The industrial waste water corridor route is led in the close vicinity of the southern edge of CHA Malé Vážky. The existing pipeline is led in that space at the distance of approximately 95 m to the South of the CHA. The new pipeline route is proposed to the South of the existing pipeline, i. e., the new pipeline will be laid at a greater distance than 100 m from the CHA border. In case of the new pipeline construction, there is therefore no assumption that the protected area will be affected, its water regime will be aggravated and, thus, states of biotopes and animal populations will be worsened. During the construction period, it will be necessary to adhere to nature conservation conditions, not to interfere in the territory and not to fill up marginal parts of the territory. If technical measures and work discipline rules are adhered to, neither any disturbances, nor any aggravation of the current state of the territory is assumed. The protected territory is in an advanced state of degradation at present, marshland communities are grown over by Sedge Wren *(Phragmites communis)* forming dense coppices around the whole area. Marshland species are only occurring at edges and achieve a very low coverage. Based on consultations held with the State Nature Protection Authority of the Slovak Republic (ŠOP SR), the Protected Countryside Area (CHKO) Malé Karpaty, it was detected that management measures had been taken on the territory in the past to preserve marshland communities. The management measures do not continue for a longer time period which results in changes in the floristic structure of the biotope and in subsequent hydrological changes.

As for impacts on other protected areas, they will not be virtually affected. Increased movements of construction machinery will be made around the territory during the construction period, with the related air quality aggravation, noise and dustiness exceeding the construction site area itself. Mechanisms that will be working on the construction can be the water pollution source during the construction period – oil substances and operating liquids (in case of accident states). Those unfavourable impacts can be minimized by means of complying with protection and preventive measures, e. g., to prevent engine fuels and oils from leakage, to eliminate possibly pollution sources, to make accident means available. During the construction period, it will be necessary to implement the construction work in off-vegetation and off-nesting periods, prevent from direct interferences in protected areas, from construction mechanisms riding in the close vicinity of the territories, from the localization od stock-piles and plant depots in their close vicinity. In case that those measures are complied with, no negative impact on the protected territories, impact on the water regime of the local marshlands, on marshland biotopes and animal communities situated in the vicinity of proposed raw and waste water corridors are assumed.

Impacts on the protected territories during the operation termination period will not exceed the impacts induced during the construction period. Possible remediation works are only expected within the NJZ site.

C.III.10. Impacts on the Territorial Ecological Stability System

10. Impacts on the territorial ecological stability system.

C.III.10.1. Impacts on the Territorial Ecological Stability System

The NJZ siting and construction area will not interfere directly in any territorial ecological stability system element. Territorial ecological stability system elements are situated in sufficient distances and no impacts are assumed during the NJZ operation period (including the concurrent run of operations along with the other installations on the site).

In case of raw and waste water corridors routing, several contacts with the territorial ecological stability system occur. Raw and waste water pipelines are led under the canalized RBk – the Dudváh River watercourse. The waste water pipeline crosses the southern edge of RBc Dedova jama, it is routed along the south-western edge of LBc Červeník-Ypsilon and crosses its eastern part, it is routed to the North of LBc Štrkovka and interferes in the NRBk Váh River – due to the fact that the discharge facility is localized on the Drahovce Channel bank.

The raw and waste water pipelines are laid in the ground and they will not be the sources of impacts (disruptions of migration routes, impacts on biodiversity) during the NJZ operation period that could disrupt the functionality of biological centres and biological corridors. The indirect impacts are related to impacts on surface water that can be assumed due to the water pumping and discharging. However, those impacts represent neither the threat, nor the disruption of territorial ecological stability system elements.

The raw water take-off object is localized on the bank of the Sĺňava Water Reservoir representing a regional biological centre (RBc). If technical measures of operation of the take-off object technical equipment are complied with, it is not assumed that biological centre functions will be affected.

In all cases of contacts with the territorial ecological stability system, spatial parameters will be maintained and no restrictions or disruptions of the spatial parameters, functionality and integrity of those elements will occur. Impacts by the NJZ operation on territorial ecological stability system elements can be considered as equal to zero.

C.III.10.2. Impacts during Construction and Operation Termination Periods

The NJZ main construction site and the construction site equipment do not interfere directly in any territorial ecological stability system element. The territorial ecological stability system elements are situated in sufficient distances, that is why, no impacts are assumed during the operation period and the operation termination period either.

Raw and waste water corridor routes cross the territorial ecological stability system elements in several cases:

- The raw and waste water corridor route crosses the RBk Dudváh River. The Dudváh River is canalized and without any streamside stands at the point of crossing. The pipeline will be led under the bottom whereby the construction technology is not known at present. It can be expected that corridor functions of the watercourse will be affected temporarily and for a short time period due to the construction activities.
- The rain waste water pipeline led in this corridor is discharged into the Dudváh River. During the construction period, the streamside stands will be clear-felled within the temporary seizure width and the banks will be modified. After the construction activities are completed, the territory will be remediated and damaged parts will be reclaimed.
- The industrial waste water corridor route crosses the southern edge of RBc Dedova jama. During the construction period, the streamside stands will be clear-felled within the temporary seizure width and after the construction activities are completed, the territory will be remediated and shrubs and trees will be planted. With regard to the fact that the interference will take place in the southern edge of the territory, it will not be fragmented and, thus, there is no assumption that the biological centre function will be disrupted.
- The industrial waste water pipeline is routed along the south-western edge of LBc Červeník-Ypsilon and in its eastern part. This section of the waste water pipeline route is proposed to be laid to the South of the existing pipeline route (Socoman), i. e., it will be laid further from the LBc than the present pipeline. If this route is adhered to, no clear-felling will be done and there is no assumption that the present state of LBc will be aggravated, including the areas of genetic resources.
- The industrial waste water pipeline is routed to the North of LBc Štrkovka. In case of an appropriate routing, no clear-felling will be necessary in that space.
- The industrial waste water pipeline interferes in the NRBk Váh River (the discharge facility is localized on the Drahovce Channel bank). The pipeline construction will be bound to a relatively short time period lasting several months and it will be of local character, without more significant impacts on the birds' migration corridor. During the construction work, banks of the channel will be affected, after the construction work is completed, the territory will be remediated and damaged parts will be reclaimed.

The raw water take-off object is localized on a bank of the regional biological centre Sĺňava Water Reservoir. With regard to the localization of the take-off object on the water reservoir bank, if technical measures are complied with and the construction work is performed off the nesting period, impacts on the RBc can be considered as little significant and without any disruption of RBc function or integrity.

Impacts on the territorial ecological stability system elements can be considered as insignificant during the NJZ construction period. When planning transport routes, it will be necessary to use the existing road network to as large extent as possible in order to minimize direct interventions in the territorial ecological stability system elements.

The extent of impacts during the operation termination period will not exceed the above described impacts during the construction or operation periods.

C.III.11. Impacts on Urban Complex and Land Use

11. Impacts on urban complex and land use.

C.III.11.1. Impacts on Urban Complex and Land Use

The concerned territory is formed by an agricultural-residential landscape. The territory structure consists of extensive agricultural areas, residential areas including civic and technical amenities, communications and the territory technical infrastructure. Power engineering infrastructure elements are present to a significant extent, i. e., the site of nuclear facilities, high-voltage overhead transmission lines and the additional related infrastructure.

The EBO site was therefore devoted already in the past to serve as an economic-power-engineering utilization area, other activities on the site and in its surroundings are limited just due to this prioritized site utilization.

This territory utilization will not be modified by the NJZ, the mentioned territory structure will be maintained after the NJZ implementation as well.

C.III.11.2. Impacts during Construction and Operation Termination Periods

During the construction or operation termination periods, no impacts on the urban complex and land utilization will occur. The Access to surrounding allotments (outside the area dedicated for the construction) will be maintained.

C.III.12. Impacts on Cultural and Historical Monuments

12. Impacts on cultural and historical landmarks.

C.III.12.1. Impacts on Cultural and Historical Monuments

No monuments of cultural and historical values are found either on the NJZ siting and construction areas, or in their surroundings. Equally, no objects of tiny sacral architecture that could be affected due to the intended project implementation are found either on the NJZ siting and construction areas, or in their surroundings.

Several objects of cultural and historical values are found within the wider territory of interest, however, they will not be affected by the implementation of the assessed activity, with regard to its character and proposed localization.

C.III.12.2. Impacts on Tangible Assets

In connection with the proposed construction, some construction objects will have to be demolished and some underground services will have to be transferred. They are operational objects related to the electric power generation, property relations to those objects have been settled. Third parties' tangible assets will not be affected.

No long-term use of the existing objects situated on the investor's site is counted on. The existing objects were built in the 1960s to the 1980s, their reconstruction would be ineffective and, that is why, they will not be used for the NJZ operation. However, some objects can be used for the temporary construction site equipment.

The potential impact of transport vibrations on the tangible assets (i. e., the construction-technical state of the objects situated at transport communications) is commented in Chapter C.III.16.2. 'Impacts of Vibrations' (page 324 of the present Report).

C.III.12.3. Impacts during Construction and Operation Termination Periods

The above described impacts especially regard to the construction period. No additional impacts will occur during the operation termination period.

C.III.13. Impacts on Archaeological Discovery Sites

13. Impacts on archaeological discovery sites.

C.III.13.1. Impacts on Archaeological Discovery Sites

Some possibility of making an archaeological finding at the earthmoving work during the construction of the intended project is not unambiguously excluded. A Bronze Age burial place situated on the Pravé pole site is registered by the Regional Conservation Authority in Trnava. It was studied partially during the construction of the Nuclear Power Plant in Jaslovské Bohunice. For the mentioned reason, it is required to perform a rescue archaeological research in connection with the implementation of this construction. The archaeological research type, scope and method is to be determined by the Regional Conservation Authority in Trnava as the state administration body in its rescue archaeological research decision. In order to get the land use decision, the investor will submit a request for an opinion to the Regional Conservation Authority in Trnava along with the marked-out earthmoving work extent and area necessary for the construction.

C.III.13.2. Impacts during Construction and Operation Termination Periods

The above described impacts especially regard to the construction period. No additional impacts will occur during the operation termination period.

C.III.14. Impacts on Paleontological Discovery Sites and Geological Sites

14. Impacts on paleontological discovery sites and significant geological sites.

C.III.14.1. Impacts on Paleontological Discovery Sites and Geological Sites

No geological and paleontological monuments are found either on the NJZ site or in its surroundings, they will therefore not be affected by the proposed activity.

C.III.14.2. Impacts during Construction and Operation Termination Periods

Impacts during the construction or operation termination periods are excluded.

C.III.15. Impacts on Cultural Values of Intangible Nature

15. Impacts on cultural values of intangible nature (e. g., local traditions).

C.III.15.1. Impacts on Cultural Values of Intangible Nature

The NJZ construction site is stabilized on the basis of its economic-power-engineering utilization in the long term. Thus, the intended project implementation will not affect any cultural values of intangible nature, or local cultural traditions.

C.III.15.2. Impacts during Construction and Operation Termination Periods

The proposed activity will not affect any cultural values of intangible nature either during the construction or operation termination periods.

C.III.16. Other Impacts

16. Other impacts.

C.III.16.1. Noise Impacts

C.III.16.1.1. Technology Noise

Noise impacts (from both the existing and future sources) depend on the distance and character of acoustic parameters showed by technology equipment (i. e., their acoustic power output), on the equipment localization and actions in time. Potential increases in the noise level can be assumed predominantly on a local level inside the power plant site or in its nearest surroundings.

Noise impacts induced by a power plant will be defined by the localization of the NJZ. New objects and activities related to the NJZ operation will be added to the existing SE-EBO and JAVYS plants.

The technology operation impact is analysed by means of a computer code. Resulting values of the determining quantity are related to reference points whose characteristics are presented in Chapter C.II.15.1. 'Noise' (page 227 of the present Report). Results of model calculations are presented in the following table along with increments, as compared with the zero variant (i. e., if the NJZ is not implemented and the current state continues).

Table C.III.23: Noise levels produced by the operation of stationary sources, operation period

Reference point	Reference time interval	Permissible value [dB]	Noise levels [dB]			Change due to the NJZ [dB]	Assessed value (including uncertainty of predictions) [dB]
			Zero state (without the NJZ)	Perspective state (the NJZ only)	Perspective state (concurring effect)		
S1	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S2	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S3	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S4	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S5	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S6	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S7	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S8	day	50	< 25.0	42.1	42.1	+ > 17.1	43.9
	evening	50	< 25.0	42.1	42.1	+ > 17.1	43.9
	night	45	< 25.0	42.1	42.1	+ > 17.1	43.9
S9	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	evening	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
	night	45	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0

Assessed acoustic pressure level values, extended by the uncertainty of prediction, are compared with permissible noise values produced by other sources in compliance with Decree No. 549/2007, Coll., Laying down Details on Permissible Noise, Infra-Sound and Vibration Levels in the Environment and on Requirements for the Objectification of Noise, Infra-Sound and Vibrations in the Environment. Based on analyses performed, it can be judged that permissible noise values produced by other sources are not exceeded in any reference point for all reference time intervals. The potential noise increase in calculation point S8 is caused by the NJZ cooling tower operation that will be dominating at that calculation point from the point of view of effects produced by stationary noise sources (however, reliably below the limit).

In addition to the assessments in particular calculation points representing the nearest built-up residential area (territory category III), the compliance with limits of permissible noise values produced by other sources was verified for territory category IV (borders of industrial plants). Based on the areal distribution of noise dispersion throughout the territory, it can be judged that the compliance with the legislative limit of 70 dB is assumed on the power plant site borders (both EBO and the NJZ). However, the detailed assessment is recommended for further project phases when a more detailed specification of noise characteristics of significant noise sources will already be known along with the final layout of objects within the NJZ site.

Plants producing emissions of the noise tone component (e. g., transformers and electrical stations) are more significant from the noise effect point of view. Non-standard activities, such as steam generator safety valves, steam dump stations into the atmosphere and step-down station safety valves, can also be significant from the noise emissions point of view. However, those sources do not act during normal power plant operation (they are intended for transition states and abnormal or accident conditions, they act for several seconds at the most and are also put into operation during their periodical tests).

C.III.16.1.2. Transport Noise

The noise impact induced by the vehicle transport running on public roads is analysed by means of a computer code. Resulting values of the determining quantity are related to reference points whose characteristics are presented in Chapter C.II.15.1. 'Noise' (page 227 of the present Report). Results of model calculations are presented in the following table along with increments, as compared with the zero variant (i. e., if the NJZ is not implemented and the current state continues).

Table C.III.24: Noise levels produced by the land transport, operation period

Reference point	Reference time interval	Permissible value [dB]	Noise levels [dB]			Change due to the NJZ [dB]	Assessed value (including uncertainty of predictions) [dB]
			Zero state (without the NJZ)	Perspective state (the NJZ only)	Perspective state (concurring effect)		
D1	day	60	66.7	37.7	66.7	± 0.0	68.5
	evening	60	65.1	37.0	65.1	± 0.0	66.9
	night	50	58.0	27.1	58.0	± 0.0	59.8
D2	day	60	69.3	40.3	69.4	+ 0.1	71.2
	evening	60	67.7	39.6	67.7	± 0.0	69.5
	night	50	60.5	29.6	60.6	+ 0.1	62.4
D3	day	60	69.7	40.7	69.7	± 0.0	71.5
	evening	60	68.1	40.0	68.1	± 0.0	69.9
	night	50	60.9	30.0	61.0	+ 0.1	62.8
D4	day	60	64.2	35.2	64.2	± 0.0	66.0
	evening	60	62.7	34.6	62.7	± 0.0	64.5
	night	50	55.6	< 25.0	55.6	± 0.0	57.4
D5	day	60	62.5	58.9	64.4	+ 1.9	66.2
	evening	60	60.9	58.3	61.7	+ 0.8	63.5
	night	50	55.1	49.3	55.9	+ 0.8	57.7
D6	day	60	60.4	56.7	62.2	+ 1.8	64.0
	evening	60	58.8	56.1	59.7	+ 0.9	61.5
	night	50	53.2	47.1	54.0	+ 0.8	55.8
D7	day	60	64.5	42.1	64.5	± 0.0	66.3
	evening	60	62.8	41.5	62.8	± 0.0	64.6
	night	50	55.9	32.3	55.9	± 0.0	57.7
D8	day	60	67.4	45.3	67.5	+ 0.1	69.3
	evening	60	65.8	44.7	65.8	± 0.0	67.6

Reference point	Reference time interval	Permissible value [dB]	Noise levels [dB]			Change due to the NJZ [dB]	Assessed value (including uncertainty of predictions) [dB]
			Zero state (without the NJZ)	Perspective state (the NJZ only)	Perspective state (concurring effect)		
	night	50	58.7	35.6	58.7	± 0.0	60.5
D9	day	60	66.2	40.0	66.2	± 0.0	68.0
	evening	60	64.6	39.5	64.6	± 0.0	66.4
	night	50	58.9	29.9	58.9	± 0.0	60.7
D10	day	60	68.3	46.2	68.4	+ 0.1	70.2
	evening	60	66.7	45.6	66.8	+ 0.1	68.6
	night	50	59.6	36.5	59.6	± 0.0	61.4
D11	day	60	62.2	48.5	62.4	+ 0.2	64.2
	evening	60	60.6	48.0	60.7	+ 0.1	62.5
	night	50	54.9	38.9	55.0	+ 0.1	56.8
D12	day	60	63.7	41.1	63.7	± 0.0	65.5
	evening	60	62.0	40.5	62.1	+ 0.1	63.9
	night	50	56.3	31.1	56.3	± 0.0	58.1
D13	day	60	65.1	47.1	65.2	+ 0.1	67.0
	evening	60	63.5	46.6	63.6	+ 0.1	65.4
	night	50	57.8	37.6	57.8	± 0.0	59.6
D14	day	60	64.8	39.0	64.8	± 0.0	66.6
	evening	60	63.2	38.7	63.2	± 0.0	65.0
	night	50	57.4	28.0	57.5	+ 0.1	59.3
D15	day	60	63.5	40.9	63.5	± 0.0	65.3
	evening	60	61.9	40.3	61.9	± 0.0	63.7
	night	50	56.1	30.8	56.2	+ 0.1	58.0

The contribution itself provided by the transport caused by the NJZ operation is acoustically insignificant in the majority of cases and varies mostly around levels of up to 0.1 dB. The increment achieves up to 2 dB at the area most heavily loaded points due to the NJZ, The Žlkovce municipality site is in question above all.

Based on those facts, a recommendation is given to perform noise measurements in the most intensively concerned areas during the operation period and, based on their assessment, to take measures leading to the noise load reduction on the monitored territory. The so-called primary measures (the roadway surface replacement) and, possibly, tertiary measures (the replacement of windows in residential objects affected by the noise produced by the land transport causes by the NJZ) are recommended, as it is not possible to take secondary measures of the counter noise wall type in residential areas of individual municipalities. Those measures are then primarily under the noise source (the land communication – road) owner's responsibility

C.III.16.1.3. Impacts during Construction and Operation Termination Periods

The construction stage will be of key significance for the concerned territory, from the noise conditions point of view. It will be connected with intensive construction activities on the NJZ site and with the transport of building and raw materials and staff transport. In addition to construction activities performed on the NJZ site and to the newly proposed switchyard, it is necessary to also count on the transport intended for the construction of underground services.

The noise in the surroundings of machines in operation is, naturally, a temporary noise and achieves relatively high levels on the construction site. Impacts on the noise load in the surroundings of the proposed NJZ were divided into the preparation and construction periods from the time point of view. During the preparation stage, earthmoving work (gross ground shaping) or activities related to the demolition work will be performed. The construction stage will predominantly include activities consisting of civil and structural works.

During the preparation and construction stages, sources are only assessed within the reference time interval 'day', as their activities are only assumed within that time interval. Results of analyses are presented in the following tables.

Table C.III.25: Noise levels produced by stationary sources, preparation and construction periods

Reference point	Reference time interval	Permissible value [dB]	Noise levels [dB]			Change due to the NJZ [dB]	Assessed value (including uncertainty of predictions) [dB]
			Zero state (without the NJZ)	Perspective state (the NJZ only)	Perspective state (concurring effect)		
Preparation period							
S1	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S2	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S3	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S4	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S5	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S6	day	50	< 25.0	30.5	30.5	+ > 5.5	32.3
S7	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S8	day	50	< 25.0	33.0	33.0	+ > 8.0	34.8
S9	day	50	< 25.0	31.1	31.1	+ > 6.1	32.9
Construction period							
S1	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S2	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S3	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S4	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S5	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S6	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S7	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S8	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0
S9	day	50	< 25.0	< 25.0	< 25.0	± 0.0	< 25.0

Slight increases in the noise level can be assumed at calculation points S6 (the eastern edge of Jaslovské Bohunice municipality), S8, S9 (the eastern edges of Radošovce municipality), namely during the preparation period. The assessed values of acoustic levels extended by the uncertainty of predictions are further compared with permissible values for noise produced by other sources. Based on calculations performed, it can be therefore judged that permissible values of noise produced by other sources are not exceeded in any selected point for the reference time interval 'day'.

From the point of view of impacts on protected residential areas, the transport related to construction activities and driving on public roads is more significant. Mobile sources to be active during the preparation and construction periods were only assessed within the reference time interval 'day' again, as their operation is only expected during this time interval. The following tables present calculated vales and theoretical increments resulting from the assumed road transport intensities and from the assumed intensities of the transport only related to the NJZ, calculated and assessed values to be produced by the overall road transport during the preparation and construction periods, namely in both the perspective state without the NJZ implementation and the perspective state including the NJZ implementation.

Table C.III.26: Noise levels produced by road transport, preparation and construction periods

Reference point	Reference time interval	Permissible value [dB]	Noise levels [dB]			Change due to the NJZ [dB]	Assessed value (including uncertainty of predictions) [dB]
			Zero state (without the NJZ)	Perspective state (the NJZ only)	Perspective state (concurring effect)		
Preparation period							
D1	day	60	66.3	65.5	68.9	+ 2.6	70.7
D2	day	60	68.9	68.2	71.6	+ 2.7	73.4
D3	day	60	69.3	68.6	72.0	+ 2.7	73.8
D4	day	60	63.8	63.1	66.5	+ 2.7	68.3
D5	day	60	62.2	68.0	68.0	+ 5.8	69.8
D6	day	60	60.1	65.8	65.8	+ 5.7	67.6
D7	day	60	64.1	< 25.0	64.1	± 0.0	65.9
D8	day	60	67.0	< 25.0	67.0	± 0.0	68.8
D9	day	60	65.9	< 25.0	65.9	± 0.0	67.7
D10	day	60	68.0	< 25.0	68.0	± 0.0	69.8
D11	day	60	61.8	< 25.0	61.8	± 0.0	63.6
D12	day	60	63.4	< 25.0	63.4	± 0.0	65.2
D13	day	60	64.8	< 25.0	64.8	± 0.0	66.6
D14	day	60	64.6	< 25.0	64.6	± 0.0	66.4
D15	day	60	63.2	< 25.0	63.2	± 0.0	65.0
Construction period							
D1	day	60	66.5	53.2	66.5	± 0.0	68.3
D2	day	60	69.1	55.8	69.2	+ 0.1	71.0
D3	day	60	69.6	56.2	69.6	± 0.0	71.4
D4	day	60	64.0	50.7	64.1	+ 0.1	65.9
D5	day	60	62.4	66.4	68.2	+ 5.8	70.0
D6	day	60	60.3	64.2	66.0	+ 5.7	67.8
D7	day	60	64.3	57.9	65.0	+ 0.7	66.8
D8	day	60	67.2	59.5	68.0	+ 0.8	69.8
D9	day	60	66.1	54.9	66.2	+ 0.1	68.0
D10	day	60	68.2	60.4	68.9	+ 0.7	70.7
D11	day	60	62.0	63.6	65.4	+ 3.4	67.2
D12	day	60	63.5	62.3	64.6	+ 1.1	66.4
D13	day	60	64.9	57.7	65.8	+ 0.9	67.6
D14	day	60	64.7	47.7	64.8	+ 0.1	66.6
D15	day	60	63.4	62.1	64.5	+ 1.1	66.3

Due to the NJZ preparation or construction periods, increases in values occur at calculation points, ranging from 0.1 dB to 5.8 dB. Based on legal regulations in force (Decree No. 549/2007, Coll., Laying down Details on Permissible Noise, Infra-Sound and Vibration Levels in the Environment and on Requirements for the Objectification of Noise, Infra-Sound and Vibrations in the Environment), it is necessary to comply with the highest permissible noise limits from 07:00 a.m. till 09:00 p.m. on working days and from 08:00 a.m. till 01:00 p.m. on Saturdays whereby if noise levels produced by construction activities are assessed in the external environment, the assessed value is determined by the sum of correction K = (−10) dB and the equivalent noise level A during the mentioned time intervals. During those time intervals, corrections used for the determination of assessed noise levels in the external environment are not applied. Moreover, if noise levels produced by construction activities inside buildings from 08:00 a.m. till 07:00 p.m. on working days are assessed, the assessed value is determined by the sum of correction K = (−15) dB and the maximum noise level A. The specific noise correction is not applied if noise levels produced by construction activities are assessed.

Under the assumption that those corrections will be applied for activities caused by the NJZ construction, it can be subsequently expected that below-limit effects of those activities can be achieved in the majority of cases. Based on the cautiousness principle selected in the transport model (the overlapping of all transport intensities from all theoretically possible transport routes of individual materials), this state can be considered as the worst possible scenario for each of the selected calculation sites. However, this state cannot occur concurrently in all municipalities, lower transport intensities are assumed in the real state in individual monitored sections. With regard to those uncertainties, a suggestion is made to

perform an operative noise monitoring during the preparation and operation periods so that it is possible to define clearly whether the permissible values will be actually exceeded.

Based on the completed prediction of acoustic conditions within the NJZ territory of interest, thus, a recommendation is made to perform the noise monitoring during the NJZ preparation and construction periods – twice annually, within the project territory of interest, in compliance with requirements specified by technical terms TP 13/2011 of the Ministry of Transport, Construction and Regional Development and within the meaning of related regulations.

Based on the assessment of that operative monitoring, the road owner can then take measures leading to the reduction of the noise load acting on the assessed territory (e. g., vehicle speed reduction and the like).

It is difficult to predict the NJZ operation termination stage from the time point of view. If an analogy with the contemporary JE A1 and JE V1 reactor units operation termination procedures is taken into account, both activities and impacts related to them will be similar or lower than during the NJZ preparation and construction stages. Based on this fact, a judgement is made that the impact of the NJZ operation termination activities will not represent a significant change, as compared with the present and it will be restricted in time.

C.III.16.2. Impacts of Vibrations

C.III.16.2.1. Impacts of Vibrations

Impacts of vibrations are excluded. Vibrations produced by the technology operation (especially by turbines) fade-away within the bedrok in the close surroundings of turbine stand foundations. The residential area is then situated within the distance of the order of kilometres, a significant impact at that distance is reliably excluded.

The same assumption is also related to road or railway transport impacts. Impacts of vibrations produced by transport sources on the surroundings will not markedly differ from the present state. This results from the fact that the vibration level (i. e., the vibration speed or acceleration) in the surroundings of roads is given by the passage of each discrete vehicle, not by the total transport intensity. The increase in the transport intensity does not lead to the increase in the vibration level then, but only to the increase in the repetition frequency of the identical vibration situation.

In general, transport sources do not have a significant impact on the surroundings, as far as vibrations are concerned. The produced vibrations (especially shocks caused by the drive on roadway unevenness) are already attenuated within the subsoil in the immediate surroundings of their occurrence points and they do not express themselves in the foundations of surrounding buildings any more on levels that could affect their statics, or cause their damage. The limit of the first damage signs on buildings varies (in compliance with STN 73 0036, Seismic Loads to Civil Structures) within the range of vibration speeds from 10 to 30 mm/s whereby speeds of vibrations produced by the transport in nearby built-up areas do not normally exceed 2.5 mm/s and they are rather significantly lower. In this case, all applicable requirements for the human health protection are also safely complied with (the vibration acceleration limit in compliance with Decree No. 549/2007, Coll.).

That is why, any occurrence of a significant vibration impact on tangible assets or public health is virtually excluded.

However, the operation of heavy transport means can be expected especially during the NJZ construction period, the aggravated state of roads cannot be excluded either (as a factor affecting vibration occurrences). For that reason, it is suggested to monitor vibration impacts on areas that will be loaded by the transport at the most (simultaneously with the noise impact monitoring) and then, based on the results, to take relevant organizational or technical measures (if necessary). The suggested measure is mentioned in Chapter C.IV.4. Organizational and Operational Measures (page 411 of the present Report).

C.III.16.2.2. Impacts during Construction and Operation Termination Period

Vibration impacts are excluded during the construction and operation termination periods. No blasting work using explosives will be performed. Potential vibrations produced by construction technologies (vibration compactions, pneumatic bore hammers and the like) will be attenuated within the subsoil in the immediate surroundings of their occurrence points and in no case they will affect the wider surroundings. Impacts of transport vibrations produced on the road network of the concerned territory are commented above.

C.III.16.3. Impacts of Ionizing Radiation

C.III.16.3.1. Impact of Radioactive Effluents

C.III.16.3.1.1. Input Data

In case of the NJZ (and the existing nuclear facilities on the EBO site), ionizing radiation impacts can express themselves, above all, by means of discharges of small amounts of radioactive substances into the air and water courses, the so-called effluents.

Assessments of ionizing radiation impacts induced by radioactive effluents from the normal operation[26] were made separately for the NJZ and further for the parallel operations of the NJZ along with the existing nuclear facilities on the EBO site (JE V2 and JAVYS). The assessments were performed using the RDEBO computer code accepted by the Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR), as well as by the State Nuclear Safety Authority of the Czech Republic (SÚJB).

The following are the input data to the RDEBO computer code:

- design based or measured data on effluents into the air (tritium, carbon, noble gases, iodines, aerosols, etc.) for the considered time period;
- design based or measured data on effluents into the surface water (tritium, corrosion and fission products) for the considered time period;
- statistically processed meteorological data – hourly records (the wind direction, wind speed, atmosphere stability category, inverse layer altitude, precipitation intensity) for the considered time period;
- both flow rate and speed of streams in surface water routes, volumes of water reservoirs situated in the surface water routes, prerequisites for the surface water utilization as potable water sources, for the agricultural crops irrigation, recreation and other purposes.

The evaluation of population radiation loads in the surroundings of the Jaslovské Bohunice site under normal operation conditions from discharges into the air and watercourses for the analysed time period makes it possible to calculate individual effective or equivalent doses for six age groups of the population (infants at the age from 0 till 1 year, children at the age 1 till 2, 2 till 7, 7 till 12 years, youth at the age from 12 till 17 years and adults). Equivalent doses calculated for 6 bodies (gonads, bone marrow, lungs, thyroid gland, digestive tract, and skin). The following exposure paths are considered:

- external exposure by the atmosphere – caused by radioactive substances (RAL) dispersed in the air (the so-called plume) and by the deposit;
- internal exposure by the atmosphere – inhalation, digestion, i. e., the receipt of radionuclides that enter food chains due to the atmospheric fallout: milk, meat (beef, pork and poultry), cereals, vegetables (leaf green, fruiter vegetables and potatoes), fruits and other foodstuffs (eggs, sugar, beer, etc.), when doses received from food chains are calculated, the seasonality is taken into account;
- the dispersion of radioactive substances and their daughter products within the aquatic environment, impacts of bathing in water to which effluents are discharged, of boating on such water, of stays on deposits (stays on the bank), of stays on soil irrigated by such water, potable water ingestions, ingestions of fish living in such water, ingestions of meat and milk of animals fed by such water, and ingestions of agricultural products irrigated by such water.

The mentioned exposure paths are considered for all the age groups.

The RDEBO computer code enables to determine the critical group of the population, the critical exposure path and critical radionuclides for individual exposure paths from the effluents into the air, including contributions by individual radionuclides.

[26] See Chapter C.III.19. 'Operational Risks' (page 351 of the present Report) for the evaluation of accident states.

It is necessary to state that the RDEBO computer code calculates the contribution of ingestion to the annual individual effective dose as a lifetime commitment from the annual receipt of contaminated food.

In order to achieve the maximum representativeness in calculations of radiological impacts on the population caused by the NJZ, the whole surroundings of Jaslovské Bohunice municipality were divided into 192 zones delimited by circle sectors á 22.5° (i. e., into 16 directions) and annuli with radii of 1, 2, 3, 5, 7, 10, 20, 30, 50, 70, 90 and 110 km. The calculations were performed as far as the distance of 110 km so that they can also serve for the evaluation trans-border impacts on territories of the Czech Republic, Hungary and Austria.

The RDEBO system calculation area is illustrated on the map background in the following figures, including numbers of zones. The scale of the first figure enables especially to depict zones interfering on the territories of neighbouring states. The second figure illustrates the nearer NJZ surroundings, including zone No. 66 where the NJZ waste water pipeline collector empties into the Drahovce Channel, a part of the Váh River, and in parallel, the Socoman pipeline collector draining the waste water from the existing nuclear facilities, as well.

Figure C.III.11: RDEBO system calculation area extent and zone numbers

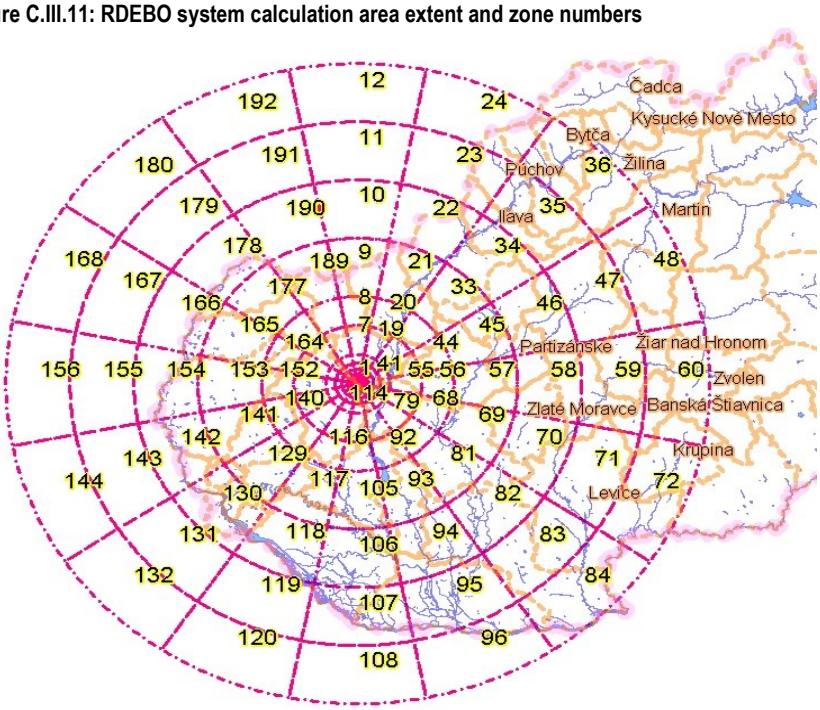
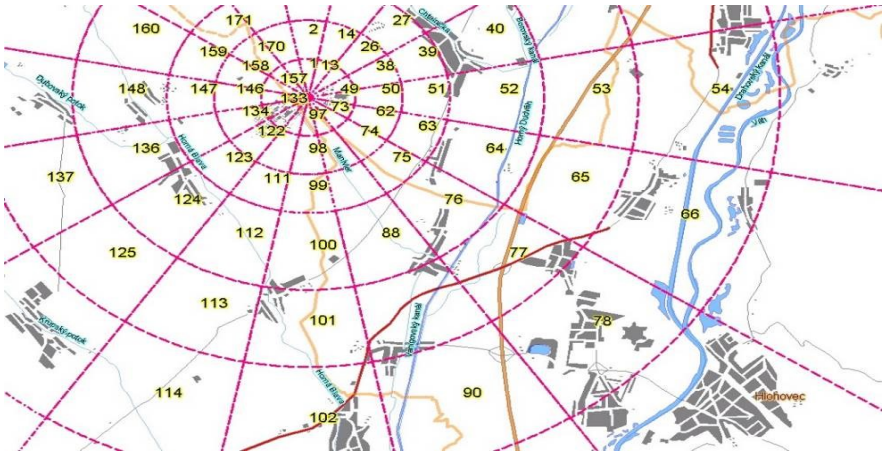


Figure C.III.12: Positions of RDEBO system calculation zones in the nearer surroundings of the NJZ site



The following table presents the numbering of zones depending on the source direction and distance, corresponding to the numbering indicated in the figures above.

Table C.III.27: Numbering of RDEBO system zones

Direction	Distance [km]											
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
S	1	2	3	4	5	6	7	8	9	10	11	12
SSV	13	14	15	16	17	18	19	20	21	22	23	24
SV	25	26	27	28	29	30	31	32	33	34	35	36
VSV	37	38	39	40	41	42	43	44	45	46	47	48
V	49	50	51	52	53	54	55	56	57	58	59	60
VJV	61	62	63	64	65	*66*	67	68	69	70	71	72
JV	73	74	75	76	77	*78*	*79*	80	81	82	83	*84*
JJV	85	86	87	88	89	90	*91*	*92*	*93*	*94*	*95*	*96*
J	97	98	99	100	101	102	103	104	105	106	107	108
JJZ	109	110	111	112	113	114	115	116	117	118	119	120
JZ	121	122	123	124	125	126	127	128	129	130	131	132
ZJZ	133	134	135	136	137	138	139	140	141	142	143	144
Z	145	146	147	148	149	150	151	152	153	154	155	156
ZSZ	157	158	159	160	161	162	163	164	165	166	167	168
SZ	169	170	171	172	173	174	175	176	177	178	179	180
SSZ	181	182	183	184	185	186	187	188	189	190	191	192

Zones affected by discharges into watercourses are indicated in the table using *italics*:

- zone No. 66, where pipeline collectors from the NJZ and the other nuclear facilities are inflowing into the Drahovce Channel;
- zones No. 78, 79, 84, 91, 92, 93, 94 through which the Váh River is flowing;
- zone No. 95, where the Váh River is inflowing into the Danube River;
- zone No. 96, through which the Danube River is flowing downstream of its confluence with the Váh River in Hungary[27].

Zones representing foreign territories are indicated in the table by the grey background colouring:

- Czech Republic: zones No. 9, 10, 11, 12, 22, 23, 24, 166, 167, 168, 178, 179, 180, 189, 190, 191, 192;
- Austria: zones No. 130, 131, 132, 142, 143, 144, 154, 155, 156, 166, 167, 168;
- Hungary: zones No. 84, 96, 108, 118, 119, 120.

C.III.16.3.1.2. Assumptions Used

In order to evaluate impacts of radioactive effluents, a series of conservative assumptions is used to ensure that actual impacts of radioactive effluents from the NJZ and from the existing nuclear facilities are always lower than impacts considered in the calculation, or in the EIA report. Thus, possible uncertainties of the assessment are always considered on the safe side and can only act in favour of the environment protection.

The effluent source term determination procedure is describe in Chapter B.II. 'Data on Outputs', or in its Sub-Chapter B.II.5. 'Radiation and Other Physical Fields' (page 137 of the present Report). Maximum envelope effluent values were used for the NJZ, in compliance with the data provided by suppliers of the reference reactor units, and measured maximum effluent values for individual radionuclides were used for the existing nuclear facilities.

No shading by buildings and due to stays in the buildings was applied during the calculations of volumetric activities closely above the ground, plume exposure, inhalation, deposition on the ground surface from the atmospheric fallout and deposit exposure.

The RDEBO computer code used takes into account the ground surface roughness, the so-called land-use (the type of the ground surface – grass, fields, forests, waters, municipal built-up areas), in compliance with the real situation in the EBO site surroundings.

[27] From the affected Danube River watercourse point of view, that zone is the first affected zone in Hungary. That is why, it is considered as decisive for the trans-border impact assessment.

When modelling, the following average volumetric flow rate values in the Váh River (in the profile where the NJZ waste water is discharged into the Váh River) and in the Danube River, at the Váh - Danube Rivers confluence point, in compliance with the SHMÚ Summary Report 2012 prepared for the EBO site, were used :

- the Váh River – average flow rate of 140 m^3/s and average flow speed of 0.7 m/s,
- the Danube River – average flow rate of 2,400 m^3/s and average flow speed of 0.9 m/s.

The Kráľová Water Reservoir volume was considered to be 2.2E+07 m^3, i. e., it was reduced conservatively with regard to the actual total volume of 5.2E+07 m^3 in order to take into account a higher condensation of radionuclides during low water level periods.

Real meteorological data for the site taken from the SHMÚ Jaslovské Bohunice meteorological station were used for the calculations. Particularly, hourly meteorological data recorded in the year 2010 (the wind speed and direction, atmosphere stability category and atmospheric precipitation intensity) were used and in order to get a comparison, calculations were also made using average values of probabilities of simultaneous occurrences of the atmosphere stability category and wind speed and direction for the period from 1999 till 2010. Average meteorological data for the period from 1999 till 2010 related to the atmosphere stability category includes the stability evaluation from 06:00 a.m.-10:00 p.m. It means that nightly measurements are not included in the statistical data which leads to lower probabilities that stable categories E and F will occur (see the following table) and to the overestimation of probabilities that labile and neutral stratifications (A to D categories) will occur whereby F category leads usually to higher doses. The meteorological data for the year 2010 is complete and, that is why, it was used as the primary input data. Differences in results for the reference year 2010 and for the period from 1999 till 2010 are very small and do not exceed 5 % of the annual dose in zones of the highest individual effective doses.

Probabilities that relevant categories of atmosphere stability will occur are presented in the following table for both the sets of meteorological data used.

Table C.III.28: Probabilities that relevant categories of atmosphere stability will occur on the Jaslovské Bohunice site

Stability category	A	B	C	D	E	F
Probability of occurrence [%], year 2010	3.89	8.32	16.36	40.08	16.78	14.57
Probability of occurrence [%], from 1999 till 2010	3.80	13.10	24.00	41.20	8.40	9.50

The following table presents probabilities that relevant wind directions will occur, for both the sets of meteorological data.

Table C.III.29: Probabilities that relevant wind directions will occur in the year 2010 and during the period from 1999 till 2010

Direction	2010		1999 to 2010	
	Occurrence [%]	Frequency	Occurrence [%]	Frequency
S	16.51	1,446	8.55	5,254
SSV	4.84	424	7.93	4,874
SV	1.58	138	2.24	1,374
VSV	1.53	134	1.23	758
V	6.79	595	2.33	1,430
VJV	8.12	711	5.81	3,567
JV	6.43	563	12.81	7,867
JJV	4.42	387	6.26	3,845
J	4.22	370	4.43	2,721
JJZ	2.40	210	3.26	2,003
JZ	1.63	143	3.30	2,029
ZJZ	2.28	200	2.80	1,720
Z	8.44	739	5.17	3,179
ZSZ	10.94	958	9.24	5,677
SZ	11.97	1,049	16.14	9,918
SSZ	7.91	693	8.49	5,218
SUMA	100.00	8,760	100.00	61,434

It follows from the data that the North wind was the predominating wind direction in the year 2010. It means that the maximum value for the discharges into the air occurs in the direction to the South from the source for the year 2010. Based on the 1999-2010 data, the wind direction from the North-West was predominating, with the maximum in the South-East

direction.

The NJZ ventilation stack height was considered in compliance with the contractor's data within the range from 56 m to 100 m. It followed from variant calculations that if the lower stack is considered, higher doses are obtained. Thus, the stack height of 56 m was used for the calculations. The value of 2 MW was used to represent the thermal uplift power of gaseous effluents. The value ensures conservatism during the calculations of radionuclide dispersion in the atmosphere. The air mass flow speed of 2.0 m/s in the stack mouth and the stack mouth diameter of 4.2 m were considered.

The contribution to the lifetime individual effective dose (IED) induced by the annual food receipt (i. e., the individual effective dose commitment value) is analysed by the RDEBO system for all age groups whereby conservative considerations are made that 100 % of foodstuffs consumed by the population are contaminated by trace amounts of radioactive substances due to effluents from the assessed installations. The food consumption basket derived from the statistical data for the Slovak Republic and the farmer consumption basket for Austria (it was defined by the Austrian side during the "Melk" process during the NPP Temelín (the Czech Republic) assessment) are presented in the following tables.

As the RDEBO calculation system is only able to use one consumption basket for all calculation zones, alternative calculations were made for the needs of comparisons, namely for the Slovak consumption basket and for the Austrian consumption basket separately. Although differences between Austrian and Slovak consumption basket values are relatively great, differences between effective dose commitment values from ingestion related to the consumption baskets are small. However, the Austrian consumption basket leads to slightly higher dose commitment values from ingestion in categories of infants and adults as well. Within that meaning, the Austrian farmer consumption basket was used for the conservative determination of radiation consequences of normal operations for the whole calculation area.

Table C.III.30: Annual food consumption in the Slovak Republic

Foodstuff	Age category [years]					
	0 to 1	1 to 2	2 to 7	7 to 12	12 to 17	adults
Milk [l]	145.60	116.90	216.00	230.00	200.20	148.70
Beef meat [kg]	0.60	1.60	2.60	3.60	4.00	3.70
Pork meat [kg]	0.90	3.80	6.50	14.10	17.00	34.00
Poultry meat [kg]	0.50	5.90	11.20	12.80	22.00	18.50
Other meat [kg]	0.00	0.80	0.80	1.10	1.20	1.30
Cereals [kg]	8.60	22.00	35.40	59.00	81.60	91.00
Fruit [kg]	11.70	25.50	39.40	53.30	65.70	52.80
Potatoes [kg]	2.80	13.20	23.50	32.60	49.50	51.40
Vegetables [kg]	32.60	47.50	62.50	78.70	98.50	106.40
Eggs [piece]	35.30	88.90	142.50	206.60	239.20	226.20
Beer [l]	0.00	0.00	0.00	0.00	32.00	90.40
Sugar [kg]	0.00	14.60	21.20	22.50	24.60	31.20
Other foodstuffs [kg]	9.30	9.50	9.60	10.70	14.70	38.40

Table C.III.31: Annual food consumption in Austria

Foodstuff	Age category [years]					
	0 to 1	1 to 2	2 to 7	7 to 12	12 to 17	adults
Milk [l]	179.60	134.40	89.00	117.00	136.20	152.00
Beef meat [kg]	5.10	11.50	17.80	21.90	20.80	22.40
Pork meat [kg]	9.50	21.20	32.90	36.50	42.00	52.20
Poultry meat [kg]	2.20	4.80	7.30	7.30	9.10	12.10
Other meat [kg]	0.00	0.20	0.40	0.80	1.20	1.30
Cereals [kg]	9.20	20.30	31.40	42.20	47.80	55.00
Fruit [kg]	46.40	42.10	36.60	41.60	48.60	68.70
Potatoes [kg]	1.40	6.90	12.40	23.70	31.00	61.30
Vegetables [kg]	42.70	30.00	29.40	36.90	66.50	68.60
Eggs [piece]	36.00	84.00	132.00	146.00	220.00	284.00
Beer [l]	0.00	0.00	0.00	0.00	25.20	117.90
Sugar [kg]	0.00	14.60	21.20	22.50	24.60	31.20
Other foodstuffs [kg]	9.30	9.50	9.60	10.70	14.70	38.40

The following table presents the distribution of the population into age categories by the breathing speed and annual potable water consumption for individual age categories. The inhaled air amount values for individual age categories were determined in compliance with the Regulation of the Government of the Slovak Republic No. 345/2006, Coll., on Fundamental Safety Requirements for the Protection of Employees and Population from Ionizing Radiation. The potable water consumption values by the age categories were defined on the basis of the Decree of the Ministry of Health of the Slovak Republic No. 545/2007, Coll., Laying down Details of Requirements for the Radiation Protection Assurance during Activities Leading to Exposure and during Radiation Protection Important Activities. The RDEBO computer code assumes very conservatively that infants drink 250 l of water a year with the same volumetric radionuclide concentration as is found in the river flowing through the given zone.

Table C.III.32: Age categories, breathing speed and annual potable water consumption

	Age category [years]					
	0 to 1	1 to 2	2 to 7	7 to 12	12 to 17	adults
Breathing speed [m^3/s]	3.2E-05	6.3E-05	1.3E-04	1.9E-04	2.5E-04	2.7E-04
Annual potable water consumption [l/year]	250.00	250.00	450.00	450.00	450.00	700.00

The RDEBO computer code makes it possible to simulate effluents both into the air and into the hydrosphere at the same time during one calculation run whereby contributions to the exposure from all the paths are calculated and the results also include the summary dose load value from all the contributions.

The RDEBO computer code searches for zones with maximum summary values of annual individual effective doses IED (the sum of both the atmosphere and hydrosphere exposure paths) whereby the maximum is searched for inhabited zones and uninhabited zones separately. The annual individual effective dose (IED) assumes that the inhabitant lives and receives food on the territory, affected by annual discharges, for the whole year. The annual individual effective dose consists of the external exposure (plume + deposit) and the commitment from effective doses received due to the annual consumption of food and from the inhalation during the given year.

The calculation results are documented for individual distances along the wind direction (the wind direction sector) with maximum calculated effective dose values, and contributions to the individual dose from all the exposure paths are also presented for the inhabited zone with the highest summary individual effective dose value. In addition to annual effective doses, lifetime effective doses (50 to 70 years of an individual's life) are also evaluated.

Concurrent effects of the existing nuclear facilities (JE V2 and JAVYS) were considered conservatively on the level of actually measured maximum discharge values during the lifetime dose calculations. Besides, it is realistic to assume the concurrent run of the JE V2 and the NJZ operations for the period of 20 years and, after the JE V2 is shut down, the level of effluents will drop by 1 order at least (similarly, as recorded for the JE V1).

C.III.16.3.1.3. Evaluation of Radioactive Effluent Impacts

Radioactive effluents will be discharged into the environment as follows:

- into the air,
- into the watercourse.

Into the air: Radioactive effluents will be discharged from the NJZ in a controlled manner by means of ventilation stacks built at generation units and at auxiliary plants. At the same time, radioactive effluents will be discharged into the air from other nuclear facilities on the Jaslovské Bohunice site (the operated JE V2, to be decommissioned later on, the JE V1 and A1 that are under decommissioning, radioactive waste treatment facilities and spent nuclear fuel storage facilities), namely depending on the schedules of their operations. Effluent activities produced by the NJZ and the other existing nuclear facilities on the site (the so-called source term) will not exceed values specified in Chapter B.II.5.'Radiation and Other Physical Fields' (page 137 of the present Report).

Into the watercourse: Radioactive effluents will be discharged from the NJZ into the Váh River in a controlled manner by means of the new waste water collector channel. At the same time, radioactive effluents will be discharged into the same watercourse (however, by means of the existing Socoman waste water pipeline collector) from the other nuclear facilities on the Jaslovské Bohunice site (the operated JE V2, to be decommissioned later on, the JE V1 and A1 that are under decommissioning, radioactive waste treatment facilities and spent nuclear fuel storage facilities), namely depending on the schedules of their operations. Effluent activities produced by the NJZ and the other existing nuclear facilities on the site (the so-called source term) will not exceed values specified in Chapter B.II.5.'Radiation and Other Physical Fields' (page 137 of the present Report).

Results (maximum annual individual effective dose values) of calculations are presented in the following table for different combinations of two source terms (the NJZ separately, the sum of the NJZ + existing nuclear facilities), two consumption baskets (Slovak, Austrian), two ventilation stack heights (100 m, 56 m) and different age categories.

The maximum individual effective dose (IED) values (both the annual and lifetime) for an inhabited zone are found in zone No. 78 in all cases. Zone No. 78 is situated to the North-West of Hlohovec centre and is crossed by the Váh River. It is the first zone through which the Váh River is flowing and for which hydrological exposure paths are therefore calculated as well, following zone No. 66 (where waste water pipeline collector from the NJZ and the existing nuclear facilities are discharged). Contribution to the effective dose from the hydrological exposure path are the same in zone No. 78 as in zone No. 66, but as the probability of the North-West wind direction occurrence is higher than that of the West-North-West (see above), contributions from atmospheric exposure paths are greater in zone No. 78 than in zone No. 66. That is why, the summary annual individual effective dose is also higher in zone No. 78.

Table C.III.33: Maximum annual effective dose values in inhabited zone No. 78 for different calculation scenarios

Emission source	Consumption source	Stack height [m]	Maximum dose [Sv/year]	Critical age category
NJZ	Austrian	100	1.576E-06	infants (0 to 1 year)
		56	1.618E-06	infants (0 to 1 year)
	Slovak	100	1.525E-06	adults
		56	1.559E-06	children (2 to 7 years)
Sum (the NJZ+JE V2+ JAVYS)	Austrian	100	1.697E-06	infants (0 to 1 year)
		56	1.760E-06	infants (0 to 1 year)
	Slovak	100	1.631E-06	children (2 to 7 years)
		56	1.690E-06	children (2 to 7 years)

It is obvious from comparisons of results that the highest annual maximum value occurs in case of the combination: the summary source term, the Austrian consumption basket and the ventilation stack height of 56 m. *The maximum annual individual effective dose (IED) for the summary discharge from the NJZ and the other nuclear facilities on the site achieves the level of 1.760E-06 Sv/year (i. e., 1.76 µSv/year) for the critical individual.*

Although results obtained by individual calculations are different for the used scenarios, resulting radiation consequences for individual calculation scenarios differ on the level of 0.2 µSv/year, which is virtually a negligible difference.

Based on results obtained by the mentioned calculations, the calculation bringing maximum annual individual effective dose (IED) values is taken as a basis for further comparisons, i. e., the calculation for the 'adults' age group[28], the summary discharge, the Austrian consumption basket, the ventilation stack height of 56 m.

Results of annual individual effective dose (IED) calculations from discharges of the NJZ itself for individual zones, in compliance with distances and directions are presented in the following table.

Table C.III.34: Annual individual effective doses (IED) from the NJZ effluents (adults, Austrian consumption basket, stack height of 56 m)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Individual effective dose [Sv/year]					
S	8.610E-08	2.680E-07	2.280E-07	1.610E-07	1.120E-07	7.920E-08
SSV	4.800E-08	1.430E-07	1.250E-07	9.340E-08	6.730E-08	4.880E-08
SV	3.240E-08	9.200E-08	8.190E-08	6.180E-08	4.490E-08	3.290E-08
VSV	4.290E-08	1.320E-07	1.090E-07	7.790E-08	5.460E-08	3.920E-08
V	1.500E-07	5.490E-07	4.170E-07	2.730E-07	1.800E-07	1.220E-07
VJV	1.840E-07	7.480E-07	5.440E-07	3.360E-07	2.090E-07	***1.560E-06*** *
JV	2.240E-07	8.250E-07	5.820E-07	3.550E-07	2.200E-07	***1.560E-06*** **
JJV	1.650E-07	4.740E-07	3.630E-07	2.480E-07	1.720E-07	1.230E-07
J	3.480E-07	**9.500E-07** ***	7.940E-07	5.730E-07	4.090E-07	2.970E-07
JJZ	9.820E-08	3.030E-07	2.450E-07	1.720E-07	1.210E-07	8.770E-08
JZ	2.590E-08	8.260E-08	7.930E-08	6.340E-08	4.770E-08	3.550E-08
ZJZ	2.730E-08	7.000E-08	7.230E-08	6.130E-08	4.840E-08	3.720E-08
Z	1.140E-07	4.000E-07	3.500E-07	2.540E-07	1.780E-07	1.270E-07
ZSZ	1.290E-07	5.390E-07	4.170E-07	2.740E-07	1.820E-07	1.250E-07
SZ	1.270E-07	4.360E-07	3.300E-07	2.140E-07	1.400E-07	9.580E-08
SSZ	1.160E-07	3.180E-07	2.370E-07	1.570E-07	1.050E-07	7.210E-08
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Individual effective dose [Sv/year]					
S	4.310E-08	2.330E-08	1.230E-08	6.600E-09	4.100E-09	2.780E-09
SSV	2.690E-08	1.440E-08	7.540E-09	4.010E-09	2.470E-09	1.660E-09
SV	1.870E-08	1.030E-08	5.440E-09	2.870E-09	1.740E-09	1.150E-09
VSV	2.190E-08	1.210E-08	6.360E-09	3.380E-09	2.070E-09	1.380E-09
V	6.280E-08	3.280E-08	1.720E-08	9.440E-09	6.030E-09	4.210E-09
VJV	6.830E-08	3.560E-08	1.890E-08	1.060E-08	6.900E-09	4.910E-09
JV	*1.490E-06*	3.630E-08	1.910E-08	1.070E-08	7.030E-09	*9.350E-08*
JJV	*1.490E-06*	*1.450E-06*	*1.430E-06*	*1.430E-06*	*1.420E-06*	***9.300E-08*** ****
J	1.620E-07	8.660E-08	4.530E-08	2.450E-08	1.540E-08	1.060E-08
JJZ	4.820E-08	2.590E-08	1.360E-08	7.380E-09	4.630E-09	3.170E-09
JZ	2.010E-08	1.090E-08	5.710E-09	3.010E-09	1.830E-09	1.210E-09
ZJZ	2.160E-08	1.180E-08	6.120E-09	3.170E-09	1.900E-09	1.240E-09
Z	6.900E-08	3.670E-08	1.920E-08	1.030E-08	6.460E-09	4.410E-09
ZSZ	6.540E-08	3.440E-08	1.800E-08	9.900E-09	6.330E-09	4.420E-09
SZ	5.020E-08	2.680E-08	1.420E-08	7.800E-09	4.970E-09	3.450E-09
SSZ	3.790E-08	2.020E-08	1.070E-08	5.890E-09	3.750E-09	2.600E-09

The following zones are highlighted in the table:

[28] The 'adults' age group was selected as the reference one, because an adult receives the dose every year for his/her whole adult age which represents the highest contribution to the lifetime dose based on which possible health risks are assessed (see Chapter C.III.1.1. 'Health Impacts and Risks', page 266 of the present Report and following pages).

- * (VJV, 7 to 10 km, zone No. 66) – the mouth of the NJZ waste water pipeline collector into the Drahovce Channel, a part of the Váh River,
- ** (JV, 7 to 10 km, zone No. 78) – maximum individual effective dose (IED) in an inhabited zone (the Váh River is flowing through the zone),
- *** (J, 1 to 2 km, zone No. 98) – maximum individual effective dose (IED) in an inhabited zone (impacts of discharges into the atmosphere only, no watercourse affected by effluents is flowing through the zone),
- **** (JJV, 90 to 110 km, zone No. 96) – downstream of the Váh River mouth into the Danube River (Hungary).

Zones affected by liquid effluents from the NJZ are indicated in the table using *italics*. Zones zones extending to foreign territories are indicated by the grey background colouring.

Results of annual individual effective dose (IED) calculations from the summary discharge (the NJZ, JE V2 and JAVYS facilities) for individual zones, in compliance with distances and directions are presented in the following table.

Table C.III.35: Annual individual effective doses (IED) from the NJZ+JE V2+JAVYS effluents (adults, Austrian consumption basket, stack height of 56 m)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Individual effective dose [Sv/year]					
S	2.760E-07	4.420E-07	3.620E-07	2.520E-07	1.720E-07	1.210E-07
SSV	1.590E-07	2.390E-07	2.000E-07	1.460E-07	1.040E-07	7.440E-08
SV	1.100E-07	1.550E-07	1.320E-07	9.700E-08	6.930E-08	5.010E-08
VSV	1.410E-07	2.180E-07	1.740E-07	1.220E-07	8.420E-08	5.980E-08
V	4.620E-07	8.790E-07	6.530E-07	4.240E-07	2.760E-07	1.870E-07
VJV	5.580E-07	1.180E-06	8.440E-07	5.190E-07	3.220E-07	***1.680E-06*** *
JV	6.280E-07	1.300E-06	9.010E-07	5.470E-07	3.380E-07	***1.690E-06*** **
JJV	4.860E-07	7.720E-07	5.750E-07	3.870E-07	2.660E-07	1.890E-07
J	1.070E-06	**1.580E-06** ***	1.270E-06	8.970E-07	6.320E-07	4.540E-07
JJZ	3.120E-07	4.980E-07	3.890E-07	2.690E-07	1.880E-07	1.340E-07
JZ	1.010E-07	1.430E-07	1.280E-07	9.970E-08	7.360E-08	5.410E-08
ZJZ	1.050E-07	1.250E-07	1.190E-07	9.700E-08	7.490E-08	5.660E-08
Z	4.020E-07	6.630E-07	5.560E-07	3.960E-07	2.750E-07	1.950E-07
ZSZ	4.340E-07	8.670E-07	6.540E-07	4.250E-07	2.800E-07	1.920E-07
SZ	3.810E-07	7.000E-07	5.170E-07	3.330E-07	2.160E-07	1.470E-07
SSZ	3.110E-07	5.130E-07	3.730E-07	2.450E-07	1.610E-07	1.100E-07
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Individual effective dose [Sv/year]					
S	6.470E-08	3.450E-08	1.800E-08	9.580E-09	5.920E-09	4.000E-09
SSV	4.030E-08	2.130E-08	1.100E-08	5.820E-09	3.560E-09	2.390E-09
SV	2.790E-08	1.520E-08	7.940E-09	4.150E-09	2.500E-09	1.650E-09
VSV	3.290E-08	1.780E-08	9.310E-09	4.910E-09	2.990E-09	2.000E-09
V	9.490E-08	4.900E-08	2.540E-08	1.380E-08	8.790E-09	6.120E-09
VJV	1.040E-07	5.360E-08	2.820E-08	1.560E-08	1.010E-08	7.160E-09
JV	*1.570E-06*	5.460E-08	2.850E-08	1.580E-08	1.030E-08	*9.890E-08*
JJV	*1.570E-06*	*1.520E-06*	*1.490E-06*	*1.480E-06*	*1.470E-06*	***9.800E-08*** ****
J	2.450E-07	1.290E-07	6.660E-08	3.580E-08	2.240E-08	1.530E-08
JJZ	7.260E-08	3.850E-08	2.000E-08	1.070E-08	6.710E-09	4.570E-09
JZ	3.000E-08	1.610E-08	8.310E-09	4.350E-09	2.630E-09	1.740E-09
ZJZ	3.220E-08	1.740E-08	8.900E-09	4.580E-09	2.730E-09	1.770E-09
Z	1.040E-07	5.450E-08	2.820E-08	1.510E-08	9.360E-09	6.360E-09
ZSZ	9.880E-08	5.130E-08	2.660E-08	1.450E-08	9.210E-09	6.400E-09
SZ	7.590E-08	4.000E-08	2.100E-08	1.140E-08	7.220E-09	5.000E-09
SSZ	5.710E-08	3.010E-08	1.580E-08	8.570E-09	5.430E-09	3.750E-09

The following zones are highlighted in the table:

- * (VJV, 7 to 10 km, zone No. 66) – the mouth of the NJZ waste water pipeline collector into the Drahovce Channel, a part of the Váh River,
- ** (JV, 7 to 10 km, zone No. 78) – maximum individual effective dose (IED) in an inhabited zone (the Váh River is flowing through the zone),
- *** (J, 1 to 2 km, zone No. 98) – maximum individual effective dose (IED) in an inhabited zone (impacts of discharges into the atmosphere only, no watercourse affected by effluents is flowing through the zone),
- **** (JJV, 90 to 110 km, zone No. 96) – downstream of the Váh River mouth into the Danube River (Hungary).

Zones affected by liquid effluents from the NJZ are indicated in the table using *italics*. Zones extending to foreign territories are indicated by the grey background colouring.

Results of annual individual effective dose (IED) calculations from the summary discharge (the NJZ, JE V2 and JAVYS) for adults can be summarized as follows:

- The highest individual effective dose from discharges into the atmosphere is expected in uninhabited zone No. 98 (geographical direction J (South), distance 1 to 2 km from the NJZ), with the value of 1.580E-06 Sv/year.
- The highest individual effective dose from discharges into the atmosphere is expected in inhabited zone No. 75 (geographical direction JV (South-East), distance 2 to 3 km from the NJZ, Pečeňady municipality residential area), with the value of 9.010E-07 Sv/year. The second highest individual effective dose from discharges into the atmosphere is in inhabited zone No. 100 (geographical direction J (South), distance 3 to 5 km from the NJZ, Malženice municipality residential area), with the value of 8.970E-07 Sv/year. The third highest individual effective dose from discharges into the atmosphere is in inhabited zone No. 63 (geographical direction VJV (East-South-East), distance 2 to 3 km from the NJZ, Pečeňady municipality residential area), with the value of 8.440E-07 Sv/year.
- The highest individual effective dose in an inhabited zone in the aggregate (i. e., from discharges into the atmosphere and onto watercourses) is expected in zone No. 78 (geographical direction JV (South-East), distance 7 to 10 km from the NJZ, to the North-West of Hlohovec, downstream of the Drahovce Channel and the Váh River confluence), with the value of 1.690E-06 Sv/year. 90 % of the individual effective dose in zone No. 78 account for discharges into watercourses, while 10 % account for discharges into the atmosphere.

Ranges of annual individual effective doses from the summary discharge (the NJZ+JE V2+JAVYS) are distinguished in colour in the following figures.

Figure C.III.13: Graphical representation of annual individual effective dose values [Sv/year] – the whole calculation area

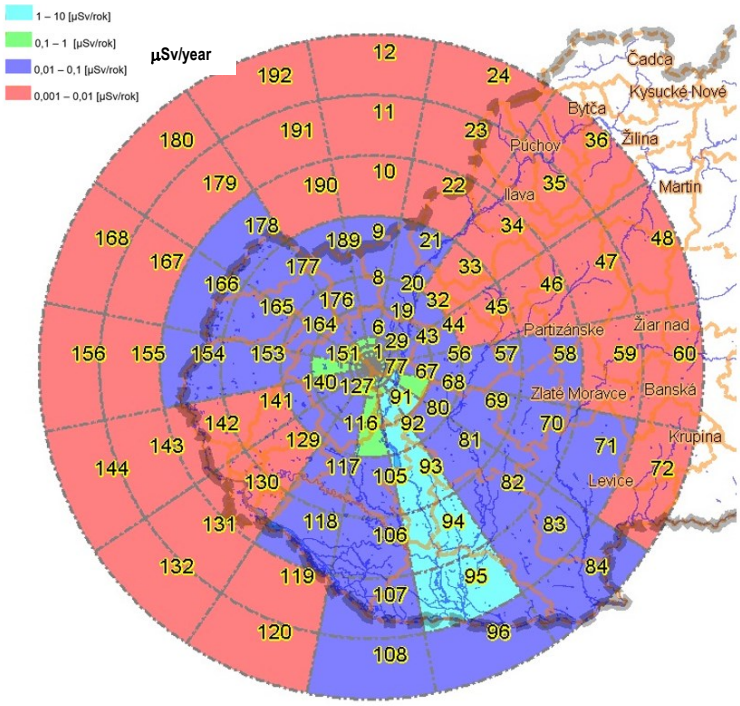
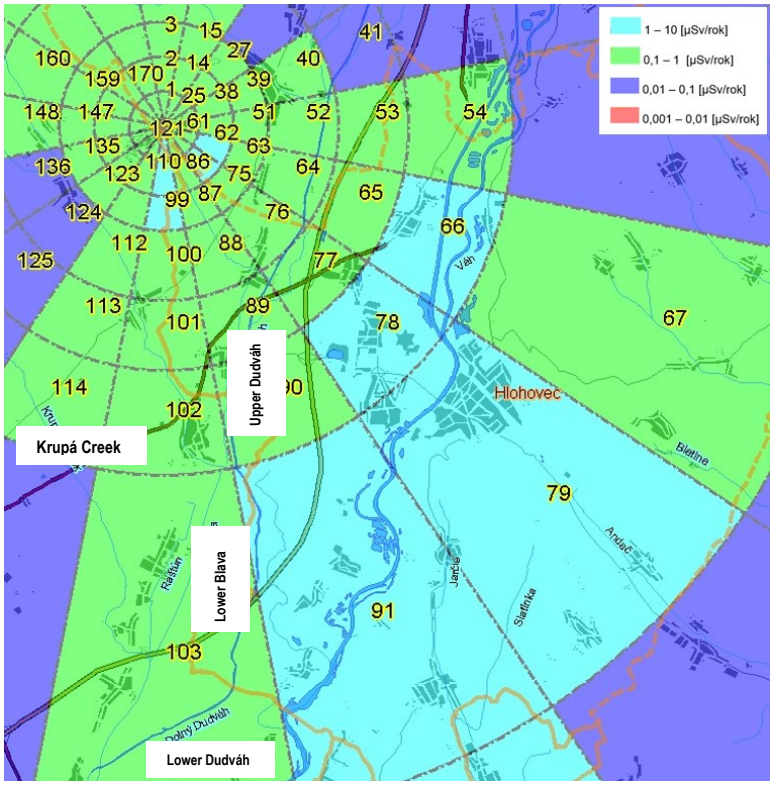


Figure C.III.14: Graphical representation of annual individual effective dose values [Sv/year] – a detail of the nearer area



It follows from both the figures that the highest individual effective dose values are achieved in areas around the Váh River, thanks to the contribution of effluents discharged into watercourses. This is based especially on very conservative assumptions related to exposure paths from liquid effluents contaminated by trace amounts of radioactive substances contained in effluents from nuclear facilities into the atmosphere. The contribution from the external exposure caused by streamside depositions plays the decisive role. In case of annual doses, this contribution accounts for more than 60 % of the individual effective dose value, namely due to the assumption that, every year, an individual from the monitored group spends approximately 1,000 hours on the river bank (angling, lying on a beach, and the like) and additional 500 hours on the soil irrigated with the river water[29].

Contributions to the summary annual individual effective doses from exposure paths in zones No. 78 (the first zone downstream of the liquid waste inflow into the Drahovce Channel, a part of the Váh River), No. 107 (the Danube River, Hungary, upstream of the Váh River inflow), No. 95 (the Váh River, Slovakia, upstream of the inflow into the Danube River) and No. 96 (the Danube River, Hungary, downstream of the Váh River inflow) are compared in the following table. The calculations were made for the summary discharge (the NJZ+JE V2+JAVYS), the 'adults' age group, the Austrian consumption basket and the ventilation stack height of 56 m. The calculations assume that the zone inhabitant covers his whole potable water consumption directly from the river. It is also assumed conservatively that he only consumes foodstuffs produced in his place of residence and polluted by the atmospheric fallout or irrigation.

[29] The calculation method and data related to the beach time during the year and the time spent on the irrigated soil during the year were taken from the IAEA Safety Report Series No. 19.

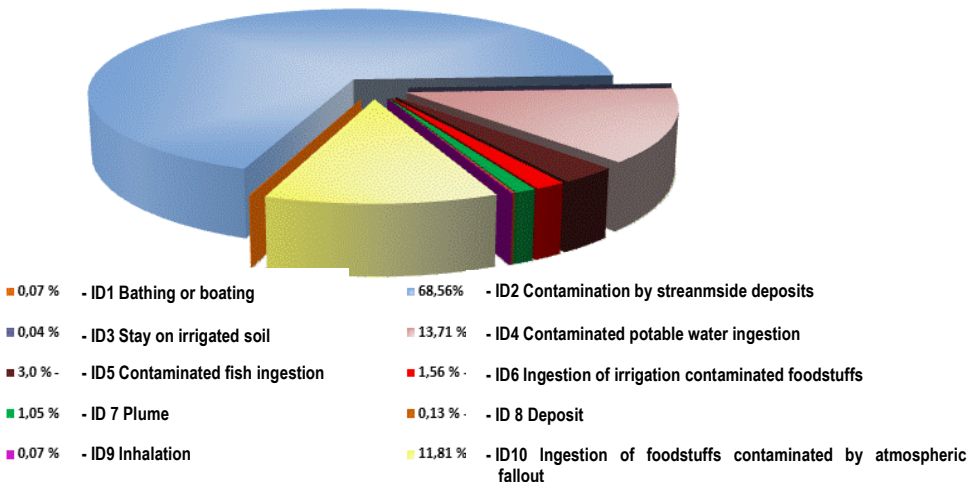
Table C.III.36: Contributions of the NJZ+JE V2+JAVYS discharges by exposure paths to the summary annual individual effective dose in zones No. 78, 107, 95 and 96 (adults, Austrian consumption basket, ventilation stack height of 56 m)

Exposure path	Contribution to the annual individual effective dose [Sv/year]			
	Zone No. 78	Zone No. 107	Zone No. 95	Zone No. 96
ID1: Bathing or boating	1.101E-09	0.000E+00	1.095E-09	6.856E-11
ID2: Contamination by streamside deposits	1.156E-06	0.000E+00	1.154E-06	7.218E-08
ID3: Stay on irrigated soil	6.094E-10	0.000E+00	6.080E-10	3.803E-11
ID4: Contaminated potable water ingestion	2.313E-07	0.000E+00	2.312E-07	1.445E-08
ID5: Contaminated fish	5.066E-08	0.000E+00	5.054E-08	3.161E-09
ID6: Ingestion of irrigation contaminated foodstuffs	2.638E-08	0.000E+00	2.636E-08	1.683E-09
Total: water	1.466E-06	0.000E+00	1.464E-06	9.158E-08
ID7: Plume	1.767E-08	3.891E-10	1.964E-10	1.126E-10
ID8: Deposit	2.209E-09	3.214E-10	1.361E-10	1.006E-10
ID9: Inhalation	1.219E-09	5.944E-11	2.636E-11	1.732E-11
ID10: Ingestion of foodstuffs contaminated by atmospheric fallout	1.991E-07	2.160E-08	9.010E-09	5.990E-09
Total: atmosphere	2.202E-07	2.237E-08	9.369E-09	6.220E-09
Grand total	1.687E-06	2.237E-08	1.473E-06	9.780E-08

It follows from the results that the total annual individual effective dose (IED) for the population living along the Váh River course between zones No. 78 and 95 is only decreasing little by little, of course, with extremely low IED values. A great decrease, by more than one order, occurs downstream of the Váh River inflow to the Danube River. The difference in individual effective doses between zones found on both the affected and non-affected sides of the Danube River (zones No. 96 and 107) achieves approximately 7.5E-08 Sv/year (0.075 μSv/year) which can be considered as a negligible contribution.

Percentage shares in the annual individual effective dose by individual exposure paths in zone No. 78 are presented in the following figure. Zone No. 78 represents a zone where the critical group of the population is found with the highest IED values from both the NJZ operation and the summary operation of the NJZ in the concurrence with nuclear installations existing on the site (JE V2, JAVYS). Contributions of exposures by effluents into watercourses are the dominating source. Above all, it is exposure path ID2 (streamside sediments) and, to a less extent, ID4 (potable water ingestion). Lower annual IED values, but with a similar distribution of individual exposure paths, are achieved in zones No. 95 and 96. On the other hand, the plume exposure is the dominating contribution in zone No. 107, however, the contribution is very small (0.024 μSv/year).

Figure C.III.15: Shares by contributions of exposure paths to the annual individual effective dose [%] in zone No. 78



Contributions of the most significant radionuclides to the annual individual effective dose for external and internal (inhalation and ingestion) exposure paths in zone No. 78 are presented in the following tables. The contribution values are expressed in percentages and only the radionuclides exceeding the value of 0.2 % in one exposure path at least are selected.

Table C.III.37: Contributions of the most significant radionuclides to the annual individual effective dose in zone No. 78 for external exposure paths

Nuclide	Contribution from external exposure paths [%]				
	Plume	Deposit	Bathing and boating	Contamination by streamside sediments	Stay on irrigated soil
C-14	0.00	0.65	0.00	0.00	0.00
Ar-41	93.43	0.00	0.00	0.00	0.00
Mn-54	0.00	1.23	1.72	0.41	1.56
Co-58	0.01	19.28	14.30	7.11	4.34
Co-60	0.01	65.18	56.54	90.51	72.22
Kr-85	1.02	0.00	0.00	0.00	0.00
Kr-87	0.51	0.00	0.00	0.00	0.00
Kr-88	2.20	0.00	0.00	0.00	0.00
Zr-95	0.00	0.60	0.00	0.00	0.00
Nb-95	0.00	0.87	0.01	0.00	0.00
Ag-110m	0.00	1.60	11.62	0.00	9.71
Sb-124	0.00	0.08	6.82	0.03	1.52
Sb-125	0.00	0.08	2.48	0.04	3.26
I-131e	0.00	0.26	0.04	0.00	0.00
I-133e	0.00	0.66	0.01	0.00	0.00
Xe-131m	0.71	0.00	0.00	0.00	0.00
Xe-135	1.42	0.00	0.00	0.00	0.00
Xe-138	0.36	0.00	0.00	0.00	0.00
Cs-134	0.00	9.21	6.29	1.88	7.35

Table C.III.38: Contributions of the most significant radionuclides to the annual individual effective dose in zone No. 78 for internal exposure paths

Nuclide	Contribution from internal exposure paths [%]				
	Inhalation	Potable water	Fish ingestion	Foodstuffs affected by atmospheric fallout	Foodstuffs affected by irrigation
H-3	78.04	99.17	3.75	4.65	91.49
C-14	5.72	0.00	0.00	95.01	0.00
Mn-54	0.02	0.01	0.22	0.00	0.02
Co-58	0.91	0.05	1.11	0.00	0.02
Co-60	2.34	0.33	7.48	0.04	1.90
Sr-90	0.75	0.01	0.01	0.12	0.08
Ag-110m	0.04	0.06	0.47	0.00	0.13
Sb-124	0.00	0.00	0.27	0.00	0.01
Sb-125	0.00	0.00	0.19	0.00	0.12
I-131e	0.52	0.02	0.23	0.00	0.00
I-131o	0.88	0.03	0.47	0.00	0.00
I-133e	1.40	0.00	0.01	0.00	0.00
I-133o	2.71	0.00	0.00	0.00	0.00
I-133a	0.21	0.00	0.00	0.00	0.00
Cs-134	0.39	0.14	36.63	0.06	2.06
Cs-137	0.45	0.17	46.25	0.12	4.12
Pu-238	0.73	0.00	1.02	0.00	0.00
Pu-239	1.95	0.00	0.85	0.00	0.00
Pu-240	0.90	0.00	0.85	0.00	0.00
Am-241	1.66	0.00	0.01	0.00	0.00

It follows from the results that Ar-41 (plume) and Co-60 (deposits and other external paths) are the most important nuclides for the external exposure paths. H-3 (inhalation, potable water and foodstuffs affected by irrigation), C-14 (foodstuffs affected by atmospheric fallout) and Cs-134 and Cs-137 (fish ingestion from a river affected by effluents) are the most important nuclides for the internal exposure paths.

The following table compares contributions from individual exposure paths to the summary individual effective dose necessary for the annual individual effective dose calculations in zone No. 78 for the summary discharge (the NJZ+JE V2+JAVYS) for individual age categories of the population.

Table C.III.39: Contributions from exposure paths to the summary individual dose in zone No. 78

Exposure path	Age category [years]					
	0 to 1	1 to 2	2 to 7	7 to 12	12 to 17	adults
	Contribution from exposure path to IED [Sv/year]					
ID1: Bathing or boating	1.101E-09	1.101E-09	1.101E-09	1.101E-09	1.101E-09	1.101E-09
ID2: Contamination by streamside deposits	1.156E-06	1.156E-06	1.156E-06	1.156E-06	1.156E-06	1.156E-06
ID3: Stay on irrigated soil	6.094E-10	6.094E-10	6.094E-10	6.094E-10	6.094E-10	6.094E-10
ID4: Contaminated potable water ingestion	2.973E-07	2.218E-07	2.577E-07	1.909E-07	1.494E-07	2.313E-07
ID5: Contaminated fish	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.066E-08
ID6: Ingestion of irrigation contaminated foodstuffs	4.361E-08	3.118E-08	2.013E-08	1.999E-08	2.028E-08	2.638E-08
Total: water	1.499E-06	1.411E-06	1.436E-06	1.369E-06	1.328E-06	1.466E-06
ID7: Plume	1.767E-08	1.767E-08	1.767E-08	1.767E-08	1.767E-08	1.767E-08
ID8: Deposit	2.209E-09	2.209E-09	2.209E-09	2.209E-09	2.209E-09	2.209E-09
ID9: Inhalation	5.602E-10	8.741E-10	1.120E-09	1.155E-09	1.183E-09	1.219E-09
ID10: Ingestion of foodstuffs contaminated by atmospheric fallout	2.403E-07	2.632E-07	1.651E-07	1.653E-07	1.487E-07	1.991E-07
Total: atmosphere	2.607E-07	2.840E-07	1.861E-07	1.863E-07	1.697E-07	2.202E-07
Grand total	*1.760E-06*	1.695E-06	1.622E-06	1.555E-06	1.498E-06	1.687E-06

It is obvious that external exposures (ID1, 2, 3, 7 and 8) are the same for all age categories, dose values from internal exposures (inhalation and ingestion commitments) are only varying within a small range.

The following table presents lifetime individual effective doses for zone No. 78 with the highest annual IED and for the lifetime exposure (50 years in case of an adult). The lifetime individual effective dose is defined as a total sum of fifty-year effective dose commitments from inhalation and ingestion and of effective doses from external exposures for 50 years. Besides, assumptions were made that the same meteorological conditions were repeated and surface watercourse parameters were the same every year during 50 years and the summary 50-year discharge was calculated as 50-multiple of the annual discharges into the atmosphere and hydrosphere.

Table C.III.40: Annual and lifetime individual effective doses (50-year commitments) in zone No. 78

Exposure path	Annual and lifetime individual effective dose	
	Annual IED [Sv/year]	Lifetime IED [Sv/50 years]
ID1: Bathing or boating	1.101E-09	5.506E-08
ID2: Contamination by streamside deposits	1.156E-06	5.566E-05
ID3: Stay on irrigated soil	6.094E-10	2.423E-08
ID4: Contaminated potable water ingestion	2.313E-07	1.156E-05
ID5: Contaminated fish	5.066E-08	2.533E-06
ID6: Ingestion of irrigation contaminated foodstuffs	2.638E-08	1.319E-06
Total: water	1.466E-06	7.115E-05
ID7: Plume	1.767E-08	8.837E-07
ID8: Deposit	2.209E-09	9.688E-08
ID9: Inhalation	1.219E-09	5.540E-08
ID10: Ingestion of foodstuffs contaminated by atmospheric fallout	1.991E-07	9.852E-06
Total: atmosphere	2.202E-07	1.089E-05
Grand total	1.687E-06	8.204E-05

In order to make comparisons, annual and lifetime individual effective doses are also presented in the following table for zone No. 98. Zone No. 98 is an uninhabited zone with the maximum IED value from effluents into the atmosphere. It follows from the comparisons that zone No. 98 also shows maximum annual and lifetime individual effective doses as well.

Table C.III.41: Annual and lifetime (50-year commitments) individual effective doses in zone No. 98

Exposure path	Annual and lifetime individual effective dose	
	Annual IED [Sv/year]	Annual IED [Sv/year]
ID1: Bathing or boating	0.000E+00	0.000E+00
ID2: Contamination by streamside deposits	0.000E+00	0.000E+00
ID3: Stay on irrigated soil	0.000E+00	0.000E+00
ID4: Contaminated potable water ingestion	0.000E+00	0.000E+00
ID5: Contaminated fish	0.000E+00	0.000E+00
ID6: Ingestion of irrigation contaminated foodstuffs	0.000E+00	0.000E+00
Total: water	0.000E+00	0.000E+00
ID7: Plume	2.702E-07	1.351E-05
ID8: Deposit	1.837E-08	8.749E-07
ID9: Inhalation	8.932E-09	3.971E-07
ID10: Ingestion of foodstuffs contaminated by atmospheric fallout	1.279E-06	6.305E-05
Total: atmosphere	1.576E-06	7.783E-05
Grand total	1.576E-06	7.783E-05

Thus, if all the nuclear facilities found on the site (the NJZ+JE V2+JAVYS) were releasing equal amounts of gaseous and liquid radioactive substances into the air and surface water for 50 years, the maximum summary 50-year commitment from individual effective doses caused by 50-year discharges for the most loaded individual from the critical group of the population would be 8.204E-05 Sv (i. e., approximately 82 µSv).

During lifetime individual effective dose calculations, the average annual values in the ground surface deposits, in sediments and the on irrigated soil were calculated as a time integral of the deposit for 50 years. The radioactive decay of the deposit and its infiltration into the soil was also taken into account, distributed into the 50-year time period whereby half-lives of the majority of radionuclides are less or equal to 1 year. The cumulated lifetime load calculated as a simple product of the annual individual effective dose and the exposure time expressed in years would achieve valued of approximately 84 µSv (for 50 years) which is a value that is not significantly different from the detailed calculation.

Thus, this procedure represents a conservative approach to the lifetime exposure evaluation (50 years for an adult, 70 years if the children's age is taken into account). The results are presented in the following tables.

Table C.III.42: Lifetime individual effective doses from the NJZ+JE V2+JAVYS discharges (adults)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime individual effective dose [Sv/50 years]					
S	1.38E-05	2.21E-05	1.81E-05	1.26E-05	8.60E-06	6.05E-06
SSV	7.95E-06	1.20E-05	1.00E-05	7.30E-06	5.20E-06	3.72E-06
SV	5.50E-06	7.75E-06	6.60E-06	4.85E-06	3.47E-06	2.51E-06
VSV	7.05E-06	1.09E-05	8.70E-06	6.10E-06	4.21E-06	2.99E-06
V	2.31E-05	4.40E-05	3.27E-05	2.12E-05	1.38E-05	9.35E-06
VJV	2.79E-05	5.90E-05	4.22E-05	2.60E-05	1.61E-05	8.40E-05
JV	3.14E-05	6.50E-05	4.51E-05	2.74E-05	1.69E-05	8.45E-05
JJV	2.43E-05	3.86E-05	2.88E-05	1.94E-05	1.33E-05	9.45E-06
J	5.35E-05	7.90E-05	6.35E-05	4.49E-05	3.16E-05	2.27E-05
JJZ	1.56E-05	2.49E-05	1.95E-05	1.35E-05	9.40E-06	6.70E-06
JZ	5.05E-06	7.15E-06	6.40E-06	4.99E-06	3.68E-06	2.71E-06
ZJZ	5.25E-06	6.25E-06	5.95E-06	4.85E-06	3.75E-06	2.83E-06
Z	2.01E-05	3.32E-05	2.78E-05	1.98E-05	1.38E-05	9.75E-06
ZSZ	2.17E-05	4.34E-05	3.27E-05	2.13E-05	1.40E-05	9.60E-06
SZ	1.91E-05	3.50E-05	2.59E-05	1.67E-05	1.08E-05	7.35E-06
SSZ	1.56E-05	2.57E-05	1.87E-05	1.23E-05	8.05E-06	5.50E-06
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime individual effective dose [Sv/50 years]					
S	3.24E-06	1.73E-06	9.00E-07	4.79E-07	2.96E-07	2.00E-07
SSV	2.02E-06	1.07E-06	5.50E-07	2.91E-07	1.78E-07	1.20E-07
SV	1.40E-06	7.60E-07	3.97E-07	2.08E-07	1.25E-07	8.25E-08
VSV	1.65E-06	8.90E-07	4.66E-07	2.46E-07	1.50E-07	1.00E-07
V	4.75E-06	2.45E-06	1.27E-06	6.90E-07	4.40E-07	3.06E-07
VJV	5.20E-06	2.68E-06	1.41E-06	7.80E-07	5.05E-07	3.58E-07
JV	7.85E-05	2.73E-06	1.43E-06	7.90E-07	5.15E-07	4.95E-06
JJV	7.85E-05	7.60E-05	7.45E-05	7.40E-05	7.35E-05	4.90E-06
J	1.23E-05	6.45E-06	3.33E-06	1.79E-06	1.12E-06	7.65E-07
JJZ	3.63E-06	1.93E-06	1.00E-06	5.35E-07	3.36E-07	2.29E-07
JZ	1.50E-06	8.05E-07	4.16E-07	2.18E-07	1.32E-07	8.70E-08
ZJZ	1.61E-06	8.70E-07	4.45E-07	2.29E-07	1.37E-07	8.85E-08
Z	5.20E-06	2.73E-06	1.41E-06	7.55E-07	4.68E-07	3.18E-07
ZSZ	4.94E-06	2.57E-06	1.33E-06	7.25E-07	4.61E-07	3.20E-07
SZ	3.80E-06	2.00E-06	1.05E-06	5.70E-07	3.61E-07	2.50E-07
SSZ	2.86E-06	1.51E-06	7.90E-07	4.29E-07	2.72E-07	1.88E-07

Zones extending to foreign territories are indicated by the grey background colouring.

Table C.III.43: Lifetime individual effective doses from the NJZ+JE V2+JAVYS discharges (children)

Direction	Distance [km]					
	0 to 1	1 to 2	2 to 3	3 to 5	5 to 7	7 to 10
	Lifetime individual effective dose [Sv/50 years]					
S	1.93E-05	3.09E-05	2.53E-05	1.76E-05	1.20E-05	8.47E-06
SSV	1.11E-05	1.67E-05	1.40E-05	1.02E-05	7.28E-06	5.21E-06
SV	7.70E-06	1.09E-05	9.24E-06	6.79E-06	4.85E-06	3.51E-06
VSV	9.87E-06	1.53E-05	1.22E-05	8.54E-06	5.89E-06	4.19E-06
V	3.23E-05	6.15E-05	4.57E-05	2.97E-05	1.93E-05	1.31E-05
VJV	3.91E-05	8.26E-05	5.91E-05	3.63E-05	2.25E-05	1.18E-04
JV	4.40E-05	9.10E-05	6.31E-05	3.83E-05	2.37E-05	1.18E-04
JJV	3.40E-05	5.40E-05	4.03E-05	2.71E-05	1.86E-05	1.32E-05
J	7.49E-05	1.11E-04	8.89E-05	6.28E-05	4.42E-05	3.18E-05
JJZ	2.18E-05	3.49E-05	2.72E-05	1.88E-05	1.32E-05	9.38E-06
JZ	7.07E-06	1.00E-05	8.96E-06	6.98E-06	5.15E-06	3.79E-06
ZJZ	7.35E-06	8.75E-06	8.33E-06	6.79E-06	5.24E-06	3.96E-06
Z	2.81E-05	4.64E-05	3.89E-05	2.77E-05	1.93E-05	1.37E-05
ZSZ	3.04E-05	6.07E-05	4.58E-05	2.98E-05	1.96E-05	1.34E-05
SZ	2.67E-05	4.90E-05	3.62E-05	2.33E-05	1.51E-05	1.03E-05
SSZ	2.18E-05	3.59E-05	2.61E-05	1.72E-05	1.13E-05	7.70E-06
Direction	Distance [km]					
	10 to 20	20 to 30	30 to 50	50 to 70	70 to 90	90 to 110
	Lifetime individual effective dose [Sv/50 years]					
S	4.53E-06	2.42E-06	1.26E-06	6.71E-07	4.14E-07	2.80E-07
SSV	2.82E-06	1.49E-06	7.70E-07	4.07E-07	2.49E-07	1.67E-07
SV	1.95E-06	1.06E-06	5.56E-07	2.91E-07	1.75E-07	1.16E-07
VSV	2.30E-06	1.25E-06	6.52E-07	3.44E-07	2.09E-07	1.40E-07
V	6.64E-06	3.43E-06	1.78E-06	9.66E-07	6.15E-07	4.28E-07
VJV	7.28E-06	3.75E-06	1.97E-06	1.09E-06	7.07E-07	5.01E-07
JV	1.10E-04	3.82E-06	2.00E-06	1.11E-06	7.21E-07	6.92E-06
JJV	1.10E-04	1.06E-04	1.04E-04	1.04E-04	1.03E-04	6.86E-06
J	1.72E-05	9.03E-06	4.66E-06	2.51E-06	1.57E-06	1.07E-06
JJZ	5.08E-06	2.70E-06	1.40E-06	7.49E-07	4.70E-07	3.20E-07
JZ	2.10E-06	1.13E-06	5.82E-07	3.05E-07	1.84E-07	1.22E-07
ZJZ	2.25E-06	1.22E-06	6.23E-07	3.21E-07	1.91E-07	1.24E-07
Z	7.28E-06	3.82E-06	1.97E-06	1.06E-06	6.55E-07	4.45E-07
ZSZ	6.92E-06	3.59E-06	1.86E-06	1.02E-06	6.45E-07	4.48E-07
SZ	5.31E-06	2.80E-06	1.47E-06	7.98E-07	5.05E-07	3.50E-07
SSZ	4.00E-06	2.11E-06	1.11E-06	6.00E-07	3.80E-07	2.63E-07

Zones extending to foreign territories are indicated by the grey background colouring.

It is necessary to view the mentioned resulting lifetime individual effective dose values as conservatively determined (potentially the worst possible). The results are applicable to the situation when the assessed person stays in the given place and in the open space for the whole time period and consumes exclusively products grown locally and drinks potable water from the river.

At the same time, envelope (maximum) annual activities of discharges of individual radionuclide groups are considered during the normal operation in the concurrence along with the maximum measured activities of discharges from the operated JE V2 (data from 2003 to 2013) and from the other JAVYS facilities (data from 2009 to 2013). With regard to the time trends of NJZ impacts in the concurrent run with the other installations on the site, further decreases in IED can be expected, of course, due to the operation termination of the other installations.

C.III.16.3.1.4. Evaluation of Váh River Recipient Pollution Depending on Flow Rate Changes

In order to evaluate the compliance with limits, an analysis was performed to assess NJZ waste water impacts with the concurrent radioactive effluent discharges from the other existing sources on the EBO site. Values of the discharges corresponded to envelope values of discharges from the NJZ and from the existing installations as specified in Chapter B.II.5. 'Radiation and Other Physical Fields' (page 137 of the present Report). The same values of discharges were also used for the determination of annual and lifetime individual effective doses.

The following background data was used for the calculation analysis:

- average Váh River (140 m^3/s) and Danube River (2,400 m^3/s)flow rates, in compliance with reports prepared by the Slovak Hydrometeorological Institute;
- neither the impact of sediments on the radionuclide volumetric concentration reduction in water along the Váh River flow towards the mouth into the Danube River, nor the dilution in the Kráľová Water Reservoir (i. e. the impact on the radionuclide concentration downstream of that reservoir) were considered for the conservative approach reasons;
- natural decays of radionuclides were considered along the Váh River course towards Hungary.

In compliance with the analysis performed using the RDEBO computer code, results of the imission radiological pollution are presented for the following zones and presented in the following table:

- zone No. 66 – the zone is situated in the East-South-East direction, both the Socoman and the NJZ waste pipeline empty there into the diversion channel (the Drahovce Channel, a part of the Váh River);
- zone No. 78 – the zone contains the confluence of the diversion channel (the Drahovce Channel, a part of the Váh River) and the Váh River (the South-East direction, the distance of 1,290 m from the discharge object);
- zone No. 79 – the Váh River passage beside the town of Hlohovec (the South-East direction, the distance of 6,450 m from the discharge object);
- zone No. 91 – the Váh River passage beside municipalities of Horné Zelenice, Dolné Zelenice and Siladice (the South-South-East direction, the distance of 14,600 m from the discharge object);
- zone No. 92 – the Váh River passage beside municipalities of Sereď, Dolná Streda, a part of the Kráľová Water Reservoir, the South-South-East direction, the distance of 23,900 m from the discharge object);
- zone No. 93 – the Kráľová Water Reservoir zone, the Váh River passage beside the town of Šaľa (the South-South-East direction, the distance of 23,900 m from the discharge object);
- zone No. 94 – the Váh River passage besides municipalities of Vlčany, Neded, Kolárovo (the South-South-East direction, the distance of 60,400 m from the discharge object);
- zone No. 95 – the confluence of the Váh and Danube Rivers, near to the border with Hungary (the South-South-East direction, the distance of 80 km (zone 70 to 90 km from the NJZ site));
- zone No. 96 – downstream of the confluence of the Váh and Danube Rivers, Hungary, (the South-South-East direction, the distance of 100 km (zone 90 to 110 km from the NJZ site)). This zone extends to the foreign territory and, that is why, it is indicated in the following table by the grey background colouring.

Table C.III.44: Expected imission radiological pollutions of the Váh River water in individual zones due to discharges of summary radioactive effluents (the NJZ+JE V2+JAVYS)

Nuclide	Zone								
	66	78	79	91	92	93	94	95	96
	Volumetric activity [Bq/l]								
H-3	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.82E+01	1.14E+00
Cr-51	1.35E-05	1.35E-05	1.35E-05	1.34E-05	1.33E-05	1.28E-05	1.30E-05	1.29E-05	8.15E-07
Mn-54	5.92E-05	5.92E-05	5.92E-05	5.92E-05	5.91E-05	5.89E-05	5.90E-05	5.89E-05	3.69E-06
Fe-55	2.88E-06	2.88E-06	2.88E-06	2.88E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06	1.80E-07
Fe-59	1.88E-07	1.88E-07	1.88E-07	1.88E-07	1.87E-07	1.82E-07	1.84E-07	1.83E-07	1.15E-08
Co-57	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.91E-07	1.90E-07	1.90E-07	1.90E-07	1.19E-08
Co-58	4.38E-04	4.37E-04	4.37E-04	4.37E-04	4.36E-04	4.29E-04	4.32E-04	4.30E-04	2.70E-05
Co-60	6.41E-04	6.41E-04	6.41E-04	6.41E-04	6.40E-04	6.40E-04	6.40E-04	6.40E-04	4.00E-05
Ni-63	2.03E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04	2.03E-04	1.27E-05
Zn-65	7.55E-07	7.55E-07	7.55E-07	7.54E-07	7.54E-07	7.50E-07	7.52E-07	7.51E-07	4.70E-08
Se-75	1.37E-07	1.37E-07	1.37E-07	1.37E-07	1.36E-07	1.35E-07	1.36E-07	1.35E-07	8.48E-09
Sr-89	1.33E-07	1.33E-07	1.33E-07	1.33E-07	1.32E-07	1.29E-07	1.31E-07	1.30E-07	8.17E-09
Sr-90	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.67E-06	1.04E-07
Zr-95	1.64E-07	1.64E-07	1.63E-07	1.63E-07	1.63E-07	1.60E-07	1.61E-07	1.60E-07	1.01E-08
Nb-95	2.13E-07	2.13E-07	2.13E-07	2.13E-07	2.12E-07	2.05E-07	2.08E-07	2.06E-07	1.30E-08
Ru-103	9.30E-08	9.29E-08	9.28E-08	9.27E-08	9.23E-08	8.96E-08	9.08E-08	8.99E-08	5.68E-09
Ru-106	2.85E-07	2.85E-07	2.85E-07	2.85E-07	2.85E-07	2.84E-07	2.85E-07	2.84E-07	1.78E-08
Ag-110m	1.23E-04	1.23E-04	1.23E-04	1.23E-04	1.23E-04	1.22E-04	1.22E-04	1.22E-04	7.64E-06
Sb-124	1.04E-04	1.04E-04	1.04E-04	1.04E-04	1.04E-04	1.02E-04	1.03E-04	1.02E-04	6.43E-06
Sb-125	1.73E-04	1.73E-04	1.73E-04	1.73E-04	1.72E-04	1.72E-04	1.72E-04	1.72E-04	1.08E-05
I-131e	3.22E-06	3.22E-06	3.20E-06	3.18E-06	3.10E-06	2.71E-06	2.86E-06	2.74E-06	1.80E-07
I-131o	6.44E-06	6.43E-06	6.40E-06	6.35E-06	6.20E-06	5.41E-06	5.72E-06	5.47E-06	3.59E-07
I-131a	1.07E-06	1.07E-06	1.07E-06	1.06E-06	1.03E-06	9.02E-07	9.54E-07	9.12E-07	5.99E-08
I-133e	2.75E-07	2.69E-07	2.57E-07	2.41E-07	1.93E-07	8.20E-08	9.16E-08	6.03E-08	5.94E-09
I-133o	5.50E-07	5.39E-07	5.14E-07	4.81E-07	3.87E-07	1.64E-07	1.83E-07	1.21E-07	1.19E-08
I-133a	9.17E-08	8.98E-08	8.56E-08	8.02E-08	6.45E-08	2.74E-08	3.05E-08	2.01E-08	1.98E-09
Cs-134	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.20E-04	7.51E-06
Cs-137	2.22E-04	2.22E-04	2.22E-04	2.22E-04	2.22E-04	2.22E-04	2.22E-04	2.22E-04	1.39E-05
Ce-141	1.31E-07	1.31E-07	1.31E-07	1.31E-07	1.30E-07	1.25E-07	1.27E-07	1.26E-07	7.96E-09
Ce-144	1.66E-06	1.66E-06	1.66E-06	1.66E-06	1.66E-06	1.66E-06	1.66E-06	1.66E-06	1.04E-07
Hf-181	7.82E-09	7.82E-09	7.81E-09	7.80E-09	7.76E-09	7.55E-09	7.65E-09	7.58E-09	4.78E-10
Pu-238	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.16E-09
Pu-239	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	8.85E-10
Pu-240	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	1.42E-08	8.85E-10
Am-241	2.24E-08	2.24E-08	2.24E-08	2.24E-08	2.24E-08	2.24E-08	2.24E-08	2.24E-08	1.40E-09
Nb-94	1.80E-07	1.80E-07	1.80E-07	1.80E-07	1.80E-07	1.80E-07	1.80E-07	1.80E-07	1.13E-08
Sum without H-3	2.11E-03	2.11E-03	2.11E-03	2.11E-03	2.11E-03	2.10E-03	2.10E-03	2.10E-03	1.32E-04

Indicators of surface water pollution by radioactive substances are prescribed by the Regulation of the Government of the Slovak Republic (NV) No. 269/2010, Coll., Laying down Requirements for the Achievement of Good Water Conditions (Annex 1, Part D), the limit values are presented in the following table:

Table C.III.45: Surface water quality indicators – radioactivity indicators specified by the Regulation of the Government of the Slovak Republic (NV) No. 269/2010 Coll.

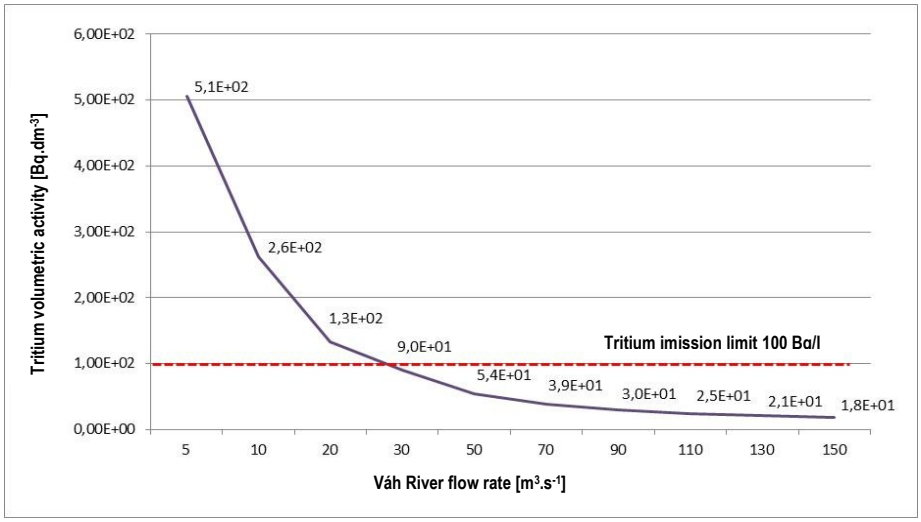
Indicator	Symbol	Unit	Value
Total alpha volumetric activity	$a_{v,c\alpha}$	Bg/l	0.5
Total beta volumetric activity	$a_{v,c\beta}$	Bg/l	1
Radium 226	Ra-226	Bg/l	0.2
Natural Uranium	U-nat	µg/l	50
Tritium	H-3	Bg/l	100
Strontium 90	Sr-90	Bg/l	1.0
Caesium 137	Cs-137	Bg/l	0.5

It follows from the results that tritium H-3, strontium Sr-90 and caesium Cs-137 values are significantly lower than limits specified by the Regulation of the Government of the Slovak Republic (NV) No. 269/2010, Coll., and, thus, the limits determined for the NJZ operation in the concurrent run along with operations of the other nuclear facilities on the site (JE V2, JAVYS facilities) are complied with, including great margins.

Except for tritium, the margins to limit values are of several orders of the magnitude for the other radionuclides and, that is why, it was not necessary to make any surveillance calculations with regard to the reduced Váh River flow rate. An additional calculation was performed for tritium in order to determine the minimum average annual value of the Váh River flow rate for which the summary effluents limit of 100 Bq/l will be achieved.

The calculation showed that, in case of concurrent operations of all the mentioned nuclear facilities (the NJZ+JE V2+JAVYS), the tritium volumetric activity would approach the limit if the average Váh River water flow rate was Q_r = 26.8 m^3/s. The calculation results are presented in the following figure.

Figure C.III.16: Chart of the tritium imission volumetric activity due to the NJZ+JE V2+JAVYS effluents against the Váh River recipient water flow rate



However, such a situation is very unlikely, as the lowest average annual Váh River flow rate in the Hlohovec – Šaľa profile for the bygone 90 years was recorded in the year 1954, namely Q_r = 84.809 m^3/s. The tritium limit would be complied with at such a flow rate, including a great margin.

It follows from the analysis that even in case of concurrent operations of all nuclear facilities on site (the NJZ+JE V2+JAVYS), the tritium annual imission limit value cannot be really achieved. The tritium concentration will be approximately 20 Bq/l in the Hlohovec profile at the normal Váh River flow rate (140 m^3/s). Such a concentration will be maintained along the whole Váh River course and will only be decreasing little by little as far as the mouth into the Danube River. It will decrease to levels of 1 to 2 Bq/l under nominal flow rate conditions in the Danube River due to the dilution which is on the tritium natural radioactivity level in surface waters.

C.III.16.3.1.5. Conclusions Drawn from Radioactive Effluent Impacts Assessment

In compliance with the Regulation of the Government of the Slovak Republic No. 345/2006, Coll., on Fundamental Safety Requirements for the Protection of Employees and Population from Ionizing Radiation, as well as in compliance with international practices, an arbitrary individual staying in the surroundings of the complex of nuclear facilities can receive a total dose from all the sources included in the complex for one year of the normal operation that is lower than the limit dose value (250 µSv/year).

The Chief Hygiene Officer of the Slovak Republic permitted, by means of a decision issued by the Public Health Authority of the Slovak Republic, to discharge radioactive substances from the administrative supervision by their releasing into the surrounding atmosphere and hydrosphere and, at the same time, established conditions for individual operators of nuclear facilities on the Jaslovské Bohunice site governing the performance of activities leading to exposure. Those conditions also

include the duty to ensure that the effective dose received by the representative person from the population (at the point of the maximum effective dose to an individual in a residential area) and caused by radioactive substances discharged into the air and surface water from individual nuclear facilities on the Jaslovské Bohunice site will not exceed the following basic limiting conditions:

32 μSv/year for JAVYS nuclear facilities, out of which:
- 20 μSv/year for the JE V1,
- 12 μSv/year for the other JAVYS nuclear facilities (JE A1, TSÚ RAO, MSVP),

50 μSv/year for SE nuclear facilities (JE V2).

The summary limiting condition for all the nuclear facilities on the Jaslovské Bohunice site that are functional at present therefore equals to 82 μSv/year.

It follows from the radioactive effluents impacts evaluation that, under all the conservative assumptions, the maximum annual individual effective dose from the NJZ effluents in the concurrent effect along with the existing nuclear facilities on the Jaslovské Bohunice site (JE V2, JAVYS) will be received by an individual in zone No. 78. The maximum annual individual effective dose equals to 1,76E-06 Sv/year (1.76 μSv/year) for the age group from 0 to 1 year (infants) whereby the dose is the sum of contributions from all atmospheric and hydrologic exposure paths. The maximum annual individual effective dose for adults will also be achieved in zone No. 78 and equals to 1.69E-06 Sv/year (1.69 μSv/year).

Hydrosphere is the dominating exposure path in zone No. 78. The zone is situated to the North-West of Hlohovec, downstream of the Drahovce Channel and Váh River confluence. 90 % of the individual effective dose in that zone account for discharges into watercourses and 10 % only account for discharges into the atmosphere. Annual individual effective doses of values comparable with that in zone No. 78 are also achieved in further zones situated along the Váh River course towards the Danube River (whereby individual effective dose shares from discharges into watercourses are virtually constant and individual effective dose shares from discharges into the atmosphere are decreasing quickly). The situation is only changed downstream of the Váh River mouth into the Danube River when the individual effective dose decreases by more than one order due to the dilution.

The highest individual effective dose from discharges into the atmosphere (without any contribution from new into the hydrosphere) in uninhabited zone No. 98 (the geographical direction South, the distance of 1 to 2 km from the NJZ) equals to 1.580E-06 Sv/year (1.58 μSv/year). As for inhabited zones, the maximum dose from discharges into the atmosphere (without any contribution from discharges into the hydrosphere) equals to 9.010E-07 Sv/year (0.90 μSv/year) and will be achieved in zone No. 75 (the geographical direction South-East, the distance of 2 to 3 km from the NJZ, the Pečeňady municipality residential area).

The maximum lifetime dose from 70-year summary discharges (the NJZ+JE V2+JAVYS) for the age group from 0 to 1 year (infants) will be achieved in zone No. 78 and will equal to 118 μSv/70 years.

The maximum lifetime dose from 50-year summary discharges (the NJZ+JE V2+JAVYS) for the adult age group will be achieved in zone No. 78 and will equal to 84.5 μSv/50 years.

The above mentioned annual dose value of 1.760E-06 Sv/year (1.76 μSv/year) only represents 2.22 % out of the limiting summary condition (82 μSv/year) determined by the Public Health Authority of the Slovak Republic for all nuclear facilities on the Jaslovské Bohunice site that are functional at present. The calculated value only represents 0.7 % out of limit dose value (250 μSv) determined by Slovak legal regulations for all the sources of the complex of nuclear facilities. Based on the assessment performed, it is therefore possible to assume that the maximum dose load value for an individual from the critical group of the population (taking into account the concurrent effect of the NJZ and all the nuclear facilities existing on the Jaslovské Bohunice site at present) will be at least by two orders lower than all applicable limit values required by Slovak legal regulations.

As for trans-border impacts, they are at least by one order lower in case of Hungary (that is affected by both discharges into the atmosphere and hydrosphere) and at least by two orders lower in case of Austria and Czech Republic (that are only affected by discharges into the atmosphere) than in zone No. 78 where the critical group of the population is found.

The lifetime (taking the children's age into account) individual effective dose induced by the existence of normal operations of nuclear facilities on the Jaslovské Bohunice site will vary in the order of up to 10 μSv/70 years (Hungary), 1 μSv/70 years

(Austria, Czech Republic) an even by significantly less (Poland, Ukraine). The values are negligible and correspond to the dose received from the natural background during the maximum of several hours.

C.III.16.3.2. Impacts on Ground Water

No radionuclide discharges will be made from the NJZ to the rock environment or to ground water. Thus, any impact on the ground water can potentially arise only due to faults and failures against which, however, the project will be equipped with adequate technical solutions (double-bottomed tanks, retention tanks, regular technology tightness inspections, parameter measurements and alarm annunciation of their changes), despite their very low probabilities. It the mentioned technical solutions failed, the following potential impacts would come into question:

- Failure states within the waste water treatment and drainage system – a potential impact mainly outside the NJZ site area itself, i. e, along the new waste water pipeline collector route from the NJZ. In case of a collector tightness failure, the waste water can penetrate the rock environment and to ground water. With regard to the fact that supervised and diluted low-activity waste water is only discharged into the collector, the surroundings will not be endangered, the ground water in the collector surroundings will only be affected locally.
- Failures related to medium leakages from the operated technological equipment – if substances leaked into the geological environment of the Main Reactor Building, construction foundation piles would mainly be at risk, they would form a potential preferential route for the contamination penetration into hydrological collector I.

In case that the mentioned states occur, the ground water monitoring system is designed to identify contamination penetrations. Monitoring drill holes are designed to enable remediation interventions into the hydrological collector, if necessary.

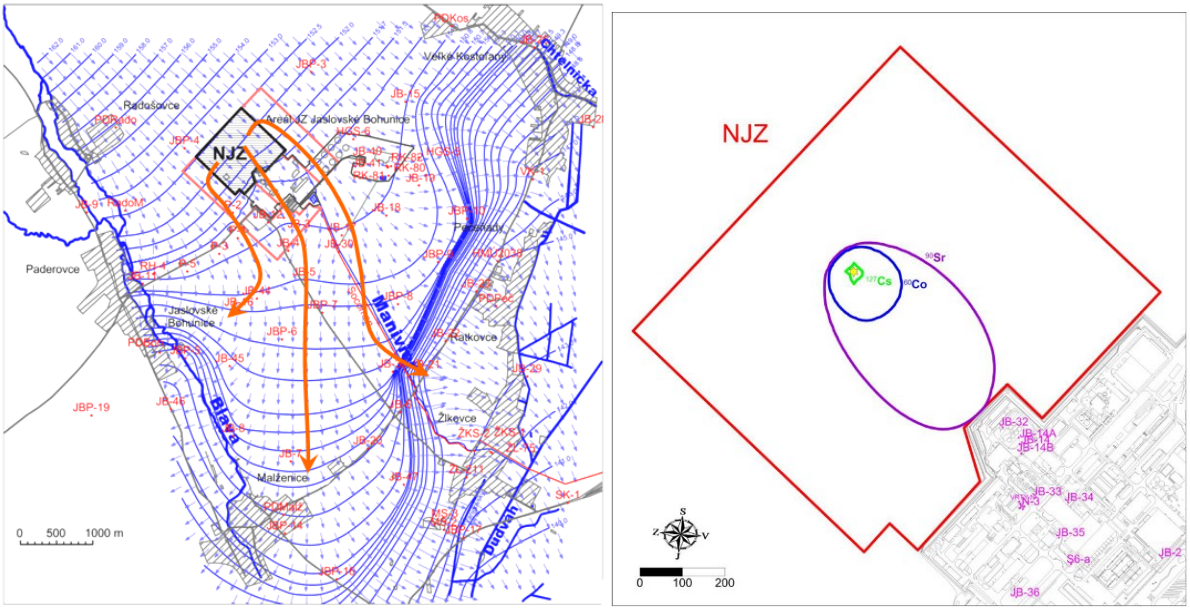
There are no possible connections between hydrological collectors I and II on the territory are possible. With regard to the fact that hydrological collector II is protected from both the overlying and underlying rock strata by isolators (impermeable clays) and, in view of its depth location, too (48 to 58 m under the ground) it is not real that it would be affected.

It follows from evaluations of impacts of a hidden failure or a long-term and unobserved leakage of a liquid medium from the NJZ into the underlying rock that tritium (H-3) is the only possible ground water contaminant within a wider NJZ surroundings, namely in hydrological collector I. Tritium as a hydrogen isotope propagates within the environment in the form water molecules. The tritium contamination therefore propagates potentially in the direction of the ground water flow. During the tritium dispersion within the ground water, its volumetric activities are decreasing quickly due to the dilution within the collector. The possible affected zone can be designated as local, extending in the order if units of kilometres along which the tritium volumetric concentration in the ground water decreases by as much as five orders with regard to the initial concentration at the leakage point. If the maximum tritium activity within NJZ technological circuits achieves values of the order of 1E+06 Bq/l, the decreased activity achieves values of the order of 1E+01 Bq/l. Communications between the ground and surface waters and further dilutions occur then in surface watercourses locations. Distances to residential areas in combination with the hydrogeological environment then guarantee that the tritium concentration in ground water will decrease to the volumetric activity value <100 Bq/l in those locations which does not represent any hazard to the environment or to the public health. Moreover, the presence of considerable number of monitoring (or remediation) objects, the collector continuity and the collector localization in small depths achievable by classic remediation technologies enable to make a quick intervention and remediation action against the ground water pollution by tritium.

If some potential unobserved leakage of Co-60, Sr-90 and Cs-137 radionuclides into ground water occurs, they will only propagate within the ground water found below the NJZ site which follows from retardation properties of those radionuclides in relation to the geological environment. Volumetric concentration values in the ground water will decrease by five orders outside the NJZ site (i. e., still within the site of the existing nuclear complex) which should not represent any hazard to the environment or health at usual concentrations of those radionuclides in technological circuits and in liquid radioactive waste tanks of the NJZ.

The following figures represent indications of H-3, Co-60, Sr-90 and Cs-137 radionuclide dispersion indicating that impacts would be below the levels of hazard to the environment and public health in the nearest residential areas. It is only a schematic modelling, because remediation technologies would be activated in any case if some ground water contamination was identified based on the regular monitoring of the NJZ surroundings.

Figure C.III.17: Directions of H-3 dispersion and Co-60, Sr-90 and Cs-137 impact zones within hydrological collector I in case of a long-term liquid medium leakage



Key:

- contamination penetration point into hydrological collector I
- indication of contamination dispersion direction within hydrological collector I
- indication of Cs-137 radionuclide dispersion
- indication of Co-60 radionuclide dispersion
- indication of Sr-90 radionuclide dispersion
- JB-3 - hydrogeological object

The existing radiation situation within the ground water in the Drahovce Channel and the Váh River surroundings is affected by waste water discharges from the existing installations on the EBO site into the Drahovce Channel, namely due to the surface water (affected by radioactive effluents) infiltration into ground water. This situation will be also maintained after the NJZ commissioning (the waste water from the NJZ will be drained by a channel running in parallel with the existing Socoman Channel). Tritium discharges (as the dominating radionuclide) into surface water are presented in the following table.

Table C.III.46: Annual discharges into surface water (the Váh River – the Drahovce Channel)

Nuclide	The NJZ	SE EBO (JE V2)	JAVYS (JE A1+JE V1+TSÚ RAO)	Sum
	[Bq/year]			
H-3	7.50E+13	1.02E+13	9.23E+11	8.61E+13

Note: In case of the NJZ, it is a very conservatively determined (maximum envelope) value of discharges.

Even if the NJZ waste water discharge profile is introduced and the total waste water amount is increased, it may not affect the radiation situation within ground water below the concerned territory, namely if the following measures are taken:

- the dilution in the discharge channel to the level achieved in the existing Socoman Channel at present, and
- the coordination of discontinuous low-activity water discharges so that discharges from SE EBO, JAVYS and the NJZ are not made simultaneously.

Afterwards, it will be possible to maintain the radiation situation at the present state. This state is really achievable which can be documented on the basis of the history of the existing state, taking the following facts into account:

- The JE A1 was in operation from the year 1972 till 1977. The JE V1 was in operation from the year 1978 till 2006 (Reactor Unit 1), or from the year 1980 till 2008 (Reactor Unit 2). The JE V2 has been in operation since the year 1984 (Reactor Unit 1), or 1985 (Reactor Unit 2) up to now. The continual remediation pumping from N-3 drill hole on the JE A1 site with tritium waste water discharges has been running since the year 2000 up to now.

- Till the year 2000 (the JE V1 and JE V2 in operation, the JE A1 under decommissioning), the ground water state within the infiltration area had been monitored occasionally, higher tritium volumetric activities were identified in Hlohovec water source wells with regard to the present (e. g., 08/1996: S-1 well – 35.7 Bq/l, S-3 well – 32.2 Bq/l and S-5 well – 31.0 Bq/l) which was evaluated as a consequence of a weak, although permitted by limits, dilution of radioactive effluents in the Socoman Channel.
- From the year 2000 till the year 2006, the operational situation was the same (the JE V1 and JE V2 in operation, the JE A1 under decommissioning), but measures were taken to intensify the dilution of low-activity waters from the JE V1 and JE V2 and continual discharges of waste water contaminated by tritium from the ground water remediation pumping on the JE A1 site were added. The radiation situation within the infiltration area (the regular monitoring since the year 2001 with quarterly frequency) has markedly improved (tritium volumetric activities in Hlohovec water source wells: S-1: 7 to 17 Bq/l, S-2: 5 to 12 Bq/l, S-3: 6 to 17 Bq/l, S-5: 5 to 9 Bq/l, S-6: 6 to 11 Bq/l) which was evaluated as a consequence of measures taken to intensify the dilution of low-activity waters from the operated nuclear power plants in the Socoman Channel with the simultaneous coordination with the Madunice Hydro Power Plant operation.
- After the year 2006 and till now, the operational situation on the EBO site has markedly changed (in the year 2006, the JE V1 Reactor Unit 1 was shut down and in the year 2008, the JE V1 Reactor Unit 2 was shut down; thus, the JE V1 entered the decommissioning phase) while the radiation situation in the infiltration area remained virtually unchanged (tritium volumetric activities in Hlohovec water source wells: S-1: 6 to 16 Bq/l, S-2: 6 to 11 Bq/l, S-3: 6 to 19 Bq/l, S-5: 5 to 8 Bq/l, S-6: 5 to 9 Bq/l) which was evaluated as a consequence of measures taken to intensify the dilution of low-activity waters from the operated nuclear power plants in the Socoman Channel with the simultaneous coordination with the Madunice Hydro Power Plant.

It follows from the preceding facts that the tritium volumetric activity level in the Socoman Channel achieved by the dilution of low-activity waters from the operated nuclear reactor units (JE V2), possibly supported by the coordination with the Madunice Hydro Power Plant is the determining factor of the radiation situation (tritium volumetric activity) within the infiltration area of the Drahovce Channel (and, thus, of the Hlohovec water source, too), and not the total integral discharges from the Bohunice nuclear facilities. Discharges of low-activity waste water from JAVYS (the JE A1 and JE V1 under decommissioning, the remediation pumping), in spite of the fact that they are not coordinated with the JE V2, are not the determining factor, their levels being another reason (integrally, by 2 orders lower than those from the JE V2 at the same required volumetric discharge limits).

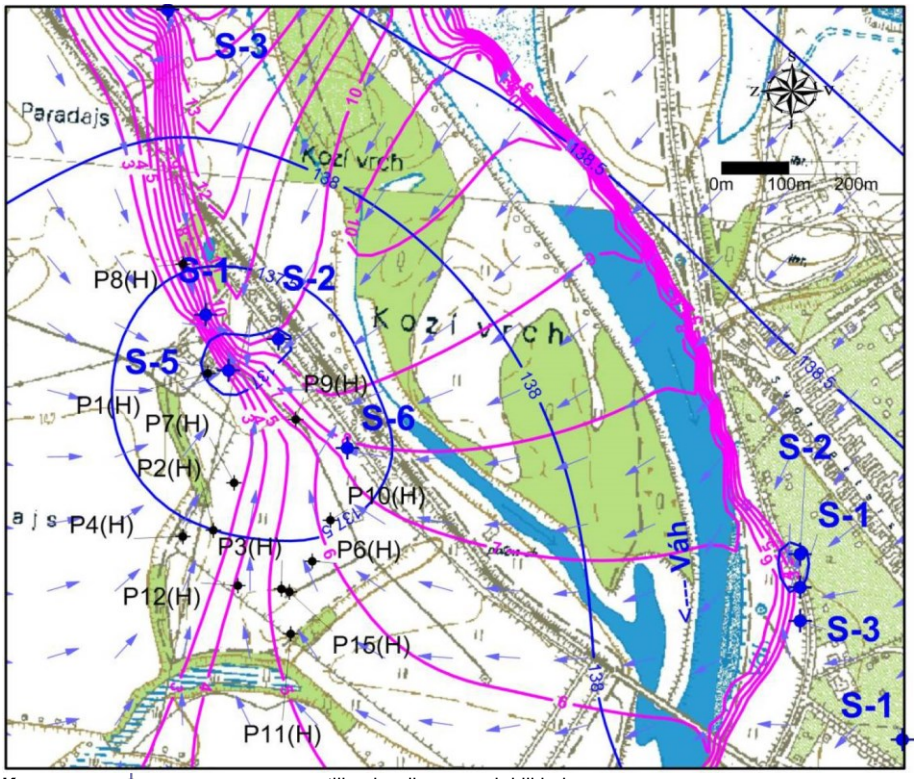
Within the meaning of those facts, low-activity discharges from the NJZ will not affect markedly the radiation situation within the infiltration area of the Drahovce Channel and the Váh River, if the dilution ratios existing in the Socoman Channel will be maintained in the new waste collector pipeline which is an adequate operational requirement. Basically, discharges from the JE V1 operation period will be replaced whose existence or non-existence was not changing historically the state in the concerned area monitored in a long-term.

In case of cumulative discharges from the JE V2 and waste water discharges from the NJZ and, mainly, in case of a change in the waste water dilution within waste water channels, the ground water radiation situation (tritium volumetric activities) will be changed by a coefficient taking into account the change in the infiltrating surface water contamination.

From the point of view of impacts on the existing water sources, the Hlohovec water source territory (the infiltration area of the Drahovce Channel and the Váh River) will remain the concerned area where the ground water indicates higher tritium values on the level of approximately 10 Bq/l (i. e., reliably below the limit[30]). The model prognosis of the radiation state stabilized in the long term as a consequence of the contaminated surface water infiltration from the Drahovce Channel and the Váh River in the Hlohovec water source area for the year 2021 is presented in the following figure whereby this state is assumed for the NJZ operation period (and the post-operation period, too), if he above mentioned conditions (the waste water dilution, coordinated discharges) are maintained.

[30] In compliance with the amended Regulation of the Government of the Slovak Republic No. Republic No. 354/2006, Coll., laying down indication limit values of radiological indicators of potable water quality, the tritium (H-30) limit equals to 100 Bq/l and the limit of the total annual commitment from the effective dose caused by the receipt of radionuclides equals to 0.10 mSv/year, i. e., 100 µSv/year.

Figure C.III.18: Tritium volumetric activities in ground water, a detail of the Hlohovec water source area



It follows from the stabilized model solution of the existing state that:

- S-1, S-2, S-3 and S-5 wells (Hlohovec water source) are affected, above all, by the infiltration of contaminated surface water from the Drahovce Channel, namely on the level of approximately 8 to 15 Bq/l. S-6 well is affected by water from the Váh River area downstream of the confluence with the Drahovce Channel, namely on the level of approximately 5 to 10 Bq/l.
- Other water sources on the right banks of the Drahovce Channel and Váh River will not be affected.
- If stabilized model solution parameters are not changed in the future, the radiation situation will not be changed significantly in the area either. It is legitimate to assume that both the hydraulic situation and the present situation in the low-activity water discharge mode from the Bohunice nuclear facilities will be stabilized. This means that the NJZ will have to establish such a future discharge mode that the dilution achieved in the Socoman Channel at present will also be maintained in the new waste water channel and the discontinuous discharges will be made in free time windows between discontinuous discharges from the other Bohunice nuclear facilities. In this manner, the present tritium contaminated water source infiltration into ground water will be maintained.

C.III.16.3.3. Other Ionizing Radiation Impacts

Other ionizing radiation impacts can be excluded.

The ionizing radiation field (i. e., impacts of electromagnetic (gamma) radiation or neutrons coming directly from technological objects, without any contribution of discharges) is insignificant already in the close surroundings of the technological objects (both the NJZ and the existing installations) and it does not affect the surrounding environment.

C.III.16.3.4. Impacts during Construction and Operation Termination

During the construction period, no ionizing radiation sources will be used that could be of a practical significance from the environment protection point of view. Sealed emitters that are a part of various instruments (e. g., non-destructive testing facilities used for the supervision of welds) are sources coming into question, but without significant impacts on the surrounding. No radioactive substances will be used on the construction site that could penetrate the geological environment. The existing distribution of radioactive contamination within the ground water on the Bohunice nuclear facilities site does not interfere in the main NJZ construction site area and will not interfere there even during the construction period.

During the operation termination and decommissioning periods, radiation impacts will decrease by several orders with regard to the operation period, above all, after waste water discharges are terminated. In proportion to that, corresponding effective doses to the population will also decrease. Thus, it can be expected that if operation period impacts are satisfactory, impacts of the operation termination and decommissioning periods will also be reliably satisfactory.

C.III.16.4. Impacts on other physical and biological characteristics

C.III.16.4.1. Non-Ionizing Radiation Impacts

Potential non-ionizing radiation impacts (magnetic or electric fields in the surroundings of electric equipment) will not be significant and will comply with required limits. They are defined by the Decree No. 534/2007, Coll., on Details of Requirements for Electromagnetic Radiation Sources and for Limits of Population Exposure to Electromagnetic Radiation in the Environment, whose annex determines the following action values (effective values for continuous exposures) for the frequency of 50 Hz (AC voltage frequency of the generated electric power that is output to the transmission network of the Slovak Republic): electric field intensity E of 5 kV/m, magnetic induction B of 100 μT. They are in compliance with the scientific knowledge and recommendations by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

All facilities of the NJZ significant from the point of view of the electric or magnetic fields production (i. e., electric equipment) will be installed in closed sites of the power plant or switchyard that are inaccessible to the public. The electric power output line from the power plant to the electric station and the house load reserve power supply line are the only elements found in freely accessible spaces. Those lines will be designed to ensure the compliance with the required limits. The design will consist (like in case of any other overhead electric transmission lines) in the determination of the minimum admissible height of line conductors above the ground so that the limit values are complied with anywhere in freely accessible spaces. This design is reliably feasible and is a common part of design (structural) procedures during the preparations of overhead electric transmission lines.

C.III.16.4.2. Impacts of other Physical and Biological Characteristics

Potential impacts of other physical and biological agents are excluded. Biocide preparations used to restrict the growth of microorganisms and algae within cooling circuits or cooling towers will be accompanied with relevant test certificates and will not represent any danger to the environment and public health.

C.III.16.4.3. Impacts during Construction and Operation Termination Periods

Potential impacts of vibrations, non-ionizing radiation or other physical and biological agents during the construction and operation termination periods are excluded.

C.III.17. Spatial Synthesis of Impacts Induced by the Activity

17.The spatial synthesis of impacts induced by the activity on the territory (e. g., the assumed anthropogenic load to the territory, the spatial synthesis of negative impacts on the population, natural environment, landscape , urban complex and the ground utilization, the spatial distribution of assumed overloaded sites in the territory, the spatial synthesis of positive impacts induced by the activity.

The NJZ will be situated in a space related to the existing site of Jaslovské Bohunice (EBO) nuclear facilities, i. e., on the territory utilized intensively for industrial activities. Thus, the existing territory arrangement defined by the coexistence of industrial, agricultural, housing and natural functions will not be changed significantly.

As an agricultural area will be predominantly utilized for the siting of the intended project (partially, the industrial site area, too - brownfield, i. e., an urban term designating a non-utilized industrial territory), neither the housing function, nor the natural function (significantly) of the territory will be restricted. Thus, the agricultural-to-industrial utilization of the territory ratio will only be changed, the rate of this change being relatively little significant.

C.III.18. Complex Assessment of Expected Impacts

18. Complex assessment of expected impacts from their significance point of view and their comparisons with applicable legal regulations.

Expected impacts of the proposed activity on the environment are insignificant, on the whole, in all the assessed spheres (impacts on the population, air and climate, noise and other physical and biological agents, surface and ground waters, rock environment and natural sources, fauna, flora and ecosystems, landscape, tangible assets and cultural monuments, transport and other infrastructure, and other). No facts that would show any evidence of exceeding legal limits determined by applicable legal regulations (or, if no limits are determined, of any inacceptable impacts) are identified.

Potential negative impacts, including the consideration of the concurrent effect along with the existing activities on the territory (especially other nuclear facilities found in relevant phases of their life cycles) are acceptable in all spheres and occur deeply within the range of admissible and/or acceptable values.

C.III.19. Operational risks

19. Operational risks and their possible impact to the territory (the possibility of accident formations).

C.III.19.1. Radiation risks

C.III.19.1.1. Safety characteristics of reactors of the generation III+

With the operation of nuclear power unit (as well as with the operation of any other industrial equipment and human behaviour), generally it is not possible to exclude absolutely the possibility of emergency state formation (failures, accidents, emergency states). Specific feature of nuclear facilities is that they contain radioactive substances that could potentially release into the environment in case of the emergency conditions. Even considering this risk, electricity production in nuclear power plants, in terms of the public health and life hazard, is not more dangerous as the production from the other power sources. This can be demonstrated on the power plants already in the operation, following the statistics of the international organizations on the rate of the risk of life hazard for the individual types of the sources of energy production per a unit of produced energy (see e.g. report OECD/ NEA 2010 Comparing Nuclear Accident Risks with Those from Other Energy Sources).

The reactors of the generation III and III+ are safer as the reactors of the previous generations. Their development was initiated by the effort to improve operational-reliability indicators of the reactors of the generation II and at the same time to continue to improve their safety characteristics. Basic safety characteristics of the reactors of the generation III and III+, with the respect to the previous generations, are as follow:

- they have lower frequency of emergency conditions formation (including severe accidents),
- they get severe accidents under the control including the catching and the cooling of potentially formed reactor core melt, they are equipped by the means for severe accidents managing as a part of design solution,
- they get Station Blackout under the control (the loss of all power supply sources),
- core damage frequency (CDF) is at least about one order lower than with the existing NPPs in the operation (the value of CDF is significantly lower than 1E-5/year),
- the probability of early or large releases of the radioactivity into the environment (LER) is at least about one order lower than with the existing NPPs in the operation (the value of LER is significantly lower than 1E-6/year),
- in a bigger extent, they use passive elements for safety systems; basic natural physical principles are used for their function and this way they are less dependent on the power supply and other support systems,
- they have higher redundancy of the safety systems,
- they get significant external events under the control (e.g. aircraft crash, earthquake) and the means for these events management are a part of their standard project,
- they have better fire protection,
- they have prolonged period during which operators' intervention is not required in case of the accidents.

C.III.19.1.2. Potential risks with the impact to nuclear safety and radiation protection

Emergency conditions (a failure, an accident, an emergency state) on the nuclear power facility and generally on any industrial equipment can occur due to a failure of one or potentially even more components due to internal or external cause. Internal cause can be given by a component or a system failure due to design or structure error, quality assurance failure during the manufacturing, assembly, operation, maintenance, inspections and tests or component failure due to other internal cause as well as a mistake of the operational personnel. Internal causes include also support system failure e.g.: cooling, lubrication or power supply. The other category of internal events are dynamic effects of coolant leakage with pipe breaks, pipe swings, internal shots that could arise e.g. from the rupture of rotating mechanical parts. The other representatives of this group of events can be internal floods, internal fires and explosions, falls and bumps of heavy loads, a failure of pressure parts, supports and other structural parts, electromagnetic interference among the power plant equipment, leakages of water, gas, steam or harmful substances, occurrence of nonstandard conditions of the environment parameters.

External cause can be the occurrence of extreme meteorological events (extreme external temperatures, extreme wind, tornado, extreme precipitations, extreme snowing, external flooding, ice formation, the storm, the increasing of groundwater level, extreme drought, extreme high temperature of cooling water or its freezing, other risks in cooling water and air supply), seismic event or an event caused by human activity in the surrounding of nuclear power plant. The events caused by human activity can include a rupture of dams on water flows near nuclear facility, leakage and explosion of gas, leakage of toxic, explosive or other dangerous substances in the surrounding of nuclear facility, e.g. during the transport on a road or during the storage of such substances inside the site. Furthermore, such event can be also a pressure wave induced by an explosion in the surrounding of nuclear facility, aircraft fall on the nuclear facility due to an accident, the accident on the other nuclear facility in the site with the leakage of radioactive or other dangerous substances. A specific type of events with the external cause are sabotages and terroristic attack on nuclear facility (including intentional aircraft crash).

All types of possible abnormal situations shall be evaluated within nuclear facility licencing process and the acceptability of their effects or practical impossibility of their formation shall be proved, whereby the evaluation of radiation effects has a crucial importance. The proof of the acceptability shall be based on deterministic basis when the effect of the event is qualified and its acceptability for nuclear facility safety including its acceptability for the environment is proved. For extreme, improbable events (the frequency of the occurrence is, with high rate of reliability, lower than 1E-7/year), their evaluation and the assessment is acceptable on probabilistic basis. The assessment of protection level against terroristic attack and sabotage is a part of the documentation of physical protection assurance, which is approved by UJD SR and is subject to a special mode (it means confidentiality).

Safety systems of nuclear facility shall be resistant against single failure and common cause failure. The resistance of systems is assured by the redundancy and for different levels of defence in depth by diversity. The redundancy is assured by multiple backup of safety systems performing the same function (for nuclear units of the generation II, it is usually double to triple redundancy, for the units of the generation III and III+, it is usually triple to quadruple redundancy), by physical separation of the individual redundant systems and their functional independence. The other possibility is the use of passive safety systems. The diversity is assured the way that basic safety functions - reactor shutdown, heat removal from the fuel, the limitation of radioactive substances leakage out of the containment in case of the failure of primary circuit integrity are assured by functionally different systems which exclude the possibility of common cause failure occurrence, e.g. by using of different physical principles for their functions performance.

C.III.19.1.3. Characteristics of abnormal states

C.III.19.1.3.1. Definition of abnormal states

The acceptability of the effects of a failure or an accident generally depends on the frequency of failure or accident occurrence, whereby limit values of the effects determined by national legislative procedures and international requirements shall not be exceeded. In general, the criteria of maximum admissible effects are determined more strictly for more probable types of abnormal states than for less probable accidental conditions.

For abnormal states on nuclear facilities, in the projects, there is applied the division to:

- Abnormal operation.
- Emergency conditions:
- Design basis accidents (DBA),
- Accidents in design extension conditions (DEC):
- Accidents during which is prevented serious damage of nuclear fuel (mainly multiple failures),
- Accidents with serious damage of nuclear fuel (severe accidents).
- Conditions during which could occur early or large leakages of radioactive substances into the environment shall be practically eliminated (practically eliminated conditions).

Abnormal operation — it is operational state deviating from the normal operation, which occurrence is assumed at least once a lifetime of a nuclear facility; whereby, with the respect to corresponding design measures, it neither causes significant damage of components important for nuclear safety nor leads to emergency conditions. Typical cases of this category include the loss of external power supply, failures in the system of reactivity control, short-time opening of steam generators safety valves, the break of a pipe with small dimensions (auxiliary pipeline, the pipeline of measurements and bleed line) etc.. Abnormal operation, in the worst case, leads to reactor scram. After the termination of abnormal operation mode and the removal of its causes and effects, power plant is capable to return into the normal operation. Abnormal operation shall not lead to the loss of the function of any of barriers (fuel system damage, breach of fuel cladding, breach of primary circuit or containment integrity). Furthermore, abnormal operation shall not lead to the loss of the function of safety systems and its impact to the environment shall be minimum, characterized by not exceeding of the basic limit for population exposure 1 mSv/year for any of the inhabitants outside the power plant, without considering any protective measures (governmental regulation of SR No. 345/2006 Coll. on basic safety requirements for the health protection of workers and inhabitants against ionizing radiation and safety guide UJD SR BNS I.11.1/2013).

Design basis accidents — are the malfunctions and failures, which should not occur during the operation period, but their formation can´t be practically eliminated during the operation period and therefore the project directly counts with their occurrence. Typical events of this category include the break of big pipeline - main feedwater pipeline, break of a tube/tubes in steam generator, mechanical failure in the system of reactor scram. Safety systems shall be capable, with sufficient reserve and reliability, to assure the protection of barriers and the limitation of design basis accidents effects for the environment to the acceptable limit. As an acceptable limit is considered the one not reaching indicative values for intervention levels to perform immediate and consequent protection measures

according the governmental regulation SR No. 345/2006 Coll. for any of permanently inhabited area in the surrounding of power plant with the exception of temporary and locally limited regulation of the consummation of locally produced food and very small limited economic impact.

Accidents in design extension conditions are such accidents that are not considered within design basis accidents, they are more serious than design basis accidents, but for their getting under the control, specific systems are used in the design so that their radiological impacts are limited in terms of affected territory and the time necessary for the performance of external protection measures. It concerns to the accidents usually caused by the combination of multiple independent failures or common cause failures, where is assumed very low probability of the formation usually less than 1E-6/year (it means less than once a 1 000 000 years). Design extension conditions are divided into:

- Accidents, during which serious damage of nuclear fuel is prevented,
- Accidents with serious damage of nuclear fuel usually by fuel melting (severe accidents).

Whereas currently operated reactors weren´t originally designed for such conditions and their resistance has been increased only by performed reconstruction measures, the reactors of the generation III and III+ have the capability to manage or to minimize the consequences of design extension conditions including severe accidents already included in the project. The most important features of the reactors of the new generation III+ include increased resistance against Station Blackout, the capability to get under the control events related to fuel melting without containment failure and the increased resistance against external extreme events including crash of big plane. The examples of multiple failures as a part of design extension conditions (DEC) include e.g. abnormal states with anticipated transient without scram (ATWS), Station Blackout, complete failure of all systems of feedwater supply into the steam generators, primary circuit leakage with partial failure of emergency core cooling system, the break of a tube/tubes of steam generators combined with a loss of secondary circuit integrity, the loss of spent fuel storage pool cooling, multiple failures in cooling water system, essential service water system, heat removal to the environment, multiple common cause events of internal or external origin.

For the accident in design extension conditions (DEC) during which serious damage of nuclear fuel is prevented, there are valid the same or similar criteria of radiation effects as for design basis accidents.

For severe accidents related to fuel melting, for the reactors of the generation III and III+, there is required the preservation of containment functionality, practical excluding of the possibility of large and early leakages of radionuclides from the containment, the elimination of the necessity of permanent dislodgement of the inhabitants living anywhere in the surrounding of the power plant and the elimination of the necessity to implement immediate measures of the type as provide a sheltering, iodine prophylaxis and the evacuation out of the nearest surrounding of the power plant or if the measures in the nearest surrounding of the power plant are necessary, sufficient time to take above mentioned measures has to be available. Furthermore, the limitation of such economic impacts, which could endanger free market with food and food consummation on large territory for a long time, is required for severe accidents.

Practically eliminated conditions are such conditions, which occurrence is provably, physically impossible or which formation is extremely improbable with high level of the credibility. It concerns sequences of severe accidents with reactor core melting or severe damage of stored spent fuel out of the containment that could lead to early or large leakages of radioactive substances into the environment. Summary probability of the origin of large or early leakage of radioactive substances into the environment of the power plant shall be with the reserve and reliably lower than 1E-6/year. For the possibility of the mitigation of accident impacts exceeding design extension conditions (DEC) by their effects, the project of NJZ will include such technical and organizational means that are needed by the operator to be able to meet all his obligations defined by atomic act in case of radiation accident arising. The implementation of relevant protection measures will be based on the levels and criteria determined by legislative procedures of SR, EU and IAEA and ICRP recommendations.

C.III.19.1.3.2. Definition of groups of the initiation events for NJZ design

The design will include the analysis of nuclear facility response to all types of malfunctions and failures and their selected combinations that can occur during the operation of NJZ. All initiation events in NJZ design will be grouped into groups according above defined categories (abnormal operation, design basis accidents (DBA), accidents in design extension conditions (DEC)), above all according the frequency of their occurrence. The division of initiation events, in compliance with the regulation UJD SR No. 430/2011 Coll. on the requirements for nuclear safety and safety guideline UJD SR BNS I.11.1 and the recommendations (Deterministic Safety Analysis for Nuclear Power Plants, No. SSG-2, 2009), will be made into the following groups:

1. Initiation events for power operational modes:
   a) increasing of heat removal from the primary circuit by the secondary circuit,
   b) decreasing of heat removal from the primary circuit by the secondary circuit,
   c) decreasing of primary coolant flow through the reactor,
   d) reactivity failures and changes of power distribution,
   e) increase of coolant inventory in the primary circuit,
   f) loss of primary circuit coolant,
   g) radioactivity leakages from systems or components,
   h) thermo-hydraulic response of the containment to design basis accidents,
   i) pressure-thermal shocks,
   j) load of reactor internal parts during the event with loss of coolant accident (LOCA).
2. Initiation events for non-power operational modes:
   a) events with reactivity control,
   b) loss of coolant from the primary circuit,
   c) loss of residual heat removal as a consequence of primary coolant circulation degradation,
   d) loss of residual heat removal caused by equipment failures (e.g. closing of main stop valve, loss of the flow through technological condenser, loss of essential service water, loss of power supply, etc.),
   e) increase of coolant inventory in the primary circuit,
   f) events with the cooling of spent fuel storage pool,
   g) damage of spent fuel storage pool during refuelling.
3. Initiation events in the category of the accident in design extension conditions (DEC):
   a) assumed events with the failure of automatic reactor protection,
   b) other accidents in design extension conditions (in accordance to BNS I.11.1).

In the Annex No. 1 to the safety guideline UJD SR BNS I.11.1, detailed list of all initiating events is presented indeed with the limitation to reactor design of the type VVER 440/V213, but currently it represents the most complex list of initiating events, taking into the consideration also the requirements of all similar lists presented in the documents IAEA, WENRA as well as the requirements of EUR. This list of initiating events has the character of recommendations. According to the particular type of the reactor that will be selected for NJZ, the list used for NJZ can be enhanced or modified the other way after the justification.

C.III.19.1.4. Characteristics of events according the international classification scale INES

International Nuclear Event Scale (INES) is used for immediate providing of the information, from which safety significance of an accident and its probable effects are obvious. This scale has been defined by expert group, which was jointly nominated by IAEA and OECD/NEA as a tool for promptly communicating to the public on the events on nuclear facilities by a unique manner in terms of the severity of operational events at nuclear power plants.

Comprehensive communication among nuclear experts, media and public is enabled by an adequate arrangement of operational events according to their significance pursuant to this scale. Mainly the experiences from France and Japan were used with the creation of this scale, because similar national scales had been already implemented into the practice in

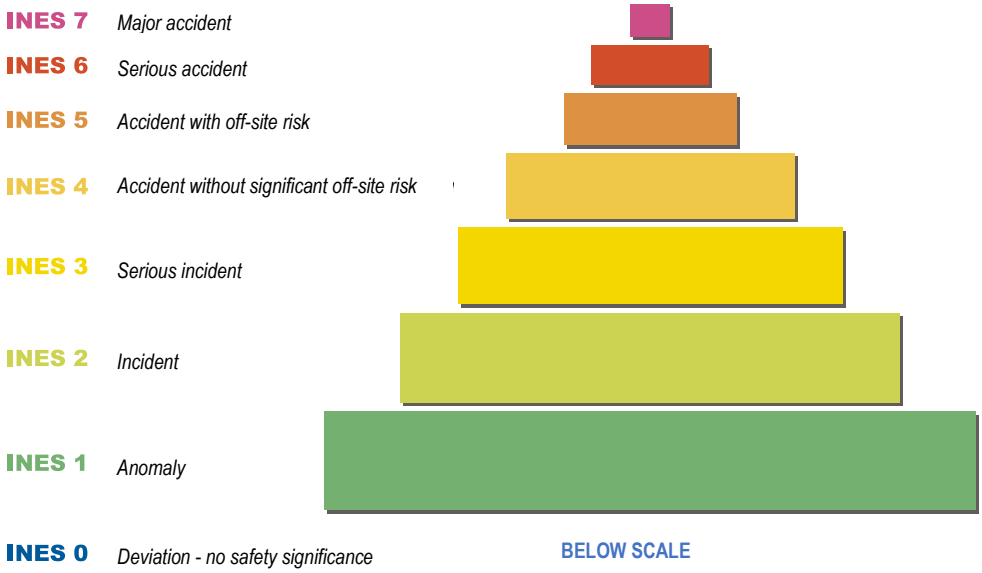
these countries. The scale, by simple notions, names and quantifies accidents, failures or operational deviations that can occur in NPP.

According to this scale, events at nuclear power plants and nuclear facilities are evaluated according three basic criteria:

- impact to the people and the environment,
- impact to radiological barriers and the control of the equipment, in which considerable amounts of radioactive materials are disposed,
- impact to the defence to depth.

Events are classified into eight levels, clear from the following figure.

Figure C.III.19: INES scale for the assessment of nuclear-safety events



For events classification, there is used the following procedure:

- events classified into higher levels (INES 4 to INES 7) are called accidents,
- events classified into lower levels (INES 1 to INES 3) are called incidents or anomalies and
- events that have no safety significance (INES 0) are classified below scale.

The scale evaluates only those events that are related to nuclear safety. Events that are not related to nuclear safety are indicated as out of scale. For example industrial accidents or other events that have the impact only to the operation of a turbine or a generator, they belong to this group.

Currently, the assessment according this scale is also enhanced with the events related to radioactive emitters, sources of ionizing eradiation and the transport of emitters and radioactive materials.

INES scale does not replace internal criteria for the classification of the significance of an incident or an accident in the individual countries and with accident assessment, exerted system of relevant country has priority.

Each participating country is obliged to inform the coordination centre of IAEA on each incident and accident in exactly defined deadline. Absolute majority of reported events at nuclear power plants is under the Level 3. Accidents with the impact to the environment (Level 4) are exceptional and as an example we can mention historical accident at JE A1 in Jaslovské Bohunice (1977). So far, accidents of nuclear power plant of the Level 5 have been only two at NPP Windscale (England, 1957) and NPP Three Mile Island (USA, 1979). There haven´t been any accident of the Level 6. The accidents of the highest category of the Level 7 belong the accidents at NPP Černobyľ (Ukraine, 1986) and NPP Fukushima Daiichi (Japan, 2011).

C.III.19.1.5. Characteristics of accident environmental risks

The risk related to possible impacts of a radiation accident (i.e. event, which causes significant release of radioactive substances into the environment) can be assessed according the scope of measures that could be necessary for the protection of endangered inhabitants and according the level of the contamination of affected environment.

Potential importance of radiological effects of an accident relates to the inventory of fission products in the reactor and the scope of damage of the barriers preventing the leakage of radioactive substances into the environment. Fission products and other radioactive substances are in primary coolant, under the claddings of fuel assemblies and mainly in fuel structure of reactor core of a nuclear reactor itself. Overall activity of fission products during reactor power operation depends mainly on fuel composition, the amount of the fuel in reactor core and its burnout in the time of accident and it represents in orders multiples of 1E+20 Bq. In the coolant and under the cladding of fuel assemblies, from fission products, there are only isotopes, noble gases, iodine and caesium in the significant amount, but their activity in the coolant is in orders hundred thousand times lower than in fuel. Other relevant isotopes, e.g. Sr, Te, Ru, La, Ce, Ba etc. are in the coolant in insignificant amounts. The radioactivity of isotopes in gas gap under the cladding represents fractions of the percentages of the inventory of fuel activity. Therefore, the importance of radiological impacts of accidents basically differs depending on the fact if there occurred only the loss of reactor cooling circuit integrity or also the damage of claddings of fuel assemblies (gas leakages), or even fuel melting.

After radioactive substances release from the nuclear facility, the population could be endangered by passing cloud of radioactive gasses and aerosols. The cloud is potential source of external as well as internal radiation, which could occur by the inhalation of radioactive substances. During the passage of the cloud, there could occur gradual fall out of radioactive aerosols and terrain contamination. This contamination could cause external radiation from so called deposit, and also internal radiation with the inhalation of contaminated dust even after cloud dissolution.

Since radioisotopes of noble gases, mainly xenon, iodine and caesium have the biggest proportion on the load of effective dose, for the assessment of the urgency of immediate measures are mainly important the information on potential leakages of these radioisotopes. Terrain contamination can represent long-time damage of the environment affecting flora and fauna in different extent. Afterwards, in terms of health risk for population, activity transport in food chains is important due to which there can occur internal exposure by ingestion, mainly by the consummation of contaminated agricultural products.

Admissible radiological impacts of accidents are, in the national legislation of the Slovak Republic and in safety requirements of IAEA, WENRA and EUR, limited the way that the leakage of radioactive substances with design basis accidents shall not require any protection measures outside the nuclear facility and even with severe accidents, radioactivity leakage shall cause neither important exposure nor health damage of population in near surrounding of nuclear power plant, nor to lead to the implementation of long-time and large-scale limitations in food chains control, in the utilization of the land or water areas. This way, the environmental risk is limited to the admissible level.

C.III.19.1.5.1. Acceptance criteria for design basis accidents

UJD SR / Slovak legislation: According the safety guide UJD SR BNS I.11.1/2013, acceptance criteria (PH 10) for events of the type of design basis accidents (DBA) is defined as follows: Calculation values of radiation doses for average effective dose of the individual from critical group of the population on the boundary of protection zone[31] of nuclear facility are lower than 10 mSv/year. Nuclear facilities can also have determined lower value of acceptance criteria in their quality plans. This criteria is in compliance with the standard IAEA SSR-2/1.

[31] For new nuclear power plant in the site Jaslovské Bohunice, protection zone is not determined in the state of Environmental Impact Assessment. The size of protection zone is not regulated in current legislation of SR (construction act, atomic act and act on protection, support and development of public health). For the site EBO, protection zone was historically determined as a border of permanently inhabited zone in the distance from 2 to 3 km from the site EBO. This border remains valid for the existing installations and therefore also for new nuclear power plant (NJZ).

IAEA: Safety standard IAEA SSR-2/1 requires that design basis accidents do not have any or only minimum radiation impacts in the site or off-site and not to require the implementation of protection measures off-site.

WENRA: The document WENRA Safety of NJZ designs, 2013 (Objective O.2, chap. 03.1) requires that design basis accidents do not have any radiation impact to the environment (level of the defence into the depth 3.a). For the accidents with multiple failures considered on the level of the defence into the depth 3.b that do not lead to fuel melting (the level of the defence into the depth 3.b), only minimum radiation impact to the nearest surrounding of NPP is acceptable, but without the necessity to implement immediate protection measures of the type of iodine prophylaxis, the sheltering or the evacuation (chap. 03.3).

EUR: Following the requirements of EUR, following safety goals are defined for design basis accidents:

1st safety goal requires that no immediate protection measures including the sheltering, iodine prophylaxis and the evacuation are not necessary within the distance over 800 m.

2nd safety goal requires that economic impacts of an accident due to consequent protection measures including resettlement, the regulation of the utilization of food and water contaminated by radionuclides and the regulation of the utilization of feed contaminated by radionuclides are minimum (limited to several square kilometres and for one harvest [32]).

3rd safety goal requires that radiation impacts for reference inhabitant in the surrounding of nuclear facilities due to design basis accidents do not exceed doses defined in the international standard ICRP 63.

C.III.19.1.5.2. Acceptance criteria for severe accidents

UJD SR / Slovak legislation: According the safety guide UJD SR BNS I.11.1/2013, for new nuclear facilities, in case that the accidents with nuclear fuel melting are not possible practically eliminated, there shall be adopted such design measures to be necessary to apply only area and time limited protection measures for the inhabitants (no permanent resettlement, the evacuation only in the immediate vicinity of the NJZ, limited sheltering, no long-time restrictions for food consummation) while there shall be available enough long time for the implementation of these protection measures.

According the governmental regulation SR No. 345/2006 Coll. (the Annex No. 10, table No. 3), measures of early phase of radiation accident are planned and prepared in compliance with the values of intervention levels for avoidable doses for immediate anti-radiation measures that are listed in the following table.

[32] According the governmental regulation SR No. 345/2006 Coll. (the Annex No. 10, table No. 4), indicative value of intervention level for the consequent measures "The regulation of the utilization of food, water and feed contaminated by radionuclides" for annual effective individual dose from the ingestion has the range from 5 mSv/year to 50 mSv/year.

With the calculations of radiation impacts of design basis accidents for the purposes of the Report EIA of the NJZ, no implementation of protection measures, with the exception of area and time limited regulation of the consummation of locally produced food, is considered for the inhabitants living in immediate vicinity of the NJZ. The procedure is that doses without and with ingestion are evaluated and there is evaluated the distance from the new NPP in which the contribution from ingestion is smaller than 5 mSv/year (lower limit for the application of the restrictions for food consummation according the governmental regulation SR No. 345/2006 Coll.).

Tab. C.III.47: Range of indicative values of intervention levels for immediate measures implementation based on Slovak legislation and international recommendations

Measure	Indicative values for intervention levels [mSv]		
	Avoidable effective or equivalent dose	Avoidable equivalent dose in the individual organs and tissues	Recommended optimized avoidable dose
Sheltering a)	5 to 50		10
Iodine prophylaxis b)		50 to 500	100
Evacuation of inhabitants c)	50 to 500	500 to 5000	100 (50) c)

a) It is assumed that the sheltering does not take longer time than 48 hours, values of avoidable dose for the period of the sheltering.
b) Values of avoidable proportion of equivalent dose caused by iodine radionuclides in thyroid gland.
c) It is assumed that the evacuation does not take longer time than 7 days, values of avoidable doses for the period of the evacuation.
(the document IAEA GS-R-2 presents the value 50 mSv/7 days for immediate measures of the „evacuation“).

There are evaluated intervention levels for the implementation of immediate – urgent measures (the sheltering, iodine prophylaxis, temporary evacuation) that are listed in the following table (see also optimized values in the previous table) while they are considered in compliance with IAEA (the Annex III of the document GS-R-2).

Tab. C.III.48: Intervention levels for the implementation of immediate – urgent measures

Č.	Urgent measure	Value of intervention level for avoidable dose
1.	Sheltering	10 mSv – avoidable effective dose in the period within 2 days
2.	Iodine prophylaxis	100 mSv – avoidable absorbed (equivalent) dose in thyroid gland caused by radioactive iodine
3.	Evacuation	50 mSv – avoidable effective dose in the period within 7 days

EUR: According the requirements of EUR, for severe accidents related to fuel melting, for reactors of the generation III for the NJZ, the preservation of containment functionality and practical exclusion of the possibility of large and early leakages of radionuclides from the containment is required. There are defined the following four safety goals:

1st safety goal: the evacuation of the inhabitants shall not be required in the distance bigger than 800 m (i.e. intervention level for inhabitants evacuation, what is the value 50 mSv/7 days, shall not be exceeded; see previous table). The exposure from the cloud, from the deposit at the terrain and the exposure form the inhalation is considered in the calculation for proving of the exceeding/non-exceeding of intervention level, the ingestion is not considered. There can be applied less demanding measure, e.g. the utilization of iodine prophylaxis or the sheltering; however positive effect of these measures is not considered with the proving of the compliance with defined criteria.

2nd safety goal: indicative levels for the commencement of temporary resettlement of inhabitants shall not be reached in the distance bigger than 3 km from the reactor, i.e. intervention level for temporary resettlement of inhabitants, what is the value 30 mSv per month, shall not be exceeded. The exposure from the deposit and the inhalation caused by deposit resuspension is considered in the calculation for proving of the exceeding/non-exceeding of intervention level, the ingestion is not considered[33].

3rd safety goal: indicative values, with which the suitability of permanent resettlement of inhabitants is considered, shall not be reached in the distance bigger than 800 m from the reactor. It means that intervention level for permanent resettlement of inhabitants, what is the value 1 Sv (the governmental regulation SR No. 345/2006 Coll.) for lifelong individual equivalent dose, shall not

[33] This criteria is not directly evaluated in this Report. Its performance is proved by the fact that neither annual individual equivalent dose from all ways of the exposure (without ingestion) in the distance bigger than 3 km doesn´t exceed the value of 30 mSv.

occur. The exposure from the deposit and the inhalation caused by deposit resuspension[34] is considered in the calculation for proving of the exceeding/non-exceeding of this intervention level.

4th safety goal: economic impacts of an accident shall be limited by contamination limitation in terms of affected area and the time; there is particularly accepted only short-time limitation of agricultural land utilization, maximum for the period of one month to one year, on the area approximately 10 to 30 km^2.

WENRA: In the document WENRA Safety of NJZ designs, 2013 (Goal O.3 chap. 03.4), there are, within the reaching of safety goal for the type of the event "Accidents with core melt", defined protection measures as follows and they are moderated in comparison with above mentioned requirements of EUR:

Immediate vicinity of nuclear power plant: New reactors shall be designed the way that, with the possible leakage of radionuclides during postulated severe accident with fuel melting, following the analysis of radiation effects, there will not occur the requirement to initiate (implement) immediate measure – the evacuation of the inhabitants behind the border of immediate vicinity of NPP. Immediate vicinity of NPP is defined as the zone with the radius within 3 km (lower border of precautionary action zone (PAZ) according IAEA GS-G-2.1, Evacuation Zone).

Temporary sheltering and iodine prophylaxis: New reactors shall be designed the way that, with the possible leakage of radionuclides during postulated severe accident with fuel melting, following the analysis of radiation effects, there will not occur the requirement to initiate (implement) immediate measure – the sheltering and iodine prophylaxis behind the border of the zone with the radius 5 km (lower border of Urgent Protective Action Planning Zone (UPZ) according IAEA GS-G-2.1, Sheltering Zone).

C.III.19.1.6. Methodology of the assessment of accident radiological impacts in the process of Environmental Impact Assessment (EIA)

C.III.19.1.6.1. General data

The proving of the acceptability of impacts of possible failures and accidents (and also their causes and their development) will be the subject of subsequent licencing process for selected project of NJZ administered according the atomic act. In this report, the impact to the environment and the population for representative envelope cases of design basis accident and severe accident with fuel melting is demonstrated; it is done by a conservative method in terms of source term (size of radioactive substances leakage into the environment) and other assumptions (e.g. meteorological conditions, assumptions on the sources for food and water consummation, habits and behaviour of the inhabitants). For severe accidents with fuel melting, the preservation of containment integrity as a basic design characteristic of the reactors of the generation III or III+ for this category of accidents is assumed.

The methodology of the assessment consists of steps described below in this chapter – it concerns the determination of source term for accidents and the selection of representative groups of events for the calculation. The calculations of the radioactive substances spreading and their impact to the environment is demonstrated in the following chapter.

[34] According the governmental regulation SR No. 345/2006 Coll. (the Annex No. 10, table No. 4), indicative value of intervention level for subsequent measures „Permanent relocation (resettlement)" for lifelong individual equivalent dose is 1 Sv. However, it is not explicitly specified if this value includes also the contribution from ingestion. Therefore, the consideration of the contribution from the ingestion can be considered as extremely conservative approach. The fulfilment of this criteria is proved by the fact that even lifelong individual equivalent dose from all ways of the exposure (without ingestion and also with ingestion) in the distance bigger than 800 m doesn´t exceed the values 1 Sv.

C.III.19.1.6.2. Source term for accidents

C.III.19.1.6.2.1. Basic data

The notion source term means the amount, isotope composition and time distribution of radioactive substances released during the accident from the containment or other part of power plant into the environment. Source term significantly determines possible radiological effects of nuclear power plant accident. In addition to source term, the following main factors have the impact to potential accident effects: current meteorological conditions, season and demography in the surrounding of the power plant. Each analysed scenario of the radiation accident is characterized by specific source term, which parameters are given by the degree of damage of particular technological system, by inventory of radioactive substances occurred in the system and by the condition of the individual barriers.

Conservative envelope approach to determine source term was applied with the analysis of the environmental risk of accidents in the process EIA. Source term is determined the way that radiological effects corresponding to this source term are worse, with sufficient reserve, than those, with the consideration of uncertainty level, which will be the result of future safety analyses for the selected project. Therefore the estimation of radiological effects, for purposes of the assessment of environmental impacts, can be more general provided that it will be performed with sufficient reserve and detailed assessment for particular design solution will be performed in Preliminary and Final Safety Analysis Report of NJZ.

C.III.19.1.6.2.2. Qualitative determination of source term for accidents

Fission product

For the determination of envelope source term, it is necessary to take into account different proportion of the individual radioisotopes to health risk. Not all fission products are dangerous the same way for human body. In general, the most dangerous fission products are the products that enter into human body in the form of radioactive dust and they can act inside in case of long half-time of the decay during very long period. Typical representative is caesium that causes long-time contamination of the environment and also long-time exposure of human body. Iodine isotopes are less dangerous; however they accumulate in thyroid gland, they decay rather quickly (half-time of the decay of I-131 is 8 days and for the other isotopes even shorter). The less dangerous are noble gases, although they release into the environment in the biggest amount during an accident, they do not accumulate themselves in human body and they do not cause long-time exposure.

In the following table, with the utilization of support documents IAEA (TECDOC-955 - Generic assessment procedures for determining protective actions during a reactor accident, 1997) and US NRC (Response Technical Manual, 2002), there are listed fission products that are necessary to be considered with the assessment of radiological impacts either because they represent the important proportion to exposure doses or they easily release during the accidents (e.g. noble gases).

Tab. C.III.49: Fission products considered with the assessment of radiological effects of reactor accidents

Fission product	Half-time of decay	Fission product	Half-time of decay
Kr-85	10,72 years	I-133	20,8 hours
Kr-85m	4,48 hours	I-134	52,6 minutes
Kr-87	76,3 minutes	I-135	6,61 hours
Kr-88	2,84 hour	Xe-131m	11,84 days
Sr-89	50,55 days	Xe-133	5,245 days
Sr-90	28,6 years	Xe-133m	2,19 days
Sr-91	9,5 hours	Xe-135	9,11 hours
Y-91	58,51 days	Xe-135m	15,36 minutes
Mo-99	66,06 hours	Xe-138	14,13 minutes
Ru-103	39,35 days	Cs-134	2,062 years
Te-129m	33,6 days	Cs-136	13,16 days
Te-131m	30 hours	Cs-137	30,17 years
Te-132	78,2 hours	Ba-140	12, 789 days
Sb-127	3,85 days	La-140	40,22 hours
Sb-129	4.40 hours	Ce-141	32,50 days
I-131	8,04 days	Ce-144	284,3 days
I-132	2,30 hours	Np-239	2,355 days

Depending on chemical and physical forms of the individual radioisotopes and their radiological/health impacts, radioisotopes can be divided more in details into several groups. The behaviour of each of groups can be described by the most important, characteristic/reference radioisotope. Usually used groups of isotopes (e.g. according US NUREG 1465 Accident Source Terms for Light-Water Nuclear Power Plants, 1996) and characteristic radioisotopes in each group (reference isotopes used with the assessment of radiological impacts in the document EUR) are listed in the following table.

Tab. C.III.50: Division of fission products into groups

Group	Name of group	Elements in group	Reference isotope
1	Noble gases	Xe, Kr	Xe-133
2	Halogens	I, Br	I-131
3	Alkaline metals	Cs, Rb	Cs-137
4	Tellurium group	Te, Sb, Se	Te-131m
5	Strontium	Sr	Sr-90
6	Precious metals	Ru, Rh, Pd, Mo, Tc, Co	Ru-103
7	Lanthanides	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am	La-140
8	Cerium group	Ce, Pu, Np	Ce-141
9	Barium	Ba	Ba-140

The necessity to consider the following main groups of fission products follows from the results of the studies of accident radiological effects:

- Noble gases (mainly Xe-133 with half-time of the decay 5,245 days) – are the source of external exposure of people from the cloud of spreading radioactive substances in the time of the passage of contaminated air masses over the given site, however it is necessary to say that in terms of long-time radiological effects of and accident, this exposure is not so much significant.
- Iodine (mainly I-131 with half-time of the decay 8,04 days) – it enters into human body by the breathing, it accumulates particularly in thyroid gland and its proportion is significant in terms of short-time and mid-term effects of an accident, in case that the blocking of the deposition in thyroid gland will not occur by early application of non-active iodine (iodine prophylaxis).
- Caesium (mainly Cs-137 with half-time of the decay 30,17 years) – usually represents, in long-time terms, main source of external and also internal exposure of people affected by and accident due to the contamination of earth surface and other elements of the environment (water, flora) and finally the contamination of the individual food chain commodities.
- Other fission products (mainly Te, Sr, Ru, La, Ce, Ba) and actinides – are released mainly from melted fuel in smaller amounts, they are negligible (there does not occur fuel melting) with design basis accidents and also with severe accidents they are less important than caesium. However, particularly in the first year after an accident origin, it is necessary to take into consideration their proportion on the exposure of people and also the environment and food chains.

For the proving of relative radiological risk of different radioisotopes, the study of Nuclear Energy Agency (Insights into the control of the release of iodine, strontium and other fission products in the containment by severe accident management, NEA/CSNI/R, 2000) assessed relative impacts of the release of particular proportion from the original inventory of reactor core for selected radioisotopes. This proportion was selected the same for all radioisotopes. The risk resulting from the individual elements is the result of radiological importance of the element and its released amount. The study confirmed that iodine is dominant in terms of short-time risk and caesium is dominant element for long-time health effects.

For the purposes of the determination of the NJZ source term, reference isotopes have been completed by another important isotopes of the relevant group in proportion to their contribution towards reference isotope, in which they occur in the inventory of fission products in reactor core.

Overall summary of all considered isotopes and their proportional activities is listed in the following table.

Tab. C.III.51: Values of relative activity of isotopes in the inventory of reactor core due to the activity of reference isotope in each group

Group	Reference isotope	Another isotopes in group	Relative activity due to reference isotope	Group	Reference isotope	Another isotopes in group	Relative activity due to reference isotope
1	Xe-133	Kr-85	0,006	3	Cs-137	Cs-134	2,0
		Kr-85m	0,15			Cs-136	0,5
		Kr-87	0,3	4	Te-131m	Te-129m	0,4
		Kr-88	0,4			Te-132	10
		Xe-131m	0,006			Sb-127	0,8
		Xe-133m	0,03			Sb-129	2,3
		Xe-135	0,3	5	Sr-90	Sr-89	12
		Xe-135m	0,22			Sr-91	15
		Xe-138	0,9	6	Ru-103	Mo-99	1,3
2	I-131	I-132	1,5	7	La-140	Y-91	0,7
		I-133	2,1	8	Ce-141	Ce-144	0,8
		I-134	2,3			Np-239	12
		I-135	2,0	9	Ba-140	-	-

Time of fission products release into the environment after reactor shutdown

Although, it is not possible completely exclude the possibility of severe accident arising, the NJZ will be equipped by the means that will enable delay of core melting and thus leakage of fission products from melted fuel. The delay of a release will be applied in radioactive decay of shortly living fission products and thus in particular decrease of source term.

If reactor core melting shifts in the time, e.g. about another 4 hours, the activity of 9 reference isotopes will stay nearly without any change, only in case of Xe-133 and Te-131m their activity could decrease about approximately 2% or 8%. However, if complete spectrum of isotopes is taken into consideration, the activity of some isotopes decreases more significantly and some of the isotopes nearly disappears due to the decay (e.g. Xe-138, I-134). If the beginning of reactor core melting delays more significantly, e.g. about 24 hours after reactor shutdown, activity decreasing of reference isotopes would be still insignificant (less than 4%) with the exception Te-131m, which activity decreases approximately on 60%. In terms of long-time contamination, mainly caused by Cs-137 and Sr-90, the impact of time shifting is still negligible although, in terms of immediate health effects, time shifting of reactor core melting can decrease doses to some extent. Of course, except direct impact of radioactive decay, other impacts for leakages decreasing, e.g. sedimentation or washing out of fission products in the containment, can be applied substantially.

As can be seen in above mentioned facts, the impact of reactor core melting delay to effective dose depends, to a large extent, on the composition of radioisotopes in source term. If only long-time living isotopes are taken into consideration, the delay about 4 or 24 hours has negligible impact. If, however, complete spectrum of isotopes is taken into the consideration, the effect of the same delay in reactor core melting can be more significant. It can be concluded that if the time of the leakages of radioactive substances and corresponding delay in reactor core melting reaches only several hours or dozes of hours, it is important, but not the crucial factor for radiological effects limitation.

Due to the preservation of conservative approach, decreasing of source term due to isotopes decay in reactor core in the time from reactor shutdown to the beginning of fuel melting, but even not further in time until the end of release into the environment was not considered in the analysis of accidents for this Report EIA.

Duration of fission products release into the environment

Distribution of the release into sufficiently long time period will enable the application of radioactive decay or removal of fission products by any other relevant manner and thus at the same time decreasing of source term. For new reactors with the capability to preserve the containment integrity also in case of severe accidents, the release of radioactive substances will be distributed in the period of several days and even weeks. In general, it is suitable to consider the realistic time dependence of releases. For conservative estimations of radiological effects, it is possible to shorten source term determined for complete time sequence of an accident by a calculation and to let release the complete source term for assessed accident into the environment in shorter period. Radiological effects of this procedure will be higher than with the

realistic time sequence, when smaller amount of radioactive substances is released into the environment for longer time period.

Due to the preservation of conservative approach, decreasing of source term due to duration of the release into the environment was not considered in the analysis of accidents for this Report EIA. The period of the release was appropriately shortened and the complete source term corresponding to real period of relevant accident duration was released into the environment during the period of the release.

Amount of the release

Typically, for accidents, there are two different situations: ground release by leakages of the containment or other buildings in the amount of several meters to dozes of meters or by height release usually through ventilation stack. The effect of height release can be also reached or reinforced by the energy of thermal raise, e.g. in case of steam release through by-pass valve to atmosphere from the secondary circuit.

With the exception of very specific meteorological conditions, ground release with the same source term leads to significantly bigger doses of the exposure in the nuclear facility surrounding considering the fact that in case of height release, radionuclides are dispersed on bigger area. In terms of the contribution to doses from the individual isotopes, ground release typically causes doses 2 to 20 times higher than height release. The results are different for different isotopes and they are dependent on the distance from the place of the release. In the overall result, in case of ground release, effective doses in the distance approximately 10 km from the place of the release with the same source term are 2 to 3 times higher (depending on real height of the release, weather and the distance from the place of the release).

The same way, long-time contamination of the area in the distance 5 to10 km from the place of the release can be 2 to 5 times higher in the comparison with height release. However, this conclusion shouldn´t be much generalized, because it is strongly dependent on particular height of the release, meteorological conditions and on the distance. In case of height release through ventilation stack, the results will be even more optimistic in the reality, because the amount of isotopes (except noble gases) will be captured by filters on the inlet into the stack.

For conservative calculations of radiological effects, ground releases were assumed in the analysis of accidents for this Report EIA, except those cases, when it is possible to justify sufficiently height release (e.g. in case of the ventilation of premises for the manipulation of nuclear unit spent fuel through ventilation stack.

Chemical and physical form of released radioactive substances

In the analysis of accidents, in source term, it is necessary to consider at least three groups of radioactive substances with significantly different behaviour: 1) noble gases, 2) different forms of iodine, 3) all other fission products, typically in the form of aerosols.

In case of noble gases, no physical or chemical changes occur. Most of radioactive substance, except a part of iodine, behave as particles (aerosols). Due to the fact that iodine represents significant contribution to the effects in terms of short-time as well as long-time effects, respecting of its different forms is substantial. Iodine exists in three different forms:

- aerosol (particles), mainly as CsI,
- elementary (basic) form I_2 and as HI,
- organic form CH_3I.

These forms behave differently during their transport in the environment and they also have different health effects. Elementary iodine (I_2 and HI) and organic iodine (methyl iodide CH_3I, etc.) are volatile substances that behave as gases and they are also more dangerous for human health. These forms have also higher speed of deposition than aerosol form. Higher proportion of elementary and organic iodine leads to higher doses near the source and consequently to a little bit lower doses in bigger distances.

For the analysis of severe accidents, usually recommended composition of iodine is released into the containment (US NRC RG 1.183 Alternative Radiological Source Term for Evaluating Design Basis Accidents at Nuclear Power Reactors 2000, EUR) in the form of 95 % of aerosols, 4,85 % in elementary form (whereby from realized experiments PHEBUS results that prevailing form is I_2) and 0,15 % in organic form. Concerning to different behaviour of these forms on the way

from damaged fuel to the place of the release, the representation of the individual forms in source term released into the environment is considerably different.

Several chemical and physical processes occur in the containment as well as in escape routes. Aerosol form of iodine can change to elementary form by the impact of radiolysis, elementary iodine reacts with the paint coats and surfaces of cabling and there is generated organic compound of iodine, elementary iodine binds with silver and remains permanently in aerosol form. All processes moreover depend on the environment conditions in the containment (acidity and alkalinity).

Therefore, for the forms of iodine released into the environment, conservative approach was used in the analysis of radiological effects for this Report EIA and it will be described independently for the individual types of source term.

Impact of the utilization of MOX fuel to source term after reactor accident

With the development of the Report EIA, the utilization of mixed uranium-plutonium fuel (MOX) in the NJZ reactor is not assumed and therefore, further presented assessment in this report is included only as a supplementary information.

According the implemented researches (e.g. Impacts on Reactor Systems, Operations, Equipment, and Facilities from the Use of Mixed Oxide (MOX) Fuels, ORNL/MD/LTR-140, 1998), behaviour of MOX fuel and the fuel from low enriched uranium (LEU) is very similar in the reactor. With the exception of different composition of fuel pellets (MOX fuel contains small particles enriched by plutonium dispersed in uranium matrix), mechanical structure of the fuel is the same. More important differences can be summarized as follows:

- Effective cross sections of Pu-239 for fission and absorption of neutrons are significantly higher than in the case U-235 and thereby lower flow of thermal neutrons is in MOX fuel. This way efficiency of absorbents of thermal neutrons decreases, what is necessary to compensate by different means, e.g. by a bigger number of absorbing organs, increasing of the concentration of soluble absorbents, etc.
- For the preventing of big gradients in the flow of neutrons on the interface of uranium and plutonium fuel assemblies, it is necessary to profile plutonium concentration across the assembly section, with a lower content of plutonium on assembly periphery.
- With the higher burnout, the release of fission gases from MOX fuel could be higher mainly due to higher local power, but this effect is reduced by the utilization of special limitations of burnout for MOX fuel.
- Due to partially different composition of fission products, residual power of MOX fuel is, in the comparison with LEU fuel, lower shortly after reactor shutdown and higher in long-time processes, however it will be applied only in safety limits and in the manner of spent fuel management.

The impact of plutonium admixture in MOX fuel on the inventory of fission products in the fuel is not very significant. According the calculations by the program Scale6/Origen, event with the high proportion of 40% MOX fuel in the comparison with clearly uranium fuel, the activity of reference isotopes with the same burnout approximately 45 MWd/kg in case of Xe-133 and Cs-137 is practically unchanged, in case of the isotopes Ba-140, La-140 and Ce-141 the activity decreased about 2,3 to 3,5 %, with Sr-90 the activity decreased even about 21 %, with I-131 it increased insignificantly about 2,5 % and only in case of isotopes Ru-103 and Te-131m the activity increased about approximately 15 %. The content of plutonium and the other actinides is certainly significantly higher, but their impact could be applied only with the violation of containment integrity.

The release of fission products from MOX fuel with severe accidents was assessed in the experiments VERCORS RT-2 for the fuel with the burnout 47,3 MWd/kg with temperatures about 2500 K and the results were compared with the experiment RT-1 for the fuel LEU in the same conditions. From experiments results comparison results that the proportion of released fission products from uranium fuel and MOX fuel is comparable in the conditions of severe accident and it is little bit higher for uranium fuel. Following the available findings, it is possible to conclude that the impact of MOX fuel utilization to radiological effects of accidents is relatively small, in terms of fission products inventory as well as in terms of the proportions of released radioisotopes from damaged fuel.

C.III.19.1.6.2.3. Selection of representative groups of events

Basic possibilities of radioactive substances leakage into the environment with design basis accident are possible to be summarized as follows:

- The source of radioactive substances is reactor cooling system and the release of radioactive substances runs into the containment (e.g. accidents with reactivity control, accidents with significant decrease of primary coolant flow, the opening of safety valves of the pressurizer, the break of pipelines connected to primary circuit inside the containment, the break of pipelines in secondary circuit inside the containment). Radioactive substances release into the environment either through containment leakages (in case of double containments, there still exists certain bypass of secondary containment) or through ventilation system of the interspace of double containment or through the surrounding construction of primary containment.
- The source of radioactive substances is reactor cooling system with the release of radioactive substances out of the containment, e.g. the break of pipeline of primary coolant purification out of the containment, the break of secondary circuit pipeline out of the containment or the opening of safety or by-pass valves of secondary circuit steam or the violation of pressure limit between primary and secondary circuit with tube break or steam generator header damage.
- The source of radioactive substances is out of reactor cooling system. Typical sources in this group of accidents are spent fuel pools, systems of radioactive waste disposal or spent fuel assemblies that can be damages during the handling of nuclear fuel. In the most cases, all of these sources are located out of the containment (in fuel building and the typical way of radioactive substances release into the environment is ventilation system and ventilation stack of the power plant.

From the assessment of available safety documentation of potentially usable pressurized water reactors results that the most serious accidents, in terms of radiological effects, are:

- total break of main circulation pipeline in the containment;
- the break of primary coolant purification pipeline outside the containment with outflow of primary coolant into the environment;
- the break of steam generator tube or the damage of steam generator primary header (considered as design basis accident for VVER reactors) with the release of primary coolant into the environment through safety or by-pass valves of secondary circuit;
- the damage of fuel assembly (or assemblies) with the handling of spent nuclear fuel[35].

Following qualitative comparison of presented accidents, the determination of envelope source term was made independently: for design basis accidents initiated in reactor cooling system and independently for the accidents initiated out of reactor cooling system.

The source of radioactive substance, which in case of accidents arising in reactor cooling system can release into the environment, is the activity contained in primary circuit coolant and the activity accumulated in reactor core fuel. The activity of primary circuit coolant is formed by a sum of the activities of corrosion products in the coolant, tritium activity, the activity of coolant itself and admixtures in the coolant and it is dependent mainly on the level of operational leakages of fuel assemblies. Accumulated activity in reactor core fuel is dependent, above all, on reactor power, the amount and enrichment of the fuel and mainly on its burnout. If claddings of fuel assemblies lose their tightness with an accident, there occurs the release of fission products from the gap between the fuel and claddings of fuel assemblies. In such case, gas fission products are released from the gap, mainly noble gases, iodine and also caesium in a small amount.

If, with the violation of reactor core cooling, fuel heating reaches even the melting temperature, fission products are not further bind in the fuel and they release. There starts the condition, which is characterize as a severe accident. From the requirement of practical elimination of large leakages results, that it is necessary to assume severe accident as an accident localised in the containment, which is related to loss of coolant accident and subsequent failure of safety injection system. After the initial release of fission products from under the claddings of fuel assemblies, the release continues from melted fuel, first in the early phase of the accident, which is realised inside reactor vessel, after potential failure of reactor vessel after its remelting by melted reactor core; in the late phase of the accident, another phase occurs, which runs out of the reactor vessel. In this phase, there occurs the release of significant amount of volatile products and smaller amount of less volatile products, which did not release in the previous phase. Big part of fission products (approximately 90 %), except

[35] Fuel damage doesn´t occur with the other design basis accidents in spent fuel pools and the consequences of accidents in radioactive waste disposal systems are small in the comparison with the accident during spent fuel handling.

tellurium and ruthenium, is released into the atmosphere of the containment already during first two hours after the beginning of fuel melting. The release of tellurium and ruthenium takes approximately 5 – 6 hours. The release of fission products during this phase finishes when debris of reactor core is successfully cooled into such extend when the release of significant amount of fission products will not occur. Then, in the final phase of severe accident, volatile radioisotopes settled on reactor components are released in a smaller amount by the impact of residual heat.

The proportion of released radioactive fission products, depending on the extent of reactor core damage, is an important factor for source term determination. The following table, adopted from the document US NRC NUREG-1465 (Accident Source Terms for Light-Water Nuclear Power Plants, 1996) provides typical values on the composition and size of released fission products from melted fuel into the containment. The amount of released fission products is expressed in the fractions of the inventory of reactor core.

Tab. C.III.52: Release of fission products from damaged fuel into the containment according the document NUREG-1465

Group of fission products	Phase of accident				Total proportion of released fission products
	Release from gap fuel - cladding	Early phase of severe accident	Late phase of severe accident	Final phase of severe accident	
Noble gases	0,05 *)	0,95	0	0	1,00
Halogens	0,05 *)	0,35	0,25	0,1	0,75
Alkaline metals	0,05 *)	0,25	0,35	0,1	0,75
Tellurium group	0	0,05	0,25	0,005	0,305
Strontium, barium	0	0,02	0,1	0	0,12
Precious metals	0	0,0025	0,0025	0	0,005
Lanthanides	0	0,0002	0,005	0	0,0052
Cerium group	0	0,0005	0,005	0	0,0055

*) Amount of released products can differ depending on the type of the accident. For design basis accidents with assured long-time emergency cooling of reactor core, assumed release from the gap between the cladding and the fuel is approximately 3 % of noble gases, iodine, caesium from overall inventory in reactor core (the same value as it is recommended in the document EUR).

The determination of envelope source term for severe accident was made on the basis of above mentioned description of severe accident development.

C.III.19.1.6.2.4. Quantitative determination of source term for accidents

Source term for design basis accidents initiated in reactor cooling system

Safety requirements EUR were used as the main source for the determination of source term for design basis accidents initiated in reactor cooling system. Safety requirements EUR, regardless of the kind and manner of taking design basis accidents under the control, limit the release of radioactive substances into the environment by two criteria:

- by the limitation of short-time radiation effects by effective dose reduction, criteria meeting is verified by linear combination of releases of three reference radioisotopes: Xe-133, I-131 and Cs-137
- by the limitation of economic impacts of the accident, which is assured by the reduction of overall release of isotopes I-131 and Cs-137.

In case of ground releases, i.e. the release from the containment, there is required that the release of I-131 into the environment does not exceed 10 TBq and the release of Cs-137 does not exceed 1,5 TBq. From the analyse of the requirements EUR, it is possible to deduce that the requirement for economic impacts limitation is, in case of design basis accidents, stricter than the requirement for effective dose limitation.

For the determination of the amount of Xe-133, there was used the assumption that maximum all Xe-133 contained in primary coolant and at the same time all Xe-133 that can be released from gas gap (according EUR and also NUREG-1465 maximum 3 % of the inventory in fuel elements) from the maximum number (according EUR up to 10 %) of fuel elements, which can be damaged with design basis accident can be release into the containment. Maximum all Xe-133 contained in primary coolant can be released into the environment with occurrence of the accident with primary coolant outflow directly into the environment (containment by-pass).

For the release through containment leakages, there is assumed maximum admissible leakage, according EUR 0,5 %, of the containment volume with full pressure during 24 hours. For the determination of the amount Xe-133 released into the environment, the release through containment leakage was assumed during the period of 7 days. With the utilization of presented assumption, it is possible to limit overall activity of potentially released Xe-133 into the environment by the value 5000 TBq.

With design basis accidents of the given type, in the most general cases, there occurs the release of radioactive substances into the environment by three ways: containment leakages including containment by-pass (ground release) in the combination with the ventilation of the interspace of double containment or surrounding construction of primary containment (height release, through filters) or through safety or by-pass valves of secondary circuit (ground release). In all cases, the proportion of height release is negligible in comparison with other elements, therefore it is necessary to consider conservatively that complete release is realised as ground one.

Duration of the release strongly depends on used technological solutions (e.g. for the activities of containment spray or ventilation system) or the period necessary for the insulation of the release from primary to secondary circuit and unit residual heat removal through by-pass valve into the atmosphere. The consideration of release duration for 2 hours for radiological effects calculation is sufficiently conservative assumption. At the same time, it applies that overall source term is released into the environment during this period. The ambiguity of escape routes for radioactive substances has also an impact to the determination of proportions of different forms of iodine in releases. Conservatively, it is necessary to consider elementary iodine (even 100 %), which has the highest speed of deposition, as a prevailing form.

The composition of activities of other radioisotopes from groups relevant to reference isotopes was determined on the basis of the proportion, in which the relevant isotopes occur in the inventory of reactor core against reference isotopes. Conservative values of these proportions are presented above, in the chapter C.III.19.1.6.2.2. Qualitative determination of source term for accidents (page 361 of this Report), particularly in Tab. C.III.51: Values of proportional activity of isotopes in the inventory of reactor core due to the activity of reference isotopes in each group.

Resulting source term for design basis accident initiated in reactor cooling system is summary form presented in the following table.

Tab. C.III.53: Conservative source term for design basis accidents initiated in reactor cooling system

Group	1		2		3		4 - 9	
Reference isotope	Xe-133		I-131		Cs-137		Te-131m Sr-90 Ru-103 La-140 Ce-141 Ba-140	
Released activity into the environment for reference isotope [TBq]	5 000		10		1,5		0	
Released activity into the environment for other isotopes from the group [TBq]	Kr-85 Kr-85m Kr-87 Kr-88 Xe-131m Xe-133m Xe-135 Xe-135m Xe-138	30 750 1500 2000 30 150 1500 1100 4500	I-132 I-133 I-134 I-135	15 21 23 20	Cs-134 Cs-136	3 0,75	---	0
Iodine form: Duration and kind of release:	100 % elementary iodine 2 hours, ground release							

Source term for design basis accidents initiated out of reactor cooling system

In this case, the goal is to find and quantify conservative representative case of the accident with height release, it means the release, when radionuclides are released into the environment through ventilation stack. Height release through ventilation stack can occur also with the accidents with radioactive substances release into the containment and

consequently by the ventilation of the interspace or surrounding construction of primary containment through ventilation stack. However, with the exception of noble gases, releases of the other radioisotopes through ventilation stack are very small and about several orders lower than the releases through by-pass of secondary containment) and they can´t represent limiting height releases.

The other group of relevant releases are the accidents arising in radioactive waste disposal systems or the accidents arising during spent fuel handling. From the assessment of available safety documentation results that radioactive substances releases and radiological effects of accidents in radioactive waste disposal systems are very small in the comparison with the accidents during spent fuel handling and the methodology EUR does not prescribe any method of safety goals verification for these accidents.

Therefore, as a potential source of height releases comes into the consideration only accidents during fuel handling. Two types of accidents are considered in this group:

- fall of one fuel assembly with spent fuel into spent fuel pool either in the containment or in the building of spent fuel storage (auxiliary service building).
- fall of spent fuel container; for this accidents, available safety reports states that damage of a container during a fall is excluded due to container structure and the accident does not have any radiological effects.

The only relevant event with potentially big height releases is a fall of fuel assembly into spent fuel pool on the grid of stored spent fuel.

In compliance with available safety documentation of new nuclear units, it is conservatively assumed that, with the accident, there will occur the violation of such number of fuel elements, which corresponds to one fuel assembly, whereby from strength calculations of different variants of a fall results that there will not occur the damage of stored assemblies. It is possible to say that the damage of falling assembly even shouldn´t occur according strength calculations of fuel suppliers for new fuel. Potential partial damage of fuel assembly in storage grid is possible to include into safety reserves included in derived source term. From damaged fuel, it is necessary to consider the release of volatile radioisotopes, mainly noble gases of xenon and krypton and different isotopes of iodine and caesium occurred in gas gap between the fuel and the cladding of damaged fuel assembly.

Important fact is that fuel handling and therefore also the fall of fuel assembly occurs in sufficient depth under water surface. Sufficient depth of water assures the capturing of practically all aerosols, so only noble gases and gas isotopes of iodine (elementary and organic iodine) get over the surface level in spent fuel pool. Therefore, in other considerations, it is possible to concentrate only on these radioisotopes.

Despite different structure of reactors and nuclear fuel, different reactor power as well as different fuel burnout, differences in the inventory of volatile fission products contained in one fuel assembly are not too much big. E.g. for considered technologies of the NJZ, the inventory of Xe-133 in average fuel assembly is in the range (3,75 - 4,48).10^4 TBq and I-131 in the range (1,78 - 2,27).10^4 TBq. Upper limits of the activity of volatile fission products in one fuel assembly were used for further estimations.

With the estimation of the inventory of volatile radioisotopes in damaged fuel assembly, it is necessary to take into consideration that fuel assemblies have different power and accidentally the assembly with the highest power can be damaged. At the same time, it is possible to use the fact that the inventory of I-131 and Xe-133 in fuel assembly depends proportionally on the power and relatively few on burnout after enough long operation. On the contrary, the inventory of Kr-85 depends mainly on burnout and significantly less on the power. The overestimated power of damaged fuel assembly was used for conservative estimations.

With the utilization of above mentioned basic facts, the following procedure was used with conservative estimation of released fission products from damaged fuel assembly:

- It is assumed that the accident occurs immediately after reactor shutdown; in safety analysis for considered unit, assumed period of the accident was 60 to 100 hours after reactor shutdown in compliance with operational procedures.
- It is assumed that the accident occurred on fuel assembly with the biggest power in reactor core, which power will be 1,8 multiple of the power of average fuel assembly and in which the power of all fuel elements will be the

same; in reality according design data, the power of any of fuel element does not exceed 1,65 multiple of the power of medium element.

- The inventory of all relevant volatile fission products (Xe, Kr, I) was, in the comparison with medium inventory conservatively derived, increased proportionally to the increased power.
- It is assumed that 10 % of the inventory of all noble gases (including Xe-133) and 8 % of iodine isotopes (including I-131) releases from damaged fuel assembly. This assumption is conservative, because for this type of the accident, the release of 3 % could be possible to assume according the document EUR, 10 % of noble gases and 5 % of iodine according safety documentation EPR and 10 % Kr-85, 5 % Xe-133 and 8 % I-131 according the recommendation RG 1.183.
- In compliance with RG 1.183 as well as EUR, it is assumed that iodine releasing from damaged fuel contains 95 % of aerosol form, 4,85 % of elementary iodine and 0,15 % of organic iodine, but at the same time it is conservatively assumed that all iodine in the form of aerosols will immediately change to elementary iodine.
- It is assumed that the coefficient of elementary iodine capturing in water of spent fuel pool has the value 100 (i.e. 1/100 of elementary iodine is released over the surface level, zero capturing in water of the pool is assumed for organic iodine. The lowest value of capturing coefficient used by a supplier for EPR reactor was 105, the value in the range from 200 to 500 was used by suppliers for the other reactors.
- It is assumed that the efficiency of filters on the input into ventilation stack is 99 % to elementary iodine and 90 % to organic iodine; in the reality there is required filters efficiency to elementary iodine is even 99,9 % and to organic iodine even 99 – 99,5 %.
- Duration of the release into the environment will be assumed for 2 hours, during which all released radioactive substances – overall source term will release. In the reality, the release can take from 2 hours up to several days for the same overall source term.
- It is assumed that all released radioactive substances release directly into ventilation stack, without mixing with air in the containment or in the building of spent fuel storage.

Following numerical values for releases of selected fission products and releases of radioactive substances into the environment through ventilation stack were obtained by the presented procedure:

- The inventory of fission products of average fuel assembly contained 4,48E+04 TBq Xe-133 and 2,268E+04 TBq I-131, the inventory of fission products of damaged fuel assembly contained 8,064E+04 TBq Xe-133 and 4,082E+04 TBq I-131.
- After conservative rounding of 10 % of the release of fuel assembly inventory to higher values, Xe-133 = 10000 TBq, elementary I-131 = 50 TBq, organic I-131 = 5 TBq will release from surface level of spent fuel pool into the containment or into the building of spent fuel storage.
- 10000 TBq Xe-133, 0,5 TBq I-131 in elementary and 0,5 TBq in organic form releases on the output from filters through ventilation stack into the environment.
- Another isotopes of iodine, xenon and krypton were added into source term proportionally to their concentrations in the inventory of fission products in reactor core.

Basic parameters of source term for design basis accidents initiated out of reactor cooling system are in summary form presented in the following table.

Tab. C.III.54: Conservative source term for design basis accidents initiated out of reactor cooling system

Group	1		2		3 - 9	
Reference isotopes	Xe-133		I-131		Cs-137 Te-131m Sr-90 Ru-103 La-140 Ce-141 Ba-140	
Released activity into the environment for reference isotope [TBq]	10 000		1		0	
Released activity into the environment for other isotopes from the group [TBq]	Kr-85 Kr-85m Kr-87 Kr-88 Xe-131m Xe-133m Xe-135 Xe-135m Xe-138	60 1500 3000 4000 60 300 3000 2200 9000	I-132 I-133 I-134 I-135	1,5 2,1 2,3 2	---	0
Iodine form: Duration and kind of release:	50 % elementary, 50 % organic iodine 2 hours, height release					

Source term for severe accident

Determination of source term for severe accidents was based on the assumption that containment integrity will be preserved also with severe accident and fractions of fission products release into the containment during severe accident will correspond to the recommendations of the document US NRC NUREG-1465 (Accident Source Terms for Light-Water Nuclear Power Plants, 1996). In compliance with the requirements EUR, severe accidents out of the containment shall be practically eliminated.

With the determination of envelope source term for severe accident, limit value of the release Cs-137 into the environment 30TBq was used as a base according safety requirements EUR. This maximum admissible value shall assure the limitation of economic impacts of severe accident. Isotope Cs-137 was selected due to its dominant meaning for long-time contamination of the environment as well as its contribution on health effects. Further, the procedure for the determination of source term for severe accident was as follows:

- With the utilization of the inventory of fission products in reactor core from available safety documentation for reference units of the NJZ, overall activity of the radioisotope released into the containment was determined for Cs-137 and each another isotope according the document NUREG-1465 for pressurized water reactor. Proportional values of released activity in the relation to overall activity of the isotope in reactor core were then following (determination of isotopes proportion, see chapter C.III.19.1.6.2.2 Quantitative determination of source term for accidents (page 361 of this Report): Xe-133 = 1; I-131 = 0,75; Cs-137 = 0,75; Sr-90 = 0,12; Te-131 = 0,305; Ru-103 = 0,005; La-140 = 0,0052; Ce-141 = 0,0055; Ba-140 = 0,12. These values represent overall released activities into the containment for all phases of an accident from its beginning to long-time processes out of reactor vessel in case of its violation.
- Further, it is assumed that limit value 30 TBq of Cs-137 will be released into the environment of the NJZ, this value results from the limitation of economic impacts of severe accident according EUR. Other isotopes in the form of aerosols (i.e. all radioactive fission products except noble gases and iodine gas isotopes) will then release into the environment proportionally to this value particularly in the same proportion as these isotopes are release into the atmosphere of the containment. It has been verified that this assumption is met with satisfactory accuracy by the comparison with more detailed calculation of accident course for particular projects.
- Presented procedure was repeated for each of the considered reactors, for which necessary support documents were available and the worst variant was selected for the determination of limit releases into the environment. It is necessary to specify that the assignment of releases of all isotopes to the same reference

value of the release Cs-137 (30 TBq) significantly reduces differences among reactors in terms of overall released activity. This procedure enables the release of bigger proportion of isotopes inventory in reactor core into the environment for smaller reactors.

- In source term into the environment, according US NRC NUREG-1940 (Description of Models and Methods, 2012), there is recommended to assume conservatively that 25 % of iodine release in aerosol form, while remaining 75 % releases in gas form (as elementary and organic iodine in the proportion 40:60 %). From overall released activity of iodine into the environment, there will be 25 % in aerosol, 30 % in elementary and 45 % in organic form. Whereas, more optimistic values for iodine forms are presented in available safety documentation: For the containment EPR – it is 42 % aerosols, 29 % elementary and 29 % organic iodine, for AES-2006 – it is 31 % aerosol, 49 % elementary and 20 % organic iodine.
- Released activity for noble gases and gas forms of iodine was calculated as 0,5 % of volume activity in the containment per a day. Overall released activity for total duration of the release was conservatively determined as 7 times activity released during first day.

Source term should be conservatively assumed as ground one, what corresponds to assumed release routes with severe accident – through containment leakages.

In overall source term into the environment, another isotopes belonging to the same group were added to reference isotopes, while their representation in source term was determined in the same proportion against reference isotope, in which they are in the inventory of fission products in reactor core.

With the calculation of doses with the utilization of proposed source term, there is recommended to consider the release of the individual radioisotopes depending on the time of linear interval 0 to 24 hours after accident origin, what is conservative assumption in comparison with considered duration of the release 7 days with source term proposal. In the available calculation reference types of reactors, the release of all radioisotopes except noble gases and gas iodine was finished in much shorter time.

Basic parameters of source term for severe accident are presented in summary form in the following table.

Tab. C.III.55: Conservative source term for severe accidents

Group	1		2		3		4		
Reference isotope	Xe-133		I-131		Cs-137		Te-131m		
Released activity into the environment for reference isotope [TBq]	350 000		1000		30		20		
Released activity into the environment for other isotopes from the group [TBq]	Kr-85 Kr-85m Kr-87 Kr-88 Xe-131m Xe-133m Xe-135 Xe-135m Xe-138	2,1E+03 5,3E+04 1,1E+05 1,4E+05 2,1E+03 1,1E+04 1,1E+05 7,7E+04 3,2E+05	I-132 I-133 I-134 I-135	1500 2100 2300 2000	Cs-134 Cs-136	60 15	Te-129m Te-132 Sb-127 Sb-129	8 200 16 46	
Group	5		6		7		8		9
Reference isotope	Sr-90		Ru-103		La-140		Ce-141		Ba-140
Released activity into the environment for reference isotope [TBq]	5		3		5		4		100
Released activity into the environment for other isotopes from the group [TBq]	Sr-89 Sr-91	60 75	Mo-99	4	Y-91	4	Ce-144 Np-239	3 48	---
Iodine forms: Duration and kind of release:	25 % aerosol, 30 % elementary and 45 % organic iodine 24 hours, ground release								

Proposed source term for reference radioisotopes overestimates effective doses in the distance 800 m from the reactor approximately 1,8 multiple in comparison with the application of linear combination according EUR for first safety goal, so

future more specified assessment of radiological effects for particular unit should be always more favourable in comparison with source term for EIA.

The verification of the conservatism of such determined source term and quantitative assessment of the reserve was made by the comparison with releases presented in available safety reports of NJZs for reference isotopes.

Tab. C.III.56: Comparison of proposed source term with the data on severe accident calculation in safety reports for other new units in preparation phase

Radioisotope	Activity released into the environment in 7 days according available safety reports [TBq]					
	AP 1000, UK	VVER 92, Belene	EPR, Olkiluoto	APR 1400 (in 1 day)	NJZ	Reserve *)
Xe-133	-	22 000	313 000	4470	350 000	1,1 - 15,9
I-131 overall	482	44,8	14,2	54,5	1000	2,1 - 70,4
I-131 aerosol	-	14,2	9,9	-	250	17,6 - 25,3
I-131 gases	-	31,8	4,3	-	750	23,6 - 58,1
Cs-137	4,9	1,72	1,5	9,6E+0	30	3,1 - 20,0
Te-131m	-	2,10E-4	3,4E-1	3,41E+0	20	5,9 - 95,2
Sr-90	2,0E-1	9,72E-2	3,3E-2	3,10E-1	5	16,1 - 151,5
Ru-103	-	6,35E+0	3,3E-1	8,88E+0	3	0,34 - 9,1
La-140	-	9,72E-1	5,4E-1	8,6E-1	5	5,1 - 9,3
Ce-141	-	8,97E-1	3,7E-1	1,3E-2	4	4,5 - 307,7
Ba-140	-	1,79E+1	7,8E-1	8,63E+0	100	5,6 - 128,2

*) Range of the proportions of limit value considered for this Report EIA of the NJZ to the values presented in safety documentations.

From the comparison of reference source term for the NJZ with specific source terms determined by detailed calculation results that reference source term with sufficient reserve overestimates all specific units. The exception is ruthenium release in case of the unit VVER and APR. The reason is assumed proportion of released Ru into the containment, which is considered 40 % in safety report for VVER, while NUREG-1465 presents the value 80 times lower. However, the importance is not significant, because ruthenium contribution on accident effects is small in comparison with other isotopes.

C.III.19.1.6.3. Methodology of the calculation of accidents radiological impacts

C.III.19.1.6.3.1. Methodology of the calculation of design basis accidents radiological effects

The analysis of radiation effects were performed for two defined representative source terms of the following design basis accidents:

- source term for design basis accident initiated in reactor cooling system (ground release through the leakages of intact protection enveloped of the reactor – containment) and
- source term for design accident initiated out of reactor cooling system (height release through ventilation stack with the accident caused by a fall of one fuel assembly into spent fuel storage pool during refuelling).

Potential source of radionuclides release into the environment of the power plant is the radionuclide inventory in the primary circuit coolant, and also the radionuclide inventory in free volumes under the cladding of fuel elements; the breach of these elements is assumed during the accident. These types of accidents are classified by the level 2 or 3 (incident or serious incident) on the scale INES.

Evaluation of radiation effects of two representative types of design basis accidents was performed by conservative calculation software RTARC version 6.1 and RDEBO version 1.

The software RTARC 6.1 is accepted by UJD SR for the assessment of radiological effects of design basis accidents within the development of relevant chapters Final Safety Analysis Reports for reactor units in the operation or in the construction (Mochovce, unit 3 & 4) in Slovak Republic.

It is modular calculation code intended for the calculation of radiation effects with emergency release of radionuclides into the atmosphere in the surrounding environment of nuclear facility. This program enables to model local geographical conditions (flat terrain or broken terrain – terrain altitude is taken into the consideration), terrain roughness (i.e. type of earth

surface – grass, field, forest, water, urban area) and different meteorological situations (categories of atmosphere stability A to F according the method Pasquill and Gifford without precipitation as well as with precipitation consideration) for 6 age groups of the population (babies 0-1 year, children 1-2, 2-7, 7-12 years, teenagers 12-17 years and adults) and to determine critical age group of the population.

A part of software system RTARC is the module PTM (Puff Trajectory Model – model of leakage path), which enables the evaluation of radiological effects in big distances (>40 km). Effective individual doses as well as equivalent doses on selected organs (thyroid gland, bone marrow, skin, etc.) are calculated in defined times after release beginning (including lifelong doses). Population exposure is calculated on the basis of local, time dependent concentration of radionuclides in the air and earth surface.

Following exposition paths are considered:

- external exposure from the passing radioactive cloud,
- external exposure from radionuclides deposited on earth surface,
- internal exposure from the inhalation, which includes radionuclides inhalation from the passing cloud and the inhalation of radionuclides resuspended from earth surface.

The software RTARC does not have a module for the calculation of the contribution to IED from the ingestion contaminated by atmospheric deposition during the accident. For this purpose, modular calculation software RDEBO version 1 was used.

The software RTARC was verified e.g. by following comparative analysis:

- within comparative analyse for comparative tasks No. 1 and 2 of specified by Experts commission No. 6 State Nuclear Safety Authority of the Czech Republic (SÚJB ČR) in Prague (calculations of radioactive substances spreading, which are obligatory for the software used in Czech republic for this area) – comparative analysis of SÚJB were made with the following software, which is used in Europe for the calculation of radionuclides leakage and radiological effects:
  - InterRAS – used by SÚJB ČR (described in the document IAEA TECDOC-955 - Generic assessment procedures for determining protective actions during a reactor accident, 1997),
  - HERALD – developed and used by ŠKODA Plzeň,
  - HAVAR – developed and used by EGP Praha, a.s.,
  - CRAC2M – adapted in VUJE, a.s. and used by ÚJV Řež (developed in USA),
- Within models comparison – by the comparison of RTARC (Gauss and PTM model) with Austrian disperse model TAMOS on the basis of bilateral cooperation of SÚJB ČR and Austria (Brussels Agreement of November 29th, 2001).

Software validation was performed e.g. by the analysis of the following experiments:

- model experiments in wind tunnel – measurements in wind tunnel in the Institute for Fluid Mechanics and Aerodynamics, Universität der BundTVDehr München, Neubiberg, 1994
- INEL experiment (Idaho National Engineering Laboratory) - multi-tracer atmospheric experiment 1998 – the comparison between results of the experiment and calculated concentrations in the distances 3 km, 50 km and 90 km,
- international comparison implemented within the project ENSEMBLE 2003 – the results were presented also on international level.

For the calculation of the contribution to IED from internal exposure from ingestion of contaminated food is used modular calculation software RDEBO version 1, which is accepted by ÚJD SR and it is also standardized by SÚJB ČR for the performance of radiation effects analysis. The software RDEBO was developed in VUJE, a.s. and software verification was realized during its development by the comparison of model calculation results with the results of standardized (SÚJB) software RDOJE II. The conclusions are valid for all calculation software RDxxx, because all systems (RDEBO, RDEMO, RDEDU and RDETE) are based on unique methodology and calculation modules use the same algorithms and software means. More detail description of the software RDEBO is presented in the chapter C.III.16.3.1. The impact of radioactive effluents (page 325 of this Report).

With the analysis of the assessment of radiological effects of design basis accidents were used the following assumptions:

- A person is permanently (i.e. 24 hours/day – during complete analysed period) under the axis of passing radioactive cloud (with maximum concentration of radionuclides), the sheltering in terms of normal stay inside the buildings is not conservatively considered (i.e. protection "shielding" factor (shielding coefficient) is 1,0).
- The following distances (calculation points) are considered: 0,5 km; 1,5 km; 2,5 km; 4,0 km; 6,0 km; 8,5 km; 15 km; 25 km; 40 km; 60 km; 80 km and 100 km, i.e. the way to be possible to evaluate also radiation impact in the nearest populated territory of the neighbouring states (Czech Republic: 37 km, Austria: 54 km and Hungary: 61 km; the nearest distances of another neighbouring states – Poland: 139 km and Ukraine: 330 km are considerably bigger and it is possible to relate conservatively the results for nearer distances).
- The impact of the Carpathian Mountains on the decreasing of radiation load in distances ≥40 km (direction ČR and partially also Austria) is not considered.
- The analysis of radiation effects (i.e. calculation of annual effective IED) are performed with alternatives for all 6 age groups, the category of atmosphere stability F without precipitation (the most stable category with the smallest spread in horizontal and vertical direction, what leads to maximum concentrations of radionuclides and doses) and for the category of atmosphere stability D (the most likely category on SR territory) by the software RTARC 6.1:
  - with the consideration of precipitation intensity 5 mm/hour[36] in all distances and
  - with the consideration of precipitation intensity 5 mm/hour from the distance 40 km from the NJZ (maximization of radionuclides fall due to rain washout, i.e. only dry fall is considered in the area between the NJZ locality and the nearest analysed locality of neighbouring state, what guarantees conservative approach for the evaluation of the effects behind the distance of 40 km.
- Above mentioned categories of atmosphere stability are considered during overall period from the beginning of the release to the passage of radioactive cloud over the evaluated territory.
- The contribution of annual ingestion of contaminated food to lifelong effective individual equivalent dose (i.e. the value of the contribution of effective individual equivalent dose) is analysed by the software RDEBO for all age groups, while there is conservatively considered that 100 % of food consumed by the inhabitants is contaminated. With the evaluation of border area impacts (Czech Republic, Austria, Hungary), conservative assumption of the consummation all food exclusively from local source is considered. For the determination of the contribution of effective dose from ingestion within the distance 40 km, there is used Slovak consumer basket and Austrian consumer basket for bigger distances (annual consumption of food for Austria and Austrian consumer basket was selected as a representative one also for the other neighbouring countries). The composition of food baskets is presented in the chapter C.III.16.3.1. The impact of radioactive effluents (page 325 of this Report).

C.III.19.1.6.3.2. Methodology of the calculation of severe accidents radiological effects

The evaluation of radiation effects of severe accident with the utilization of representative (envelope) source term are performed by the realistic manner (best estimate) with the utilization of probabilistic software system COSYMA, which is accepted by ÚJD SR for the evaluation of radiation effects of severe accidents (e.g. with the development of technical reports for the justification of emergency planning zone for reactor units in the operation (JE V2, EMO1,2) or reactor units in the construction in the Slovak Republic (MO3,4) as well as for EIA studies (MO3,4)). Software system COSYMA has been implemented in SR within the participation in COSYMA User's Group (V. European Union Framework Design) and it meets conditions of central Europe.

Regarding the modelling of meteorological conditions, software COSYMA uses probabilistic differences according real assessment measurements of meteorological situations in the locality and their frequency. The result of probabilistic software COSYMA are then statistic characteristics for calculated values of doses from all exposure paths (i.e. also from the ingestion of contaminated food): medium value and standard deviations (expressed in the form of quantiles - 50 %, 90 %, 95 %, 99 % and maximum value). For the calculation, statistically processed hourly meteorological data for the year 2010 in the site Jaslovské Bohunice, according annual data for this year developed by Slovak Hydrometeorological Institute, were

[36] If it would be considered that the most likely meteorological conditions according to the guide ÚJD SR *BNS I.11.1/2013* mean the inclusion of the most likely intensity of precipitation, then this is order smaller than conservatively considered value 5 mm/hour.

used. System COSYMA does not allow to consider the average for several years. Discussion to the selection of reference year is presented in the chapter C.III.16.3.1.2. Used assumptions. The selection of the year 2010 leads to the higher frequency of the occurrence of the category of atmosphere stability F, while category F leads usually to bigger doses.

The software enables to model all important paths of external and internal exposure (external exposure from previous radioactive cloud, external exposure from radionuclides deposited on earth surface, internal exposure from the inhalation, which includes radionuclides inhalation from the previous cloud and the inhalation of radionuclides resuspended from earth surface, internal exposure from ingestion of the food contaminated by radioactive fall).

Identically with the analysis performed by the software RDEBO for design basis accidents, there is conservatively assumed that 100 % of food consumed by the inhabitants is contaminated. With the evaluation of border area impacts (Czech Republic, Austria, Hungary), conservative estimation of the consummation of all food exclusively from local sources in relevant country and assessed areas is considered. For the determination of effective dose contribution from ingestion, Slovak and Austrian consumer basket was used. Annual food consumption for Austria and Austrian consumer basket was selected as a representative one also for the other neighbouring countries. Considered food consumer baskets are presented in the chapter C.III.16.3.1. Impacts of radioactive effluents (page 325 of this Report). The assumption of normal way of life (a person spends a part of a day in the buildings) is used with the calculation by the software COSYMA.

The analysis were performed not taking into account the possible implementation of protection measures (sheltering, iodine prophylaxis) and then also with taking them into the account to enable the assessment of “avoidable” doses.

With distances assessment, where it is necessary to implement immediate measures, calculated medium values of doses as well as the values corresponding to 95 %of quantile are considered by the software COSYMA.

With the utilization of software RDEBO, there also has been analysed the variant of severe accident scenario with the assumption of maximum fall of radionuclides into the nearest water reservoir on the Váh River due to strong intensity of precipitation (5 mm/hour) after radioactive cloud arrival (firth of Sĺňava into Váh, direction east-north-east, zone No. 43, distance 15 km) with subsequent contamination of Danube and with the assessment of radiation effects on the nearest territory of Hungary (confluence of the rivers Váh and Danube, direction south-south-east, distance 80 km or 100 km).

C.III.19.1.7. The evaluation of accidents radiological impacts

C.III.19.1.7.1. Radiation impacts in reactor cooling system

Radiation impacts of design basis accident initiated in reactor cooling system (ground release from the containment) were analysed by the software RTARC 6.1 (contributions from all paths of the exposure except ingestion) and RDEBO (only contributions from ingestion of contaminated food) for all 6 age groups. The calculations are performed for these variants of atmospheric conditions:

(1) category of atmospheric stability F without precipitation,
(2) category of atmospheric stability D with precipitation intensity 5 mm/hour for all distances,
(3) category of atmospheric stability D with precipitation intensity 5 mm/hour from the distance 40 km from the NJZ.

The results of the analysis are presented below in the table form. From the results, these conclusions result for presented variants of calculations (1) to (3):

(1) With not considering of the ingestion, critical age group are children in the age 2-7 years. Maximum annual individual equivalent dose (IED) in the distance ≥800 m is <10 mSv/year and in the distance ≥40 km (cross border impact – Czech Republic, Austria, Hungary) is the value <1 mSv/year. Maximum calculated value of annual IED in the distances ≥40 km is 0,595 mSv/year.

    In terms of the ingestion of contaminated food, critical age group are adults.

Maximum calculated overall value of annual IED (i.e. including ingestion[37]) decreases under the value of 5 mSv/year (lower limit for the application of food limits according the governmental regulation SR No. 345/2006 Coll.) approximately in the distance 15 km (and with the consideration of the contribution only from the ingestion in the distance 13 km). In the distances ≥40 km, calculated values of overall annual IED including the ingestion are <1,4 mSv/year, maximum value corresponds the distance of 40 km (annulus 30-50 km), namely 0,436+0,9632 = 1,3992 mSv/year.

(2) With not considering of the ingestion, critical age group are children in the age 2-7 years. Maximum annual IED in the distance ≥800 m is <5 mSv/year and in the distance ≥40 km (cross border impact - Czech Republic, Austria, Hungary) is the value <1 mSv/year. Maximum calculated value of annual IED in the distances ≥40 km is 0,151 mSv/year.

In terms of the ingestion of contaminated food, critical age group within the distance 15 km are children in the age 1-2 years, for bigger distances critical age group are adults.

Maximum calculated overall value of annual IED, including the ingestions, decreases under the value 5 mSv/year approximately in the distance 6 km, for age group of children 1-2 years old. With the consideration of the contribution only from the ingestion, it is the distance 5 km and for the distances ≥40 km is <1 mSv/year (maximum value corresponds to the distance 40 km for age group of adults, namely 0,146+0,4564 = 0,6024 mSv/year).

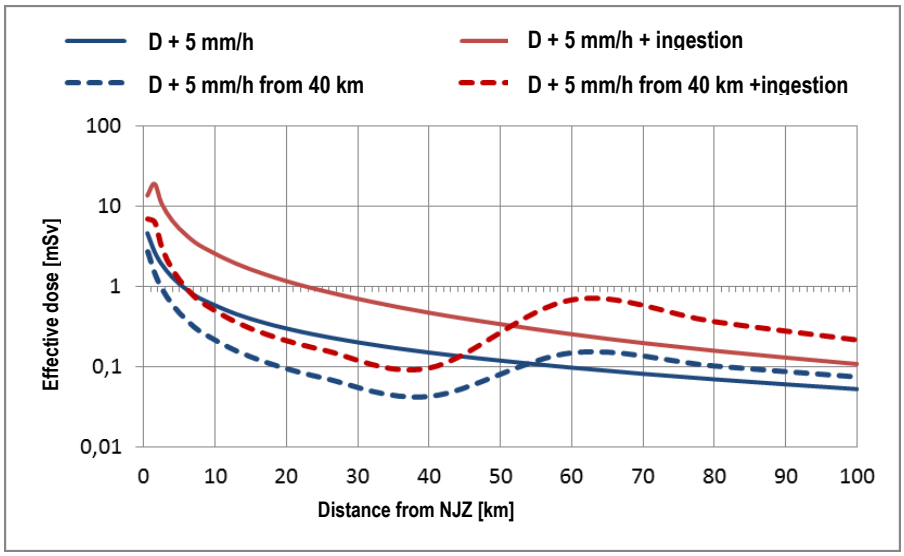
(3) With not considering of the ingestion, the values of IED are calculated more favourable (smaller) within the distance approximately 40 km in comparison with the analysis for the variant (2). In terms of cross border impact (distances ≥40 km), maximum annual value of IED without ingestion 0,15 mSv/year is calculated for the distance 60 km and age group of babies 0-1 years old and children 2-7 years old.

In terms of the ingestion of contaminated food, critical age group are children 1-2 years old.

In terms of cross border impact (for the distances ≥40 km) maximum calculated overall value of annual IED including ingestion is <1 mSv/year (calculated maximum value corresponds to the distance 60 km (annulus 50-70 km) for age group of children 1-2 years old, namely 0,149+0,5256 = 0,6746 mSv/year).

The following figure shows results of the calculations for annual IED without the consideration of the ingestion for critical age group of children 1-2 years old, and it also includes the contribution from annual ingestion of contaminated food (the contribution to lifelong IED) for calculation variants (2) and (3), i.e. with the consideration of most likely category of atmosphere stability D.

Figure C.III.20: Annual IED without ingestion and with the inclusion of precipitation from annual ingestion of contaminated food for design basis accident with the release from the containment and the category of atmosphere stability D

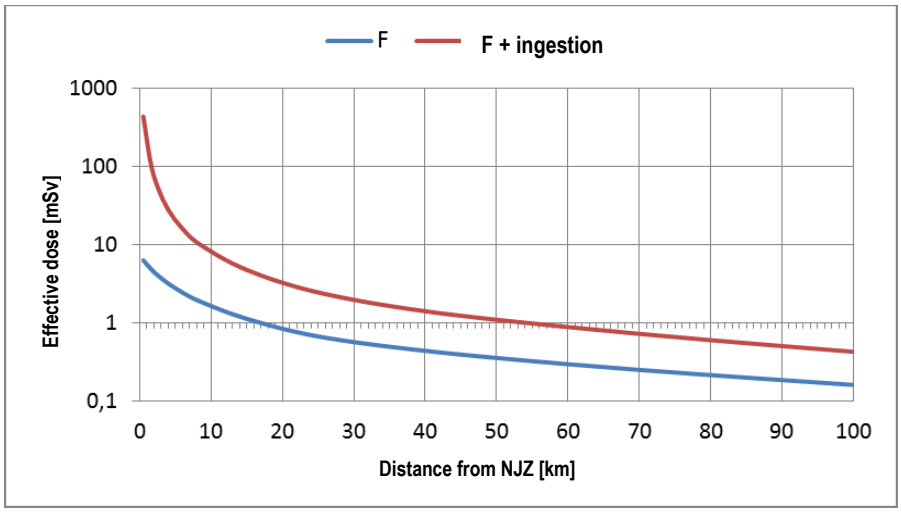


[37] However, it is necessary to point out that calculated value for the contribution from the ingestion corresponds to lifelong IED and the assumption that all food consumed by an individual during one year is contaminated. It is possible to assume that corresponding annual IED from the ingestion could be smaller than a lifelong one.

As it is already mentioned above in the chapter C.III.19.1.6.3.1, calculation points – distances: 0,5 km; 1,5 km; 2,5 km; 4,0 km; 6,0 km; 8,5 km; 15 km; 25 km; 40 km; 60 km; 80 km a 100 km are considered in the analysis. It means that the distance 0,5 km corresponds to the annulus with the radius 30 to 50 km and the distance 60 km of the annulus 50 to 70 km (analogously for the other calculation points – distances). For this reason, for the distance 60 km, calculated maximum value of annual IED (in terms of cross border impact with the consideration of precipitation from the distance 40 km) corresponds to the annulus with the radius 50 to 70 km.

The following figure presents analogous results for annual IED, with conservative consideration of the category of atmosphere stability F, calculation variant (1) for age group of adults (that is critical in terms of overall doses).

Figure C.III.21: Annual IED without ingestion and with the inclusion of contribution from annual ingestion of contaminated food for design basis accident with the release from the containment and the category of atmosphere stability F



In the distance 500 m from the NJZ, there are calculated , for critical age group of children 2-7 years old (with not considering the contribution from the ingestion) and for the stability category F without precipitation, the following values of IED: 6,36 mSv/2days, 6,51 mSv/7days and the contribution of equivalent dose in thyroid gland 17,8 mSv. For the stability category D with precipitation 5 mm/hour, there are calculated the following values IED: 1,99 mSv/2days, 2,14 mSv/7days and the contribution of equivalent dose in thyroid gland 5,26 mSv.

From the presented results follows that the implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) is not necessary in the distance ≥800 m from the reactor. In terms of possible cross border impact (distances ≥40 km), calculated results have confirmed that the overall maximum annual IED from all paths of the exposure, i.e. also with the inclusion of the contribution (the contribution to lifelong dose) from annual ingestion of contaminated food, does not even exceed, with the consideration of the most likely category of atmosphere stability D, the limit value 1 mSv/year for normal and abnormal operational conditions (directive of the Council 2013/59/Euratom as of December 5th, 2013 or ICRP publication 103). With the conservative consideration of the category of atmosphere stability F, calculated maximum value of the overall annual IED from all paths of the exposure is ~1,4 mSv/year.

From the analysis of results of the exposure paths has resulted that, for external path of the exposure, the most important nuclides are Cs-134, Cs-137 (mainly deposit), noble gases Kr-88, Xe-138, Kr-87 (cloud) and iodine I-131, I-133 (inhalation and deposit). The contribution from internal exposure from the ingestion is formed mainly by nuclides Cs-134, Cs-137 and I-131. Percentage composition of the contribution depends on meteorological conditions. The contribution from the internal exposure from the ingestion to lifelong IED creates dominant contribution within the distance ~ 10 - 20 km, its proportion decreases in bigger distances. Detailed results of the calculations for critical age groups are presented in the following tables.

Tab. C.III.57: Annual and lifelong IED for age group of babies 0-1 year old [Sv]

Distance [km]	Cloud	Deposit dry	Deposit wet	Inhalation	Annual IED (sum)	Lifelong IED (without ingestion)	Ingestion (lifelong)
Category of atmosphere stability F							
0,5	2,14E-03	3,88E-03	0,00E+00	3,62E-03	9,64E-03	2,39E-02	2,500E-01
1,5	1,73E-03	3,01E-03	0,00E+00	2,76E-03	7,50E-03	1,86E-02	6,181E-02
2,5	1,44E-03	2,45E-03	0,00E+00	2,21E-03	6,10E-03	1,51E-02	2,766E-02
4,0	1,15E-03	1,90E-03	0,00E+00	1,68E-03	4,72E-03	1,17E-02	1,311E-02
6,0	8,86E-04	1,45E-03	0,00E+00	1,24E-03	3,58E-03	8,95E-03	6,944E-03
8,5	6,77E-04	1,11E-03	0,00E+00	9,18E-04	2,71E-03	6,84E-03	4,050E-03
15,0	4,02E-04	6,78E-04	0,00E+00	5,14E-04	1,59E-03	4,14E-03	1,704E-03
25,0	2,34E-04	4,12E-04	0,00E+00	2,76E-04	9,22E-04	2,48E-03	7,822E-04
40,0	1,51E-04	2,73E-04	0,00E+00	1,55E-04	5,79E-04	1,63E-03	3,955E-04
60,0	1,02E-04	1,85E-04	0,00E+00	8,37E-05	3,71E-04	1,09E-03	2,226E-04
80,0	7,42E-05	1,35E-04	0,00E+00	4,85E-05	2,57E-04	7,88E-04	1,382E-04
100,0	5,57E-05	1,02E-04	0,00E+00	2,92E-05	1,87E-04	5,91E-04	9,092E-05
Category of atmosphere stability D (precipitation 5 mm/hour)							
0,5	6,26E-04	1,08E-03	1,92E-03	1,01E-03	4,64E-03	1,50E-02	5,431E-03
1,5	3,74E-04	5,50E-04	1,31E-03	4,99E-04	2,73E-03	9,11E-03	9,722E-03
2,5	2,59E-04	3,44E-04	9,99E-04	3,04E-04	1,91E-03	6,53E-03	5,276E-03
4,0	1,71E-04	2,09E-04	7,48E-04	1,78E-04	1,31E-03	4,61E-03	3,135E-03
6,0	1,13E-04	1,31E-04	5,67E-04	1,06E-04	9,18E-04	3,34E-03	2,027E-03
8,5	7,66E-05	8,68E-05	4,40E-04	6,58E-05	6,69E-04	2,52E-03	1,402E-03
15,0	3,81E-05	4,35E-05	2,85E-04	2,81E-05	3,95E-04	1,57E-03	7,602E-04
25,0	1,92E-05	2,32E-05	1,87E-04	1,17E-05	2,41E-04	1,02E-03	4,209E-04
40,0	9,76E-06	1,28E-05	1,23E-04	4,44E-06	1,50E-04	6,69E-04	2,284E-04
60,0	5,31E-06	7,47E-06	8,28E-05	1,57E-06	9,72E-05	4,51E-04	1,264E-04
80,0	3,42E-06	4,95E-06	6,05E-05	6,36E-07	6,95E-05	3,31E-04	8,060E-05
100,0	2,41E-06	3,51E-06	4,63E-05	2,80E-07	5,25E-05	2,53E-04	5,620E-05
Category of atmosphere stability D (precipitation 5 mm/hour from 40 km)							
0,5	6,26E-04	1,08E-03	0,00E+00	1,02E-03	2,73E-03	6,70E-03	2,661E-03
1,5	3,74E-04	5,56E-04	0,00E+00	5,19E-04	1,45E-03	3,49E-03	3,056E-03
2,5	2,59E-04	3,52E-04	0,00E+00	3,27E-04	9,37E-04	2,23E-03	1,319E-03
4,0	1,71E-04	2,16E-04	0,00E+00	2,00E-04	5,88E-04	1,38E-03	6,395E-04
6,0	1,14E-04	1,38E-04	0,00E+00	1,27E-04	3,79E-04	8,87E-04	3,533E-04
8,5	7,69E-05	9,32E-05	0,00E+00	8,54E-05	2,56E-04	5,98E-04	2,184E-04
15,0	3,84E-05	4,93E-05	0,00E+00	4,47E-05	1,32E-04	3,14E-04	1,052E-04
25,0	1,94E-05	2,84E-05	0,00E+00	2,54E-05	7,32E-05	1,78E-04	5,776E-05
40,0	9,90E-06	1,75E-05	0,00E+00	1,54E-05	4,28E-05	1,08E-04	3,456E-05
60,0	5,38E-06	1,08E-05	1,26E-04	7,41E-06	1.50E-04	6,35E-04	3,175E-04
80,0	3,44E-06	7,01E-06	8,84E-05	2,95E-06	1,02E-04	4,60E-04	1,737E-04
100,0	2,42E-06	4,91E-06	6,60E-05	1,26E-06	7,45E-05	3,50E-04	1,059E-04

Tab. C.III.58: Annual and lifelong IED for age group of children 1-2 years old [Sv]

Distance [km]	Cloud	Deposit dry	Deposit wet	Inhalation	Annual IED (sum)	Lifelong IED (without ingestion)	Ingestion (lifelong)
Category of atmosphere stability F							
0,5	2,14E-03	3,88E-03	0,00E+00	3,57E-03	9,59E-03	2,38E-02	3,866E-01
1,5	1,73E-03	3,01E-03	0,00E+00	2,72E-03	7,46E-03	1,85E-02	9,364E-02
2,5	1,44E-03	2,45E-03	0,00E+00	2,18E-03	6,06E-03	1,51E-02	4,127E-02
4,0	1,15E-03	1,90E-03	0,00E+00	1,65E-03	4,70E-03	1,17E-02	1,922E-02
6,0	8,86E-04	1,45E-03	0,00E+00	1,22E-03	3,56E-03	8,93E-03	9,980E-03
8,5	6,77E-04	1,11E-03	0,00E+00	9,05E-04	2,69E-03	6,83E-03	5,702E-03
15,0	4,02E-04	6,78E-04	0,00E+00	5,06E-04	1,59E-03	4,13E-03	2,295E-03
25,0	2,34E-04	4,12E-04	0,00E+00	2,72E-04	9,18E-04	2,48E-03	9,977E-04
40,0	1,51E-04	2,73E-04	0,00E+00	1,52E-04	5,76E-04	1,62E-03	4,712E-04
60,0	1,02E-04	1,85E-04	0,00E+00	8,25E-05	3,70E-04	1,09E-03	2,144E-04
80,0	7,42E-05	1,35E-04	0,00E+00	4,78E-05	2,57E-04	7,87E-04	1,409E-04
100,0	5,57E-05	1,02E-04	0,00E+00	2,87E-05	1,86E-04	5,91E-04	8,718E-05
Category of atmosphere stability D (precipitation 5 mm/hour)							
0,5	6,26E-04	1,08E-03	1,92E-03	9,93E-04	4,62E-03	1,50E-02	9,031E-03
1,5	3,74E-04	5,50E-04	1,31E-03	4,91E-04	2,72E-03	9,10E-03	1,644E-02
2,5	2,59E-04	3,44E-04	9,99E-04	3,00E-04	1,90E-03	6,53E-03	8,953E-03
4,0	1,71E-04	2,09E-04	7,48E-04	1,75E-04	1,30E-03	4,61E-03	5,313E-03
6,0	1,13E-04	1,31E-04	5,67E-04	1,05E-04	9,16E-04	3,34E-03	3,415E-03
8,5	7,66E-05	8,68E-05	4,40E-04	6,48E-05	6,68E-04	2,52E-03	2,341E-03
15,0	3,81E-05	4,35E-05	2,85E-04	2,77E-05	3,94E-04	1,57E-03	1,232E-03
25,0	1,92E-05	2,32E-05	1,87E-04	1,15E-05	2,41E-04	1,02E-03	6,468E-04
40,0	9,76E-06	1,28E-05	1,23E-04	4,36E-06	1,50E-04	6,69E-04	3,211E-04
60,0	5,31E-06	7,47E-06	8,28E-05	1,54E-06	9,72E-05	4,51E-04	1,568E-04
80,0	3,42E-06	4,95E-06	6,05E-05	6,19E-07	6,95E-05	3,31E-04	8,873E-05
100,0	2,41E-06	3,51E-06	4,63E-05	2,70E-07	5,25E-05	2,53E-04	5,595E-05
Category of atmosphere stability D (precipitation 5 mm/hour from 40 km)							
0,5	6,26E-04	1,08E-03	0,00E+00	1,00E-03	2,71E-03	6,68E-03	4,138E-03
1,5	3,74E-04	5,56E-04	0,00E+00	5,12E-04	1,44E-03	3,48E-03	4,743E-03
2,5	2,59E-04	3,52E-04	0,00E+00	3,22E-04	9,33E-04	2,22E-03	2,044E-03
4,0	1,71E-04	2,16E-04	0,00E+00	1,97E-04	5,85E-04	1,38E-03	9,898E-04
6,0	1,14E-04	1,38E-04	0,00E+00	1,25E-04	3,77E-04	8,85E-04	5,461E-04
8,5	7,69E-05	9,32E-05	0,00E+00	8,41E-05	2,54E-04	5,97E-04	3,371E-04
15,0	3,84E-05	4,93E-05	0,00E+00	4,40E-05	1,32E-04	3,13E-04	1,620E-04
25,0	1,94E-05	2,84E-05	0,00E+00	2,50E-05	7,28E-05	1,78E-04	8,865E-05
40,0	9,90E-06	1,75E-05	0,00E+00	1,51E-05	4,26E-05	1,07E-04	5,285E-05
60,0	5,38E-06	1,08E-05	1,26E-04	7,30E-06	1,49E-04	6,35E-04	5,256E-04
80,0	3,44E-06	7,01E-06	8,84E-05	2,90E-06	1,02E-04	4,60E-04	2,577E-04
100,0	2,42E-06	4,91E-06	6,60E-05	1,23E-06	7,45E-05	3,50E-04	1,389E-04

Tab. C.III.59: Annual and lifelong IED for age group of children 2-7 years old [Sv]

Distance [km]	Cloud	Deposit dry	Deposit wet	Inhalation	Annual IED (sum)	Lifelong IED (without ingestion)	Ingestion (lifelong)
Category of atmosphere stability F							
0,5	2,14E-03	3,88E-03	0,00E+00	4,00E-03	1,00E-02	2,42E-02	3,672E-01
1,5	1,73E-03	3,01E-03	0,00E+00	3,05E-03	7,79E-03	1,88E-02	8,955E-02
2,5	1,44E-03	2,45E-03	0,00E+00	2,44E-03	6,33E-03	1,53E-02	3,967E-02
4,0	1,15E-03	1,90E-03	0,00E+00	1,85E-03	4,90E-03	1,19E-02	1,859E-02
6,0	8,86E-04	1,45E-03	0,00E+00	1,37E-03	3,71E-03	9,08E-03E	9,721E-03
8,5	6,77E-04	1,11E-03	0,00E+00	1,01E-03	2,80E-03	6,94E-03	5,595E-03
15,0	4,02E-04	6,78E-04	0,00E+00	5,67E-04	1,65E-03	4,19E-03	2,289E-03
25,0	2,34E-04	4,12E-04	0,00E+00	3,06E-04	9,52E-04	2,51E-03	1,016E-03
40,0	1,51E-04	2,73E-04	0,00E+00	1,71E-04	5,95E-04	1,64E-03	4,926E-04
60,0	1,02E-04	1,85E-04	0,00E+00	9,27E-05	3,80E-04	1,10E-03	2,640E-04
80,0	7,42E-05	1,35E-04	0,00E+00	5,38E-05	2,63E-04	7,93E-04	1,572E-04
100,0	5,57E-05	1,02E-04	0,00E+00	3,24E-05	1,90E-04	5,95E-04	9,996E-05
Category of atmosphere stability D (precipitation 5 mm/hour)							
0,5	6,26E-04	1,08E-03	1,92E-03	1,11E-03	4,74E-03	1,51E-02	8,373E-03
1,5	3,74E-04	5,50E-04	1,31E-03	5,50E-04	2,78E-03	9,16E-03	1,516E-02
2,5	2,59E-04	3,44E-04	9,99E-04	3,36E-04	1,94E-03	6,56E-03	8,247E-03
4,0	1,71E-04	2,09E-04	7,48E-04	1,96E-04	1,32E-03	4,63E-03	4,896E-03
6,0	1,13E-04	1,31E-04	5,67E-04	1,17E-04	9,29E-04	3,36E-03	3,153E-03
8,5	7,66E-05	8,68E-05	4,40E-04	7,26E-05	6,76E-04	2,52E-03	2,168E-03
15,0	3,81E-05	4,35E-05	2,85E-04	3,10E-05	3,97E-04	1,57E-03	1,152E-03
25,0	1,92E-05	2,32E-05	1,87E-04	1,29E-05	2,43E-04	1,02E-03	6,156E-04
40,0	9,76E-06	1,28E-05	1,23E-04	4,90E-06	1,51E-04	6,70E-04	3,152E-04
60,0	5,31E-06	7,47E-06	8,28E-05	1,73E-06	9,74E-05	4,51E-04	1,614E-04
80,0	3,42E-06	4,95E-06	6,05E-05	7,01E-07	6,96E-05	3,31E-04	9,581E-05
100,0	2,41E-06	3,51E-06	4,63E-05	3,08E-07	5,25E-05	2,53E-04	6,308E-05
Category of atmosphere stability D (precipitation 5 mm/hour from 40 km)							
0,5	6,26E-04	1,08E-03	0,00E+00	1,12E-03	2,83E-03	6,80E-03	3,922E-03
1,5	3,74E-04	5,56E-04	0,00E+00	5,73E-04	1,50E-03	3,54E-03	4,499E-02
2,5	2,59E-04	3,52E-04	0,00E+00	3,61E-04	9,71E-04	2,26E-03	1,939E-03
4,0	1,71E-04	2,16E-04	0,00E+00	2,21E-04	6,09E-04	1,40E-03	9,397E-04
6,0	1,14E-04	1,38E-04	0,00E+00	1,41E-04	3,92E-04	9,00E-04	5,187E-04
8,5	7,69E-05	9,32E-05	0,00E+00	9,43E-05	2,64E-04	6,07E-04	3,203E-04
15,0	3,84E-05	4,93E-05	0,00E+00	4,93E-05	1,37E-04	3,19E-04	1,540E-04
25,0	1,94E-05	2,84E-05	0,00E+00	2,80E-05	7,58E-05	1,81E-04	8,440E-05
40,0	9,90E-06	1,75E-05	0,00E+00	1,70E-05	4,44E-05	1,09E-04	5,038E-05
60,0	5,38E-06	1,08E-05	1,26E-04	8,19E-06	1,50E-04	6,36E-04	4,880E-04
80,0	3,44E-06	7,01E-06	8,84E-05	3,26E-06	1,02E-04	4,60E-04	2,482E-04
100,0	2,42E-06	4,91E-06	6,60E-05	1,39E-06	7,47E-05	3,50E-04	1,399E-04

Tab. C.III.60: Annual and lifelong IED for age group of adults [Sv]

Distance [km]	Cloud	Deposit dry	Deposit wet	Inhalation	Annual IED (sum)	Lifelong IED (without ingestion)	Ingestion (lifelong)
Category of atmosphere stability F							
0,5	2,14E-03	3,88E-03	0,00E+00	2,67E-04	6,29E-03	2,05E-02	4,285E-01
1,5	1,73E-03	3,01E-03	0,00E+00	2,04E-04	4,94E-03	1,60E-02	1,099E-01
2,5	1,44E-03	2,45E-03	0,00E+00	1,63E-04	4,05E-03	1,30E-02	5,045E-02
4,0	1,15E-03	1,90E-03	0,00E+00	1,24E-04	3,17E-03	1,02E-02	2,463E-02
6,0	8,86E-04	1,45E-03	0,00E+00	9,22E-05	2,43E-03	7,80E-03	1,344E-02
8,5	6,77E-04	1,11E-03	0,00E+00	6,84E-05	1,86E-03	5,99E-03	8,083E-03
15,0	4,02E-04	6,78E-04	0,00E+00	3,86E-05	1,12E-03	3,66E-03	3,609E-03
25,0	2,34E-04	4,12E-04	0,00E+00	2,10E-05	6,67E-04	2,23E-03	1,771E-03
40,0	1,51E-04	2,73E-04	0,00E+00	1,20E-05	4,36E-04	1,48E-03	9,632E-04
60,0	1,02E-04	1,85E-04	0,00E+00	6,71E-06	2,94E-04	1,02E-03	5,848E-04
80,0	7,42E-05	1,35E-04	0,00E+00	4,05E-06	2,13E-04	7,43E-04	3,848E-04
100,0	5,57E-05	1,02E-04	0,00E+00	2,56E-06	1,60E-04	5,65E-04	2,643E-04
Category of atmosphere stability D (precipitation 5 mm/hour)							
0,5	6,26E-04	1,08E-03	1,92E-03	7,43E-05	3,70E-03	1,40E-02	8,021E-03
1,5	3,74E-04	5,50E-04	1,31E-03	3,69E-05	2,27E-03	8,65E-03	1,380E-02
2,5	2,59E-04	3,44E-04	9,99E-04	2,25E-05	1,62E-03	6,25E-03	7,428E-03
4,0	1,71E-04	2,09E-04	7,48E-04	1,32E-05	1,14E-03	4,45E-03	4,427E-03
6,0	1,13E-04	1,31E-04	5,67E-04	7,93E-06	8,19E-04	3,25E-03	2,902E-03
8,5	7,66E-05	8,68E-05	4,40E-04	4,95E-06	6,09E-04	2,46E-03	2,053E-03
15,0	3,81E-05	4,35E-05	2,85E-04	2,15E-06	3,69E-04	1,54E-03	1,189E-03
25,0	1,92E-05	2,32E-05	1,87E-04	9,22E-07	2,31E-04	1,01E-03	7,296E-04
40,0	9,76E-06	1,28E-05	1,23E-04	3,73E-07	1,46E-04	6,65E-04	4,564E-04
60,0	5,31E-06	7,47E-06	8,28E-05	1,49E-07	9,58E-05	4,50E-04	2,953E-04
80,0	3,42E-06	4,95E-06	6,05E-05	7,14E-08	6,90E-05	3,30E-04	2,111E-04
100,0	2,41E-06	3,51E-06	4,63E-05	3,91E-08	5,23E-05	2,53E-04	1,592E-04
Category of atmosphere stability D (precipitation 5 mm/hour from 40 km)							
0,5	6,26E-04	1,08E-03	0,00E+00	7,50E-05	1,79E-03	5,75E-03	4,514E-03
1,5	3,74E-04	5,56E-04	0,00E+00	3,83E-05	9,69E-04	3,01E-03	5,205E-03
2,5	2,59E-04	3,52E-04	0,00E+00	2,41E-05	6,35E-04	1,92E-03	2,251E-03
4,0	1,71E-04	2,16E-04	0,00E+00	1,48E-05	4,02E-04	1,20E-03	1,094E-03
6,0	1,14E-04	1,38E-04	0,00E+00	9,40E-06	2,61E-04	7,69E-04	6,060E-04
8,5	7,69E-05	9,32E-05	0,00E+00	6,31E-06	1,76E-04	5,19E-04	3,755E-04
15,0	3,84E-05	4,93E-05	0,00E+00	3,30E-06	9,10E-05	2,73E-04	1,818E-04
25,0	1,94E-05	2,84E-05	0,00E+00	1,88E-06	4,97E-05	1,55E-04	1,003E-04
40,0	9,90E-06	1,75E-05	0,00E+00	1,14E-06	2,86E-05	9,35E-05	6,044E-05
60,0	5,38E-06	1,08E-05	1,26E-04	5,62E-07	1,43E-04	6,28E-04	4,740E-04
80,0	3,44E-06	7,01E-06	8,84E-05	2,39E-07	9,91E-05	4,57E-04	3,197E-04
100,0	2,42E-06	4,91E-06	6,60E-05	1,13E-07	7,34E-05	3,49E-04	2,322E-04

C.III.19.1.7.2. Radiation impacts of design basis accident initiated out of reactor cooling system

Radiation impacts of design basis accident initiated out of reactor cooling system (the release through ventilation stack with the height 100 m or 56m) were analysed by the software RTARC 6.1 (contributions from all paths of the exposure except the ingestion) and RDEBO (only the contribution from the ingestion of contaminated food) for all 6 age groups. The calculation are performed for these variants of the atmospheric conditions:

(1) category of atmosphere stability F without precipitation,
(2) category of atmosphere stability D with the intensity of precipitation 5 mm/hour for all distances,
(3) category of atmosphere stability D with the intensity of precipitation 5 mm/hour from the distance 40 km from the NJZ.

The results of the analysis are presented below in the table form. From the results follow, for presented variants of the calculations (1) to (3), these conclusions:

(1) With not considering of the ingestion, critical age group are children in the age 2-7 years. Maximum annual individual equivalent dose (IED) in the distance ≥800 m is je <5 mSv/year (for the distance 500 m and the stack with the height 100 m: 2,86 mSv/year; for the stack with the height 56 m: 4,57 mSv/year) and in the distance 40 km (cross border impact – Czech Republic, Austria) the values is <1 mSv/year (the stack with the height 100 m: 0,29 mSv/year; for the stack with the height 56 m: 0,324 mSv/year).

In terms of the ingestion of contaminated food, critical age group are children 1-2 years old.

Maximum calculated overall value of annual IED (i.e. including ingestion), for the individual from the critical group of population permanently living in the immediate surrounding of the NJZ, is under the value of 5 mSv/year (lower limit for the application of the limitations for food according to the governmental regulation SR No. 345/2006 Coll.) for all age groups and the stack 100 m and also for the stack 56 m.

(2) With not considering of the ingestion, critical age group are children in the age 2-7 years. Maximum annual IED in the distance ≥800 m is <5 mSv/year (for the distance 500 m and the stack with the height 100 m: 1,01 mSv/year; for the stack 56 m: 1,35 mSv/year).

In terms of the ingestion of contaminated food, critical age group are children 1-2 years old. Maximum annual (lifelong) IED from the ingestion, in the nearest permanently inhabited area, is <1 mSv.

Overall maximum annual (lifelong) IED from all paths of the exposure is <5 mSv for all age groups already from the distance 500 m.

(3) Within the distance ~40 km, calculated values of IED are more favourable (smaller) in comparison with the analysis – variant (2). In terms of possible cross border impact (distances ≥40 km), maximum annual value of IED without ingestion is 0,0203 mSv/year for the stack 100 m height, calculated for the distance 40 km and age group of children 2-7 years old or for the stack 56 m height: 0,021 mSv/year. Overall maximum annual (lifelong) IED from all paths of the exposure for the distances ≥40 km is <0,1 mSv for all age groups.

The following figures present, for calculation variants (1), (2) and (3), maximum calculated values for annual IED without ingestion consideration and also overall IED with the inclusion of the contribution from the annual ingestion of contaminated food (the contribution to lifelong IED) depending on the distance from the NJZ.

Figure C.III.22: Annual IED without ingestion and with the inclusion of the contribution from annual ingestion of contaminated food for design basis accident with the release through the stack and the category of atmosphere stability F

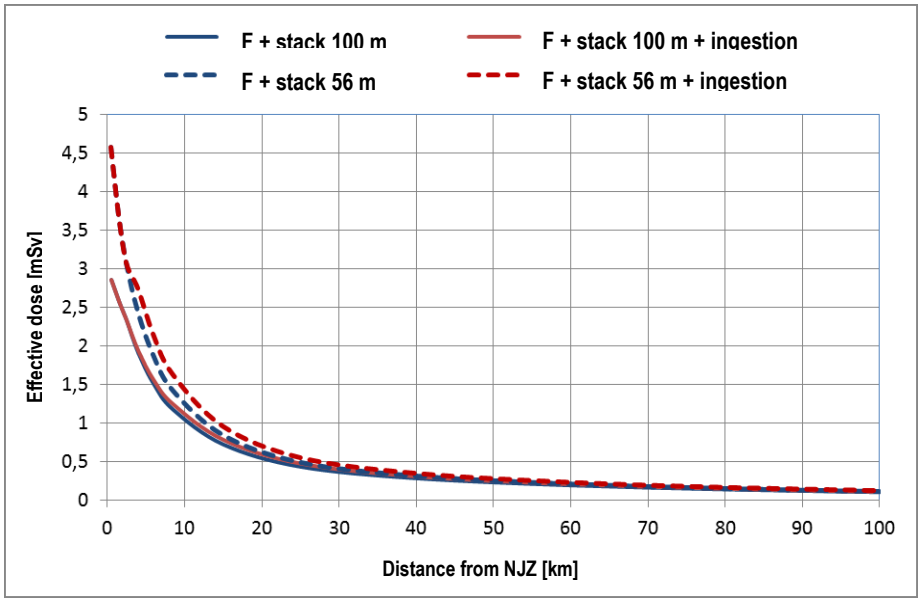


Figure C.III.23: Annual IED without ingestion and with the inclusion of the contribution from annual ingestion of contaminated food for design basis accident with the release through the stack and the category of atmosphere stability D with precipitation 5 mm/h

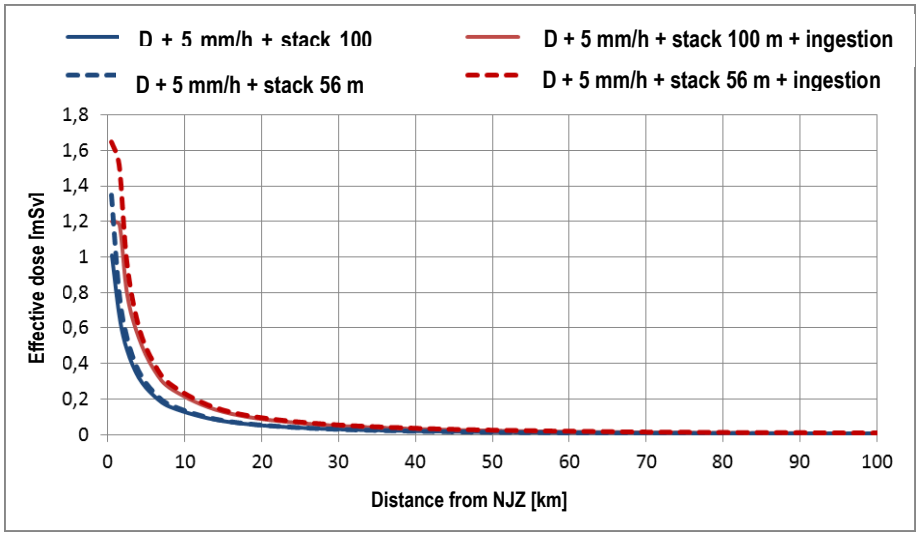
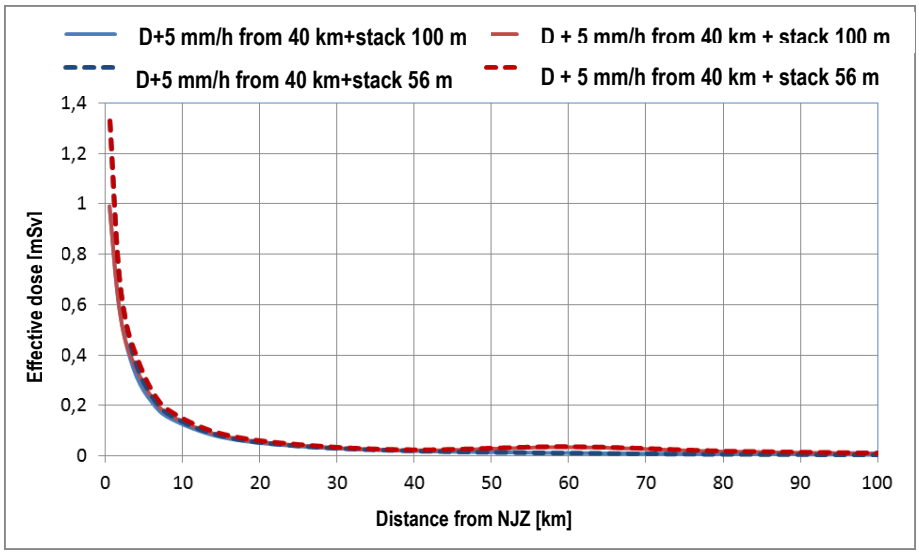


Figure C.III.24: Annual IED without ingestion and with the inclusion of the contribution from annual ingestion of contaminated food for design basis accident with the release through the stack and the category of atmosphere stability D with precipitation 5 mm/h from the distance 40 km



In the distance of 500 m from the NJZ, for critical age group of children 2-7 years old (with not considering of the contribution from the ingestion), height of the stack 56 m and for stability category F without contribution, there are calculated the following values of IED: 4,56 mSv/2days, 4,57 mSv/7days and the contribution of equivalent dose in thyroid gland 7,18 mSv. For stability category D with contribution 5 mm/hour, there are calculated the following values of IED: 1,34 mSv/2days, 1,35 mSv/7days and the contribution of equivalent dose in thyroid gland 1,42 mSv.

From presented results follows that the implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) in the distance ≥800 m from the reactor is not necessary.

In terms of possible cross border impact (distances ≥40 km), calculated results have confirmed that overall maximum annual IED from all pathd of the exposure, i.e. also with the inclusion of the contribution (the contribution to lifelong dose) from annual ingestion of contaminated food, does not even exceed limit value 1 mSv/year for normal and abnormal operation conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103).

Due to the fact that radiation results of this group of events lead to lower effects as design basis accidents initiated in reactor cooling system, table results are presented only for the age group of children 2-7 years old, for who the highest IED have been calculated. Table results are presented only for the stack 56 m that leads to higher IED than the stack 100 m in all variants.

From the analysis of results of exposure paths follows that the most important nuclides are noble gases Kr-88, Xe-138, Kr-87 (cloud) and in smaller extend iodine I-131, I-133 (inhalation and deposit) for external paths of the exposure. Percentage composition of the contribution depends on the meteorological conditions. The contribution from internal exposure from ingestion is created nearly exclusively by the nuclide I-131. The contribution from internal exposure from ingestion on overall lifelong IED depends on the meteorological conditions, but it is smaller than the contribution from external paths of the exposure in all distances.

Tab. C.III.61: Annual and lifelong IED for age group of children 2-7 years old [Sv], stack 56 m

Distance [km]	Cloud	Deposit dry	Deposit wet	Inhalation	Annual IED (sum)	Lifelong IED (without ingestion)	Ingestion (lifelong)
Category of atmosphere stability F							
0,5	4,20E-03	2,02E-05	0,00E+00	3,57E-04	4,57E-03	4,57E-03	2,125E-09
1,5	3,40E-03	1,53E-05	0,00E+00	2,76E-04	3,69E-03	3,69E-03	8,082E-05
2,5	2,83E-03	1,23E-05	0,00E+00	2,24E-04	3,07E-03	3,07E-03	2,396E-04
4,0	2,25E-03	9,28E-06	0,00E+00	1,73E-04	2,44E-03	2,44E-03	2,959E-04
6,0	1,74E-03	6,86E-06	0,00E+00	1,32E-04	1,88E-03	1,88E-03	2,562E-04
8,5	1,33E-03	5,06E-06	0,00E+00	1,00E-04	1,43E-03	1,43E-03	1,956E-04
15,0	7,89E-04	2,80E-06	0,00E+00	6,07E-05	8,53E-04	8,53E-04	1,052E-04
25,0	4,61E-04	1,49E-06	0,00E+00	3,66E-05	5,00E-04	5,00E-04	5,207E-05
40,0	2,99E-04	8,24E-07	0,00E+00	2,45E-05	3,24E-04	3,24E-04	2,493E-05
60,0	2,03E-04	4,40E-07	0,00E+00	1,72E-05	2,20E-04	2,20E-04	1,197E-05
80,0	1,47E-04	2,53E-07	0,00E+00	1,33E-05	1,61E-04	1,61E-04	6,232E-06
100,0	1,11E-04	1,52E-07	0,00E+00	1,09E-05	1,22E-04	1,22E-04	3,404E-06
Category of atmosphere stability D (precipitation 5 mm/hour)							
0,5	1,23E-03	5,61E-06	1,82E-05	9,94E-05	1,35E-03	1,35E-03	2,985E-04
1,5	7,34E-04	2,77E-06	1,20E-05	5,01E-05	7,99E-04	7,99E-04	7,187E-04
2,5	5,08E-04	1,69E-06	8,98E-06	3,11E-05	5,50E-04	5,50E-04	4,205E-04
4,0	3,36E-04	9,88E-07	6,49E-06	1,86E-05	3,62E-04	3,62E-04	2,522E-04
6,0	2,23E-04	5,89E-07	4,69E-06	1,15E-05	2,40E-04	2,40E-04	1,618E-04
8,5	1,51E-04	3,65E-07	3,44E-06	7,46E-06	1,62E-04	1,62E-04	1,091E-04
15,0	7,52E-05	1,55E-07	1,91E-06	3,59E-06	8,09E-05	8,09E-05	5,539E-05
25,0	3,79E-05	6,42E-08	9,93E-07	1,83E-06	4,08E-05	4,08E-05	2,757E-05
40,0	1,94E-05	2,42E-08	4,58E-07	9,78E-07	2,08E-05	2,08E-05	1,235E-05
60,0	1,06E-05	8,50E-09	1,91E-07	5,79E-07	1,13E-05	1,13E-05	5,115E-06
80,0	6,80E-06	3,44E-09	8,86E-08	4,09E-07	7,30E-06	7,30E-06	2,378E-06
100,0	4,81E-06	1,53E-09	4,48E-08	3,18E-07	5,17E-06	5,17E-06	1,207E-06
Category of atmosphere stability D (precipitation 5 mm/hour from 40 km)							
0,5	1,23E-03	5,66E-06	0,00E+00	9,99E-05	1,33E-03	1,33E-03	2,396E-06
1,5	7,34E-04	2,89E-06	0,00E+00	5,12E-05	7,88E-04	7,88E-04	8,174E-05
2,5	5,08E-04	1,82E-06	0,00E+00	3,24E-05	5,42E-04	5,42E-04	5,722E-05
4,0	3,36E-04	1,11E-06	0,00E+00	1,99E-05	3,57E-04	3,57E-04	3,377E-05
6,0	2,23E-04	7,07E-07	0,00E+00	1,27E-05	2,36E-04	2,36E-04	2,037E-05
8,5	1,51E-04	4,73E-07	0,00E+00	8,55E-06	1,60E-04	1,60E-04	1,305E-05
15,0	7,52E-05	2,47E-07	0,00E+00	4,51E-06	8,00E-05	8,00E-05	6,463E-06
25,0	3,79E-05	1,40E-07	0,00E+00	2,59E-06	4,07E-05	4,07E-05	3,581E-06
40,0	1,94E-05	8,39E-08	0,00E+00	1,59E-06	2,10E-05	2,10E-05	2,156E-06
60,0	1,06E-05	4,01E-08	8,77E-07	9,09E-07	1,24E-05	1,24E-05	2,368E-05
80,0	6,80E-06	1,58E-08	3,87E-07	5,42E-07	7,75E-06	7,75E-06	1,044E-05
100,0	4,81E-06	6,66E-09	1,80E-07	3,76E-07	5,37E-06	5,37E-06	4,883E-06

C.III.19.1.7.3. Radiation impacts of severe accident

The main results of the analysis of radiation impacts, performed by probabilistic calculation software COSYMA for envelope source term of severe accident, are presented in the following tables namely for *medium values* of doses and for the values corresponding to *95 % of the quantile*. In the tables, there are presented calculated assumed (forecasted) IED (2-days, 7-days, 1-year and lifelong), lifelong equivalent doses for thyroid gland and avoidable ones by the application of iodine prophylaxis and lifelong IED with the inclusion of contaminated food ingestion.

Tab. C.III.62: Forecasted and avoidable medium values of IED and equivalent doses for age group of adults [Sv]

Distance [km]	IED for 2 days	IED for 7 days	IED for 1 year	Lifelong equivalent dose for thyroid gland	Avoidable iodine prophylaxis	Lifelong IED	Lifelong IED with ingestion (Slovak basket)	Lifelong IED with ingestion (Austrian basket)
0,5	7,16E-03	9,06E-03	1,20E-02	9,51E-02	8,27E-02	1,34E-02	6,28E-02	5,91E-02
1,5	1,83E-03	2,22E-03	2,83E-03	2,00E-02	1,73E-02	3,14E-03	1,32E-02	1,24E-02
2,5	8,41E-04	1,01E-03	1,29E-03	8,80E-03	7,63E-03	1,43E-03	6,01E-03	5,65E-03
4,0	3,86E-04	4,62E-04	5,87E-04	3,94E-03	3,41E-03	6,54E-04	2,74E-03	2,58E-03
8,5	1,07E-04	1,27E-04	1,62E-04	1,05E-03	9,02E-04	1,82E-04	8,49E-04	7,98E-04
20,0	2,32E-05	2,83E-05	3,78E-05	2,59E-04	2,22E-04	4,38E-05	2,24E-04	2,09E-04
30,0	1,27E-05	1,58E-05	2,16E-05	1,60E-04	1,40E-04	2,51E-05	1,19E-04	1,11E-04
40,0	5,56E-06	7,21E-06	1,04E-05	8,14E-05	7,15E-05	1,24E-05	7,31E-05	6,80E-05
50,0	4,09E-06	5,47E-06	8,13E-06	6,79E-05	6,02E-05	9,83E-06	5,68E-05	5,28E-05
60,0	3,20E-06	4,38E-06	6,68E-06	5,78E-05	5,14E-05	8,17E-06	4,90E-05	4,55E-05
80,0	1,48E-06	2,11E-06	3,41E-06	3,01E-05	2,67E-05	4,32E-06	3,40E-05	3,15E-05
100,0	9,00E-07	1,33E-06	2,24E-06	2,04E-05	1,82E-05	2,89E-06	2,33E-05	2,16E-05

Software COSYMA enables the calculation of avoidable IED by sheltering for only 24 hours (limitation of the code) and not for 48 hours. These avoidable doses are not presented in the tables, because the utilization of 2-days forecasted IED assures the conservative approach. In case of 7-days forecasted dose, it is also conservatively assumed that complete dose (i.e. forecasted = avoidable dose) will be stave off by the evacuation.

From the presented medium values, calculated forecasted (2-days and 7-days) and lifelong equivalent doses for thyroid gland avoidable by the implementation of iodine prophylaxis results that it will not be necessary to implement immediate measures of the type of sheltering, iodine prophylaxis and evacuation in the distance bigger than 800 m.

Tab. C.III.63: Forecasted and avoidable values of IED and equivalent doses corresponding to 95 % of the quantile, for age group of adults [Sv]

Distance [km]	IED for 2 days	IED for 7 days	IED for 1 year	Lifelong equivalent dose for thyroid gland	Avoidable iodine prophylaxis	Lifelong IED	Lifelong IED with ingestion Slovak basket)	Lifelong IED with ingestion (Austrian basket)
0,5	3,98E-02 *	5,01E-02 *	6,61E-02	5,13E-01	4,42E-01 *	7,24E-02	3,55E-01	3,31E-01
1,5	7,94E-03	9,12E-03	1,12E-02	6,92E-02	5,72E-02	1,23E-02	4,68E-02	4,37E-02
2,5	3,47E-03	3,98E-03	4,90E-03	2,82E-02	2,32E-02	5,50E-03	1,95E-02	1,82E-02
4,0	1,62E-03	1,86E-03	2,34E-03	1,29E-02	1,05E-02	2,63E-03	8,51E-03 **	7,94E-03
8,5	6,17E-04	7,41E-04	9,12E-04	5,13E-03	4,26E-03	9,77E-04	3,55E-03	3,24E-03
20,0	1,23E-04	1,55E-04	2,00E-04	1,48E-03	1,28E-03	2,34E-04	1,05E-03	9,77E-04
30,0	4,17E-05	5,75E-05	8,13E-05	6,46E-04	5,72E-04	9,55E-05	5,75E-04	5,25E-04
40,0	2,14E-05	2,95E-05	4,68E-05	4,27E-04	3,81E-04	5,75E-05	3,47E-04	3,16E-04
50,0	1,51E-05	2,09E-05	3,39E-05	3,16E-04	2,85E-04	3,98E-05	2,82E-04	2,63E-04
60,0	1,10E-05	1,78E-05	2,88E-05	2,69E-04	2,44E-04	3,55E-05	2,29E-04	2,14E-04
80,0	4,68E-06	8,32E-06	1,55E-05	1,45E-04	1,30E-04	2,04E-05	1,32E-04	1,23E-04
100,0	2,75E-06	4,37E-06	1,05E-05	1,02E-04	9,30E-05	1,35E-05	9,55E-05	8,91E-05

* Distance of the exceeding of avoidable dose level (10 mSv/48 hours for sheltering, 50 mSv/7 days for the evacuation and 100 mSv for lifelong equivalent dose for thyroid gland avoidable by the implementation of iodine prophylaxis).

** According the governmental regulation SR No. 345/2006 Coll. (the Annex No. 10, Table No. 4) indicative value of intervention level for the subsequent measures "Control of the consumption of food, water and feed contaminated by radionuclides, for annual IED from ingestion has the range: 5 mSv to 50 mSv. Lower limit 5 mSv is exceeded maximum within the distance 5 km (Note: Calculation point 4 km corresponds to the annulus 3-5 km). However, it is necessary to point out that calculated value 8,51 mSv corresponds to lifelong IED from the ingestion and provided that corresponding annual IED from the ingestion would be smaller than lifelong one (presented fact results from the comparison of annual and lifelong conservative factors for the ingestion for crucial radionuclides – e.g. Sr-90, Cs-137 and Cs-134).

From presented values of 95 % of quantiles, calculated, forecasted (2-days and 7-days) and lifelong equivalent doses for thyroid gland avoidable by the implementation of iodine prophylaxis results that the implementation of immediate measures of the type of sheltering, iodine prophylaxis and evacuation would be necessary to implement maximum within the distance approximately 1 km. It means that the requirements of ÚJD SR according BNS I.11.1/2013 and WENRA 2013 (evacuation only in immediate vicinity of the NJZ, limited sheltering) are met with sufficient reserve. However, it is necessary to point out that used envelope source term for severe accident is significantly conservative (there was not applied linear combination for the limitation of short-time effects of severe accident). Therefore, it is possible to assume that real evaluated source term into the environment for particular design of selected NJZ will be smaller and also the requirement EUR for the exclusion of immediate measures in the distance bigger than 800 m from the reactor will be met with the sufficient reserve. Note: calculation distance 1,5 km corresponds to the annulus 1 to 2 km.

The data also clearly shows that even the value of lifelong effective IED with the inclusion of contaminated food ingestion does not exceed the value of 1 mSv in the distances ≥40 km (evaluation of possible cross border impact).

Probabilistic software COSYMA has predefined the age group adults as a representative one (the most numerous age group; used converse factors from the inhalation corresponds to age group "adults" and they are in-built in source code, i.e. code user can change them). Dose factors from external exposure are the same for all age groups. With the group of babies, there are applied higher converse coefficients for the inhalation that are compensated by several times lower speed of breathing for babies. In the result, there are calculated effective (forecasted/avoidable) doses for age group of babies as doses for adults about the factor not bigger than 1,3 for all considered distances. Such factors do not have any impact to the size of distances, where are reached intervention levels for immediate measures and therefore they do not influence conclusions and results of the analysis.

The results are graphically processed in the following figures.

Figure C.III.25: Forecasted IED in 2 days, in 7 days, in 1 year, lifelong IED without the ingestion, lifelong IED with the ingestion (Slovak basket) and lifelong IED with the ingestion (Austrian basket)

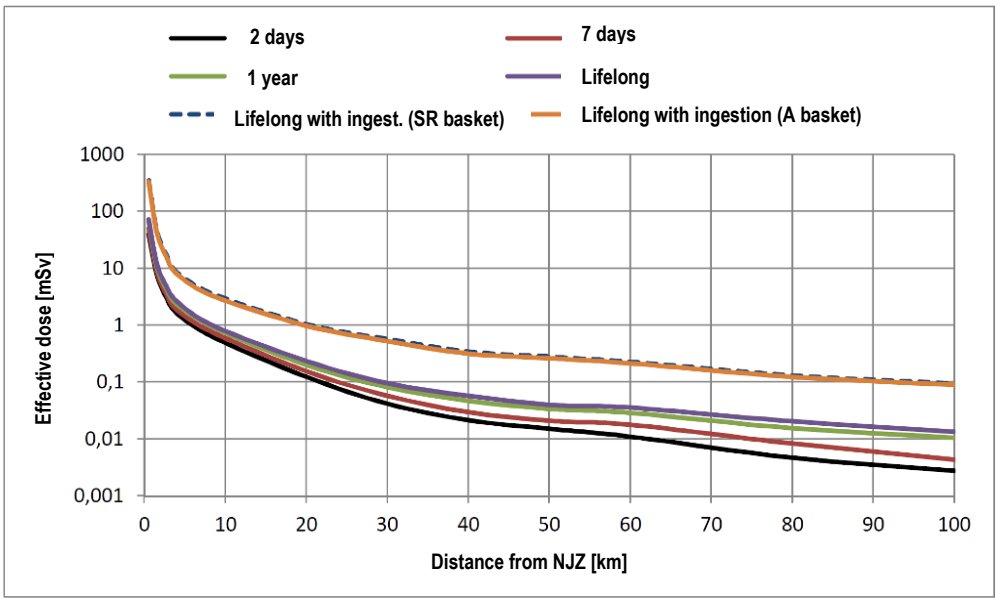


Figure C.III.26: Forecasted IED in 2 days and 7 days, the comparison with intervention level for the sheltering (10 mSv/2 days) and for the evacuation (50 mSv/7 days)

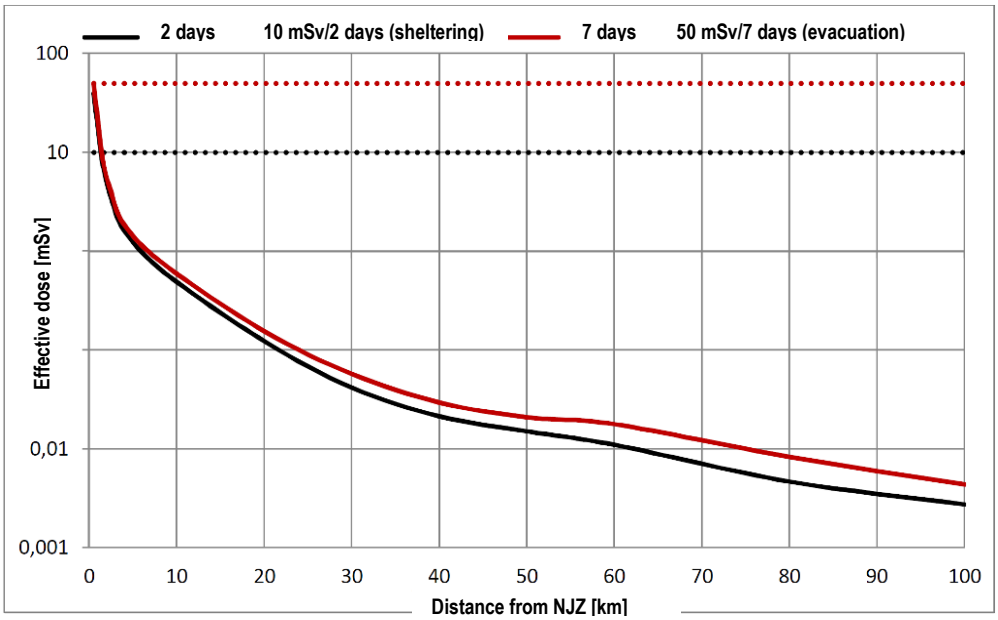
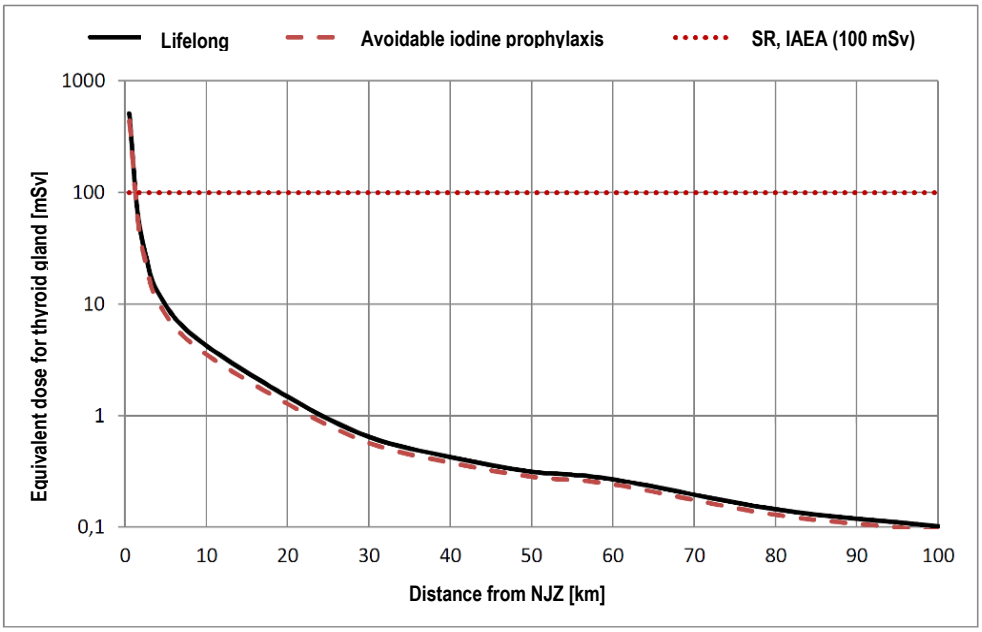


Figure C.III.27: Lifelong equivalent dose for thyroid gland and avoidable one by the application of iodine prophylaxis, comparison with the intervention level 100 mSv for the application of iodine prophylaxis



In the following table, there is presented time integral of radioactivity concentration (TIC) in the atmosphere, near over earth surface and maximum level of surface contamination.

Tab. C.III.64: Time integral of concentration (TIC) and deposit (maximum values) depending on the distance

Distance [km]	TIC [Bq.s/m^3]	Total deposit [Bq/m^2]
0,5	1,52E+12	4,75E+08
1,5	1,97E+11	5,77E+07
2,5	8,01E+10	2,40E+07
4,0	3,75E+10	1,15E+07
6,0	2,27E+10	6,62E+06
8,5	1,47E+10	4,30E+06
20,0	4,56E+09	1,23E+06
30,0	2,10E+09	5,32E+05
40,0	1,40E+09	3,38E+05
60,0	9,33E+08	1,99E+05
80,0	5,32E+08	1,12E+05
100,0	4,02E+08	7,89E+04

From the analysis of results of individual exposure paths during severe accident follows that the most important nuclides are noble gases Kr-88, Xe-133 (cloud), iodine I-131 and I-133 (inhalation and deposit) and nuclides Cs-134 and Cs-137 (deposit) for external paths of the exposure. External exposure from the passing cloud and internal exposure from the inhalation has the biggest impact to short-time doses and annual doses. The importance of the deposit and the cloud increases with lifelong doses, then the inhalation and the deposit participate approximately equally on lifelong dose from external paths of the exposure. The contribution from internal exposure from ingestion is bigger in all distances than the contribution from external paths of the exposure and it creates approximately 75 % of lifelong dose. Dominant contributions from the ingestion are from nuclides I-131 and Cs-134 (both participates through 30 % and the contribution from Cs-137 is a little bit lower (up to 20 %).

C.III.19.1.7.4. Radiation impacts of severe accident for maximized fall of radionuclides in the water reservoir Sĺňava

With the utilization of calculation software RDEBO, severe accident with the assumption of radionuclides fall to complete area of the nearest water reservoir near the Váh River (Sĺňava, zone No. 43, distance 15 km from the site of the NJZ, direction VSV) is also analysed due to strong intensity of precipitation after approaching of radionuclides cloud to this water reservoir with consequent contamination of water flow of the Váh River and the Danube River and with the assessment of radiation effects in the zones No. 43 (Sĺňava and surrounding environment), No. 95 (river confluence of the Váh River and the Danube River) and No. 96 (Hungary, the Danube River behind the confluence with the Váh River).

- For calculation analyse, there were used the following assumptions providing conservative estimation of radiation effects:
- Source term of the release into the environment for severe accident (see chapter C.III.19.1.6.2.4. Quantitative determination of source term for accidents, page 367 of this Report).
- Category of atmosphere stability D during total period of the release (24 hours) as well as the period of radioactive cloud passing over the water reservoir Sĺňava.
- Wind direction: from ZJZ to VSV to Sĺňava, wind speed: 5 m/s.
- Radioactive cloud washout into Sĺňava with the intensity of precipitation from the distance 15 km from the NJZ site over water surface of Sĺňava: 5 mm/hour.
- Radioactive fall is considered that it will affect complete area of water reservoir Sĺňava (~5 km^2) and its near surroundings. It is assumed that the fall near water reservoir is washed away into the water of Sĺňava. The point with maximum concentration of the fall is conservatively considered for total area of the fall. Complete source term (i.e. fall + radionuclides washing away into water reservoir Sĺňava) is presented in the following table, in which, for the comparison, also conservative source term for the releases from the containment with severe accident is presented.
- Average water flow through the Váh River (140 m^3/s) and the Danube River (2400 m^3/s).
- Neither the impact of sediments to the decreasing of radionuclides volume concentration in water in the direction of water flow of the Váh River to the firth into the Danube River nor the control in water reservoir Kráľová (i.e. the impact to the decreasing of radionuclides concentration behind this dam) is conservatively considered.

- Radionuclides decay on the route in the direction to Hungary is considered.
- Age category: adults.
- As a reference basket is considered (also for Hungary) Austrian consumption basket, which is, in the comparison with Slovak one, more conservative for age category of adults and radionuclides releases into the hydrosphere.

Tab. C.III.65: Conservative source term into the environment for severe accidents (ground release) and fall into Sĺňava

Nuclide	Source term [Bq]	Fall into Sĺňava [Bq]	Nuclide	Source term [Bq]	Fall into Sĺňava [Bq]
Xe-133	3,50E+17	-	Te-131m	2,00E+13	3,40E+10
Kr-85	2,10E+15	-	Sb-127	1,60E+13	-
Kr-85m	5,30E+16	-	Sb-129	4,60E+13	-
Kr-87	1,10E+17	-	Te-129m	8,00E+12	3,95E+10
Kr-88	1,40E+17	-	Te-132	2,00E+14	6,67E+11
Xe-131m	2,10E+15	-	Sr-90	5,00E+12	3,00E+11
Xe-133m	1,10E+16	-	Sr-89	6,00E+13	2,57E+10
Xe-135	1,10E+17	-	Sr-91	7,50E+13	1,16E+10
Xe-135m	7,70E+16	-	Ru-103	3,00E+12	1,47E+10
Xe-138	3,20E+17	-	Mo-99	4,00E+12	1,25E+10
I-131	1,00E+15	2,28E+13	La-140	5,00E+12	1,13E+10
I-132	1,50E+15	2,01E+07	Y-91	4,00E+12	2,01E+10
I-133	2,10E+15	1,16E+13	Ce-141	4,00E+12	1,97E+10
I-134	2,30E+15	0,0	Ce-144	3,00E+12	1,54E+10
I-135	2,00E+15	3,59E+11	Np-239	4,80E+13	1,37E+11
Cs-137	3,00E+13	1,54E+11	Ba-140	1,00E+14	4,62E+11
Cs-134	6,00E+13	3,08E+11	Iodine forms: 25 % aerosol, 30 % elementary and 45 % organic iodine		
Cs-136	1,50E+13	6,94E+10	Duration of kind of release: 24 hours, ground release		

Volume concentrations of radionuclides are, for the zones No. 43 (Sĺňava), No. 95 (Váh near the confluence with Danube, Slovakia) and No. 96 (Danube just after the confluence with Váh, Hungary – marked with grey shading) presented in the following table. The decrease of radionuclides concentration in the zone No. 95 due to the zone No. 43 is caused by radioactive decay, approximately the decrease of radionuclides concentration in the order in the zone No. 96 due to the zone No. 95 is caused by the dilution of contaminated water from the Váh River in the Danube River.

Tab. C.III.66: Concentration of radionuclides in Sĺňava (zone No. 43), the Váh River (zone No. 95) and in the Danube River (zone No. 96)

Nuclide	Zone No. 43	Zone No. 95	Zone No. 96	Nuclide	Zone No. 43	Zone No. 95	Zone No. 96
	Volume activity [Bq/m^3]				Volume activity [Bq/m^3]		
Sr-89	2,32E+04	2,25E+04	1,42E+03	I-133	8,75E+05	1,69E+05	1,91E+04
Sr-90	1,99E+03	1,98E+03	1,24E+02	I-135	2,60E+04	1,30E+02	5,99E+01
Sr-91	8,60E+02	2,13E+01	5,37E+00	Cs-134	2,38E+04	2,37E+04	1,48E+03
Y-91	1,55E+03	1,51E+03	9,54E+01	Cs-136	5,35E+03	4,79E+03	3,12E+02
Mo-99	9,54E+02	5,61E+02	4,28E+01	Cs-137	1,19E+04	1,19E+04	7,44E+02
Ru-103	1,13E+03	1,09E+03	6,91E+01	Ba-140	8.56E+04	3.17E+04	2.07E+03
Te-129m	3,05E+03	2,92E+03	1,85E+02	La-140	8,62E+02	3,61E+02	3,13E+01
Te-131m	2,59E+03	8,05E+02	7,81E+01	Ce-141	1,52E+03	1,45E+03	9,24E+01
Te-132	5,11E+04	3,23E+04	2,40E+03	Ce-144	1,19E+03	1,18E+03	7,38E+01
I-131	1,76E+06	1,47E+06	9,81E+04	Np-239	1,05E+04	5,65E+03	4,46E+02
I-132	1,30E+00	2,81E-07	5,72E-08				

The results of performed analysis of radiation effects are presented in the following table.

Tab. C.III.67: Values of annual IED for age group of adults – severe accident with maximization of the fall to water surface of the dam SÍňava

Exposition path	Zone No. 43 (SÍňava and surrounding)	Zone No. 95 (Váh before the confluence with Danube)	Zone No. 96 (Danube - Hungary)
	Annual IED [Sv/year]		
ID1: Swimming or boating	5,416E-06	2,958E-06	2,190E-07
ID2: Contamination by coastal silts *	2,358E-07	2,125E-07	1,366E-08
ID3: Stay on irrigated soil *	4,177E-08	4,077E-08	2,570E-09
ID4: Ingestion of contaminated drinking water **	6,553E-05	5,090E-05	3,461E-06
ID5: Ingestion of contaminated fish **	2,102E-04	1,660E-04	1,122E-05
ID6: Ingestion of food contaminated by irrigations **	3,363E-04	3,010E-04	1,960E-05
Sum	6,177E-04	5,212E-04	3,450E-05

* With the calculation of the contribution of extreme exposure from contaminated coastal silts is assumed that the individual from the monitored group spends approximately 1000 hours on the riverside every year (in this case river SÍňava – fishing, laying on the beach, etc.). Calculation method and the data on the duration of the stay on the beach during a year ($3{,}6.10^6$ seconds) and the duration of the stay on irrigated soil ($1{,}8.10^6$ seconds) were adopted from IAEA Safety Report Series No.19.

** The contribution of lifelong IED from annual consummation of contaminated food and drinking water. It is conservatively assumed that the dose from drinking water consummation is the same as with the consummation of the water from the dam SÍňava or from the Váh River under SÍňava. Software RDEBO assumes conservatively that an individual from age group of adults drinks 700 l of water per year with the same volume concentration of radionuclides.

Calculated results confirm that the intervention levels for countermeasures implementation are not exceeded in the evaluated critical zones (zones No. 43, No. 95 or No. 96 in terms of neighbouring state – Hungary) in no case. Even the limit of annual IED 1 mSv/year for normal and abnormal operational conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103) is not exceeded with sufficient reserve (also the governmental regulation SR No. 345/2006 Coll., § 15: the limit of population exposure for annual IED is 1 mSv).

As it follows from presented table, the crucial paths of the exposure are ID6 (ingestion of food contaminated by irrigations) and ID5 (ingestion of contaminated fish) that participate on overall annual IED approximately by 90 %. The contribution from ingestion of contaminated drinking water is also important.

The crucial radionuclides are I-131 (or Cs-134) that contribute to overall annual IED by ~60 % (or ~30 %). Radionuclides Cs-137, Sr-90 and I-133 have also considerable contribution.

C.III.19.1.7.5. The impact of severe accident with maximized fall of radionuclides into water reservoir SÍňava to ground waters

In case of severe accident with radionuclides fall into surface water and subsequent transport, in this case from water reservoir SÍňava in the direction of the flow of the Váh River to the firth into the Danube River in Hungary, there exists the risk of contamination penetration into ground water. On the places, where is performed the pumping of drinking and service water, there can occur doubts on the contamination of pumped ground water by radioactive substances that are infiltrated from the river into the aquifer of ground water. Radionuclides move in watered formation (aquifer) in the direction of hydraulic gradient falling, i.e. in the direction to the place of pumping. Potential ingestion of ground water for drinking purposes can results into dose load of the population.

With the consideration of real conditions, the movement of radionuclides occurs in ground waters by a speed, which is about several orders slower than the transport by surface waters. The speed is influenced by the retardation by the impact of contaminant capture on materials forming saturated layer (alluvial deposit of surface water flow). It means that crucial role plays the permeability of leakage rock environment, where in the conditions of radionuclides passage from surface water flow to leakage layers (and vice versa), it mostly concerns to shallow circulation systems with prevailing river deposits in the form of sands, gravel sands and gravels, thus rocks with rather height permeability. Radionuclides spread by the space among rock grains in aquifer formations.

For the calculation of volume activity in ground water, there was used the relation between contaminant amount in the given profile of the river and its volume activity within the header, by suitable activity for the assessment of the migration in the environment relatively homogenous as are the alluvial sand and gravel sediments near the rivers. The calculation was performed according the equation Bear 1979 [*Bear J., Hydraulics of Groundwater, New York, McGraw-Hill, 1979*]. The relation has a character of single contribution and it includes overall amount of radionuclides contributed from the river into leakage layer; the distance from the infiltration place in the direction of ground water flow; dispersion coefficient in longitudinal direction; flow speed of ground water; retardation coefficient; duration of radionuclides migration in aquifer horizon; overall porosity and decay constant of radionuclides.

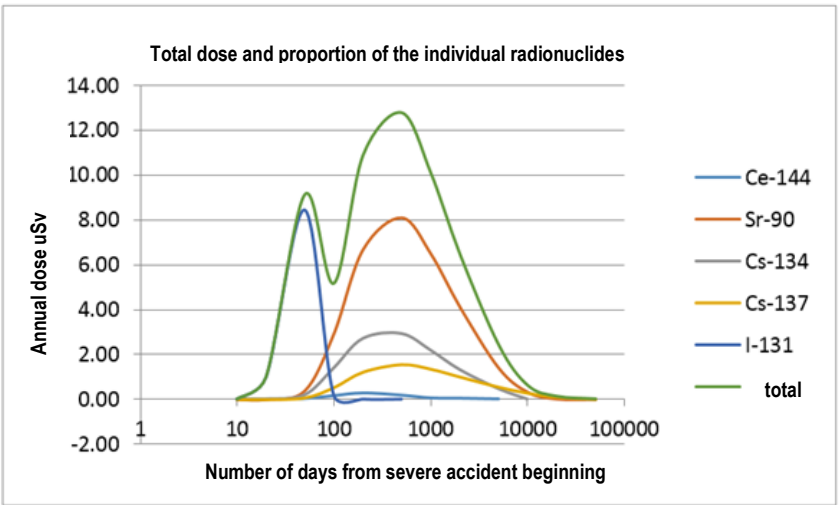
There were selected two hypothetic calculation profiles:

- Water reservoir Sĺňava: The distance of sample well from the VN Sĺňava was determined for 50 m and the profile, by which water influencing water quality in the well could infiltrate, was determined for 50 m^2 (sample length of the bank is 5 m and the discharge of leakage layer is 10 m).
- The confluence of Váh and Danube: The distance of sample well from the bank was determined for 50 m and the profile, by which water influencing water quality in the well could infiltrate, was determined for 1000 m^2 (sample length of the bank is 50 m, the discharge of leakage layer is 20 m).

It was conservatively assumed that the ingestion of drinking water from the well will be carried out during all year and the source will be maximum volume activity founded from the calculation, even if it decreases before and after the reaching of maximum value by the impact of radionuclides decay or by the impact of radionuclides capturing on the soil in saturated layer. Further, the sorption of radionuclides on sediments was not taken into the consideration; in the conditions of affected surface waters, its inclusion could mean the decreasing of volume activities of radionuclides about 5 to 10 %. For the case of year-long ingestion of drinking water from contaminated well, there was taken the consumption of 700 litres, what corresponds to daily consumption of approximately 2 litres. From the overall original number of radionuclides, there were excluded those that showed, already after 2 days, the activity decrease to the values of several orders under the average of remaining nuclides.

Water reservoir (VN) Sĺňava: Overall annual IED form ingestion of ground water from sample well distant 50 m from the bank of VN Sĺňava, in case of severe accident with maximized fall of radionuclides into water reservoir Sĺňava, is 12,5E-03 mSv/year (12,5 µSv/year).

Figure C.III.28: Sĺňava - well, overall dose and the proportion of the individual radionuclides contributing to overall dose



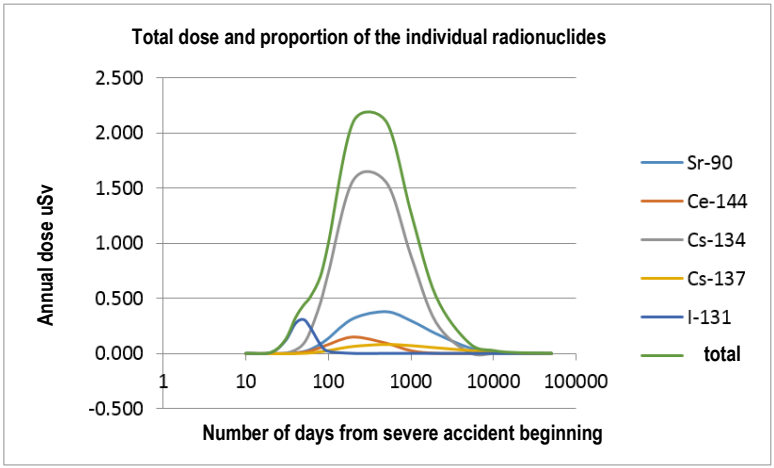
It is clear from the figure that the highest dose is assigned to the period approximately 50 days, when the impact of I-131 is manifested and approximately 500 days, when it is possible to observe the activity of Sr-90 and remaining radionuclides.

The height of individual dose equivalent can change and in the most cases it will decrease, because highly conservative estimation was used for input data. Potential increasing can be

anticipated only if higher decrease of water flow in the reservoir Sĺňava could occur and this way smaller dilution of the contaminant in river water could occur. With a low flow about 55 m³/s, overall annual dose in the period approximately 500 days could reach approximately 31,0E-03 mSv/year (31,0 µSv/year) instead of the initial 12,5E-03 mSv/year. With the flow about 100 m³/s, maximum dose could reach the value of 18,0E-03 mSv/year (18,0 µSv/year).

Confluence of Váh and Danube: Overall annual dose IED, in case of severe accident with maximized fall of radionuclides into water reservoir Sĺňava for calculation profile of ground water in the distance 50 m from the confluence of Váh and Danube is 2,1E-03 mSv/year (2,1 µSv/year).

Figure C.III.29: Confluence of Váh and Danube, overall dose and the proportion of the individual radionuclides contributing to overall dose



Indeed, overall annual IED is even lower. For example, in case of I-131, the ingestion of drinking water is approximately about two-thirds lower, because water consummation is not carried out all year (by the impact of the transformation, volume activity decreases after 100 days to negligible values).

The amount of individual dose equivalent can change and in the most cases it will decrease, because highly conservative estimation was used for input data. Potential increasing can be anticipated only if higher decrease of water flow in Danube could occur and this way smaller dilution of the contaminant in river water could occur. With a low flow about 500 m³/s, overall annual dose in the period approximately 500 days could increase to 6,3E-03 mSv/year (6,3 µSv/year) instead of the initial 2,1E-03 mSv/year. With the flow about 1000 m³/s, maximum dose could reach the value of 4,2E-03 mSv/year.

It is clear from the figure that the main contributor to the dose is Cs-134, which reaches maximum approximately after 200 days after an accident. The main cause is rather height conservative factor, which takes into the consideration the radiotoxicity of this nuclide and also relatively strong gamma radiation. Second contributor is Sr-90, while Ce-144 and Cs-137 participate only very few on the overall dose. Special role plays I-131, which rather height volume activity soon disappears with advancing radioactive transformation due to short half-time of the transformation.

The case, when bleed point of ground water is in close vicinity of surface water (several meters in orders) can be considered as the worst possible scenario. There is neither considered the capturing of contaminant on sediments nor contamination delay with the passing through aquifer layers from surface waters into ground waters – what are the main factors, by which occurs the decreasing of radionuclides volume concentration and consequently the decrease of effective dose. Ground water will show here the same characteristics and also the same contamination by radionuclides as surface water.

Following the above mentioned, direct ingestion of surface water for drinking purposes can be considered as maximum conservative case of severe accident impact on ground waters with maximized radionuclides fall into water reservoir Sĺňava. This situation is evaluated in details above in the chapter C.III.19.1.7.4. Radiation impact of severe accident for maximized radionuclide fall into water reservoir Sĺňava (page 389 of this Report). With the individual ingestion of 700 litres of drinking

water annually, contaminated in trace by radioactive substances migrating through contaminated surface water, IED for age group of adults reaches 6,553E-02 mSv/year for Sĺňava and the surrounding environment; 5,090E-02 mSv/year for the confluence of Váh and Danube and 3,461E-03 mSv/year for Danube – Hungary. It has been founded (chapter C.III.19.1.7.4), even with simultaneous utilization of ground water (with the same parameters as surface water) for drinking purposes and at the same time for the irrigation and consequent ingestion of food by contaminated irrigation, that the limit of annual IED 1 mSv/year for normal and abnormal operational conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103) is not exceeded (also governmental regulation SR No. 345, § 15: limit of population exposure for annual IED is 1 mSv).

A threat of underground sources of drinking water as a result of severe accident of NJZ will not occur even when bleed point of ground water is in close vicinity of surface water and ground water will be in so close communication with surface water that practically it will concern to surface water.

C.III.19.1.7.6. Conclusions of the assessment of radiological impacts of accidents

The assessment of accident radiation impacts of the NJZ in the site Jaslovské Bohunice to the population and the environment in its surrounding, including the evaluation of cross border impacts, was performed, for the purposes of EIA Report, for selected two envelope design basis accidents and the severe accident.

Considered emergency conditions, source terms into the environment as well as used methodology of the assessment of radiation impacts correspond to the regulations and safety guidelines of Nuclear Regulatory Authority of the Slovak Republic and also relevant international recommendations presented in the documents of IAEA, EUR and WENRA.

Radiation impacts have been analysed for the following three source terms of radioactive substances release into the environment:

- source term for design basis accident initiated in reactor cooling system (ground release of radioactive substances through the leakages of intact protection envelope of the reactor – containment),
- source term for design basis accident initiated out of reactor cooling system (height release of radioactive substances through ventilation stack with the accident caused by the fall of one fuel assembly into storage pool during the refuelling, when its damage occurs).
- Source term for envelope severe accident related to extensive fuel melting (ground release through the leakages of the containment provided the preservation of its integrity).

Used source terms are based on maximum conservative requirements for NJZ, while actually available projects provide significantly more optimistic and even several times lower source terms. Therefore, it is possible to assume that, in case of above mentioned design basis accidents and severe accident at the NJZ, the real radiation impacts would be significantly smaller than those presented in this Report.

Radiation impacts of design basis accidents

In compliance with safety guideline ÚJD SR BNS I.11.1/2013, which takes into the consideration the requirements and recommendations of relevant documents IAEA, radiation impacts of above mentioned two design basis accidents were assessed by conservative approach, i.e. for conservatively defined source term into the environment, radiation impacts have been analysed by conservative calculation software RTARC and RDEBO. These two calculation software are accepted by ÚJD SR for the assessment of radiation impacts of design basis accidents within the development of respective chapters of Final Safety Analysis Reports for reactor units in the operation or in the construction (Mochovce, unit 3&4) in Slovak Republic.

All paths of the exposition have been considered, i.e.:

- external exposure from previous radioactive cloud,
- external exposure from radionuclides deposited on earth surface,
- internal exposure from the inhalation, which includes the inhalation from radionuclides from previous cloud and the inhalation of radionuclides resuspended from earth surface and

- internal exposure from the ingestion of food and water contaminated by atmospheric fall with taking into account consumer baskets for SR and for Austria (this one was considered as representative one also for the nearest neighbouring countries – Czech Republic and Hungary).

The calculations of effective doses have been performed for the following variants of meteorological conditions:

- category of atmosphere stability F (it is the most stable category with the smallest dispersion in horizontal and vertical direction, what leads to maximum concentration of radionuclides and doses),
- category of atmosphere stability D (the most likely) with the consideration of precipitation intensity 5 mm/hour in all distances from the NJZ (maximization of radionuclides fall in close distances) and
- category of atmosphere stability D with the consideration of precipitation intensity 5 mm/hour from the distance 40 km from the NJZ (maximization of radionuclides fall due to washout by rain, i.e. in the area between the site of the NJZ and the nearest analysed site of neighbouring state, there is considered only dry fall, what guarantees conservative approach for the assessment of the impacts behind the distance of 40 km for cross border impacts assessment).

The results of calculation assessment of radiation impacts of two design basis accidents have confirmed the fulfilment of acceptance criteria according the requirements of safety guideline ÚJD SR BNS I.11.1/2013, the standard IAEA SSR-2/1, the requirements of WENRA (2013) and EUR. It means that:

- Calculated annual IED for the individual from critical group of population permanently living in the immediate vicinity of the NJZ from all paths of the exposure, with the consideration of statistically most likely meteorological conditions, did not exceed the value of 10 mSv/year (acceptance criteria according to BNS I.11.1/2013 and at the same time safety goal O.2 according WENRA is also met and it requires: no radiation impact to the environment for design basis accidents and only minimum radiation impact to the nearest environment of the NPP is acceptable for beyond design basis accidents, which do not lead to fuel melting, but without the necessity of the implementation of immediate protection measures of the type iodine prophylaxis, sheltering and evacuation).
- The implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) in the distance ≥800 m from the reactor is not necessary (the requirement of IAEA SSR-2/1 and EUR). This conclusion results from the fact that maximum value of annual IED without the ingestion in the distance 500 m is equal to the value of 10 mSv/year for the category F, or it is equal to the value of 4,74 mSv/year for the category D with the precipitation, i.e. in any case the intervention levels for immediate measures, i.e. IED 10 mSv/2 days, 50 mSv/7 days and 100 mSv for contribution of equivalent dose in thyroid gland, will not be exceeded in the distance ≥800 m.
- Calculated annual effective dose for the individual from critical group of the population from all paths of the exposure exceeded the value of 5 mSv/year (according the governmental regulation SR No. 345/2006 Coll., it is the lower limit for the application of consequent measure – the regulation of the consummation of food, water and feed contaminated by radionuclides), with the consideration of the most likely meteorological conditions, maximum within the distance of 6 km and with the consideration of the contribution only from the ingestion in the distance ~5 km (i.e. only local impact that is acceptable according the 4th safety goal of the requirements EUR and also WENRA).

In terms of possible cross border impact (distances ≥40 km), calculated results have confirmed that overall maximum annual IED from all paths of the exposure (i.e. also with the inclusion of the contribution (the contribution to lifelong dose) from annual ingestion of locally produced contaminated food) does not even exceed the limit value of 1 mSv/year for normal and abnormal operational conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP 103 publication) with the consideration of statistically most likely meteorological conditions.

Radiation impacts of severe accident

In compliance with safety guideline ÚJD SR BNS I.11.1/2013, which takes into the consideration the requirements and recommendations of relevant documents IAEA, radiation impacts of above mentioned envelope severe accident were assessed by a realistic approach (best estimate). It means that radiation impacts for conservatively defined source term were analysed by probabilistic software system COSYMA, which is accepted by ÚJD SR for the assessment of radiation

impacts of severe accidents (e.g. with the development of technical reports for the justification of the size of emergency planning zones for reactor units in the operation or in the construction in SR as well as for EIA studies).

All paths of the exposition have been considered, i.e. as in the case of the assessment of radiation impacts of design basis accidents.

The results of the calculation assessment of radiation impacts of the envelope severe accident have confirmed the fulfilment of criteria according the requirements of safety guideline ÚJD SR BNS I.11.1/2013 and also the requirements according the standard IAEA SSR-2/1, the requirements WENRA (2013) and EUR. It means that:

- The implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) would be necessary to implement within the distance maximum ~1 km, i.e. practically only within the site of the NJZ. The requirements of ÚJD SR according BNS I.11.1/2013 and IAEA are thus met with the sufficient reserve. The requirements according WENRA, i.e. the evacuation implementation maximum within the distance of 3 km or the implementation of immediate measures of the type of sheltering and iodine prophylaxis, maximum within the distance of 5 km, are met with big reserve. Presented distance (1 km) is only slightly bigger than 800 m (the requirement EUR). However, it is necessary to point out that used envelope source term for severe accident is significantly conservative, more conservative than is required by EUR. Therefore, it is possible to assume that the real assessed source term into the environment for particular project of selected NJZ (e.g. within Final Safety Analysis Report) will be significantly smaller and also the requirement EUR will be met with sufficient reserve.
- In terms of possible cross border impact (distances ≥40 km), calculated results have confirmed that overall maximum annual and also lifelong IED from all paths of the exposure (also with the inclusion of the contribution (the contribution to lifelong dose) from annual ingestion of locally produced contaminated food) does not even exceed the limit value of 1 mSv/year for normal and abnormal operation (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103).
- The same conclusion is valid also for the scenario of severe accident with identical source term and with the assumption of maximized fall of radionuclides on complete area of the nearest water reservoir on the Váh River (water reservoir Sĺňava) due to strong intensity of the precipitation, after the arrival of radioactive cloud to this water reservoir, with consequent contamination of the flow of Váh and Danube and also with the assessment of the impacts – radiation impacts to the nearest territory of Hungary (the confluence of the Váh River and the Danube River).
- For the scenario of severe accident with the assumption of maximized fall of radionuclides on the area of the nearest water reservoir Sĺňava, there was also performed the assessment of the impact to ground waters and their utilization as a drinking water, namely for the area around Danube under the confluence with Váh and for the nearest surrounding environment of water reservoir Sĺňava. The assessment has proved that the impact to drinking water quality is negligible. With the individual annual ingestion of 700 litres of drinking water, contaminated in trace by radioactive substances, migrating through contaminated surface water into ground waters, IED reaches only 12,5 μSv/year for the well near water reservoir Sĺňava or 2,1 μSv/year for the well near the Danube River (the confluence of Váh and Danube). These values were reached despite the fact that input data for the calculation had been selected to preserve as highest level of conservativism as possible. A threat of underground sources of drinking water as a result of severe accident of NJZ will not occur.

C.III.19.1.8. Risk of terroristic attack

The commitments of the Slovak Republic in the area of physical protection of nuclear materials result from the accession to the Convention of physical protection of nuclear materials, which was signed in the year 1987 and by Governmental Resolution of the Slovak Republic No. 394/2007, the Amendment to this Convention was approved. The Amendment reflects better actual safety situation in the world and it also closely relates to the International convention on the suppression of acts of nuclear terrorism, which Slovak Republic ratified in March 2006.

The risk of NJZ threat by a terroristic attack can´t be completely excluded on preventive basis. In compliance with the legislation SR in force, permit holder is obliged to monitor, control and eliminate, in the cooperation with competent authorities of the state (act No. 321/2002 Coll. on the armed forces of the Slovak Republic as amended, act No. 319/2002 Coll. on Slovak Republic protection as amended), the risk of the threat by a terroristic attack, namely in all phases of project implementation, the operation and the decommissioning of the NJZ. The permit holder is further obliged to minimize the

possibility and consequences of a terroristic attack and a sabotage mainly by the implementation of means and procedures of NJZ physical protection in compliance with the national legislation, international commitments and good practice.

The requirements for physical protection of nuclear materials and nuclear facilities in Slovak Republic are defined in the act No. 541/2004 Coll. on peaceful use of nuclear energy (atomic act) and on amendment and alterations of several acts as amended and in the regulation ÚJD SR No. 51/2006 Coll. on details concerning requirements for provision of physical protection. Both documents are based on international standards and adopted standards in this area.

In terms of the act No. 541/2004 Coll. on peaceful use of nuclear energy (atomic act) and on amendment and alterations of several acts as amended, the sabotage means any deliberate act directed against nuclear facility or nuclear materials, special materials and equipment, radioactive waste or spent nuclear fuel during their disposal or their transport, which can directly or indirectly, by the release of radioactive substances, endanger a life, health or property of inhabitants or the environment. In nuclear facilities, the protection against this type of the risk is solved by complex systems of assurance, which combine technological equipment, organizational measures and human factor. In the following phases of the preparation and the implementation of the NJZ project, the risk of the NJZ threat by a terroristic attack will be assessed and eliminated by standard means and procedures of physical protection of nuclear facilities, used in current practice in compliance with the requirements of national procedures and international standards.

State supervisory activities in this area are performed by ÚJD SR, whereas ÚJD SR focuses on the inspection of physical protection on nuclear facilities in SR and performs the inspections aimed to physical protection of nuclear facilities, nuclear materials and radioactive wastes and the transports of nuclear materials.

As an envelope case of terroristic attack against nuclear facility can be considered the malevolent targeted impact of big transport or military plane. After the terroristic attacks in New York on September 11th, 2001, the protection of all nuclear facilities against potential attack by a big transport aircraft increased in all states with developed nuclear power industry. In the act No. 321/2002 Coll. on the armed forces of the Slovak Republic as amended, there is solved the area of prevention and arising of abnormal situations from aircraft attack and it includes the series of military preventive measures and active protection procedures to the limit situation – physical termination of a fly of a transport aircraft or a violator. The state has available several means (press services, army, police, monitoring of terroristic activities, protection of airspace, prevention in the conditions of air transport, special forces, etc.), where their application means that the risk of completed terroristic attack on nuclear facility is with a big probability eliminated and minimized.

To assure nuclear facilities protection against terroristic attacks, safety measures corresponding to the actuality of safety threat, which is permanently monitored and specified, are set up on state level. These safety measures included press and information assurance, safety measures in air transport, the protection of airspace of Slovakia.

All suppliers of reference types of reactors of the generation III+ for the NJZ confirmed, in technical information, the resistance of their units against aircraft fall including big transport plane. This declared resistance shall be proved in further phases of permitting process in compliance with the international for this area.

In the requirements of WENRA (WENRA Report Safety of the NJZ designs, 2013), there is included the requirement for the consideration of intentional impact of commercial aircraft in the project of news nuclear power plants. Despite the measures for the prevention of intentional impact of commercial plane, this event is considered with the design of new reactors as a beyond design basis external event with the consequences limited by criteria for an accident in design extension conditions (DEC). Basic requirement is that an aircraft impact will not lead to reactor core melting and therefore it does not cause a bigger radiation impact. Safety functions, which are necessary to maintain NJZ in safe conditions after such impact, shall be designed and protected by a corresponding manner.

WENRA as well as the procedure US 10 CFR in the part 50.150 (Aircraft impact assessment) requires that the licence applicants for new reactor projects have performed the assessment of the impacts of big transport aircraft fall to designed power plant, whereby such event is considered as beyond design basis accident. The assessment shall prove that reactor core remains cooled (or containment integrity remains preserved) and spent fuel cooling remains preserved (or spent fuel pool integrity will be assured). Following the procedure US 10 CFR, part 50.150, the guideline NEI 07-13 Methodology for Performing Aircraft Impact Assessments for New Plant Designs, Rev.8, (2011) was developed in Nuclear Energy Institute (NEI) in cooperation with EPRI and this guideline specifies how should be such demonstration performed. Subsequently, US NRC, in its guideline US NRC RG 1.217 Guidance for the Assessment of Beyond Design Basis Aircraft Impacts (2011), approved this guideline NEI 07-13 as acceptable one. All suppliers, licence holder as well as supervisory authorities have

available updated, detailed and particular procedure how to demonstrate the resistance against aircraft fall. In the conditions of the Slovak Republic, with the assessment of the effects of aircraft impact, VUJE methodologies are currently applied and accepted by ÚJD SR: Determination of local impacts and load function from aircraft impact to the object of nuclear facility (2009) and Specification of global response of nuclear facility object structure to aircraft impact (2010), which is based on the guideline IAEA NS-G-3.1 External Human Induced Events in Site Evaluation for Nuclear Power Plants (2002) and the standard US DOE Accident Analysis for Aircraft Crash into Hazardous Facilities (2006).

In compliance with above mentioned guidelines, the following possible unfavourable effects shall be considered in the analysis of the assessment of aircraft impact effects:

1) Local damage of the subject structure. Solid parts (missile) of aircraft (motor, chassis, etc.) can cause local damage of effected barrier. The penetration of missile into the barrier, material spalling from adjacent side of the barrier, material scabbing from the remote side of the barrier, barrier perforation and hitting belong among these local damages.

   Damages caused by secondary effects of aircraft impact – aircraft fuel impacts also belong among possible local damages of the subject construction. Aircraft fuel can cause the explosion of fuel part (formation of fireball) and fires of pools of released fuel from damaged reservoirs. These impacts of aircraft fuel can occur:

   - out of affected object (in case of temporary strong barrier of the object)
   - inside affected object (in case of insufficient protection barrier against the perforation).

   Both effects cause fire load of object structural elements as well as object technological elements.

2) Global damage of the structure. With an aircraft impact, affected structure (object) can excessively deform as a whole or it can show a big displacement even without total collapse of the structure. In the limit cases, the collapse of the complete structure of the object or its crush can occur.

3) Functional damage of object element containing radioactive substances (typically fuel building). If the building containing radioactive substances is stricken by an aircraft, induced shock wave of a tension or induced vibration of the structure can cause non-functionality of the system containing radioactive substances and their release and leakage into the surrounding environment.

Direct and indirect effects of aircraft impact shall be considered, whereby it is possible to use realistic approach – to use the best estimate of materials characteristics and the latest analytical methods.

Detailed analysis of the impacts of the NJZ buildings accidents with aircraft impact and other external events caused by human activity can be potentially misused for the preparation of a sabotage or a terroristic attack. Therefore, detail lists of equipment, data on civil structures and on the impact of their potential accidents to the NJZ operation are the subject of confidentiality and it is not possible, in terms of valid legislation, to present them in general-public part of the documents (aircraft fall, sabotage, terroristic attack). This data belongs to classified information according to the act No. 215/2004 Coll. on protection of classified information and on amendments to certain laws, what mainly relates to detail assessment performed for the purposes of the plan of physical protection and another related safety documentation related to physical protection.

Except the proving of the resistance against selected risks related to physical protection (aircraft fall, explosion and shock wave, contamination by toxic cloud), the measures of physical protection are not usually considered, by suppliers, as a part of their scope of delivery and therefore physical protection remains the responsibility of licence holder.

C.III.19.1.9. Other radiation risks related to nuclear facilities operation

Safety requirements for the transport of nuclear materials and radioactive waste are specified in atomic act (act No. 541/2004 Coll., atomic act, as amended) and in the act No. 355/2007 Coll. on protection, support and development of public health and on the amendments and supplements to certain acts. Following the authorizations contained in these acts, the following implementing regulations related to the transport of nuclear materials and radioactive waste were published:

- the regulation of Nuclear Regulatory Authority of the Slovak Republic No. 57/2006 Coll., on details concerning the requirements for shipment of radioactive material;

- the regulation ÚJD SR No. 48/2006 Coll., on details of notification of operational events and events during shipment, as well as details of investigation of their reasons and the regulation ÚJD SR No. 32/2012 Coll., amending and supplementing Nuclear Regulatory Authority of the Slovak Republic Regulation No 48/2006 Coll.;
- the regulation of Ministry of health of the Slovak Republic No. 545/2007 Z. z., on details of the requirements for radiation protection assurance during the activities leading to the exposure and the activities important in terms of radiation protection;
- the regulation ÚJD No. 51/2006 Coll., on details concerning requirements for provision of physical protection.

The important part of ÚJD SR activities with the assessment of measures providing physical protection of nuclear material transports is the approval of package set for the transport of nuclear materials. The inspectors of ÚJD SR perform inspections of all transports of fresh and spent nuclear fuel and RAO.

The information on the transport and physical protection of nuclear materials are governed by relevant provisions of the act No. 215/2004 Coll. on protection of classified information and on amendments to certain laws.

Basic transports of materials related to the operation of nuclear power plant are the transports of fresh fuel from the supplier to the NJZ, the transport of RAO for treatment and conditioning in the facilities of JAVYS (within the site EBO), the transport of conditioned RAO from the NJZ to RAO repository, the transport of spent fuel from the NJZ to the storage (within the area of EBO) and the transport of spent fuel from the storage to the place of permanent repository. The base for risk management during the transport of nuclear materials and RAO are the following principles enshrined in above mentioned legislation documents:

- the permission or agreement of permitting authorities to the transport shall be issued according acts in force;
- the transport shall proceed according the approved procedures and in compliance with the requirements of national legislation regulations and international commitments and contracts of SR;
- transport procedures shall take into the consideration possible risks and minimize the probability of an accident occurrence;
- transported material shall be stored in approved transport package sets (in case of transport and storage sets), which provably provide that radioactive material does not release into the environment in case of an accident and moreover the decreasing of sub-criticality below the acceptable limit does not occur in case of nuclear fission materials and even not in case of water flooding;
- dose rate in the surrounding of transported sets and surface activity shall be minimized in compliance with legal procedures of SR – in the relation to the exposure of the inhabitants in the surrounding of the transport, then mainly: dose rate in the distance 2 m from the surface of transport mean can´t exceed the value of 0,1 mSv/h.

For the transport of fresh nuclear fuel, it is possible, with the consideration of existing units of JE V2 and NJZ, to assume on average 2 transports of fresh fuel annually in the site of EBO.

Following the situation on the market, stockpiling for several years in advance can be also useful for power plant operator. Due to the fact that nuclear fuel is not produced in SR, it is sure that it will concern to the supplies from abroad and it can concern to the combination of train, automobile, shipping and air transport.

In the comparison with other dangerous goods (from energetic point of view, transport of other kinds of fuels), the transport of radioactive materials is much less risk. In particular, there is no risk of the explosion and fire as with the transports of classical fuels, when an accident leads to direct endangering of life and it often has tragic consequences for participants of an accident. The possibility of radioactive substances releases into the environment is limited to the lowest possible level. For each transport, there are developed procedures how to limit radiation impacts of an accident to not occur the threat of public health.

The transport of spent nuclear fuel will be performed only inside the area within the locality until the starting of the operation of geological repository and it does not have any requirements for external transport infrastructure and thus any related risks of possible accidents. Any accident of the transport of low-active RAO fixed in solid matrix and stored in containers within the transport to the repository, including possible sabotage, does not represent more important risk, neither for the environment nor for the population.

C.III.19.1.10. Risks arising due to other human activity in the locality

C.III.19.1.10.1. Selection of considered risks

The risks arising due to other human activity in the site are represented by accidental events, which could potentially cause the threat of nuclear facility safety. With the assessment of these risks, possible events that could occur on stable, mobile and pipeline sources, are taken into the consideration. The sources of the risks are represented by industrial and agricultural production, military objects and transport routes in the surrounding environment of the NJZ. Preliminary assessment of the risks due to human activities is performed in compliance with the requirements and procedures of IAEA procedures, mainly NS-R-3 Site Evaluation for Nuclear facilities (2003), NS-G-3.1 External Human Induced Events in Site Evaluation for Nuclear Power Plants (2002) a NS-G-1.5 External Events Excluding Earthquakes in the Design of Nuclear Power Plants (2003) and WENRA Report Safety of the NJZ designs (2013) and it takes into the consideration the recommendations from stress tests for safety increasing of new projects of nuclear facilities.

With the assessment of possible risks, the possibility of arising and consequences mainly of these (accidentally arising) categories of events is assessed:

- aircraft fall,
- explosion connected with shock wave,
- clouds of combustible vapours,
- toxic chemical substances,
- fires,
- violation of water intake structure,
- contamination by noxious liquids.

In the following subchapters, above mentioned events that can be a source of risks in the NJZ site, are assessed.

C.III.19.1.10.2. Preliminary assessment of the risk of accidental aircraft fall on NJZ

For the purposes of risk assessment of accidental aircraft fall, the following factors are important:

- in case of aircraft fall on the building (structural element) of nuclear facility, the risk significantly increases if affected element contains the equipment important for safe reactor shutdown and its long-time cooling,
- the probability of the hitting of important element also increases with increasing geometric dimensions of this important element.

For preliminary assessment of the individual sources of the risk of aircraft fall, the guideline IAEA NS-G-3.1 (External Human Induced Events in Site Evaluation for Nuclear Power Plants, 2002) recommends the utilization of conservative approaches presented below. This approach provides the estimations of aircraft fall probabilities to reference building (main reactor building of nuclear power plant), calculated for different categories of aircrafts.

The last calculation assessment (data from the year 2011) of the probability of aircraft fall on main reactor building of JE V2 was performed by the application of internationally accepted approaches of Screening Distance Value (SDV) and Screening Probability Level (SPL). With the assessment of the probability of aircraft fall, there were considered two possible sources of the risk:

1. aircraft fall as a result of aircrafts takes off and landings on the near airport,
2. aircraft fall as a result of general air traffic in the region.

For the 1st source of the risk, it is suitable to use the approach of screening distance value. If the source is in the distance bigger than SDV, this source can be excluded, according the guideline IAEA NS-G-3.1 , from another analysis. Screening distance values are as follows:

- 4 km for boundaries of flight routes or landing and taking off runways,
- 10 km for airports (distance from the ends of landing or taking off runway) and
- 30 km for military airspace.

For the 2nd source of the risk, it is necessary to determine, using the approach of screening probability level, the probability of aircraft fall on selected, safety important buildings for the individual categories of air transport. If the probability of a fall is smaller than 1E-07/year, it is possible, according the guideline IAEA NS-G-3.1 an IAEA-TECDOC-1341 (Extreme External Events in the Design and Assessment of Nuclear Power Plants, 2003), to exclude this category of air transport from another considerations. With the assessment, there are considered the following flying categories:

- airports operation,
- transport civil flights,
- sport and recreation civil flights,
- agricultural flights and the flights for special works,
- military operation in limited spaces.

With the site assessment of JE V2 and the NJZ on the basis of the comparison of airports distances (see chapter C.II.11.5.1. Transport infrastructure, page 220 of this Report) according the presented approach SDV, it is possible to exclude airports operation from the assessment. Remaining flight categories are thus assessed by using of the approach SPL.

In case of the NJZ assessment, basic data on NJZ buildings is known for simplified estimation of aircraft fall probability. Provided certain simplified geometric similarity of safety important building with JE V2 (shape – rectangular profile) and unchanged statistical probability of aircraft fall in affected space, it is also possible to assume the similarity of numerical expressions of the risk of aircraft fall on the NJZ with the results of last probabilistic studies for existing JE V2 in the site EBO.

Last time, the calculation assessment of the probability of aircraft fall on main reactor building of JE V2 was performed in the year 2011 by approaches SDV and SPL for all flight categories. Determined summary probability 5,24E-08/year is smaller than check value 1E-07/year, which is recommended by above mentioned guidelines of IAEA.

For the biggest one from considered containments of the NJZ (EPR) units, effective impact area could be approximately 3 times smaller in the comparison with JE V2 and in the same proportion the probability of containment hitting by accidental aircraft fall will be also lower. So, final probability of accidental hitting of the NJZ containment by falling aircraft will be on the level 1E-08/year.

The performance of detail probabilistic analyse of aircraft fall is the requirement of the regulation ÚJD SR No. 430/2011 Coll. on details on nuclear safety requirements for nuclear facilities to obtain the permission for the NJZ construction and operation. These analysis shall be performed in compliance with recognized international practice and the guideline IAEA NS-G-3.1. In this stage of permission process, deterministic assessment of the impacts of big transport aircraft fall on the buildings of the NJZ will be also performed according the requirements of WENRA Report Safety of the NJZ designs (2013). For the assessment of the NJZ project safety against the effects of commercial aircraft impact, there will be used criteria applied by US NRC, which are specified in 10 CFR, part 50.150 and which require that reactor core remains cooled or containment integrity remains preserved and at the same time spent fuel cooling remains preserved or the integrity of spent fuel pool will be assured.

C.III.19.1.10.3. Preliminary assessment of the risks due to other human activities in the locality

Information on current industrial, transport and military buildings located in the perimeter of 20 km from the NJZ is collected for risks assessment. The list of 17 buildings, in which dangerous substances are stored, has been developed and this list has been completed with the companies listed in the register of companies in terms of the act No. 128/2015 Coll. on the prevention of serious industrial accidents (category A and B), as amended. It concerns to the buildings of production character or the buildings providing services with the possibility of dangerous substances release into the environment. The perimeter of 20 km is used for the description of external source risks from human activity on nuclear facilities in SR and it is accepted by ÚJD SR. Preliminary assessment of the impact of risks sources to the NJZ is performed within the distance 10 km, in compliance with the guideline IAEA NS-G-1.5 External events excluding earthquakes in the design of nuclear power plant (2003).

It is also possible to consider the buildings of nuclear facilities in the site EBO, mainly storages and inside transport of toxic, explosive, combustible, oxidizing, asphyxiant and radioactive substances (hydrogen, ammonia, diesel oil, hydrazine, oxygen, nitrogen, other chemical substances used in the power plant) and the transport of radioactive waste and spent fuel

as a potential source of external threat of the NJZ. Specific source of the threat are accidents on other nuclear facilities in the site EBO related to the release of radioactive substances into the environment. These sources of risks will be assessed in further stages of permission process.

Explosion

In terms of possible threat of NPP operation by an explosion, it is necessary to consider:

- the damage and consequent explosion of transported media in gas pipeline;
- the damage and consequent fire of products pipelines and their pumping stations in Malženice and Špačince;
- the damage of pumping station and oil reservoir in Bučany.

Pipeline routes of gas pipelines, oil pipelines and products in the surrounding of the NJZ are graphically displayed in the chapter C.II.11.5.2. Other infrastructure (page 224 of this Report). Other buildings containing big amounts of explosive substances (ammunition storage and etc.) are not located in the surrounding within 10 km from the site of the NJZ.

The territory within the distance approximately 1,8 km will be endangered with the complete pipeline break of transit gas pipeline (DN1400, DN1200) and subsequent explosion of gas. With the damage of the pipeline DN500, the territory within the distance approximately 0,4 km is endangered. The nearest route of gas pipeline “Bratstvo” (DN700) is in the distance approximately 2,5 km from the NJZ. From the comparison of presented distances, for preliminary conclusions of environmental impact assessment, results that the NJZ is not endangered from these sources.

Another source of threat can be the transport of military munition and industrial explosives. Military munition and industrial explosives are not transported on the roads that are located near the site of the NJZ.

The zone of threat from the explosion of munition and explosives transported on the highway D1 or by the railway reaches 1 km for the transport on the highway D1 and 2 and even 3 km for the transport by the railway. This way, the NJZ is not endangered by the transport of munition and explosives.

Envelope case of the explosion on sources in the current site of EBO represents hydrogen storage of JE V2. The analysis of explosion impacts showed that they will not damage safety important buildings of JE V2 and therefore they shouldn´t (as an external source) represent the risk for the NJZ.

Despite this fact, it is necessary to indicate the accident of tank truck or railway tank transporting hydrogen or fuel into the site of NPP and the accident of military munition transport in the list of possible sources of the NJZ risks, in terms of the review according the methodology SDV in the guideline IAEA NS−G−3.1 External Human Induced Events in Site Evaluation for Nuclear Power Plants (2002). The assessment of the impacts of explosion sources (envelope case) to the NJZ will be performed in further stages of permission process according atomic act.

Clouds of combustible vapours (delayed inflammation)

The source of combustible vapours can be damaged gas pipelines and products pipelines located in the distance within 10 km from the NJZ and their pump stations, reservoirs of combustible substances, furthermore an accident of tank truck or railway tank with combustible substances passing on the transport communications near the site of the NJZ. For this event, there are valid the same data on the threat of the territory as for the event “Explosion”, i.e. from the preliminary assessment results the conclusion that the NJZ will not be endangered from these sources.

Toxic chemical substances

The NJZ is not directly endangered by the release of toxic chemical substances from the plants in assessed locality. Relatively small amounts of dangerous substances (ammonia, chlorine and etc.), with the distances of plants over 10 km from the NJZ, represent only local threat of the inhabitants or workers of particular plant with dangerous substance. The area of assumed threat is determined on the basis of the regulation Ministry of Interior of the Slovak Republic No. 533/2006 Coll. on the details on population protection against the impacts of dangerous substances immediately after abnormal situation.

Potentially, bigger danger for the NJZ could occur in case of the accident of tank truck transporting dangerous substances on local roads in immediate vicinity of the NJZ. Very strict legislative measures are valid for the transport of toxic substances on transport communications on the national and international level. For the transport of dangerous substances (ammonia,

chlorine and etc.), the transporter shall have prepared and approved routes and measures for the case of an accident in terms of the regulations in force. For the completion, limit amounts of these substances, covering the exclusion of their transport on the roads located in near vicinity of NPP, are presented in the following table.

Tab. C.III.68: Allowed distance of the transport of dangerous substances from the site of EBO for their limit amounts

Distance from NPP [km]	0,5	1,0	1,5	4,0	8,0
Transported amount [t]	0,04	0,18	0,4	6,0	30,0

The roads leading to the site of the NJZ from Trnava and Piešťany are not used for public transport of dangerous substances (transport department of District office in Trnava did not issue the permission for the transport of toxic substances on these communication during the last years).

Fires

In terms of fire danger, the situation is analogous as it is presented in the previous part “Clouds of combustible vapours (delayed inflammation)”. The accident of oil pipeline and products pipeline, reservoirs with combustible substances, tank trucks or railway tanks during the transport of the fuel into the site of the NJZ can be considered as a source of fire. The possible threat of the NJZ, in terms of fire, can be potentially also the fire of agricultural crops in near vicinity of the site of the NJZ (the risk of smoke in the operational spaces and buildings).

The fire of oil pipeline with suitable wind direction could cause smoke in the site of the NJZ. The possibility of fire transmission from the field to the NJZ is excluded by multiple barriers and organizational management. Double fence of the NJZ increases the distance necessary for fire propagation, internal space between double fence will be filled with non-combustible material (stone, gravel, concrete, …), the constructions inside the site of the NJZ will be located in sufficient distance from the fence. Fire termination in the surrounding environment of the NJZ is the primary task of fire and rescue brigade. Mitigation of impacts of fumigation in the site and operational premises of the NJZ will be the subject of design solution of the NJZ.

With the fire of oil storage tansk in Bučany, the rise of combustion gases into bigger heights over the ground, where intensive dilution occurs due to air turbulences, can be assumed due to height temperature near fire source. Pollutants concentration near earth surface will be low. It is assumed that the effect of thermal flow will not exceed the border of the site of pumping station and oil reservoirs in Bučany.

The fires of fuel (PHM) (pump stations, storages in plants, etc.) in the surrounding environment of the NJZ are not dangerous with the given stored amounts and the distance from the site of the NJZ. In the zone of 10 km (nearest 4 km from the NJZ) there are two parallel routes of oil pipeline with pump station in Bučany with transit through the Váh River between the towns Hlohovec and Leopoldov. For accidents of oil pipeline connected with the release of oil, the operator of oil pipeline has developed emergency plan. The emergency plan is mainly focused on the disposal of the impacts of fire and explosion and furthermore on the disposal of ecological impacts of oil release, i.e. the prevention of the release of dangerous substances into ground waters, surface waters and the remediation of soil (secondary pollution of ground waters). The fire of oil pipeline with pipeline break can directly endanger the surrounding environment in the distance of 100 to 400 m and the safe distance is at 3- to 4-times of this value, so safely less than the nearest distance from the NJZ.

Damage of intake structures

Flood wave could occur on the territory of Trnava region, in case of concurrent disruption of the waterworks Liptovská Mara and Oravská priehrada and any regulation measures are not performed on the waterworks Vážske Kaskády. Flood wave couldn´t reach the site of the NJZ. However, it could damage the buildings for service water inlet for the NJZ needs from Váh (water reservoir Sĺňava). For the elimination of this risk, water tank will be the part of the NJZ that will perform the function of water reserve for long-time residual heat removal (at least 30 days) in case of the impossibility to charge service water from main source (water reservoir Sĺňava) or backup source (dam Drahovce).

Contamination by dangerous liquids

The damage of the NJZ cooling system caused by the release of chemicals into Váh (e.g. from industrial plants in Piešťany) is not real with the volume of water reservoir Sĺňava (approximately 8 to 12 mil. m^3) and the amount of processed or stored

chemicals (up to 10 t). So, the release of dangerous chemicals from industrial plants and buildings into Váh and subsequent entering into the cooling system of the NJZ does not mean a threat of the NJZ safety.

C.III.19.1.10.4. Conclusion to preliminary assessment of the risks due to human activity in the locality

Preliminary assessment shows that the NJZ will not be significantly endangered by any of the risks resulting from human activities in the locality. Main buildings of the NJZ will be designed as resistant against the impacts of shock wave, aircraft fall, fire, flooding, loss of power supply by external sources, water and other external impacts. The crucial element of the risk management coming from human activities in the locality will be the protection of control workplaces (main and emergency control rooms) of the NJZ against the sources of threat that can be a cloud of combustible vapours, toxic cloud of chemical substances, toxic products of combustion, radioactive substances. These sources of threat can come from transport routes in near vicinity of the NJZ as well as from other nuclear facilities in the site of EBO. For NJZ, there will be assured that potential releases of substances from these sources will not endanger nuclear safety. It means that the habitability of main and emergency control rooms remains preserved with the release of these substances. The NJZ will be equipped by technical means that prevent the penetration of radioactive, toxic or explosive substances into the control room, even in case of severe accident on the other nuclear facility in the locality. Permanent check of air composition in the inlet lines of heating, ventilation and air conditioning system, the assurance of permanent slight air overpressure in control rooms, the possibility of reliable insulation of control rooms environment from the surrounding environment with the occurrence of dangerous substances and special emergency heating, ventilation and air conditioning system in control rooms for abnormal situations belong among these technical means. The confirmation of presented conclusions will be proved in details in safety documentation of the NJZ.

C.III.19.1.11. Emergency preparedness

C.III.19.1.11.1. Internal emergency plan

Internal emergency plans of the operator and related documents are developed to assure the protection and the preparation of employees for the case when important release of radioactive substances into working environment or the surrounding environment occurs and it is necessary to take measures for the protection of persons health on the level of nuclear facility or the population in its surrounding environment.

The purpose of internal emergency plan is to assure the preparedness of power plant employees for the implementation of planned measures in case of the occurrence of an event with the focus on basic goals assurance:

- to decrease the risk or to mitigate the impacts of the event, directly near its source, on equipment, employees and inhabitants in the surrounding environment,
- to prevent severe health damages,
- to decrease the risk of the probability of stochastic effects occurrence on the health.

The goal of internal emergency plan is to assure the activities of emergency response organization (OHO), i.e. the planning and the preparation of organizational, personal and material-technical means and measures for successful management of abnormal situations. Informing itself during abnormal situation, depending on its classification, includes besides operator's management also state supervisory authorities and crisis staff on regional level of state administration.

C.III.19.1.11.2. Plan of population protection (external emergency plan)

Protection measures are a part of population protection plan that is developed by territorial competent state authorities and municipalities located in the area of nuclear facility threat.

Population protection plan, which includes the measures for population protection in the area of the threat during the release of radioactive substances into the environment, relates to internal emergency plan of the operator (permission holder). The operator is obliged to submit the support documentation related to population protection in the area of the threat to the developers of population protection plans.

Population protection plans developed for the territory of the region include the method of measures implementation, described in details, while selected measures include the activity according the levels of importance and time course of an

incident or accident including available and useful forces and means for the performance of rescue works and the assurance of the implementation of measures for population protection.

With the occurrence of abnormal situation, which has a character of radiation event on nuclear facility, authorities of local state administration assure the measures resulting from population protection plans. The activity is assured by relevant crisis staff. To prevent the threat from a delay with the performance of the tasks related to population protection, particular commissions are classified into emergency response organization within SR.

In compliance with internal emergency plan, population protection plan and following the situation assessment in the technology, the determination of source term, measured values of teledosimetric system, first measurements of radiation situation in the surrounding of nuclear facility and meteorological situation, permission holder assure the notification of competent authorities and organizations in the area of the threat in case of the occurrence of the event of 2nd level and the warning of the population without any delay in case of the occurrence of the event of 3rd level. Subsequently, the authorities of state administration, local administration and municipalities assure other urgent and consequent measures consisting mainly of iodine prophylaxis, sheltering and evacuation and the others. Presented measures are performed on territories that have been affected by the impacts of radiation event including areas, where the impacts of abnormal event can spread in terms of prognosis.

For the warning and the notification of population in 21 km zone of threat of JE V2, there has been developed system VARVYR, which was completely reconstructed in the year 2012. The system belongs to the company SE, which operates JE V2. The system consists of:

- system of population warning - 330 siren in the surrounding environment and 35 in the site of the power plant,
- system of population notification – 950 pcs of pagers assigned to commune and district authorities.

System VARVYR is connected to monitoring system, which evaluates current state of important technological parameters of the power plant as well as the state of radiation situation in the surrounding of the power plant (see chapter C.II.15.3.2.3.1. Monitoring system of the surrounding environment of nuclear facilities Bohunice, page 241 of this Report). In case of potential danger, the system issues the warning and after defined time interval it can do the automatic activation of the means of population warning and notification of endangered parts of the territory in the surrounding environment of the power plant. Siren technology enables their full programmability and also remote diagnostics, replaying of text records from the digital memory, but also local verbal notification via microphone. In case of need, the individual sirens can be activated and used also locally in the communes. Number and power of sirens for the individual communes is specified by the legislation and it assures complete covering of communes by warning signal. System VARVYR is assigned for population warning not only in case of abnormal situations on nuclear facility, but also with general threats including floods. The output from radiation monitoring system of the NJZ will be integrated into existing warning and notification system for the area of threat of the NJZ.

C.III.19.1.11.3. Cross border warning and connection to systems of neighbouring states

Slovak Republic as a country operating nuclear power plant and nuclear facility, with its establishment, committed to perform all international contracts and agreements, by which Slovak Republic is bound. It concerns to the performance of the commitments resulting from:

- the membership in the International Atomic Energy Agency (Convention of early notification of nuclear accidents, Convention on the help in case of nuclear accident or other emergency situation),
- the membership in European Union (Treaty on the establishment of European community for atomic energy (Euratom, Council Directive 2014/87/EURATOM of 8 July 2014 amending Directive 2009/71/EURATOM Establishing a Community Framework for the Nuclear Safety of Nuclear facilities and assessment of the potential risks, art. 8) on continuous monitoring of radioactivity level in the air, water and in food and the information providing on performed measurements, quick exchange of the information in case of radiological emergency situation and population informing on the measures for health protection, which have to be used and on the steps, which are necessary to be done in case of radiation abnormal situation),
- from bilateral agreements with the neighbouring states on early notification of nuclear accidents and the information exchange in the area of nuclear safety (on mutual exchange of data from the systems of early

notification against the radiation and radiation monitoring network), signed among Slovak Republic (represented by ÚJD SR as a contact authority) and these neighbouring countries:

- Austria (contact authority: The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management),
- Hungary (contact authority: Hungarian state committee for atomic energy),
- Czech Republic (contact authority: State office for nuclear safety of the Czech Republic),
- Poland (contact authority: National agency for atomic energy),
- Ukraine (contact authority: Ministry of the environment protection and nuclear safety of Ukraine, Report of nuclear regulatory authority).

Nuclear Regulatory authority of the Slovak Republic, due to its status as a contact place for IAEA and European Commission, is obliged to inform on the events on nuclear facilities as well as on the events during the transport of nuclear materials, radioactive wastes, spent nuclear fuel and on the events with ionizing radiation sources in terms of the legislative procedures of SR and EU, international agreements and commitments.

Currently used means of the notification and the warning on the international level are:

- System CoDecS (Coding Decoding System) for sending and receiving the notifications of the system of European Union early notification ECURIE (European Community Urgent Radiological Information Exchange). Technical and expert support for ECURIE is the system EURDEP (European Radiological Data Exchange Platform), which includes national databases of radiation monitoring in one central database available to all participating parties. Professional and technical centre for this system is Joint Research Centre (EC JRC). The bearer of the system EURDEP on behalf Slovak Republic is Slovak Hydrometeorological Institute.
- Protected websites USIE (Unified System for Information Exchange in Incidents and Emergencies) for the notification of IAEA.
- Fax, telephone and e-mails.

C.III.19.1.11.4. The area of threat

The area of threat, in terms of the regulation ÚJD SR No. 55/2006 Coll. on details concerning emergency planning in case of nuclear incident or accident, is defined as the area in the surrounding of nuclear facility, where the need to perform the activities for population protection is supposed, during the accidents of nuclear facility.

Existing area of threat in the site of power plants Bohunice

For JE V2, the size of the area of threat (zones of emergency planning) with the radius 21 km with the centre in the ventilation stack of main reactor building of JE V2 was approved by the decision of ÚJD SR No. 355/2007, effective from 1.1.2008.

After JE V1 shutdown, the area of threat, which is limited by JE V1 site borders, was approved for this nuclear facility by the decision of ÚJD SR No. 106/2011.

The area of the NJZ threat

The area of the NJZ threat will be defined on the basis of the application, which will be submitted by a future operator of the NJZ to ÚJD SR and the parts of this application will be analysis and support documents specified in the annex 5 of the regulation ÚJD SR No. 55/2006 Coll.

The size of the area of threat around nuclear facilities is assessed by ÚJD SR gradually in three steps:

- the proposal of the size of the area of threat by nuclear facility – in the phase of the location,
- preliminary delimitation of the size of the area of threat – in the phase of construction permission,
- the delimitation of the size of the area of threat – in the phase of the permission of nuclear facility commissioning,

With the determination of the area of threat of the NJZ and its size, there will be also used relevant requirements and recommendations presented in safety standards IAEA (GS-R-2, GS-G-2.1) and WENRA.

C.III.19.1.12. Liability for nuclear damages

The liability of nuclear facility operator for nuclear damages is specified by atomic act (No. 541/2004 Coll., as amended) in § 29, by which is fulfilled the commitment of SR that acceded, after the agreement of National Council of the Slovak Republic, to Vienna convention on civil liability for damages caused by nuclear events (The Resolution of NR SR No. 71 as of January 5th, 1995 and the approval by president of the Slovak Republic as of February 23rd, 1995).

It is possible to identify exactly all main principles of the international adaptation of civil liability for nuclear damages in the provisions of atomic act, which are:

- sole liability of nuclear facility operator for damages caused by each individual nuclear event,
- minimum liberation reasons for exclusion of the liability for nuclear damage,
- objective character of the liability (i.e. liability for the result, where is not examined the culpability of an offender),
- determined financial limit of the liability,
- operator's liability is limited in time,
- the obligation of nuclear facility operator to cover its liability up to the height of determined limit by an insurance or other kind of financial guarantee; if this insurance or other financial guarantee is not sufficient, the state of the facility is obliged to provide the covering up to the height of determined limit,
- exclusive jurisdiction to resolve claims lies in the courts of the contracting party, where nuclear event occurred,
- non-discrimination of victims based on nationality, residence and settlement.

The amendment to atomic act No. 143/2013 Coll. introduces, with effect from January 1st, 2014, the increasing of the limits of operator's liability for nuclear damage caused by each individual nuclear event, namely:

- for nuclear facilities with nuclear reactor or nuclear reactors for power engineering purposes during the commissioning and the operation up to 300 000 000 euro (what represents four times higher limit than it was initially determined by atomic act in the year 2004),
- for other nuclear facilities during the commissioning and during the operation, transport of radioactive materials and all nuclear facilities in the stage of the decommissioning up to 185 000 000 euro (what represents 3,7-times higher limit than it was initially determined by atomic act in the year 2004).

For future operator of NJZ, atomic act imposes the obligation to submit the document on the assurance of financial covering of the liability for nuclear damage as a part of the application on the permission for nuclear facility commissioning.

Practically concurrently with the international legislative process, the question of possible commercial insurance of the risks related to nuclear facilities operation for peaceful purposes is in the process of development, particularly first nuclear power plants.

First national nuclear pools were created at the beginning of the second half of 50s of the 20th century in Great Britain, USA, Japan, Belgium, Netherland, France and in many other countries practically all over the world. National nuclear pool in Slovak Republic was created in the year 1997. The youngest national nuclear pools are in Bulgaria and Ukraine and they use the experiences of other pools for fast development.

Slovak nuclear insurance pool is a free association of insurance companies located on the address of the headquarters of leading insurance company (Allianz - Slovenská poisťovňa, a. s.), which acts on its behalf on the basis of power of attorney from the other members of the pool. Special procedures are applied when concluding individual insurance contracts related to the insurance of nuclear risks in compliance with the international valid rules of the insuring. The presented rules apply that within territorial competencies, national pool covers the insuring of the individual nuclear risks on its territory, what is also the role and the mission of Slovak nuclear insurance pool.

In addition to national nuclear pools, two mutual associations of nuclear facilities operators (EMANI and ELINI) also exist in Europe. National bank of Slovakia as a supervisory authority over the financial market registers these two associations as the insurance companies operating in Slovakia, namely on the basis of licencing in other member state of European Union and within the freedom to provide insurance services following the European legislation. Similar mutual association was created also in USA (NEIL).

Note:

The act NR SR No. 54/2015 Coll. on civil liability for nuclear damage and its financial covering passed in March 2015. Crucial provisions come into force on January 1st, 2016. The act comprehensively deals with:

a) civil liability for the damage that occurs in the relation with a nuclear event,
b) scope of the activities of ÚJD SR in the relation to this act application,
c) scope of the activity of National bank of Slovakia in the relation to supervised subjects of financial market with the financial covering of the liability for nuclear damage.

New act adopts the principles and rules of the solution of the liability for nuclear damage according Vienna convention and it replaces and supplement relevant paragraphs and sections, which regulated the area of liability for nuclear damage in atomic act. New act keeps limits of operator's liability for nuclear damage without any change. New act explicitly prohibits the commissioning, operation and decommissioning of nuclear facility or to prepare radioactive materials without required financial amount and the method of the assurance of liability covering for nuclear damage. Due to the complexity, the act also solves some related questions of the insurance or the other financial covering and some civil-legal process provisions. In terms of ÚJD SR scope of activities, there does not occur any change, because the documentation on liability covering for nuclear damages remains a part of licence documentation according atomic act, but there is the reference to special submitted private-legal act. Potential penalization remains in ÚJD SR scope of activities as it is in the current modification.

C.III.19.2. Non-radiation risks

In principle, proposed activity represents, in terms of non-radiation point of view, usual industrial operation, when significant risk of emergency events arising with negative impacts to the environment and/or the population does not occur. Regarding the operation, it is not possible potentially exclude emergency situations related to the release of polluted waste waters (by the violation of sewerage tightness or by the violation of the function of oil waters purification plant), the release of stored substances (chemicals, driving propellants, lubrication and heat transfer means, cleaning products etc.) from storage tanks or pipeline bridges or eventually during the transport. There is even not potentially excluded the possibility of burning of media or other materials. Presented risks have low probability degree of the occurrence and special preventive or elimination measures are not required for their elimination except those that are usual or prescribed by the relevant procedures (constructional, safety, fire protection, transport or the other ones). The impacts of presented type of events are solved by usually available means.

The provisions of the act No. 128/2015 Coll. on the prevention of serious industrial accidents, as amended (act on the prevention of industrial accidents)[38] applies to the companies with a presence of selected dangerous substance (VNL). This act determines the conditions and procedures for the prevention of serious industrial accidents for preparedness, for their getting under the control and the limitation of their impacts to the life and health of population, the environment and the property in case of their occurrence. In the act, there are specified threshold amounts of selected dangerous substances. In case of the occurrence of higher than threshold amount, the company is classified into some of the categories A or B (from which result the respective requirements for preventive and consequent measures, specified in the act). The notifications about these facts are submitted to District Environmental Office, at the same time with the submission of the application for the issue of planning permission (for new companies).

In the site of the NJZ, it is possible to anticipate the presence of these selected dangerous substances:

- 15 % hydrazine,
- nitric acid,
- hydrogen,
- oxygen,
- oil products (transformer oil).

Threshold values for these substances, according the act, are as follows.

[38] This act is not applied to the threats having the origin in ionizing radiation.

Tab. C.III.69: Threshold substances for selected dangerous substances according to the act No. 128/2015 Coll.

Selected dangerous substances	Threshold values [t]	
	Category A	Category B
Hydrazine	0,5	2
Nitric acid (oxidising substance)	50	200
Hydrogen	5	50
Oxygen	200	2 000
Oil products	2 500	25 000

Following the experiences with similar operations, we can assume that the NJZ will feature as non-classified into the categories A or B, eventually as classified into the category A.

Regarding the applicability of the act No. 39/2013 Coll. on integrated environment pollution prevention and control and on the amendments of certain acts (IPKZ), as amended, any equipment that could be included into its mode will not be a part of the NJZ. The only potential activity, presented in the annex No. 1 of the act on IPKZ, article 1.1 could be possible to consider in case of the NJZ. Fuels combustion in the operations with total rated thermal input same or bigger than 50 MW. However, the power of considered backup boiler room (approximately 3x12,5 = 37,5 MW) does not reach the presented value and so it is not necessary to apply in the mode of the act IPKZ.

C.IV. Measures for the impacts mitigation

IV. Measures proposed for prevention, elimination, minimization and compensation of the impacts of proposed activity to the environment and health (specially present the measures during the period of construction, activities operation, measures for the case of accident arising)

Basic design measures for the prevention, exclusion, decreasing or eventually compensation of negative impacts consist of these areas:

- utilization of best available technologies of reactors of the generation III+,
- assurance of nuclear safety, radiation protection, physical protection and emergency preparedness in compliance with the requirements of valid legislative procedures, standards IAEA, requirements of WENRA or other professional standards,
- minimizing of radiation impacts to the inhabitants and employees in compliance with the principle ALARA,
- adjustment of monitoring programmes for the monitoring of individual potentially affected elements of the environment regarding the preparation and the operation of the NJZ,
- localization of the NJZ out of the environmentally sensitive territory, utilization of brownfield,
- minimizing of demands for environmental sources and outputs into the environment,
- respecting of all procedures and standards in the area of the environment and public health protection.

Above this basic scope, there are the measures proposed resulting from the conditions specified in the Scope of the assessment or the facts founded during this Report development, which are focused on further additional protection of the individual elements of the environment and public health. These measures will become a part of the conditions related to administrative proceeding and they will be implemented during the preparation, construction and operation of proposed activity.

With measures specification, there are not explicitly presented those that result from the law or other generally valid procedures. In fact, the declaration of a commitment to respect legal obligations can´t be considered as a proposal of measures for the prevention, elimination, minimization and/or compensation of the impacts to the environment or public health.

C.IV.1. Territorial planning measures

1. Territorial planning measures (e.g. the need of harmonization with valid territorial planning documentation, the recommendation of the change and the completion of valid territorial planning documentation, etc.).

- Regarding the Regional territorial planning of Trnava region, territorial plans of affected communities will be updated or completed.
- In the existing protection zone of nuclear facilities in the site Jaslovské Bohunice without permanent settlement, there will not be built other structures except the necessary ones for nuclear facility operation, transport and distribution networks; the utilization of agricultural land inside protection zone is not affected by this.
- Aviation forbidden area LZP29 Jaslovské Bohunice will be inspected and potentially modified to protect preventively and effectively also the site of NJZ.

C.IV.2. Technical measures

2. Technical measures (e.g. change of technologies, raw materials, construction schedule, area remediation, rescue researches).

Basic technical measures, which will be applied in the design of NJZ, are described in the chapters A.II.8. Brief description of technical and technological solution (page 37 of this Report) and C.III.19.1.1. Safety characteristics of reactors of the generation III and III+ (page 351 of this Report).

Among other proposed technical measures as a result of proposed activity assessment process belong:

- Technical solution of NJZ will assure that the envelope of parameters specified in the Report on the assessment of proposed activity impacts to the environment (chapter B.I. Requirements for inputs and B.II. data on outputs) will not be exceeded.
- Technical solution of NJZ will assure that parameters of source terms for the individual types of accidents considered in the Report on the assessment of proposed activity impact to the environment (chapter C.III.19.1.6.2. Source term for accidents) will not be exceeded.
- The design of NJZ will practically eliminate the possibility of severe accident in spent fuel storage pool, if storage pool is located out of the containment.
- Technical solution will take into consideration the requirements of ALARA for the protection of employees and inhabitants in the surrounding environment of the NJZ.
- Design solution of the NJZ will take into consideration the need of its future decommissioning in terms of the principles of ALARA and the minimizing of the impacts to the environment.
- There will be implemented the set of technical, mode and organizational measures of physical protection necessary for the prevention of unauthorized activities on nuclear facility (mechanical protective means, technical assurance means, safety elements of information systems).
- The system of NJZ industrial and pre-purified waste waters discharge will be implemented through closed collector of waste waters into the recipient Váh, discharge system of rain waters and waters from surface drain will be implemented into the recipient Dudváh.
- NJZ will be equipped by purification system of oil waters coming from auxiliary service buildings that will go back, after the purification, to water treatment system, and after quality control it is possible to discharge them into waste water system.

C.IV.3. Technological measures

3. Technological measures.

Basic technological measures, which will be applied in the design of NJZ, are described in the chapter A.II.8. Brief description of technical and technological solution (page 37 of this Report).

Among other proposed technological measures as a result of proposed activity assessment process belong:

- The activity of the NJZ ventilation systems will be organized in such a way that air from the spaces with lower activity will be conducted to the spaces with higher activity. Before the inlet to ventilation stack, exhausted air from power plant spaces will be conducted through the system of effective iodine and aerosol filters and the system of delay lines, where occurs degradation of short-time living radioisotopes by natural decay.
- It will be assured, by the monitoring of the individual elements of gas air pollutants (noble gases, iodine and aerosols) in ventilation stack of the NJZ that the exceeding of allowed limits of the effluents into the atmosphere with normal operation of the NJZ will not occur.
- It will be assured, by the monitoring of low active water discharges that the exceeding of allowed limits of liquid discharges under the normal operation of the NJZ will not occur.
- Used chemical mode for technological circuits will take into consideration the need of the minimizing of the effluents of low active radioactive substances and also conventional polluting substances into the environment.
- Principles of minimizing generation of RAO will be effectively applied.
- For the elimination of microorganism and algae amount in tertiary circuit, suitable biocidal agents, that will not represent any danger for the environment and public health, will be applied.

C.IV.4. Organizational and operational measures

4. Organizational and operational measures.

Organizational measures are formed by relevant limits and conditions (technical specification) of safe operation and operational procedures or handling regulations. The document Limits and Conditions belongs to the basic organizational measures in the operation of nuclear facility for preventive provision of negative development of the situation, which could lead to facility damage, the decreasing of capability to perform safety functions, the endanger of personnel, the violation of effluents limits and potentially also to the population endanger. It includes the summary of organizational, technical and technological conditions, which shall be observed for safety assurance. Limits and conditions are approved and their performances is pursued by Nuclear Regulatory Authority of the Slovak Republic. The part of procedures are operational procedures that include such planned procedures and activities, which performance will assure the reaching of required operational safety.

Among other proposed organizational and operational measures as a result of proposed activity assessment process belong:

Population and public health

- Construction traffic will be performed solely during the day.
- During the complete period of preparation, construction and operation of NJZ, there will be assured the contact of the customer with surrounding communes and the public in the area of informing on the course of project preparation and implementation and its potential impacts to the surrounding environment including the responding to raised points and questions.
- Public will be regularly informed on NJZ operation impact to the environment in summary annual reports, published on the website of the operator.
- The evaluation of health state of the population will be done in the period before the NJZ commissioning and subsequently in the interval of 10 years and the results will be available for the public.

Air and climate

- In the period of construction, the minimizing of the impact to air quality will be solved, mainly by the assurance of suitable technical state of mechanisms, the cleaning of transport routes and manipulation surfaces and maintaining of sufficient humidity of surfaces (mainly during windy weather without rain).

Noise and vibrations

- In the periods of the preparation and construction of the NJZ and in the period of the NJZ operation, noise and vibration measurement will be performed in the most affected area by land transport in terms of the requirements TP 13/2011 of Ministry of transport, construction and regional development of the Slovak Republic. Following the assessment of this measurement, the owner of roads can take measures leading to the decreasing of noise or vibration load (e.g. transport-organizational measures, decreasing of vehicles speed, exchange of road surface, exchange of windows on affected buildings, etc.).

Ionizing radiation

- In the documentation for the individual stages of permission process according atomic act, there will be, on the basis of monitoring reports of the operators of other nuclear facilities in the site, assessed if a significant change did not occur in the effluents of radioactive substances from these facilities and summary effluents from the NJZ and other facilities in the site do not exceed the envelope used in the assessment of proposed activity impact. In case of the exceeding, the analysis of causes will be performed and the review of health impacts assessment will be developed.
- In the documentation for the individual stages of permission process according atomic act, there will be, on the basis of monitoring reports of the operators of other nuclear facilities in the site, assessed if significant negative trends of radioactive substances concentration in the environment do not occur. In case of finding of this trend, the analysis of causes will be performed and the review of health impacts assessment for cumulative effects of the NJZ and other nuclear facilities in the site will be developed and the assessment of the need of corrective measures will be performed.
- Before starting of the NJZ commissioning, the measurement near effluents sources from the NJZ (ventilation stack, discharging duct) as well as in modernized parts of surrounding monitoring system will be commenced. Furthermore, there will be assessed measurement functionality near sources and surrounding monitoring system in the stage of commissioning and trial operation.
- At the end of trial operation, the validity of non-exceeding of assumptions and results of the Report on assessment, related to impacts of ionizing radiation form the NJZ and summary impacts of ionizing radiation for all nuclear facilities in the site, will be verified and confirmed.

Surface and ground water

- Handling regulation will be observed in the cooperation with SVP, š.p., Piešťany and the individual indicators of water quality in the facilities of NJZ will be checked, mainly in the end control tank where quality monitoring of waste waters before their discharge will be implemented.
- For the period of extremely low flows in Váh, the measures for improvement will be adopted, mainly in the relation to flow changes; there will be also considered the restriction of the amount of discharged waste waters (it is possible to assure it for short-time by increasing of the condensation in circulation circuit).
- The mode of discontinuous discharging of low active waste water from the NJZ will be harmonized with other nuclear facilities on the site the way not to be cumulated in the time (mainly regarding the minimizing of ground water influencing in the site of water source Hlohovec). Within the predesign preparation of the NJZ, the optimization of discharge system will be proposed within the study itself and following this study, there will be concluded the agreement with the operators of other nuclear facilities. This will be implemented into technical infrastructure and operational procedures of the NJZ and other nuclear facilities on the site.
- In terms of the limitation of contamination infiltration from “Drahovský” channel into adjacent ground waters, there will be inspected and maintained good technical conditions of shore concrete of “Drahovský” channel in the place of waste ducts outlets.
- With the well HB-1, which is located in the space of future construction site of the NJZ, the statute of water source will be cancelled; if it is possible in terms of the NJZ buildings configuration, the well will be reconstructed for monitoring purposes.
- In case of repeated utilization of the buildings HB-2 to HB-4 as water sources, the quality of ground water will be identified before their utilization and subsequently they will be included into the monitoring of ground water quality.

- Within the project of the NJZ (in the stage of the implementation of engineering-geological research of construction site), existing network of monitoring bore holes will be completed in the site to enable ground waters quality identification near future technological building of the NJZ and to identify the change of its quality on borders with current areas of JE A1 and JE V1. At the same time, site monitoring program will be modified and its implementation will start before the NJZ commissioning to find required values of selected parameters.

Soil

- Tillage taken from the surfaces of the site, construction site as well as working zone on corridors of pipeline will be stored not to occur its depreciation (tillage will be stored individually, on separated place, where can´t occur decreasing of it quality by mounding of the other excavated material).
- Surplus soil from gross landscaping and excavation works will be stored to not occur its erosion (excavation material will be stored on suitable place, e.g. plane, monticule not to occur its washout in case of torrential rains, the mound will not be height, they will have small slope angle).
- All used construction mechanisms will be in good technical conditions to not occur the contamination of soil environment; mechanisms maintenance (the exchange of lubricating fillings, etc.) will be performed only on water management secured areas, in advance prepared for this purpose.

Rock environment and natural sources

- With the proposal of the method of individual structures foundation, geotechnical characteristics of the site will be taken into consideration, they will be verified and completed with the results of the stage of detailed engineering-geological research; possible occurrence of sagging soils in loess complex will be also taken into consideration in the proposal of the foundation.
- Suitable type of geo-technical monitoring will be installed for the monitoring of the interaction of structures and foundation soils during and after the completion of the construction.
- The system of geodetic monitoring will be built for the monitoring of tectonic stability of the area.

Fauna, flora and eco-system

- The assessment, by professionally qualified person, of the state of biotopes, fauna, flora and kinds that are the subject to the protection of protected bird area “Špačinsko-nižnianske” fields and protected bird area Sĺňava will be assured, at least one year before the construction, during the construction (in the period of main construction works) and 1 year after the construction.
- Biological supervisory over performed works will be assured by professionally qualified person, mainly to control the observance of prescribed measures, the scope of construction site, deadline and time restrictions, subsequent rehabilitation of the surface affected by the construction and the performance of replacement planting.
- Movement of construction mechanisms during the construction will be restricted solely to the construction itself, manipulation zones and specified access roads.
- There will be performed single monitoring (at least during one calendar year) of the surfaces under power lines. In case of the finding of birds or bats death, effective measures will be proposed.
- During the construction, tress cutting down and the liquidation of other vegetation will be restricted to necessary extent on the areas of the site, construction site as well as corridor of pipelines. Plants and trees cutting down will be performed out of vegetation and nesting season (it means from the beginning of September to the end of March).
- It is necessary to implement construction works in shore parts of water reservoir Sĺňava in the period out of nesting season and strictly respect the inspection of technical state of machines and equipment and this way prevent potential leakages of oil substances.
- In the higher stage of project preparation, there will be developed the project of replacement planting, replacement planting will be implemented from the original kinds of bushes and trees.
- After construction works completion, the territory affected by construction activity will be put into the original state and damaged parts will be recultivated.

- Spreading of invasive and synanthropic plants species will be prevented, the method of their removal will be discussed with State nature protection of SR.

Landscape

- Cooling tower will remains in the colour of raw concrete (with potentially structured surface), other structures will be adapted with their colour to already built structures in the site.
- There will be verified the possibility of amenity planting in the areas that have the potential to participate significantly on the decreasing of the NJZ area visibility in affected communes (the positions as near as possible to affected residences, if possible in higher positions) and where it is also possible in terms of property-legal acceptable conditions as well as in terms of favourable opinion of landowners, where should be implemented the potential amenity planting. In case of this planting implementation, there will be assured that the vegetation can perform cover and landscaping function as soon as possible, i.e. there will be used grown plants or quickly growing species, mixed planting will be preferred for at least partial efficiency also in winter period.

Assets and cultural sights

- Rescue archeologic research of burial place from the Bronze Age, registered on the locality “Pravé pole – Right field” will be performed according the requirement of historic preservation authority.

Transport and other infrastructure

- Railway or shipping transport will be preferred with the transport of construction materials and structures.
- Before the NJZ construction, the state of affected communication network will be described and diagnosed. If it is necessary, the modification of roads and structures of road network will be implemented the way that there will not occur their degradation by the construction.
- After construction completion, the roads affected by the construction will be repaired. Exact scope of the reparations will be based on the diagnostics and research implemented before the NJZ construction.

Other

- In the preparation, construction and operation, available possibilities of non-active waste generation decreasing will be taken into consideration. For wastes, there will be preferred their further utilization; if it is not possible, wastes will be recycled, recovered (in terms of material and power) and only in the latest case they will be disposed.
- During the preparation, construction and also operation, there will be assured in maximum possible extent the recovery of mainly construction waste (crushing, separation, reuse in the site area or even out of this area) as well as biodegradable waste.

C.IV.5. Other measures

5. Other measures (e.g. anticipated caused investments).

- It will be necessary to take into consideration the production of radioactive waste and spent fuel from the NJZ into the balances of necessary capacities for storage and repository in the future update of the National program of RAO and spent nuclear fuel disposal.
- It will be necessary to apply the requirement for considering the synergy effects of the NJZ and relevant new-proposed activity in the future processes of the assessment of other proposed activities in the site to the environment.
- For the NJZ, it will be necessary to develop calculation analysis for the determination of new (or confirmation of the existing one) size of the threat area (21 km circuit for JE V2).
- The output from radiation monitoring system of the NJZ will be integrated into existing warning and notification system VARVYR or there will be built own warning and notification system for the area of threat of the NJZ.

C.IV.6. Statement to technical-economic feasibility of measures

6. Statement to technical-economic feasibility measures.

Presented measures are technically-economically feasible and the proposer considers them as an integral part of the project.

C.V. Comparison of variants

V. The comparison of variants of proposed activity and the design of optimal variant (including the comparison with zero variant)

Proposed activity is not solved in several variants. More detailed justification of this fact is presented in the chapter A.II.9. Variants of proposed activity (page 117 of this Report). From the justification results that, for proposed activity, there is not available any other variant solution than the one proposed, thus neither other locality nor other technology.

Therefore, proposed activity is submitted and assessed in compliance with the requirements of the Scope of assessment, in one implementation variant representing construction of NJZ in the site of Jaslovské Bohunice, namely in technical and technological parameters described in the chapter A.II.8. Brief description of technical and technological design (page 37 if this Report) and with the environmental impacts described in the chapter C.III. The assessment of the impacts to the environment including health (page 266 of this Report).

Specific role has so called zero variant. It is defined as “the variant of the state, which could occur, if proposed activity wouldn´t be performed” in the act No. 24/2006 Coll. on Environmental Impacts Assessment and alternations and amendments of certain acts as amended. In this case, the impacts of proposed activity wouldn´t be brought into affected area, thus current state of the environment (or its development trend) would be preserved in the affected area. It is described in the chapter C.II. Characteristics of current state of the environment (page 144 of this Report).

Implementation and zero variant are not directly comparable, zero variant is useful only for reference comparison of the significance or load capacity of the impacts of implementation variant.

C.V.1. Set of criteria for optimal variant selection

1. Creation of set of criteria and the determination of their importance for optimal variant selection.

Proposed activity is not solved in several variants.

C.V.2. Selection of optimal variant

2. Selection of optimal variant or the determination of suitability order for assessed variants.

Proposed activity is not solved in several variants.

C.V.3. Justification of optimal variant proposal

3. Justification of optimal variant proposal.

Proposed activity is not solved in several variants.

C.VI. Proposal of the monitoring and after-project analysis

VI. Proposal of the monitoring and after-project analysis

C.VI.1. Proposal of the monitoring

1. Proposal of the monitoring form the beginning of the construction, during the construction, during the operation and after completion of the operation of proposed activity.

C.VI.1.1. Radiation monitoring

Radiation monitoring program of the NJZ will conceptually correspond to current monitoring system of nuclear facilities in the site, and the NJZ monitoring system can be integrated into current monitoring system or an autonomous system can be built.

All existing operations in the site EBO are currently classified into safety monitoring program "Monitoring program of radiation control of the nuclear facility EBO surrounding". It was issued with the goal:

- to assure the inspection of nuclear facilities Bohunice operation impact to the environment in their surrounding;
- to assure support documents for regular informing of inspection and supervisory authorities on environment conditions in the surrounding of the nuclear facility EBO;
- to maintain required technical level of the inspection of EBO nuclear facilities surrounding environment and to use optimally the technical means;
- to obtain permanently data on the radioactivity of the environment in the surrounding of nuclear facilities EBO for the creation of data sets;
- to use systematically technical equipment, professional workers and to keep them in permanent preparedness and professional competence for the case of an accident;
- to obtain permanently the set of values for reference levels specification.

The results of the measurement and the analysis according the monitoring program are submitted quarterly in the form of written report to Public Health Authority of the Slovak Republic.

Furthermore, there is performed radiation monitoring on national level resulting from the legislative requirements of SR, namely as a part of the system of early warning against the radiation. The monitoring of radiation situation assures:

- support documents for systematic assessment and regulation of population radiation and for the assessment of population radiation arising due to performing of the activities leading to the radiation with normal radiation situation;
- data providing on the environment radioactive contamination for making decision on the performance and the ending of intervention and measures for the limitation of radiation risk with radiation threat;
- data on radiation level for population informing and for the international exchange of the information on radiation situation on the territory of Slovak Republic.

Detailed description of existing monitoring is presented in the chapters C.II.15.3.2.3.1. System of Bohunice nuclear facilities surrounding environment monitoring (page 241 of this Report) and C.II.15.3.2.3.2. Radiation monitoring on national level (page 248 of this Report). The description of existing monitoring for ground water is presented in the chapter C.II.6.2. Ground water (page 167 of this Report).

Legislative obligation to develop and publish summary reports on the results of the monitoring and surveillance of nuclear facilities and environment elements conditions in nuclear facility surrounding environment will also relate to future operator of the NJZ. The proposal of the NJZ monitoring can be divided into two areas:

The monitoring of internal operation (monitoring itself for the NJZ, regardless surrounding nuclear facilities) assigned for the surveillance, protection and prevention of the environment pollution. For this monitoring, there will be created monitoring systems, which assure the monitoring of direct impact of the NJZ to the environment. It concerns mainly to the monitoring of radiochemical parameters of technological circuits and tanks, the monitoring of environment parameters and the monitoring of active and non-active effluents into the environment.

The monitoring of surrounding environment is assigned for the monitoring of the environmental conditions. The NJZ will be included into existing common monitoring program of the surrounding of nuclear facilities in the site. Current monitoring system is fully functional and sufficient in main parameters also for the future, for the monitoring of the NJZ impact. The need of existing monitoring program completion in the individual circuits for effective consideration of the NJZ id described below.

Regarding the performance of the requirement of the Scope of assessment No. 2.2.18 *"For the future stages of project preparation, to propose, within emergency planning, the installation of measurement devices in the area of the threat, which will monitor the air and other elements of the environment and they will make a part of the system of early warning and notification in case of an event.", these monitoring systems are included:*

- 1st monitoring circuit will be completed – the measurement of dose rates in the vicinity of the NJZ the way that new teledosimetry system (TDS) for the NJZ covers the NJZ area perimeter in complete scope. At the same time, there will be assessed the need to modify also the other monitoring circuits according currently valid requirements for monitoring system, while current 2nd and 3rd circuit are, in principle, suitable also for the NJZ.
- The monitoring of radiation situation will be designed to be known qualitative and quantitative composition of radionuclides effluents into the atmosphere and hydrosphere for balance purposes and at the same time to assure also the purpose of the signalization, i.e. that the deviation from normal state will be known in the period as short as possible.

For monitoring system of ground waters, there is designed the following completion of the monitoring system:

- Due to clear differentiation of the NJZ impact from the existing radiation situation, there will be additionally built approximately 3 to 5 pcs of new monitoring objects – complete boreholes (drilled complete 1st aquifer and completed at least 1 m in impermeable basement) with assumed depth ~ 40 m. Monitoring boreholes will be located on the limit of the sites of the NJZ and JAVYS. Moreover, there is proposed the completion of the monitoring system inside the NJZ site (potentially critical buildings) by the building of approximately 3 to 5 pcs of new monitoring objects of the same specification. All boreholes will be equipped (bore holes with installed instrumentation) as potentially remediation boreholes. Particular location and numbers of monitoring boreholes will be proposed on the basis of the design of the NJZ technological buildings configuration.
- The monitoring characteristics (monitored parameters) in new built boreholes should be: ground water level, tritium volume activity, gamma nuclides volume activity the new possibly some of the selected physical-chemical characteristics (pH, conductivity, hardness). Monitoring frequency should be once a month (in case of contamination occurrence) and at least once per quarter in standard mode, mainly in terms of existing good practice in the site of nuclear facility Bohunice.
- Since the commune Madunice has own source of drinking water in affected area, there are concerns of the inhabitants that this water source can be devaluated in the future by long-time activity of all nuclear sources in the area, there is recommended to include the well HM-1 in the commune Madunice into the monitoring system/program provided that monitored parameters will be ground water level and tritium volume activity monitored with the frequency once per quarter.

C.VI.1.2. Non-radiation monitoring

Non-radiation monitoring program will, in principle, correspond to the current monitoring program of nuclear facilities in EBO site (SE EBO, JAVYS), with taking into consideration the current legislative requirements and the requirements of relevant supervisory authorities expressed in relevant permission decisions.

Monitoring will be implemented in this basic structure:

Air:

- For the individual sources of air pollution, numbers of operational hours, fuel consumption and released emissions into the air (TZL, SO_2, NO_x, CO, ΣC).

Water management:

- Amount and quality of collected raw and drinking water.
- Amount and quality of discharged waste waters. The analysis of discharged waste waters will be assures by accredited laboratory of the operator. Bleed point, period of the bleed, recommended methods for the determination of limit values indicators in discharged waste waters, the method of the assessment of flow measurement and samples analysis for purposes of registry and inspection and the obligation to submit relevant authority of state water management the information on volumes and amounts of polluting substances in discharged waste waters for the relevant calendar year will be specified for the operator by district authority of Trnava in the permission for the discharge of waste waters and waters from surface drain from nuclear facility site.

Waste management:

- Within the program of waste management, there will be monitored the registry of non-active wastes including sludge from chemical water treatment. Produced amount of wastes will be monitored specially for the others and dangerous wastes.

Other:

- Amount of selected dangerous substances will be monitored according to the act No. 128/2015 Coll. on the prevention of serious industrial accidents, as amended.

C.VI.2. Proposal of the inspection of conditions observance

2. Proposal of the inspection of determined conditions observance.

The inspection of conditions observance will be assured by supervisory authorities that issue relevant permission decisions, mainly:

- Nuclear Regulatory Authority of the Slovak Republic,
- Public Health Authority of the Slovak Republic and
- Other relevant authorities, presented in the chapter A.II.13. Affected authorities (page 123 of this Report).

C.VII. Assessment methods and data sources

VII. Methods used in the process of the assessment proposed activities impacts to the environment and the method and sources of data acquisition on the current state of the environment in the territory, where proposed activity has to be implemented

The method of Report development is strictly subordinated to conservative approach. It means that all impacts are assessed:

- in their potential maximum (for the assessment, there are used conservatively determined environmental parameters of all installations coming into the consideration) and
- in cumulative or concurrent impact with the other installations in the site and environmental background.

Details are presented in the chapter Introduction (page 10 of this Report).

Sources and support documents presented in the chapter C.XII. List of complementary reports and studies (page 449 of this Report) were used for the development of the Report.

The method of data acquisition on the current state of the environment in the territory is described in relevant chapters of the part C.II. The characteristics of the current state of the environment (page 144 of this Report and following pages).

The ways and methods of impacts assessment for the individual elements of the environment or public health are described in relevant chapters of the part C.III. The assessment of the impacts to the environment including health (page 266 of this Report and following pages).

In all areas of the environment or public health were used publicly available sources as websites addresses, publicly available reports on the environment, the information from Statistic Office of the Slovak Republic, land use plans, national programs, politics and publicly available strategic documents. Furthermore, for the individual areas of the environment or public health, there were used the following assessment methods and data sources.

Population and public health

Health conditions of the population was assessed with the utilization of the data provided by Information service of Statistic office of the Slovak Republic. The input for health impacts assessment were support studies of radiation and also non-radiation impacts.

The method of health risks assessment, based on the procedures developed by the agency US EPA, was used for the assessment of impacts to the population and public health. The procedure of risks assessment and management in the Slovak Republic, defined by Methodological instruction of Ministry of Environment of the Slovak Republic as of October 22nd, 1998 No. 623/98-2 are also based on this methodology.

For the assessment of radiation impacts, risk coefficients for health damage based on the recommendations of the International Commission ICRP were used. For the assessment of non-radiation impacts, valid legislative limits or risk coefficients based on the legislation in force or the recommendations of relevant international organizations were used.

Air and climate

The results of the measurement of polluting substances concentration in the air, which are implemented by SHMÚ on the stations of National monitoring network of air quality, were the basic data for air quality assessment.

The model MODIM´06, which is used with air quality assessment in Slovak Republic in the practice of SHMÚ, was used for the calculation of polluting substances concentrations in the air. MODIM operates on the basis of US EPA methodologies for the calculation of air pollution from stationary and line (mobile) sources.

Calculated concentrations of polluting substances were compared with limit values of the pollution of external environment, determined by the regulation of Ministry of Agriculture and Rural Development of the Slovak Republic No. 360/2010 Coll. on air quality.

Statistically processed data of SHMÚ for the site Jaslovské Bohunice were used for the assessment of climate characteristics.

Climate assessment used the results of the mathematical model CT-Plume/2 (the version Jaslovské Bohunice) with modules for characteristics calculation of plume active phase, plume passive spreading, the calculation of visible plume dimensions and the calculation of plume impact to the selected meteorological characteristics in ground level.

Noise

The methods of noise measurement and modelling were used with the assessment of noise situation impact. Data from the measurements of the most important noise sources (cooling tower, compressor plant, transformers, turbine hall, reactor hall and DGS) and data on traffic load of communication network in the affected area were used as input values for the compilation of current state model. Furthermore, the measurement of real noise values “in-situ” was performed, namely first in the vicinity of EBO area and also near transport routes in residential area. Measurement procedure was in compliance with the valid technical standards (STN ISO 1996-1 and 1996-2), methodological guidance OHŽP-7197/2009 and the requirements of the regulation MZ SR No. 549/2007 Coll., specifying details on admissible values of noise, infrasound and vibrations and on the requirements for the objectification of noise, infrasound and vibrations in the environment.

Model calculations for current and anticipated states were realized by the program CadnaA with incorporated methods for noise calculation for the conditions of Slovak Republic in terms of 99th professional guidance of ÚVZ SR. performed

measurement was used for the calibration and the verification of this calculation model. Following founded differences between the values of acoustic quantities obtained by the prediction in calculation model and real values of acoustic quantities obtained by the measurement "in-situ", setup of input acoustic quantities (terrain reflexion, terrain absorption, etc.) was performed.

Measured and calculated values of determining quantity were assessed in the relation to determined admissible values of noise in external environment, which are defined in the annex to the regulation of MZ SR No. 549/2007 Cool., specifying details on admissible values of noise, infrasound and vibrations and on the requirements for the objectification of noise, infrasound and vibrations in the environment.

Ionizing radiation

Data on current state of radiation pollution situation in the site and on the effluents of radioactive substances into the environment from existing nuclear facilities in the site were taken from annual reports of SE EBO and JAVYS on radiation protection for the years 2007 – 2013. Food baskets for the estimation of doses from the ingestion were considered from statistic data (statistic office). The maximums of real effluents for previous period were used for the calculation of current background state. The effluents from the NJZ were determined by envelope method on the basis of data provided by suppliers of the individual reference types of reactors, which were verified according the data from publicly available licensing documents of the individual reference types.

Prediction calculation of doses from the effluents from normal operation was performed by calculation software RDEBO, which is accepted by Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR) as well as State Nuclear Safety Authority of the Czech Republic (SÚJB). Doses from the effluents from the NJZ individually and summary doses from the NJZ and existing nuclear facilities in the site were modelled by the calculation. There have been performed variant calculations for different age groups, for different height of the effluents into the atmosphere according to the height of the NJZ ventilation stack and for different models of annual meteorological situation. Doses were assessed in the perimeter within 100 km from the NJZ. The calculation modelled doses from gas and also liquid effluents as overall individual effective dose per year. With the obtained results, the analysis of dominant paths of the exposure and dominant radionuclides was performed. The results were compared with limit value of annual individual effective dose (250 μSv/year) determined for the complex of nuclear facilities NV SR No. 345/2006 Coll. on basic safety requirements for health protection of workers and population against ionizing radiation and with the sum of authorized radiological limits determined for existing nuclear facilities by the decision of main public health officer of the Slovak Republic (82 μSv/year). Limits of doses, which are determined in Slovakia for nuclear facilities operation, are lower than the limits determined by the Directive EC 2013/59/Euratom or the recommendation ICRP103.

Used meteorological and hydrological data were processed from SHMÚ (used data for the year 2010 from the site Jaslovské Bohunice and statistic meteorological data for the years 1999-2011). Slovak Hydrometeorological Institute Bratislava, the observatory Jaslovské Bohunice systematically monitors climatic, meteorological and hydrological parameters in the site necessary for making prognosis of the impacts of potential nuclear facility accident, it also monitors emissions and immissions of polluting substances, quality and quantity of surface and ground waters.

To calculate the accident impacts, envelope conservative source terms were determined on the basis of the methodology described in the chapter C.III.19.1.6.2. Source term for the accidents. The calculations were performed by calculation codes RTARC version 6.1 and RDEBO for representative cases of design basis accident and by the code COSYMA or COSYMA and RDEBO for severe accident. Used codes are accepted by Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR) for safety analysis for nuclear power plants in Slovakia. Doses from all paths of the radiation were assessed within the distance of 100 km from the NJZ. For the assessment of doses acceptability, calculation doses were compared with the requirements ÚJD SR, IAEA, WENRA and EUR for the limitation of persons exposure during the accidents.

To assess the amount of spent nuclear fuel from the NJZ, the envelope data from the individual suppliers, related to the length of fuel campaign, fuel consumption and minimum fuel burnout, was used. For the production of spent fuel from the operated JE V2, data from the proposal of National policy and National program of spent fuel disposal and radioactive waste disposal in Slovak Republic was used as a review of the strategic document Strategy of final part of nuclear energy peaceful use (National nuclear fund, 2015).

To assess produced amount, categories and type of radioactive wastes from the operation and decommissioning of the NJZ, the envelope data from the individual suppliers, which was verified according the data from publicly available licensing documents of the individual reference types of reactors, was used. To determine produced amount, categories and type of radioactive wastes from the operation and decommissioning of existing nuclear facilities in the site, data from the proposal of National policy and National program of spent fuel disposal and radioactive waste disposal 2015, reports on the Inventory control of radioactive wastes JAVYS 2013, The assessment of radioactive waste disposal in SE-EBO in the year 2012 and 2013 and the Report of EIA to the individual stages of JE V1 and JE A1 decommissioning was used.

Surface and ground water

Data on basic hydrological characteristics of affected area were adopted from summary report of SHMÚ for the site Jaslovské Bohunice. Furthermore, data on current state were completed with the information from the Reports on nuclear facilities impact to the surrounding environment in the site Jaslovské Bohunice, from available publications on water quality in Slovak Republic and from publicly available sources.

To assess the impacts of the NJZ to surface waters, JE V2 was selected as a reference power plant. From the characteristics of JE V2 polluting substances discharging for the selected operation period (10 years), the individual indicators of conventional pollution were derived by the calculation for the NJZ , while there was used specific amount of waste waters [m^3] attributable to one produced MWh (assumed maximum and average pollution for each indicator). To determine annual indicators of the pollution in waste waters from the NJZ, the archived operational records of JE V2 were used as a support document; to determine the bleedings of technological, service and drinking water, the records from JE V1 operation (mainly for the period of the NJZ construction and the NJZ operation termination) were used. To determine the characteristics of rain water amount discharged from the NJZ, model calculation for the determination of max. inflow and the estimation of the size of rain water retention tanks individually for site surface and for protection trench around the NJZ area were created. For the site surface and for the area of external territory behind protection barrier of the NJZ, corresponding coefficients of rain water discharge were used in the calculation. Presented calculation model was used also for the volume calculation of capturing tank for 100-years rain.

Furthermore, there were used the Annual reports on radiation protection and the Reports on the environment developed and submitted to supervisory authorities by JAVYS and SE EBO, Annual reports of Public Health Authority, Annual reports of SHMÚ and Complex assessment of the environmental conditions in the sites of SE, a.s. power plants in selected aspects of the environment.

Another source of the information were current permissions and decisions of state supervisory authorities and relevant authority of state administration on state management of the environment, operational procedures of nuclear facilities operators and the assessment reports from the proceedings according the acts No. 127/1994 Coll. and 24/2006 Coll. on environmental impacts assessment, as amended, which had been performed for nuclear activities in the site EBO.

Source data in the issue of ground waters were obtained by long-time monitoring of their parameters in the site or by their supply to relevant subjects or from the literature, mainly from the results of the Report Monitoring and protection of ground waters of nuclear power site Jaslovské Bohunice – final report for the year 2011, 2012, 2013. Furthermore, the results of risk analysis of the NJZ in the site Jaslovské Bohunice – Risks resulting from geological structures contamination for potential localizations (Report EKOSUR, Jaslovské Bohunice, December 2008) were used.

The results were assessed by means of statistic processing of time series of measured data for the individual parameters and assessments of their development trends. Moreover, the assessment is also performed by the method of surface assessment of measured data – by means of isolines or hydroisohypses.

Reputable models - program MODFLOW, program MT3D, program PEST were used for model prognosis.

Soil

Data on current state of pedological conditions in the area were adopted from available publications on water quality in Slovak Republic, from public sources and from monitoring reports of nuclear facilities in the site of Jaslovské Bohunice.

Rock environment and natural sources

To assess geological data, archive data on wider surrounding environment of the site, geological maps, borehole data and geophysical data were used. Due to the position of prospective site of the NJZ in the vicinity of the area of nuclear power plant Bohunice, several reports documenting the preparation of the individual buildings of power plant were available for the assessment of engineering-geological review. Data on 114 boreholes with overall length approximately 3300 m and data on more than 900 samples of soils were excerpted from the Reports.

Fauna, flora and ecosystem

Basic data for the impact assessment to fauna, flora, ecosystems and institutions of nature protection was the assessment of existing support documents on the locality, selection of suitable methodology of research and locality research itself. Researches were performed during the complete vegetation season in the year 2014. The mapping of fauna, flora and biotopes in interest territory was designed to cover all localities directly and indirectly affected by proposed activity. Completely for the monitored period, there were performed from 7 to 12 researches on the individual localities, while their number and distribution into the individual months was dependant on the size and the character of particular locality. The difference between the individual researched was at least 7 days.

Landscape

Basic method for impact assessment to the landscape was the method G.L.Impact representing qualified determination of the visual impact of building projects in the landscape, based on direct calculation of the visual impact by mathematical and graphical analysis of construction visibility on the basis of digital model of assessed locality terrain. Taking into account the conclusions of presented analysis and other relevant information on the territory, the impact of the design to affected landscape was determined by the method of expert assessment.

Assets, cultural and historical sights and archaeological sites

The assessment of the impacts to assets, cultural and historical sights and archaeological sites was based on own research in the locality, the communication with relevant offices (KPÚTT) and publicly available sources.

Transport and other infrastructure

Current transport load on specified transport network of local area was based on the results of national traffic census in the year 2010. Model values of traffic intensity for the individual anticipated states were obtained by the conversion of values by traffic growth coefficients determined by technical conditions TP 07/2013. The assessment of roads technical conditions in assessed area was performed on the basis of data from Traffic database and Slovak Road Administration.

The analysis of possible impacts to road traffic infrastructure was performed by the program HDM-4, which evaluates the speed of vehicle movement, the consumption of driving propellants, costs for the maintenance and the reparation of vehicles, tire wear, salaries of truck crews, amortizations, etc. The calculation also monitors social effects, i.e. time consumption of passengers, accident rate and society-wide losses from negative impact to the environment.

Others

The international methodologies – guideline of IAEA were used with the assessment of EBO site in terms of external sources of risks caused by human activity and the probability of aircraft fall on safety important buildings of the NJZ.

C.VIII. Shortcomings and uncertainties in the knowledge

VIII. Shortcomings and uncertainties in the knowledge, which occurred with the development of the assessment report

During the Report development, any shortcomings or uncertainties in the knowledge did not occur that could make impossible the clear specification of assumed impacts of the project to the environment or public health. Support data for Report development includes all necessary information, all relevant analysis and researches, necessary for locality conditions investigation and subsequent specification of the impacts, were performed during the development of the Report:

- Data on the individual reference projects are based on the data presented by their suppliers. Thus, they are on the level limiting basic technical and technological solutions of the individual reference projects. Therefore, details of technical solution are not available.[39]. However, this fact is not limiting in terms of environmental impacts assessment. The significant is that all environmentally important parameters of the project are known (mainly inputs and outputs), which provide all relevant data for the assessment of the impacts to the environment and public health.
- Data on the rest of nuclear or other facilities in the site are known, including their impacts to surrounding environment. In this respect, mainly the availability of monitoring results of the individual facility effluents and also the results of surrounding environment monitoring is significant.
- The environment conditions in affected area are known and they are founded from search sources and completed by the researches of interested/affected area in its individual elements.
- Legislative requirements or limits are clearly defined in nuclear area as well as in the area of the protection of the environment or public health or other areas.
- In the Report, all impacts to the environment including public health are assessed by very conservative (envelope) manner, thus in its potential maximum. Also from this prospective, any uncertainties occur that could be interpreted to the detriment of legitimate interests of the protection of the environment or public health.

The process of environmental impacts assessment, according the legislation in force, passes by other related correct steps. Thus, with the development of this report, it is reasonably assumed that all legal requirements (in the area of nuclear power engineering as well as in other areas) will be observed in the further preparation of the project. Therefore, in principle, there is only one uncertainty, which can be specified. It is the results of related administrative proceedings (the agreement for the location of nuclear facility construction, planning decision, building permission, the permission for nuclear facility operation, the permission for the activities leading to the exposure or the others), which are issued by relevant offices. In the Report, there is reasonably assumed the compliance of the project with any applicable legal requirements and thus also the issue of all necessary permissions. Doing so, it is not important that it will happen only afterwards. What is important that all legal requirements shall be met during the preparation of the project, otherwise the project will not be implemented. In this point of view, it does not concern to an uncertainty, which could influence the results or assumptions presented in the Report on the impacts assessment of proposed activity to the environment.

[39] Fully in compliance with the requirements of the annex No. 11 to the act, which requires in the chapter A.II.8. "Brief description of technical and technological solution".

C.IX. Annexes

IX. Annexes to the Report on the assessment (graphical, maps, tables and photo-documentation)

Annexes are attached to main text of this report.

List of annexes:

Annex 1 Summary situation of the localization of proposed activity

Annex 2 Requirements for proposed activity assessment Scope

C.X. Non-technical comprehensive final summary

X. generally comprehensive final conclusion

C.X.1. Basic information on proposed activity

Proposed activity: NJZ in the site Jaslovské Bohunice

Proposer: Jadrová energetická spoločnosť Slovenska, a. s. (JESS) / Nuclear Energy Company of the Slovak Republic
Tomášikova 22, 821 02 Bratislava, Slovak Republic

C.X.1.1. The subject of the activity

The subject of proposed activity is the NJZ in the site Jaslovské Bohunice including the construction of NJZ with one reactor unit and all directly related civil structures, technological equipment and infrastructure connections.

The preparation of NJZ in the site Jaslovské Bohunice is in compliance with all relevant strategic and concept documents of the Slovak Republic, mainly Energy Security Strategy of the Slovak Republic (2008) and Energy Policy of the Slovak Republic (2014). The preparation of NJZ is also in compliance with the directives and documents of European Union related to low carbon energetics, energetics safety and the competitiveness as well as all commitments of the Slovak Republic, which result from the mentioned documents.

The need of NJZ in the site Jaslovské Bohunice is given mainly by:

- the necessity of replacement of basic production capacity of power plants with ending operational life in Slovakia by more modern sources,
- assumed increase of electricity consumption related to the economic growth, even despite the fact of current implementation of austerity measures in energies consumption and decreasing of energy demands,
- the need of stable, reliable and low carbon sources in power mix production,
- assumed depression in the utilization of the power plants for fossil fuel due to non-being ecological and decreasing domestic coal resources,
- unreality of the assurance of sufficient and reliable power supply from renewable sources and
- the need of overall increasing of power safety in the Slovak Republic.

The assumption of the commencement of NJZ construction in the site Jaslovské Bohunice is in the year 2021, the assumption of the commissioning into permanent operation is in the year 2029.

C.X.1.2. Location

Proposed activity is situated in western region of the Slovak Republic in Trnava Self-Governing Region, in the cadastre of the communes Radošovce and Jaslovské Bohunice, in immediate neighbourhood with existing site of nuclear facilities Jaslovské Bohunice (the site EBO). For the location of NJZ, a part of the area of shutdown JE A1 and JE V1 is proposed to be used, what decreases the need for taking the new areas.

The locality Jaslovské Bohunice is suitable in terms of legislative requirements for the localization of a nuclear facility. The locality is used for electricity production in nuclear power plants and for the construction and the operation of other nuclear facilities for long-time and there are available necessary areas and infrastructure links including water source for the cooling (the Váh River), networks of Slovak Electricity Transmission System and systems of waste disposal including radioactive wastes. The localisation of proposed activity in this locality is in compliance with strategic documents of the Slovak Republic as well as Land use plan of Trnava Self-Governing region (2014). In technical point of view, the region disposes with

sufficiently developed infrastructure, transport infrastructure as well as technical one and qualified manpower for the construction and consequent operation of NJZ. Due to above mentioned reasons, the construction in this locality brings several advantages, which contribute to the acceleration of the construction as well as to the decreasing of construction costs, what ultimately should be reflected in lower production prices of the electricity from this source.

C.X.1.3. Brief description of technical and technological solution

In technical point of view, it will be the power plant with pressurized water reactor (PWR) of the generation III+, designed in one unit arrangement. The net installed power is considered maximum up to 1700 MW. Design operational life of the power plant will be 60 years, assumed date for the commissioning into permanent operation is in the year 2029.

Proposed activity is assumed and assessed in compliance with the requirements of the Scope of the assessment, in one implementation variant representing the construction of NJZ in the site Jaslovské Bohunice.

There will be used commercially available units of reputable suppliers. As the reference solutions are considered the following design solutions:

- AP1000 (Westinghouse Electric Company LLC, USA),
- EU-APWR (Mitsubishi Heavy Industries (MHI), Japan),
- MIR-1200 (consortium Škoda JS/JSC Atomstroyexport/JSC OKB Gidropress, Czech Repubic/Russia),
- EPR (AREVA NP, France),
- ATMEA1 (AREVA NP/Mitsubishi Heavy Industries, France/Japan),
- APR-1400 (Korea Hydro&Nuclear Power (KHNP), South Korea).

The supplier of the power plant will be selected subsequently in the further stages of the project preparation, supplier selection is not the subject of environmental impacts assessment.

A part of proposed activity are all necessary civil structures and technological equipment of primary circuit, secondary circuit, cooling circuit, auxiliary service buildings and operations including all related and caused investments (communication connection, parking, pavements, planting, etc.).

Power output of the units will be brought by overhead power lines 400 kV into new power plant Jaslovské Bohunice. This plant will be a part of Slovak Electricity Transmission System. Standby power supply of station internal power consumption will be solved by new overhead line 110 kV from the same power plant and backup standby power supply from the substation JE V1.

Raw water supply will be implemented by new underground pipeline from water reservoir Sĺňava on the Váh River. Drinking water supply will be implemented by the connection to existing infrastructure in the locality. Waste water discharge will be implemented by new underground pipeline collector of waste waters into “Drahovský” channel on the Váh River. Rain water discharge will be implemented by new underground pipeline collector of rain water to the Dudváh River. All pipeline routes are implemented near existing infrastructure networks for the needs of JE V2 and other installations in the site Jaslovské Bohunice, but they will be independent of them.

General data

Basic element of nuclear power plants is nuclear reactor, where occurs the use of energy contained in the mass of nuclear fuel, particularly by nuclear fusion with heat production. This heat is subsequently used for steam production. In the power plants, which are currently available all over the world, there are used solely nuclear fusion reaction.

The reactor of the type PWR (Pressurized Water Reactor) was selected for the proposed activity; this reactor represents the most used and currently most built reactor type all over the world. These types of reactors are long-time used also in Slovakia and there are long-time operational experiences. In the technology of reactors of the type PWR, standard demineralized water is used as a coolant. With the transition through the reactor, the coolant (water) is heated, it flows by several cooling loops through primary side of steam generators, where it gives a part of its thermal energy through heat-exchange surface to secondary side and finally it goes back to the reactor. This cooling circuit is called primary circuit. In this circuit, including reactor, cooling water is kept under high pressure (to remain in liquid phase also with the temperatures over 300°C, thereof the name pressurized water reactor). This technology provides that secondary circuit (which main part is

represented by steam distribution from steam generators to the turbine, condensation system and steam generators feedwateer system) is completely separated from the reactor and nuclear fuel and thus it practically contains only non-active water.

Nuclear power plants use uranium as a nuclear fuel, where the concentration of uranium isotope U-235 is increased to the level up to approximately 5 % of U-235 by its enrichment. Basic element, in which heat releases in the reactor, is fuel element. It consists of pellets of uranium oxide (UO_2), inserted and closed in zirconium tube. Fuel elements are arranged into fuel assemblies, which are inserted into reactor core during the outage due to refuelling. The outage due to refuelling is performed once in 12 or 24 months. With the refuelling, there is exchanged only a part of the fuel and a part of fuel assemblies change their location in reactor core for balanced burnout. So, the complete refuelling is performed gradually, usually within 4 to 6 years.

The technology of nuclear reactors of commercial nuclear power plants is classified into the categories called generations according the level of technical development. Proposed reactor (or power plant) belongs to the generation III+, other nuclear power plants operated in Slovakia belong to the previous generation II. Designs of the reactor of the generation III+ currently represent the best available technique, they are currently built in several countries of European Union and all over the world and they will be commissioned in the coming period. They offer important contributions to the safety as are the higher passive safety utilization, containment resistance against big aircraft fall and other external impacts, prolonged period without necessary intervention of an operator with failures and accidents, higher seismic resistance, lower radioactive waste production. The designs of the generation III+ bring also the improvement of economic indicators – standardized design, which simplifies licensing process and contributes to the decrease of costs for the construction and the operation, higher annual energy usability and higher efficiency and capability to change supplied power output according to the requirements of electricity transmission system.

Basic legislative procedures, laying down the conditions of nuclear energy utilization in the Slovak Republic, are the Act No. 541/2004 Coll. on peaceful use of nuclear energy (Atomic Act) and on amendment and alterations of several acts as amended and the act No. 355/2007 Coll., on protection, support and development of public health and on the amendments and supplements to certain acts. According these acts and related procedures, mainly the requirements to nuclear safety, radiation protection, physical protection and emergency preparedness shall be met with the utilization of nuclear energy. Furthermore, for the NJZ (the NJZ), it is required to apply not only all national safety requirements, but also the requirements of safety standards of IAEA and the requirements of WENRA for the NJZ in power plant design.

All these requirements will be related not only to the current valid procedures in the time of preparation, designing and construction of the power plant, but also to the considering and incorporation of prospective new requirements to nuclear safety and power plant design in any phase of its operational life time. Thus, it is continuously taken in account current state of professional standards in compliance with the development of best available technology including guidance from prospective non-standard or emergency events on nuclear facilities in all over the world.

Basic technical data of the NJZ

Basic technical data of NJZ are summarized in the following items:

- Nuclear power plant unit will be equipped by the reactor PWR, the generation III+, designed in one unit arrangement.
- Net installed power up to 1700 MW.
- Operational life time at least 60 years.
- Existing design, licenced in the country of the origin, in some country of European Union or in other nuclear developed country (USA, Russia, Japan, South Korea, etc.), in the time of supplier selection at least in the stage of advanced phase of the construction in other locality.
- Turnkey supply or the supply of technological islands with coordination function of nuclear island supplier.
- Technology supply together with nuclear fuel supply, taking into account the possibility of the diversification of nuclear fuel supplier.
- The assurance of licensing process will be in compliance with legislative procedures of the Slovak Republic and with the utilization of experiences and recommendations of the international institutions.

- The power plant will operate in the basic part of daily load diagram and in technical point of view, it will be capable to provide the operator of the superior electricity transmission system detailed services corresponding to primary, secondary and tertiary control.
- The unit will be capable, for long-time, to operate on power output in the range from 50 to 100 % of rated power and it will be capable to perform required technical conditions of the access and connection of the equipment for electricity production.
- The coefficient of unit readiness for the period of 12 months will be bigger than 0,9 (the period, in which the unit is capable of the operation is divided by complete calendar fond).

C.X.2. Inputs and outputs

C.X.2.1. Inputs

Presented values represent envelope (maximum) requirements for the inputs during normal operation of the NJZ.

Occupation of the land: permanent occupation of areas: up to 46 ha
temporary occupation of areas: up to 37 ha
infrastructure networks: little significance

Due to different spatial arrangement of the individual parts of the NJZ, the area for location and construction of the NJZ is limited by conservative border, which enables all considered orientations of the NJZ buildings of the individual reference types of reactors and it respects the border presented in approved ÚPD VÚC of Trnava Self-Governing Region. Real permanent and also temporary occupation of the area will be significantly lower than this conservatively limited area for the location and construction of the NJZ.

After the NJZ construction completion, the area of construction site facilities will be released. Decommissioning of the NJZ does not require any additional permanent and temporary occupation of the area.

Permanent occupation of the area for infrastructure networks represents in order maximum few units of ha in summary. Route of inlet lines of raw water and outlet lines of waste water or rain water will be implemented under the terrain, without significant demands for permanent occupation of the area. Overhead power lines require occupation of the area only for foundation footings of poles.

Raw water: average extraction: to 1,42 m^3/s (to 45 000 000 m^3/year)
source: the Váh River

Presented values represent average maximum immediate and maximum annual extraction (with conservatively considered continuous operation) related to climatic characteristics of the year 2029.

Raw water extraction will be independent from existing bleed systems. Raw water will be obtained from the Váh River (the tank of water reservoir Sĺňava) and furthermore discharged by the line from pump station Pečeňady, transported to water tank of technological water in the NJZ site with the capacity for at least 30 days for the needs of unit residual heat removal in case of raw water supply loss. Raw water supply system will be backup by the system of alternative extraction from water-gate Drahovce.

Drinking water: average annual extraction: to approximately 50 000 m^3/year
source: public water supply

Presented value is based on conservatively determined number of 650 permanent employees with specific consumption of 120 l/person/day and 1000 external employees during the outages (approximately 1 month in a year) with the same specific consumption with conservative increase on the basis of operational experience. Drinking water will be obtained similarly as for existing installations in the site, thus from remote main conduits of water sources Dobrá Voda, Dechtice and Veľké Orvište.

Drinking water consumption during the NJZ construction (workers and other equipment) will be up to approximately 398 000 m^3/year. Current source of drinking water has sufficient capacity for this consumption covering.

Fire water: non-specified extraction

Fire water system will be supplied from circulation cooling circuit, which will be capable to cover each requirement for fire water supply with sufficient reserve.

Nuclear fuel: to 35,0 t UO_2/year

53 fuel assemblies correspond to this amount for a year. Nuclear fuel will be purchased on the market. The fuel will be based on the basis of UO2, maximum enrichment of the fuel will be up to 5 % of U-235. The lengths of fuel cycles are considered in the range of 12 – 24 months, fuel burnout is assumed in the range of 55 – 70 MWd/kgU. Nuclear fuel in the

form of fuel elements will be arranged into square and hexagonal fuel assemblies. Total amount of the fuel in reactor core will be up to 158 t (UO_2).

Operational and other material: hundreds t/year

Chemicals for technological water treatment, furthermore lubricants, driving propellants and technical gases are considered like operational materials. The need of chemicals will vary on the level of units of ton for relevant chemicals. It mainly concerns to boric acid H_3BO_3, lithium hydroxide LiOH, ferric sulphate $Fe_2(SO_4)_3$, ammonia water, hydrazine hydrate, sodium hydroxide NaOH, nitric acid HNO_3 and others. The consumption of oil products consists of diesel fuel, turbine oil, transformer oil, motor oil, synthetic oil, light fuel oil and other oils and lubricants. It concerns to the amount on the level maximum of dozens of tons annually for respective substances.

Technical gases necessary for the NJZ operation includes mainly hydrogen, carbon dioxide and other technical gases as are nitrogen, oxygen, acetylene, argon and others.

Electricity: to 120 MW_e

Presented value represents the input of internal power consumption for power plant activity. The consumption will be assured by the activity itself and by standby power supply of station internal power consumption.

Transport:

road:	250 vehicles/24 hours (thereof approximately 60 heavy vehicles)
railway:	insignificant
special:	little significance

Presented value represents conservatively determined average of daily intensity of objective traffic in the period of the NJZ operation (number of arrivals). The intensity of source traffic of the NJZ (number of departures) will be the same. The traffic includes the transport of employees, operational substances and materials, nuclear fuel, radioactive wastes and non-radioactive wastes. The route of transport will use the road No. III/50415, mainly direction to Žlkovce and direction to Jaslovské Bohunice.

The period of the NJZ operation does not have important demands for railway transport utilization.

The transport of heavy and oversized components will be in units of pieces mainly during the construction, this transport is insignificant in terms of intensity.

Other infrastructure: necessary modification/reinforcement

The NJZ connection to electricity transmission system requires the implementation of new substation Jaslovské Bohunice and its connection to Slovak Electricity Transmission System.

The NJZ will be realized independently from exiting water management systems of nuclear power plants in the site EBO. New inlet pipeline will be built for raw water supply and there will be also implemented new systems for waste and rain waters discharge. Thus, existing infrastructure systems in the site EBO will not be affected.

Number of employees: approximately 650

Conservative estimation of total number of power plant employees is approximately 650 persons. During the NJZ construction, conservatively estimated number of workers is approximately 3000 persons.

C.X.2.2. Outputs

Presented values represent envelope (maximum) outputs during the NJZ normal operation.

Emissions into the atmosphere: little significance

The NJZ is not combustion plant, therefore it will not be important source of emissions into the air. Related to the NJZ, there will be only backup technological equipment (backup dieselgenerators or gas turbines and backup boiler room, which will not be permanently operated sources) and cooling towers. The emissions of main pollutants TZL, SO_2, NO_x and CO will occur mainly with the regular tests of equipment in the scope up to 100 hours annually (it concerns to the period necessary in terms of equipment functionality testing, maintenance, etc.).

Waste heat:

waste heat:	to 3150 MWt
Evaporation dry residue:	to 1,25 m^3/s

Waste heat from the NJZ operation will be counteracted in cooling tower by cooling water evaporation.

Waste water:

industrial waste water:	to 0,25 m^3/s (to 8 000 000 m^3/year)
sewage water:	to 35 000 m^3/year
recipient:	the Váh River

Presented values represent average maximum immediate and annual amount of industrial waste water (with conservatively considered continuous operation). The amount of industrial waste water will be proportional to the amount

of extracted raw water, after deduction of the amount of evaporated water and the drift on cooling tower, the condensation in cooling circuit and the consumption for demineralized water production and softened water and for losses refilling in service water systems. Disposal of waste industrial waters will be based on their discharging by new sewage collector to the Váh River (existing "Drahovský" channel).

The amount of sewage water will correspond to the amount of extracted drinking water after consumption deduction. Produced sewage waters will be brought by sewage system to purification plant of the NJZ sewage waters and after the purification, they will be discharged by new collector (together with industrial waste waters) to the Váh River ("Drahovský" channel).

Rain water:

total:	do 102 000 m^3/year
recipient:	the Dudváh River

Presented amount is based on the surface of the NJZ area (46 ha), average precipitation of approximately 550 mm/year and drain coefficient 0,4. Rain water represents water from rain and other precipitation, which is not absorbed or discharged into the recipient. Rain waters are not waste waters, the quality of rain waters will not be changed. Disposal of rain water will be based on its discharge by new collector to the recipient Dudváh

Non-active wastes:

municipal and other waste:	do 1200 t/year
Dangerous waste:	do 120 t/year

The amount and the structure of produced non-active wastes will be, in principle, quantitatively and qualitatively correspond to the structure of wastes from existing operational units (JE V2). In concerns to usual kinds of wastes produced from the purification, maintenance, operation and replacement of non-active equipment, constructional wastes from the reparations and others. Disposal of wastes will be assured in compliance with the valid legislation (currently valid Act No. 223/2001 Coll. on wastes as amended will replace, on January 1st, 2016, the Act No. 79/2015 Coll. on wastes, on the amendment of certain laws) and it will correspond to the system in use, thus handing over to authorized companies focused on waste recovery and disposal.

Noise:

noise sources:
- cooling tower
- cooling water pump station
- turbine hall
- transformer
- TVD pump station
- spray pools
- reactor hall
- road and railway transport

Noise sources relate to main production activity – electricity production as well as secondary activities – water management, power output, waste management, etc. Noise sources are usually located in internal spaces of the NJZ site or on the roofs and facades of the NJZ buildings. The operation of main power plant equipment will be continuous and identical for both daylight and night time. Mobile source of noise will be mainly road and railway transport on public roads out of the NJZ site.

During the preparation and the implementation of the NJZ construction, noise source will be construction and structural activity on construction site and out of construction site transport, in both cases with the utilization of usual construction and earth-moving machines and transport means.

Radioactive effluents into the atmosphere:

noble gases:	to 6,2E+13 Bq/year
tritium:	to 6,7E+12 Bq/year
C-14:	to 1,0E+12 Bq/year
iodine:	to 2,5E+09 Bq/year
aerosols:	to 1,9E+09 Bq/year
Ar-41:	to 1,3E+12 Bq/year

Primary source of radioactive gases is nuclear fuel itself, where fission reaction takes place, when active isotopes of gases occur. Another source of radioactive gases in primary circuit coolant are the interactions of neutrons released from reactor core with the cores of isotopes of the elements occurred in coolant molecules, its admixtures, dirt and corrosion products.

The biggest source of gas effluents with radionuclides content is the venting of the degasser of primary circuit water. Another sources are radioactive gasses and aerosols from other technological systems and tanks, which are continuously ventilated and discharged into the systems of gas purification and in smaller rate it is also the air discharged from the space of reactor shaft.

Gas effluents from the NJZ will be discharged into the atmosphere in a controlled manner by ventilation stack after the purification on highly efficient aerosols and iodine filters and radiological control. On the output from ventilation stack, noble gases (Kr, Xe, Ar-41 isotopes), carbon C-14 and Tritium H-3 will prevail and they are not possible to capture efficiently on filters and they do not represent a danger for the environment. The effluents into the atmosphere will be approximately equally divided within the course of the operation. There will not occur big differences on the effluents to the atmosphere and their composition with power operation and the outage for refuelling.

Radioactive effluents into water flows:

tritium: to 7,5E+13 Bq/year
corrosion and fission products: to 1,0E+10 Bq/year

The sources of radioactive effluents into water flows are overbalance purified waters, which occur with the purification of water circuits from purification plants of technological circuits and tanks, waste waters from laundry room and hygienic loops, waste waters from steam generators blowdowns and from the laboratories of radiation control. Waste waters are purified in the systems of waste waters treatment, where radioactive substances are concentrated to the smallest volume as possible. Purified waste waters are collected in control tanks. Radiochemical control in these tanks determines how these waters will be disposed. It is possible to discharge into the environment only the waters that meet discharge levels. In case that waters show higher values of the activity, they are pumped back to the purification.

Liquid effluents from the NJZ including tritium waters will be discharged into the recipient (the Váh River) after radiological examination by controlled manner by new final collector of waste waters (together with industrial and sewage waste waters).

Field of ionizing radiation: insignificant

The impact of electromagnetic (gamma) radiation or neutrons directly from technological buildings (without effluents contributions) are considered as the field of ionizing radiation. It is not significant already in the vicinity of technological buildings as the NJZ and also the existing installations including their decommissioning.

Radioactive wastes: total volume: to 125 m^3/year

Radioactive wastes (RAO) from the NJZ will represent mainly the concentrates from evaporation plant, saturated ion exchangers and sludge, filters of active HVAC systems, used measurement probes and boxes of proving samples, furthermore contaminated not used parts, protection aids or clothes, separated materials from controlled area, etc. Concerning to the types of wastes, according to suppliers data, the volume of solid radioactive waste should be the same and event doubled in comparison with the volume of solidified liquid RAO.

Regarding RAO classification in terms of determined classes by the legislation, there will be produced only very low active, low active or medium active wastes. Crucial minority of wastes will be very low active and low active wastes, which will be stored, after the conditioning, on surface deposit site.

Spent nuclear fuel: to 35,0 t UO_2/year

Approximately 53 fuel assemblies correspond to this amount for a year. The amount of produced spent nuclear fuel corresponds to the amount of fresh fuel in the batch.

Non-ionizing radiation: insignificant

The proposed activity is not significant source of non-ionizing radiation (magnetic or electric field). Power lines (power output or standby power supply) located in outside publically accessible space will meet required limits.

Odour and other outputs: without outputs

Proposed activity is not the source of odour and/or other outputs into the environment.

Additional data: without outputs

A part of proposed activity are not any other outputs, significant terrain modifications or impacts to the landscape.

C.X.3. Data on environment conditions in affected area

Affected locality is characterized as a locality, which could be significantly affected by the impacts of proposed activity. As it follows from assessments performed in the relevant chapters of this Report, the scope of important impacts does not exceed the scope of cadastre localities of affected communes. The location of affected cadastres and their spatial relation to the location of proposed activity are clear from the annex 1 of this Report.

Environmental conditions in affected locality are determined by four crucial factors:

- industrial function,
- agricultural function,

- residential function and
- natural function.

These four functions are long-tie consolidated in the locality and they have clearly determined relations. Thus, they are not the source of significant stresses.

Industrial function is represented by electricity production in the site EBO and related activities and infrastructure. The deterioration of the environment and public health does not occur due to the operation (or decommissioning) of existing nuclear facilities in the site EBO. All outputs into the environment are controlled and they are, for long-time, within the limits determined by relevant legislation and/or relevant offices. In radiation area, authorized limits of effective doses from the effluents are observed with big reserve. At the same time, old ecologic load of the locality with historic origin in the power plant JE A1 is successfully remediated (pollution of ground waters by tritium).

Therefore, electricity production and the operation of other nuclear facilities in the locality does not influence significantly the quality of the environment of affected locality. An exception to this statement can be considered the impacts of cooling towers of power plants JE V2, NN V1 and other main buildings of exiting nuclear facilities in the locality to aesthetic qualities of the locality, thus the impacts to landscape picture, especially at a distance close view of the nearest surrounding communes.

Agricultural function uses favourable soil, terrain and climatic conditions of affected locality. Regarding to this fact, majority of the locality is dominantly and intensively used for agricultural purposes.

Residential function is concentrated in built-up areas of communes with sufficient distance for the site EBO. In the communes, there is available necessary infrastructure (supply, energetic, communication and transport links) including the services. Health, social and economic conditions for the inhabitants are friendly and in many aspects they are better than the average conditions in the Slovak Republic, what is also confirmed by the fact that people, in average, migrate here more and also live longer in affected locality.

Natural function is limited by extensive areas of intensive agricultural activity and also industrial production (the site EBO). Therefore, it mainly consists of species-poor agrocoenoses with local occurrence of ecologically more precious segments mostly created by line accompanies of water flows and roads. Despite this fact, special protected areas (protected areas, natural reservation), locality Natura 2000 (protected bird areas, special areas of conservation) and other elements of nature and landscape protection (significant marshland, elements of local territorial ecological stability system), which create the base of locality ecological stability, are also in the locality.

Overall quality of the environment in affected area is created by mutual relation of anthropogenic and natural elements of the environment, while anthropogenic function (industry, agriculture, habitation) is historically dominant. As such, the state of the locality corresponds to its character. Overall quality of the environment in affected locality is favourable and the locality is not, with respecting of reasonable interests of nature protection, particularly vulnerable or sensitive to anthropogenic interventions.

From the most significant existing problems of the environment of affected locality, it is necessary to mention the following ones:

- old ecological load (pollution of ground waters by tritium in the site EBO and its surrounding) – this load does not cause significant risk and it is successfully remediated,
- low biodiversity given by dominant agricultural and industrial function of the locality – extensive areas of agricultural soil and industrial sites. However, in the locality, there exists developed frame of ecological stability. Biological functions in the locality are not suppressed, as it is evident from the presence of protected areas on national and European level,
- significant presence of anthropogenic elements in landscape picture as a result of industrial site EBO with mass dimensional operational buildings and related infrastructure,
- the impact of transport to urban areas of communes (noise, atmosphere) given by historical routing of roads through the centres of the communes.

These problems are not limiting for the utilization of the locality.

C.X.4. Characteristic of the impacts to the environment

C.X.4.1. Impacts to the population

From the assessment of radiation impacts with cumulative activity of the NJZ and existing facilities in the site EBO explicitly results that the risk of health damage is very low, insignificant in comparison with the natural background and it meets the most strict internationally recognized criteria. The evaluation of health conditions of the population in affected area, after nearly 50–years of power plants operation in the locality, also corresponds to this statement and the health conditions are the same or better in comparison with geographically, socially and economically similar localities, where are not nuclear facilities, as well as in the comparison with world-wide average.

In terms of short-time exposition to non-radiation chemical pollutants, the situation in affected area can be considered as health suitable and determined legislative limits are met reliably. In terms of long-time exposition, we assume, with nitrogen dioxide, in prospective years, slow decrease of immission concentrations in the locality due to improving emission factors for driving propellants combustion with operated vehicles, the impact of the NJZ operation will be quantitatively insignificant with solid substances. For benzene and benzo(a)pyrene, which concentration in the environment does not have direct relation with the operation of nuclear facilities in the site, but only with related traffic in affected area, long-life risk of serious health consequences, currently and in prospective state, is on the acceptable level.

In terms of noise, with the nearest residential buildings, equivalent noise levels during the operation of stationary noise sources of the NJZ are reliably under the legislative limits and for the majority of the nearest buildings also under the threshold values of possible effects of the noise to public health. It is possible to consider the noise from the traffic caused by future construction and operation of the NJZ as health acceptable. In the most affected locality with transit through commune Žlkovce, there is recommended to implement control measurement in the period of construction and operation of the NJZ and according the results, to consider the implementation of eventual noise control measures.

On one hand, positive perception of safe operation of nuclear facilities and social and economic benefits of nuclear facilities and on the other hand, certain worries of a part of inhabitants of the region from indeterminate adverse effects to the environment result from the results of implemented researches of opinion pools. Therefore, there is proposed as a part of measures, the strengthening of public and the elected representatives communication and awareness on the course of the preparation, construction and operation of the NJZ, on safety aspects of the NJZ and safety assessment and on the results of environmental impacts assessment on the basis of annually performed monitoring of the surrounding environment.

The implementation of the NJZ project will have significant positive impact in terms of local, regional and national economy and employment. It will help to economic growth of complete region and it represents the assumption of the improvement of affected locality prosperity by increased creation of social product.

C.X.4.2. Impacts to rock environment

The implementation of the project has minimum impact to rock environment. Direct impact is the excavation of subsoil for the location of foundation structures without another consequences to subsoil quality. The impact is limited only to intended locality. During the NJZ operation, neither integrity nor quality of rock environment will be affected.

In the surrounding environment of the NJZ site, there are economically significant deposits of mineral resources. Existing registered mineral resources and even future potential mineral resources will not be affected by the implementation of the NJZ.

The locality for the NJZ construction is stable and there is not the assumption of landslide or other manifestations of instability with standard construction procedures. For geodynamic phenomenon, there is not excluded sagging of underlying loess in the locality although the results of present geological works in the locality do not indicate the presence of this phenomenon. The potential of sagging shall be evaluated in details in the stage of detail engineering-geological research of construction site before construction commencement and technologies of main the NJZ civil structures foundation shall take into consideration founded facts. Preliminary assessment according the results of the stage of indicative engineering-

geological research did not indicate the presence of soils, where should be assumed liquefaction. It is recommended to verify this fact again with detail engineering geological research before construction commencement.

C.X.4.3. Impacts to climatic conditions

Taking into consideration the current situation and proposed scope of the activity within the NJZ implementation, it is possible to conclude that this kind of impacts (change of average temperature, fogs, icings, relative humidity) should have only minimum and local importance, which will not represent measurable change within long-time monitoring of the locality. In all cases, it will concern to changes less significant as are normal climatic fluctuations during the individual years. These impacts completely disappear with increasing distance from the NJZ (in orders of hundreds meters to units of kilometres).

C.X.4.4. Impacts to atmosphere quality

The NJZ, like any other nuclear power plant, will not be significant source of emissions of the substances polluting the atmosphere.

Taking into account the level of immission load in the locality, it can be concluded that stationary sources of atmosphere pollution from the NJZ and even automobile traffic caused by the construction and operation of the NJZ will not change significantly the load of the locality. Following the performed calculation analysis of the future state, we assume reliable performance of legislatively determined immission limits for all monitored pollutants.

In terms of power plant operation, nuclear energy belongs to nearly zero producers of greenhouse gases. They are directly emitted only in a small amount (with periodic tests of auxiliary service equipment as e.g. backup dieselgenerators, boiler room, etc.). The biggest share on greenhouse gasses emissions, within overall life cycle of nuclear power plant, has the obtaining of uranium ore and nuclear fuel production. However, from the comparison of greenhouse gases emissions from the individual power sources, it is clear that nuclear energy also with the inclusion of all externalities, just like mining of uranium ore and fuel production, has similar greenhouse gases emissions as renewable energy resources (wind and photovoltaics) and at the same time it shows several times lower emissions of greenhouse gases than fossil energy resources.

C.X.4.5. Impacts to surface waters (non-radiation)

It is possible to assume the NJZ impact to surface waters due to raw water pumping (the Váh River – tank of water reservoir Sĺňava) and discharging of waste waters (the Váh River – “Drahovský” derivation channel) and rain waters (the Dudváh River).

For the NJZ, for the period of its operation, there are assumed approximately balanced water extractions with the assumption of slight several percentage increase of the extraction due to climatic changes during 60-years operation life-time of the NJZ. The values of currently valid permission for water extractions from VN Sĺňava on the Váh River will not be exceeded even after the NJZ commissioning. Water extraction for nuclear facilities in the site EBO (including the NJZ) will not cause, even taking into consideration the potential impact of climatic change, the need of operational procedure change of the dam Drahovce – Madunice. Regarding to rain water discharged to the Dudváh River, its average amount does not impact significantly hydrologic situation in the locality. Recipient capacity is sufficient, the system of rain water drainage will be equipped by tanks for torrential rains capturing.

Regarding to water quality development in the Váh River, the indicators of immission values in monitoring plant Hlohovec are maintained on stable level for long-time without more significant fluctuations, what can be assumed also in the future period. the NJZ does not cause any significant negative impact to qualitative characteristics of surface waters.

From the performed assessment results that the limits, according the government regulation No. 269/2010 Coll. laying down the requirements for reaching of good state of waters in the Váh River, are respected even in the most adverse conservatively considered case with concurrent impact of all nuclear facilities in the site including the NJZ, taking into consideration the climatic changes and minimum flow rate in the Váh River. Relative approximation to limit value is more significant only for the indicator of nitrates (NO_3^-), which concentrations in the Váh River relate to the NJZ only marginally, other indicators are and will be respected with significant reserve even with these conservative assumptions.

C.X.4.6. Impacts to ground waters (non-radiation)

Following the assessments of ground water monitoring (non-radiation), it is possible to conclude that significant risk impacts to physical-chemical and biological quality of ground waters in affected area did not manifest with existing nuclear facilities in the site. According support data analysis, above all, this is the result of favourable geological composition of the subsoil. Following the performed assessment of potential impact of the NJZ to ground waters, there is assume only insignificant and acceptable impact of the NJZ to the mode and also physical-chemical and biological quality of ground waters in 1st leakage collector and absolutely no impact in 2nd leakage collector.

Potential impact to ground waters with locally limited effects could occur only due to unforeseen and high unforeseen failure in operation technology system or waste water treatment and discharge system. The design of the NJZ will be equipped by adequate technical solution (tanks with double bottom, capturing tanks, regular inspections of technology tightness, measurements and signalization of parameters changes) against these failures.

The implementation of the NJZ will not have the impact to water sources and protection zones of water sources of ground water.

C.X.4.7. Impact to the soil

The most important impact of proposed construction to the soil will be permanent occupation of the land, which will reach maximum values 46 ha with conservative approach. Thereof the most significant part represents the occupation of the agricultural land, where it mostly concerns to the soils with high production capability. However, overall occupation of the land is lower than it would be with the localisation of proposed activity in the other locality, because brownfield areas after commissioned nuclear facilities in the site (JE A1 and JE V1) will be used to a large extent for the areas related to infrastructure and construction site facilities. Soil horizon will be removed during the construction and further suitably used for final treatment of construction site, its rehabilitation and further utilization. Any of the affected parcels is not a part of forest land.

From the results of long-time monitoring of the surrounding environment results that it is not possible to prove the impact of nuclear facilities operation to the soil in monitored items in the surrounding environment of the power plant. Even the operation of proposed activity does not assume significant intake of contaminants into soil environment and this way neither the pollution of soils. Soil stability will not be violated by the construction and operation of the project, there will not occur the erosion of affected soils.

C.X.4.8. Impacts to fauna, flora and their habitats

Following performed assessment, proposed activity shouldn´t cause more significant loss and fragmentation of reproduction habitats and even not the decrease of species diversity and abundance of animals in affected area. Certain problem can be the loss of a part of food (hunting) habitats mainly for some species of predators (common buzzard, common kestrel, rarer gerfalcon) due to direct occupation of the areas for the construction and construction site facilities and in their vicinity. These habitats will be naturally compensated by alternate hunting habitats in wider surrounding environment of the NJZ site.

The impacts of migration corridor are insignificant due to the fact that fauna of affected areas migrates without more significantly limited migration corridors and in case of amphibians and reptiles, there weren´t identified any migration corridors in the area. Concerning to possible collisions of fauna (birds and eventually bats) with higher constructions and overhead power lines, it can occur only exceptionally (mainly with bad weather conditions or at night in case of power line that is less visible in comparison with cooling towers) due to the fact that birds migrate through the area by wide front without more significantly limited migration corridors. But the size of this impact, probably, will not be significant, because it concerns only to short section of power line. The temperature of air mass emitted by cooling towers (approximately 30°C) does not represent any risk for flying birds or bats.

With water extraction, respecting the limits of extracted amounts, as well as the observance of the condition to preserve biological flow in the Váh River (in the place of the dam Drahovce) and in “Drahovský” channel, there is not the assumption of the violation of hydro-biological characteristics and populations of water and water related fauna (vertebrates and invertebrates) of water reservoir Sĺňava and Váh.

The most important impact to flora and habitats will be represented by permanent occupation of the land. Complete removal of tree and shrub vegetation will occur in some parts within the area for the location and construction of the NJZ. In case of permanent occupation of the soil, it will concern to irreversible changes, but of a little significance, because no biologically precious habitats are in these areas. The areas temporary occupied will be recultivated after the construction, a part of these areas will be grassed and shrub and tree vegetation will be planted on some part of the area.

The impacts of microclimatic changes due to the NJZ implementation are not significant and they do not cause any impacts to the composition of the vegetation of affected area.

C.X.4.9. Impacts to the landscape

Mainly lowland agricultural landscape will be affected by the project with very low variabilities of landscape picture with the dominancy of large units of arable land, by significant application of technical landscape layer and limited visual proportion of eco-stabilizing landscape elements.

In the area of interest, the NJZ will not degrade or unbearably influence any of basic values of landscape character, i.e. important country elements, protected areas, natural and cultural-historical dominants of the landscape, historically valuable complexes, areas and buildings, harmonic scale and harmonic relations. The most important impact of some of mentioned areas is the impact to landscape scale based in the installation of new industrial dominant – cooling tower of the NJZ, exceeding existing silhouette of EBO and thus increasing overall visibility of power plant complex in landscape pictures.

The change of visual impact intensity of power plant complex after the NJZ construction can be evaluated as globally few significant and even insignificant. In bigger distances, higher visibility radius of 180 m height cooling tower of the NJZ will manifest, while in nearer parts “disappearance” of the area of decommissioned JE V1 and its four cooling towers will be more significant in terms of observed point of view.

The impact of surrounding residential areas shading by nuclear facilities in the site Jaslovské Bohunice is possible to evaluate, in observed aspects (absolute time relations and relative change in comparison with current state), as local few significant and mostly as insignificant one. This is also valid for the impact of shading from the siding from cooling tower of the NJZ.

C.X.4.10. Impacts to protected area

It is possible to consider the impacts to protected area during the NJZ operation as well as during concurrence of operation with the other installations in the site EBO as practically excluded due to their distance. We do not assume any impacts to protected area Síňava with standard operation of extraction building located on the edge of water reservoir Síňava. The line of the corridor of industrial waste water discharge is lined in the distance approximately 150 to 300 m south from the protected area “Dedova jama” and near south edge of the protected area “Malé Vážky”. The pipeline will be embedded in the ground and it is not the source of any phenomenon, which could in any way negatively affect the protected area and endanger the subject of the protection.

The functions of protected bird area SHCHVU026 Síňava will not be affected in any way by the implementation of proposed activity as well as the operation and decommissioning of the operation. Direct impacts of the NJZ operation to protected bird area SKCHVU054 “Špačinsko-nižnianske” fields are not assumes, as well. New overhead power lines and cooling towers can have indirect negative impact, in case of decreased visibility due to fog that can represent the flight obstacle for gerfalcon and there is certain danger of possible collisions. Since it concerns only to short section of the power line, which does not interfere to protected bird area, extend of this impact can´t be considered significant.

Assessed activity does not interfere directly into any significant landscape element (VKP) and any other elements of nature protection localised in affected area. Concerning to sufficient distance of the area for the localisation and construction of the NJZ and line of the corridor of raw and waste water from the other elements of nature protection, the probability of direct and indirect negative impacts during the NJZ operation is zero.

The protection of sensitive water management area, where the project is located and which includes total territory of the Slovak Republic, will be assured by the performance of limit values of pollution indicators of waste waters discharged into surface waters according to government regulation No. 269/2010 Coll., laying the requirements for the reaching of good state of waters.

C.X.4.11. Impacts to territorial ecological stability system

The area for the location and construction of the NJZ does not interfere directly to any element of territorial ecological stability system (ÚSES). The elements of ÚSES are in sufficient distance and they do not assume any impacts during the NJZ operation including concurrence of the operations with the other facilities in the site. In case of lining of raw and waste water corridors, there occur several contacts with ÚSES. The pipeline is embedded in the ground and during the NJZ operation, it is not the source of impacts, which could violate the functionality of bio-centres and bio-corridors. Indirect impacts relate to the impacts to surface waters, which can be assumed due to pumping and discharging of waters. However, these impacts do not represent the threat or violation of ÚSES elements functionality.

C.X.4.12. Impacts to urban complex and land utilization

The site EBO was, already in the past, allocated as the area with economic-energetic utilization, the other activities in the area and its surrounding environment are limited exactly by this prioritized utilization of the locality. The NJZ will not change the utilization of the area. The existing structure of the area will be preserved also after its implementation.

C.X.4.13. Impacts to cultural and historical sites and assets

Neither the sites of cultural and historical values nor buildings of small sacral architecture, which could be affected by the impact of project implementation, are on the areas for the location and construction of the NJZ and in its vicinity.

Regarding to proposed construction, there will be necessary demolitions of some civil structures and relocations of engineering networks. It concerns to operated buildings related to electricity production, property relations to these buildings are solved. Tangible assets of third parties is not affected.

C.X.4.14. Impacts to archaeological sites, paleontological sites and geological sites

The possibility of archaeological finding during earth works for project construction is not definitely excluded. Regional Conservation Authority in Trnava (KPÚ TT) registers burial place from bronze age in the locality “Pravé pole – Right field”, which was partially studied during the construction of existing nuclear power plant Jaslovské Bohunice. For this reason, it is required that the salvage archaeological research is performed due to the construction implementation. The kind, the scope and the manner of archaeological research performance will be specified by conservation authority as involved authority of state administration in the decision on the salvage archaeological research. The investor, for the needs of the issue of planning permission, will send the application on the statement together with graphical marking of the scope and the area of construction earth works to KPÚ TT.

Neither geological nor paleontological sites are in the locality of the NJZ and its surrounding environment, it means they will not be affected by proposed activity.

C.X.4.15. Impacts of noise and vibrations

From performed measurements and analysis, we can assume that allowable values for noise from other sources for all reference time intervals are not exceeded in any of examined items in the surrounding environment of EBO site, which represent nearest residential area. Noise increasing from stationary sources of noise in the NJZ will be perceptually noticeable (if ever) only in south-east outskirts of the commune Radošovce and it will be caused by the operation of the NJZ cooling tower. This stationary source of noise from the NJZ will be dominant for this area, but it will be reliably below the limit.

The contribution of the traffic caused by the NJZ operation is in the most cases acoustically insignificant and it is mostly on the levels up to 0,1 dB. With the most loaded items by the NJZ impact, the increase reaches the value up to 2 dB, it concerns mainly to the locality of the commune Žlkovce. Following these facts, in the Report on the assessment, there is recommended to perform noise measurements in the most affected areas in the period of the construction and operation of the NJZ and to take eventual measures leading to the decreasing of noise load in monitored area on the basis of their assessment.

The impacts of vibrations are excluded. The vibrations caused by the operation of technology (mainly turbine) fade out in the subsoil near foundations of turbine stool. Residential area is located in the distance in orders in kilometres, the significant impact to this distance is reliably excluded.

C.X.4.16. Impacts of ionizing radiation

Impact of radioactive effluents

The impacts of radioactive effluents are the most sensitive topic with the assessment of nuclear facilities impact to the environment and therefore the most attention was focused on them in the Report on assessment. The assessment was performed for the NJZ individually and for cumulative activity of the effluents from the NJZ and existing installations in the locality.

Source terms of the effluents, which are described in the part Effluents, were determined on the basis of envelope maximum effluents provided by suppliers of reference types of reactors. Then, in reality, the effluents should be lower for any of selected types. The effluents from existing facilities represent envelope maximums from real measured values. For cumulative assessment with existing facilities, the effluents from JE V2 have the biggest impact. With the assessment of long-time impact of effluents, permanent concurrence of the NJZ and JE V2 was conservatively assumed for maximum period of 20 years.

Natural radiation background in the condition of the Slovak Republic represents overall annual effective dose per one inhabitant approximately 3 mSv/year (3000 µSv/year), while two thirds of this values is the exposure due to radon inhalation and its daughter products. It is important value with the comparison of nuclear facilities contributions to the effective annual dose. Exposition limit for an individual from the population is determined by governmental regulation SR No. 345/2006 Coll. on basic safety requirements for health protection of workers and population against ionizing radiation, which determined the value 1 mSv/year as limit effective dose in each calendar year. According presented governmental regulation, it is possible to discharge radioactive substances into the atmosphere and surface waters from the nuclear facilities, if there is assured that the highest individual effective doses for the population in the surrounding environment of nuclear facilities complex, due to this discharge s, do not exceed 0,25 mSv/year (250 µSv/year). This value is considered as limit dose for designing and construction of nuclear facilities and it is valid for overall complex thus also for the NJZ. For the individual nuclear facilities, Public Health Authority of the Slovak Republic (ÚVZ SR) determines authorized limits of effluents on the lower level the way that, in any case, the values 0,25 mSv/year for overall complex can´t be exceeded. Currently, existing nuclear facilities have determined authorized limits the way that their sum for EBO locality reaches 82 µSv/year.

Determination of doses from the effluents was performed by the software RDEBO, which is used for impacts assessment of radiation effluents of operated nuclear facilities in Slovak and Czech Republic. The software is accepted by Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR) as well as by State Nuclear Safety Authority of Czech Republic (SÚJB). The following paths of the exposure are considered in the program:

- external exposure from the atmosphere – from radioactive substances (RAL) diffused in the air (so called cloud) and from the deposit;
- internal exposure from the atmosphere – the inhalation and the ingestion, i.e. intake of radionuclides, which enter to food chain by atmospheric deposition: milk, meat (beef, pork and poultry), cereals, vegetables (leaf, fruit, root vegetables and potatoes), fruit and other food (eggs, sugar, bear, …) with inclusion of the seasonality with the calculation of doses from food chains;
- spreading of radioactive substances and their daughter products in water environment, the impact of swimming in the water, where are realized the effluents, boating in this water, staying on sediments (staying on the shore), staying on the land irrigated with the water, consummation of this water as drinking water, consummation of fish living in this water, consummation of meat and milk of the animals fed with the water and consummation of agricultural products irrigated by this water.

Presented exposition paths are considered for all age groups of the population. The software enables the determination of critical (thus the most affected) group of the population, critical path of the exposure and critical radionuclides for the individual paths of the exposure from the effluents into the atmosphere including the contributions of the individual radionuclides.

To reach maximum representativeness, the surrounding environment of the site Jaslovské Bohunice is, in the calculations of radiological impacts of the NJZ to the population, divided into 192 zones created by circular cut-outs in 22,5° (i.e. to 16 directions) and inter-circles with the radius 1, 2, 3, 5, 7, 10, 20, 30, 50, 70, 90 and 110 km. The calculations were performed up to the distance 110 km to be possible to use them also for the assessment of cross border impacts to the territories of Czech Republic, Hungary and Austria.

From the assessment of radioactive effluents impacts results that, with all conservative assumptions, the inhabitant of the zone No. 78 will receive maximum individual effective annual dose from the NJZ effluents and from concurrent impacts of nuclear facilities in the site Jaslovské Bohunice (JE V2, JAVYS); this zone is situated north-west from Hlohovec after the confluence of "Drahovský" channel and the Váh River. Maximum annual individual effective dose has the value 1,76E-06 Sv/year (1,76 µSv/year), while this dose represents a sum from all atmospheric and hydrological routes of the exposure. This dose is more than thousand times lower than natural background. Dominant contributor to overall dose in the zone No. 78 is hydrosphere (water), approximately 90 % of the effluents into water flows and only approximately 10 % of the effluents into the atmosphere take part on the individual effective dose in this zone. In the other zones, downstream the Váh River in the direction to Danube, there are also reached annual individual effective doses comparable to the value of the zone No. 78, while the contributions of the dose from the effluents into water flows are practically constant and the contributions of the dose from the effluents into the atmosphere decreases quickly with the distance. The situation is changing only after entering the Váh River into the Danube River, when the dose decreases more than one order due to the dilution in the water of the Danube River.

The highest annual individual dose from the effluents into the atmosphere is in unpopulated zone No. 98 (geographical direction south, the distance 1-2 km from the NJZ) with the value 1,580E-06 Sv/year (1,58 µSv/year). In populated zone is maximum dose from the effluents into the atmosphere 9,010E-07 Sv/year (0,90 µSv/year) in the zone No. 75 (geographical direction south-east, the distance 2-3 km from the NJZ, urban area of the commune Pečeňady).

Maximum lifelong dose from 50-years summary effluent (the NJZ+JE V2+JAVYS)for the age group of adults will be in the zone No. 78 and it will have the value 84,5 µSv/50 years.

Above mentioned value of annual dose 1,760E-06 Sv/year (1,76 µSv/year) creates only 2,22 % from limit summary conditions (82 µSv/year) determined by Public Health Authority of the Slovak Republic for all currently functional nuclear facilities in the site Jaslovské Bohunice. The calculated value makes only 0,7 % from the value of limit dose (250 µSv) from all sources of nuclear facilities complex, determined by Slovak legislation.

Following performed assessment, it is possible to state that maximum value of dose load of an individual from critical group of the population, with taking into consideration concurrent impacts of the NJZ and all currently existing nuclear facilities in the site Jaslovské Bohunice, will be at least two orders lower than all applicable limit values required by Slovak legislation and about three orders lower in the comparison with natural radiation background and so, it does not represent any real risk in terms of the impact to the health.

Regarding to cross border impacts, in case of Hungary, which can be influenced by the effluents into the hydrosphere and also atmosphere, they are at least one order lower and thus on the level of the tenths µSv/year and in case of Austria and Czech Republic (which are influenced only by the effluents into the atmosphere) at least about two orders lower, on the level of the tenths µSv/year, what are doses rather negligible and without any importance. Lifelong individual effective dose, also with taking into consideration child age, will be in order up to do 10 µSv/70 years for the nearest areas of Hungary, 1 µSv/70 years for the nearest areas of Austria and Czech Republic and even less significant for the nearest areas of Poland and Ukraine. It concerns to negligible values, without any health impacts, corresponding to the dose obtained from natural background during maximum of several hours.

Impacts to underground waters

Any radionuclides effluents from the NJZ will not be realized into rock environment or ground waters. The impact to ground waters can thus potentially occur only due to failures and malfunctions against which, however, the project has adequate technical solution (tanks with double bottom, collection tanks, regular inspections of technology tightness, measurements and signalizations of parameters changes). Monitoring system for ground waters is designed to identify all eventual penetrations of the contamination. Monitoring boreholes are, in case of necessity, structurally solved also for the implementation of remediation actions into leakage layer. It was proved by the analysis that hidden release of radioactive

contamination into ground waters, due to favourable geological situation in the locality, will have only local character and it will not endanger surrounding communes.

Existing radiation situation in ground waters of the surrounding environment of "Drahovský" channel and the Váh River is affected by waste waters discharging from existing facilities in the site EBO into "Drahovský" channel, namely due to the infiltration of surface waters affected by radioactive effluents into ground waters. Ground water in these areas shows slightly higher values of tritium on the level approximately 10 Bq/l, what is deeply below the limit value also for drinking water. This situation will be maintained also after the NJZ commissioning. The effluents of low active waters from the NJZ do not affect radiation situation in the infiltration area of "Drahovský" channel and the Váh River, provided that existing dilution ratios, which had been used for existing waste waters collector Socoman, will be kept and discontinuous discharging of low active waters will be coordinated the way that the effluents of tritium waters from JE V2, JAVYS and the NJZ will not be realized at the same time. In terms of this, there are proposed the relevant measures in the assessment.

Other impacts of ionizing radiation

Ionizing radiation field, thus the impact of electromagnetic (gamma) radiation or neutrons directly from technological buildings, without effluents contribution, is not significant already in the vicinity of technological buildings of the NJZ as well as existing facilities and it does not concern to the surrounding environment. The values of measured gamma radiation on the border of fenced area correspond to the values of natural background in wider surrounding environment.

C.X.4.17. Impacts during the construction and the decommissioning

The area for the NJZ localisation (main construction site) is in considerable distance from residential areas of the communes. The distance in the order approximately 1 km and more is sufficient for excluding of any negative impacts of the construction (mainly noise and air pollution). Equally the corridors of related networks (pipelines of raw, waste and rain water or electricity connection) pass out of the residential area, construction activity on these corridors will be relatively short. In principle, the only disruptive impact during the construction, which can affect the population, remains construction traffic (the transport of construction and structural materials or the transport of workers) on the existing communication network. However, even in this case, the impact will be limited, the traffic will be organized to exclude main volumes of transport operations into night and early morning and late evening period. At the same time, the situation will be monitored (noise measurement) during the preparation and the construction and in case of need the relevant measures for noise load decreasing will be performed. Other assumed impacts during the construction (the impact to habitat, rock environment, ground and surface waters and others) are characterized as usual ones and they are reliably solvable within the valid legislation.

The impacts with the NJZ decommissioning will be the subject of the process of environmental impacts assessment, which will be performed before the NJZ decommissioning (it means approximately 60 years of the operation). Preliminary, it is possible to say that the impacts of operation termination or the decommissioning reliably does not exceed the impacts assumed in the periods of the operation and the construction. Thus, it will concern to acceptable impact.

C.X.5. Operational risks

C.X.5.1. Radiation impacts of design basis accidents

To assess the impacts of nuclear facility abnormal states, calculation assessment of two envelope cases of design basis accidents was performed. It concerned to the accident with integrity violation (breaking) of reactor cooling system inside the containment and the accident with the manipulation of spent fuel assembly out of the containment with the violation (breaking) of this assembly. For the calculations, there was used conservative method of source term determination that the future analysis, performed in the process of the NJZ licencing according the atomic act, will lead to smaller impacts than those ones used in the Report on the assessment. With the calculations, maximum allowed leakages of the containment and decreased efficiency of filters for radioactive substances capturing were considered. The calculations were performed by the software RTARC, which is accepted for the performance of safety analysis in the Slovak republic and it is used in safety reports of existing nuclear power plants. Dose values from the ingestion of contaminated food and water after the

accident were performed by the software RDEBO. The results were compared with the criteria according to the requirements of ÚJD SR, standards of IAEA, requirements of WENRA and EUR. Basic criteria for design basis accidents is that dose values, which could require to apply the measures for the population protection (sheltering, evacuation, iodine prophylaxis) can´t be ever reached in permanently inhabited surrounding environment of the power plant, the restrictions in the consumption of locally produced food during one season, and only in the vicinity of the power plant, are acceptable. The results of radiation impacts calculation evaluation of two design basis accidents have confirmed the performance of all acceptance criteria. Main results can be summarized as follows:

- Calculated annual effective dose for the individual, from critical group of the population permanently living in the vicinity of the NJZ, from all paths of the exposure does not exceed the value 10 mSv/year with the consideration of statistically most likely meteorological conditions. This value represents the acceptance criteria according ÚJD SR and at the same time there is performed the safety goal according WENRA, which requires: no radiation impact to the environment for design basis accidents and only minimum radiation impact, but without the necessity of immediate protection measures implementation, of the type iodine prophylaxis, sheltering and evacuation, to the vicinity of the power plant is acceptable for beyond design basis accidents, which do not lead to fuel melting.
- The implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) in the distance ≥800 m from the reactor is not necessary (the requirements of IAEA, WENRA and EUR). This conclusion results for the fact that maximum value of annual IED without the ingestion in the distance of 500 m, for the worst category of the weather, is equal to the value 10 mSv/year or for the most probable category of the weather in the conservative combination with rain precipitations is equal to the value 4,74 mSv/year, i.e. in any case, in the distance ≥800 m, there will not be exceeded determined intervention levels for the immediate measures (i.e. individual effective doses 10 mSv/2 days, 50 mSv/7 days a 100 mSv for the contribution of the equivalent dose in thyroid gland).
- Calculated annual effective dose for the individual from critical group of the population from all paths of the exposure exceeded value 5 mSv/year (according NV SR No. 345/2006 Coll., it is the lower limit for the application of the subsequent measures – the control of the ingestion of food, water and feed contaminated by radionuclides) with the consideration of statistically most likely meteorological conditions, maximum within the distance 6 km and with the consideration of the contribution only from the ingestion in the distance ~5 km, i.e. only local impact, which is acceptable according to the requirements of EUR and also WENRA.
- In terms of possible cross border impact (distance ≥40 km), the impacts of performed analysis of design basis accidents have confirmed that overall maximum annual individual effective dose from all paths of the exposure (i.e. also with the inclusion of the contribution from annual ingestion of locally produced food) does not exceed, with statistically most likely meteorological conditions, even limit value 1 mSv/year determined for normal and abnormal operational conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103). Therefore, cross border impacts, which could anyway endanger or limit the population of the nearest areas of neighbouring countries, do not occur with the NJZ design basis accident.

C.X.5.2. Radiation impacts of severe accident

To assess the impacts of severe accident, there was used conservative envelope approach, which should assure that future analysis performed in the process of the NJZ licensing, according to the atomic act, will lead to smaller impacts than those ones, which are presented in the Report on the assessment.

Severe accident is the accident with nuclear fuel damage. For the goals of the Report on the assessment, total melting of reactor core and reactor vessel remelting, what is extremely unlikely scenario, was considered. All reference units of the generation III+ are equipped by technologies, which should exclude such scenario. Furthermore, there was assumed that containment integrity with severe accident remains preserved, what is the basic design characteristics of the generation III and III+, but at the same time the containment leakages will be on maximum allowed level. The calculations were performed with the software COSYMA, which is accepted by regulatory authorities for the calculations of severe accident consequences. Besides the classical scenario with radioactive substances discharge into the environment, there was also assessed the scenario, where the area of water reservoir Sĺňava was affected by the gradient and the contamination was spreading from there by the Váh River to Hungary. The results of impacts assessment were compared with national and international criteria. Basic criteria for design basis accidents is that dose values, which could require to apply the measures

for the population protection (sheltering, evacuation, iodine prophylaxis) can be reached in the vicinity of the power plant and the restrictions in the consumption of locally produced food and water of local sources during one year are acceptable.

The results of radiation impacts calculation evaluation of envelope severe accident have confirmed the performance of all acceptance requirements of safety guideline ÚJD SR, standards of IAEA, requirements of WENRA and EUR. It means:

- The implementation of immediate measures (sheltering, iodine prophylaxis, evacuation) would be necessary to implement within the distance maximum 1 km, i.e. practically only within the NJZ site and not in permanently inhabited areas.
- In terms of possible cross border impact (distances ≥40 km), calculated results have confirmed that overall maximum annual and also cross border individual effective dose from all paths of the exposure (also with the inclusion of the contribution from annual ingestion of locally produced contaminated food) does not exceed even the limit value 1 mSv/year for normal and abnormal operational conditions (directive of the Council 2013/59/Euroatom as of December 5th, 2013 or ICRP publication 103).
- The same conclusion is valid also for the scenario of severe accident with the assumption of maximum radionuclides fall to total area of the nearest water reservoir on the Váh River (water reservoir Sĺňava) due to strong intensity of the precipitation after radionuclides cloud arrival to this water reservoir with subsequent contamination of the river flow Váh and Danube and with impacts assessment – radiation impacts to the nearest area of Hungary (the confluence of the rivers Váh and Danube).
- For the scenario of severe accident with the assumption of maximized fall of radionuclides on the area of the nearest water reservoir Sĺňava, there was also performed the impact assessment to ground waters and their utilization like drinking water, mainly for the area around Danube behind the confluence with the Váh River and for the nearest surrounding environment of water reservoir Sĺňava. The assessment has proved that the impact to drinking water quality is insignificant. With the individual annual consummation of 700 litres of drinking water, which was contaminated by radioactive substances migrating from surface water into ground waters, the individual dose reaches only 12,5 μSv/year for the well near VN Sĺňava and 2,1 μSv/year for the well near Danube, in the area of Váh and Danube confluence. These values do not prevent to use water as drinking one, despite the fact that input data into the calculation was selected to maintain the highest level of conservativism as possible. Therefore, the threat of drinking water ground sources can´t occur due to the NJZ severe accident.

C.X.5.3. The risk of terroristic attack

The risk of the NJZ threat by a terroristic attack can´t be completely excluded on preventive basis. In compliance with the legislation SR in force, permit holder is obliged to monitor, control and eliminate, in the cooperation with competent authorities of the state (act No. 321/2002 Coll. on the armed forces of the Slovak Republic as amended, act No. 319/2002 Coll. on Slovak Republic protection as amended), the risk of the threat by a terroristic attack, namely in all phases of project implementation, the operation and the decommissioning of the NJZ. The permit holder is further obliged to minimize the possibility and consequences of a terroristic attack and a sabotage mainly by the implementation of means and procedures of the NJZ physical protection in compliance with the national legislation, international commitments and good practice. The risk of the NJZ threat by a terroristic attack will be assessed and eliminated, in the following phases of the preparation and implementation of the NJZ project, by standard means and procedures of nuclear facilities physical protection used in the current practice in compliance with the requirements of national procedures and international standards. The state has available several means (press services, army, police, monitoring of terroristic activities, protection of airspace, prevention in the conditions of air transport, special forces, etc.), where their application means that the risk of completed terroristic attack on nuclear facility is with a big probability eliminated and minimized. To assure nuclear facilities protection against terroristic attacks, safety measures corresponding to the actuality of safety threat, which is permanently monitored and specified, are set up on state level. These safety measures included press and information assurance, safety measures in air transport, the protection of airspace of Slovakia. Despite this fact, for the NJZ, there is required that power plant project assures sufficient protection against big transport aircraft fall. The basic requirement is that aircraft impact does not cause any bigger radiation impact to power plant surrounding environment.

Detailed analysis of the impacts of the NJZ buildings accidents with aircraft impact and other external events caused by human activity can be potentially misused for the preparation of a sabotage or a terroristic attack. Therefore, detail lists of equipment, data on civil structures and on the impact of their potential accidents to the NJZ operation are the subject of confidentiality and it is not possible, in terms of valid legislation, to present them in general-public part of the documents.

C.X.5.4. Other radiation risks related to nuclear facilities operation

Other radiation risks include mainly the possibility of radioactive substances release at radioactive materials transport. Basic transports of materials related to the operation of nuclear power plant are the transports of fresh fuel from the supplier to the NJZ, the transport of RAO for treatment and conditioning in the facilities of JAVYS (within the site EBO), the transport of conditioned RAO from the NJZ to RAO repository, the transport of spent fuel from the NJZ to the storage (within the area of EBO) and the transport of spent fuel from the storage to the place of permanent repository. Totally

Totally, it concerns to units of transports annually. For all transports, there shall be developed transport procedures, which are approved by ÚJD SR. Nuclear and radioactive materials can be transported only in approved transport package sets, which provably assure that in case of an accident, there will not be the release of radioactive material into the environment. Compared to the transport of other dangerous goods (from energetic point of view, it concerns to the transport of other kinds of fuels), the transport of radioactive materials is much less dangerous. In particular, there is no risk of the explosion and fire as it is with the transports of classical fuels, when an accident leads to direct endangering of life and it often has tragic consequences for participants of an accident. The possibility of radioactive substances releases into the environment is limited to the lowest possible level. For each transport, there are developed procedures how to limit radiation impacts of an accident to not occur the threat of public health.

The transport of spent nuclear fuel will be performed only inside the area within the locality until the starting of the operation of geological repository and it does not have any requirements for external transport infrastructure and thus any related risks of possible accidents. Any accident of the transport of low-active RAO fixed in solid matrix and stored in containers within the transport to the repository, including possible sabotage, does not represent more important risk, neither for the environment nor for the population.

C.X.5.5. Risks arising due to other human activity in the locality

Preliminary assessment performed in the Report on the assessment shows that the NJZ will not be significantly endangered by any of the risks resulting from human activity in the locality.

With the assessment of possible risks, the possibility of arising and consequences mainly of these accidentally arising categories of events is assessed:

- aircraft fall,
- explosion connected with shock wave,
- clouds of combustible vapours,
- toxic chemical substances,
- fires,
- violation of water intake structure,
- contamination by noxious liquids.

In the following subchapters, above mentioned events that can be a source of risks in the NJZ site, are assessed.

Main buildings of the NJZ will be designed as resistant against the impacts of shock wave, aircraft fall, fire, flooding, loss of power supply by external sources, water and other external impacts. The crucial element of the risk management coming from human activities in the locality will be the protection of control workplaces (main and emergency control rooms) of the NJZ against the sources of threat that can be a cloud of combustible vapours, toxic cloud of chemical substances, toxic products of combustion, radioactive substances. These sources of threat can come from transport routes in near vicinity of the NJZ as well as from other nuclear facilities in the site of EBO. For the NJZ, there will be assured that potential releases of substances from these sources will not endanger nuclear safety. It means that the habitability of main and emergency control rooms remains preserved with the release of these substances. The NJZ will be equipped by technical means that prevent the penetration of radioactive, toxic or explosive substances into the control room, even in case of severe accident on the other nuclear facility in the locality. Permanent check of air composition in the inlet lines of heating, ventilation and air conditioning system, the assurance of permanent slight air overpressure in control rooms, the possibility of reliable insulation of control rooms environment from the surrounding environment with the occurrence of dangerous substances and special

emergency heating, ventilation and air conditioning system in control rooms for abnormal situations belong among these technical means.

C.X.5.6. Emergency preparedness

Internal emergency plans of nuclear facility operator and related documents are developed to assure the protection and the preparation of employees for the case when the release of radioactive substances into working environment or the surrounding environment occurs and it is necessary to take measures for the protection of persons health on the level of nuclear facility or the population in its surrounding environment.

External emergency plan follows the internal emergency plan – population protection plan, which is developed by territorially competent state authorities and communes located in the area classified as the area of nuclear facility threat. They includes the measures for population protection in the area of the threat during the release of radioactive substances into the environment. The operator of the NJZ is obliged to submit the support documentation related to population protection in the area of the threat to the developers of population protection plans.

With the occurrence of abnormal situation, which has a character of radiation event on nuclear facility, authorities of local state administration assure the measures resulting from population protection plans. The activity is assured by relevant crisis staff. To prevent the threat from a delay with the performance of the tasks related to population protection, particular commissions are classified into emergency response organization within SR. Even the measures of emergency preparedness will be developed for the NJZ in compliance with legislative requirements, the basic characteristics of this type of reactors is that, with any accident, there shouldn´t be reached doses, which could require to take the measures for population protection over the frame of time limited restriction of the consummation of local food and water. The zone of threat for the NJZ will be determined in further phases of permission process according to atomic act.

The information on eventual nuclear accident and its potential impacts could be mediated to neighbouring states by ÚJD SR defined manner and by the means following the bilateral agreement. At the same time, ÚJD SR also informs IAEA and European Commission.

C.X.5.7. Liability for nuclear damages

The liability of nuclear facility operator for nuclear damages is specified by atomic act. At the same time is fulfilled the commitment of SR that acceded, after the agreement of National Council of the Slovak Republic, to Vienna convention on civil liability for damages caused by nuclear events (The Resolution of NR SR No. 71 as of January 5th, 1995 and the approval by president of the Slovak Republic as of February 23rd, 1995). The limit of operator liability for nuclear damage is determined by atomic act to 300 million Euro. Due to the requirement to minimum and only locally and time limited consequences of design basis accidents and severe accident on the reactors of Generation III+, this limit is sufficient with a big reserve for the NJZ.

For future operator of the NJZ, atomic act imposes the obligation to submit the document on the assurance of financial covering of the liability for nuclear damage as a part of the application on the permission for nuclear facility commissioning.
The act NR SR No. 54/2015 Coll. on civil liability for nuclear damage and its financial covering passed in March 2015. Crucial provisions come into force on January 1st, 2016. The act comprehensively deals with:

a) civil liability for the damage that occurs in the relation with a nuclear event,
b) scope of the activities of ÚJD SR in the relation to this act application,
c) scope of the activity of National bank of Slovakia in the relation to supervised subjects of financial market with the financial covering of the liability for nuclear damage.

New act adopts the principles and rules of the solution of the liability for nuclear damage according Vienna convention and it replaces and supplement relevant paragraphs and sections, which regulated the area of liability for nuclear damage in atomic act. New act keeps limits of operator's liability for nuclear damage without any change. New act explicitly prohibits the commissioning, operation and decommissioning of nuclear facility or to prepare radioactive materials without required financial amount and the method of the assurance of liability covering for nuclear damage.

C.X.5.8. Non radiation risks

In principle, proposed activity represents, in terms of non-radiation point of view, usual industrial operation, when significant risk of emergency events arising with negative impacts to the environment and the population does not occur.

Regarding the operation, it is not possible potentially exclude emergency situations related to the release of polluted waste waters (by the violation of sewerage tightness or by the violation of the function of oil waters purification plant), the release of stored substances (chemicals, driving propellants, lubrication and heat transfer means, cleaning products etc.) from storage tanks or pipeline bridges or eventually during the transport. There is even not potentially excluded the possibility of burning of media or other materials.

Presented risks have low probability degree of the occurrence and special preventive or elimination measures are not required for their elimination except those that are usual or prescribed by the relevant procedures (constructional, safety, fire protection, transport or the other ones). The impacts of presented type of events are solved by usually available means and they do not represent the risk for the environment and health.

C.X.6. Proposal of the monitoring

Radiation monitoring program of the NJZ will conceptually correspond to current monitoring system of nuclear facilities in the site, and the NJZ monitoring system can be integrated into current monitoring system or an autonomous system can be built.

The NJZ monitoring proposal can be divided into two areas:

- Monitoring in-situ (the monitoring for the NJZ regardless of surrounding nuclear facilities) assigned for the monitoring, protection and prevention of the environment pollution. For this monitoring, there will be created monitoring systems, which assure the monitoring of direct impacts of the NJZ to the environment. Particularly, it concerns to the monitoring of radiochemical parameters of technological circuits and tanks, the monitoring of environment parameters and the monitoring of active and non-active effluents into the environment. The results of radioactive effluents monitoring are input data for the determination of real exposure of the population by authorized calculation.
- Monitoring of the environment assigned for the monitoring of the environmental conditions. The NJZ will be included into existing common monitoring program of nuclear facilities surrounding environment in the locality. Current monitoring system is fully functional and sufficient in the main parameters also to the future for the monitoring of the NJZ impact. Regarding to the results of proposed activity assessment and the requirements specified in the Scope of the assessment, the monitoring program will be completed in the individual circuits.

In principle, non-radiation monitoring program will correspond to current monitoring program of nuclear facilities in the site EBO (JE V2, JAVYS) with taking into consideration current legislative requirements and the requirements of competent supervisory authorities expressed in relevant permission decisions.

C.X.7. Measures for the impacts mitigation

Basic design measures for the prevention, exclusion, decreasing or eventually compensation of negative impacts consist of these areas:

- utilization of best available technologies of reactors of the generation III+,
- assurance of nuclear safety, radiation protection, physical protection and emergency preparedness in compliance with the requirements of valid legislative procedures, standards IAEA, requirements of WENRA or other professional standards,
- minimizing of radiation impacts to the population and employees in compliance with the principle ALARA,
- adjustment of monitoring programmes for the monitoring of individual potentially affected elements of the environment regarding the preparation and the operation of the NJZ,
- siting of the NJZ outside of the environmentally sensitive territory, utilization of brownfield,

- minimizing of demands for environmental sources and outputs into the environment,
- respecting of all procedures and standards in the area of the environment and public health protection.

Over this basic scope, there are proposed the measures resulting from the conditions specified in the Scope of the assessment or the facts founded in the course of this Report development, which are focused on further additional protection of the individual elements of the environment and public health. These measures will become a part of the conditions related to administrative proceeding and they will be implemented during the preparation, construction and operation of proposed activity. The matter of course is compliance with the measures that result from legal or other generally applicable procedures.

C.X.8. Conclusion

Assumed impacts of proposed activity to the environment are in all assessed areas (impacts to the population, atmosphere and climate, noise and other physical or biological agents, surface and ground water, rock environment and natural source, fauna, flora and ecosystem, landscape, assets and cultural sites, transport and other infrastructure or others) are overall insignificant. There are not identified any facts, which could indicate the exceeding of legal limits, given by legislation in force (or, if the limits are not determined, on non-acceptable impact).

Potentially negative impacts, even with the consideration of cumulative impact of existing activities in the locality (particularly other nuclear facilities in the relevant phases of their life-time cycle) are acceptable in all areas, laying deeply in the zone of admissible and/or acceptable values.

The risks, resulting from proposed activity, are acceptable.

Based on the assessment, proposed activity can be identified as sustainable for the given locality.

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XI. List of solvers and organizations that participated on the development of the Report on the assessment

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C.XII. List of Support Reports and Studies

XII. List of support analytical reports and studies that are available at the proposer and that were support documentation for the development of the Report on the assessment

C.XII.1. Basic support studies for the development of the Report

Support study ČP 2.4. Technical description of the NJZ design

Support study ČP 2.4. Concept of the NJZ approach to nuclear safety

Support study ČP 2.4. Radiation protection generally

Support study ČP 2.4. Justification of the need of the NJZ JB project in the relation to energetic policy of SR, another strategic and concept document of SR and international commitment of SR

Support study ČP 2.4. Biological research, locality description and biological assessment of the NJZ

Support study ČP 2.4. Assessment of the impact to the landscape for the NJZ

Support study ČP 2.4. Locality demography and the impact of proposed activity to the demography, public opinion

Support study ČP 2.4. The assessment of health risks and the impact of the project to public health

Support study ČP 2.4. Assessment of health risks

Support study ČP 2.4. The impact of proposed activity to workers health

Support study ČP 2.4. Traffic study for the NJZ in the site Jaslovské Bohunice

Support study ČP 2.4. Atmosphere – condition and non-radiation impacts of the NJZ project

Support study ČP 2.4. Climatic conditions and the impact of the NJZ project to climate and shading

Support study ČP 2.4. Noise study

Support study ČP 2.4. Ground waters in the locality

Support study ČP 2.4. Impact of the NJZ accident to ground water

Support study ČP 2.4. Geology and seismicity

Support study ČP 2.4. Surface waters and non-radiation impact of proposed activity to surface waters

Support study ČP 2.4. The impact of proposed activity to surface waters – radiation including cross border impacts

Support study ČP 2.4. Source term for radiation releases into the environment – normal operation

Support study ČP 2.4. Determination of radiation doses for critical group of population from normal operation of proposed activity (air, water) including cumulative impacts

Support study ČP 2.4. Determination of representative envelope source term for design basis accident and severe accident with the preservation of containment functionality for EIA of the NJZ JB

Support study ČP 2.4. Assessment of radiation impacts of design basis accidents and sever accident including cross border impacts

Support study ČP 2.4. Approach to risk management of incidental aircraft fall, other external risks caused by human activity

Support study ČP 2.4. Approach to risk management of terroristic attack to proposed activity and related activities

Support study ČP 2.4. Concept of operation termination and decommissioning

Support study ČP 2.4. Production of spent nuclear fuel and radioactive wastes and their disposal for EIA of the NJZ JB

Support study ČP 2.4. Production and disposal of non-radioactive wastes of the NJZ in the site Jaslovské Bohunice

Support study ČP 2.4. Set of additional data

Holíková J: Assessment report on the assessment of the NJZ operation impacts to public health in the site Jaslovské Bohunice. Bratislava, March 2015

C.XII.2. Process support documents

Statement of Ministry of Environment of the Slovak Republic to the application for abandonment from variant solution. MŽP SR No. I. 8356/2013-3.4/hp as of 28.11.2013

The NJZ in the site Jaslovské Bohunice. Project for proposed activity. Jadrová energetická spoločnosť Slovenska, a. s. / company name: Nuclear Energy Company of the Slovak Republic, 28.2.2014

The NJZ in the site Jaslovské Bohunice. Scope of the assessment. MŽP SR No.: 3282/2014-3.4/hp as of 26.05.2014

C.XII.3. Other support documents

Related reports and documents:

- Permission of SE EBO and JAVYS for raw water extraction and waste waters discharging.
- Decision of ÚVZ SR, laying for JAVYS and SE the permission, for nuclear facilities in the site EBO, the releasing of radioactive substances into the environment.
- Final report from quantitative survey of NMS Market Research SR (2013) Attitudes to nuclear power engineering.
- EIA reports on the assessment of the facilities located in the site EBO.
- Inventory control of RAO JAVYS and SE EBO 2012, 2013.
- Summary report of SHMÚ for the site Jaslovské Bohunice 2012.
- Reports of JAVYS on radiation protection for the years 2007 - 2012.
- Reports of JAVYS on the environment for the years 2008 - 2012.
- Reports of SE EBO on radiation protection for the years 2008 - 2012.
- Reports of SE EBO on the environment 2008 - 2012.
- Reports of Statistical Office of the Slovak Republic.

Documents and recommendations valid in nuclear area:

- IAEA Basic safety principles.
- IAEA Safety Requirements.
- IAEA Safety Guides (SG) a Specific Safety Guides (SSG) related to nuclear facility localization and locality assessment.
- WENRA Safety Reference Levels for Existing Reactors 9/2014.
- WENRA Reactor Harmonization Working Group RHWG - Report on Safety of the NJZ designs, 3/2013.
- Recommendations of International Commission of Radiological protection (ICRP).
- Safety guidelines of ÚJD SR.

Concept and strategic documents:

- Strategic and concept documents of SR related to nuclear energy utilization.
- Strategic and concept documents of EC related to nuclear energy utilization, energetic efficiency, energy sources, energetic effectiveness and energy saving.

Legislation:

- Acts, relevant standards and regulations in the area of nuclear power engineering – particularly the act NR SR No. 541/2004 Coll. on Peaceful use of nuclear energy (Atomic Act) and on amendment and alterations of several acts as amended.

- Acts, relevant standards and regulations in the area of environmental impacts, particularly the act No. 24/2006 Coll. on Environmental Impacts Assessment and alternations and amendments of certain acts as amended.
- Acts, relevant standards and regulations in the area if the individual elements of the environment and public health.

Public sources and internet:

- Public sources and websites of involved Self-Governing units, state and private organizations in the area of nuclear power engineering, the environment and public health.
- Other (OECD NEA, US NRC, US EPA, WHO, UNSCEAR, ICNIRP, ...).

C.XIII. Date and the confirmation of data accuracy

XIII. Date and the confirmation of data accuracy and completeness by the signature (stamp) of authorized representative of the Report on the assessment developer and proposer.

C.XIII.1. Place and date of the Report development

In Bratislava (Slovak republic) and Brno (Czech Republic) 22.08.2015

C.XIII.2. Confirmation of data accuracy and completeness

I, with my signature, confirm the accuracy and completeness of data presented in this Report.

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List of abbreviations, acronyms and notions

a pod.	and the like
a.s.	joint stock company
A1	A1 nuclear power plant Jaslovské Bohunice
ACORN	Alpine Carpathian On-line Research Network
AES	commercial description of VVER reactor type
AEWS	the accident emergency warning system (on the Danube river basin territory)
AKOBOJE	automated nuclear power plant security complex
ALARA	as low as reasonably achievable
alt.	alternatively
angl.	English
AP1000	commercial name of Westinghouse PWR design
APR1400	commercial name of Korea Hydro & Nuclear Power PWR design
AREVA NP	company name (it is no acronym)
ARIS	name of the ARIS system stationary network
ATMEA1	commercial name of AREVA NP/Mitsubishi Heavy Industries PWR design
ATWS	anticipated transient without scram
atď.	etc.
AZ	reactor core
BaP	benzo (a) pyrene
BAT	best available techniques
BDBA	beyond design basis accident)
BIC(SWIFT)	business identification code (Society for Worldwide Interbank Financial Telecommunication)
BL	bituminization line
BNS	safety guides and guidelines issued by the Nuclear Regulatory Authority of the Slovak Republic (UJD SR)
BOZP	occupational health and safety
BPEJ	evaluated soil-ecological units
BSC	Bohunice treatment centre
BSC RAO	Bohunice RAO treatment centre
BSK	Bratislava Self-Governing region
BÚK	reactor unit condensate conditioning facility
CCHO	circulation cooling circuit
CČS	central pumping station
CDF	core damage frequency
CENEC	catalogue of earthquakes in central, northern, and northwestern Europe
CFR	code of federal regulations
CHO	emergency response centre
CI	conventional island
CoDecS	coding decoding system

COL	Construction Permit and Operating License issued to US NPPs
COSYMA	computer code name
CZ	Czech Republic
č.	number
ČOV	waste water treatment plant
ČP	partial performance
ČR	Czech Republic
ČS	pumping plant
DBA	design basis accident
DBC	design basis conditions
DEC	design extension conditions
DGS	diesel generator plant
DIČ	tax identification number
DN	diameter nominal
DPH	value added tax (VAT)
DTS	company name (it is no acronym)
EBO	Jaslovské Bohunice Nuclear Power Plant
EC	European Commission
EC JRC	European Community Joint Research Centre
ECURIE	European Community Urgent Radiological Information Exchange
EIA	environmental impact assessment
EK	registration code
ELINI	European Liability Insurance for the Nuclear Industry
EMANI	European Mutual Association for Nuclear Insurance
EMEP	European Monitoring and Evaluation Program
EMO	Mochovce Nuclear Power Plant
EMO 1,2	Mochovce Nuclear Power Plant Units 1 and 2
EN	European standard
ENSREG	European Nuclear Safety Regulators Group
ENTSO-E	European Network of Transmission System Operators for Electricity
EPR	commercial name of AREVA NP PWR design
EPRI	Electric Power Research Institute
EPS	fire detection and alarm system
ER	exposure ratio
ERICA	environmental risk from ionising contaminants: assessment and management
EU-APWR	commercial name of Mitsubishi Heavy Industries PWR design
et al.	et.al.
EU/EÚ	European Union
EUR	European utilities requirements for light water nuclear power plants
EURDEP	European radiological data exchange platform
FMFI UK	College of Mathematics, Physics and Informatics of Comenius University in Bratislava
FZ ČSFR	Federal Assembly of the Czech and Slovak Federal Republic
GMPE	ground motion prediction equations

GEN	generation
GNSS	global navigation satellite system
HDP	gross domestic product
HDS	gross inland consumption
HVB	main reactor building
CHA	protected site
CHKO	protected countryside area
CHSK	chemical oxygen demand
CHÚV	chemical water treatment plant
CHV	cooling rower
CHVO	protected water management area
CHVÚ	protected bird area
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer, a part of WHO
IBAN	international bank account number
ICRP	International Commission on Radiological Protection
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IČ DPH	VAT identification number
IČ/IČO	identification number (of an organization)
ID	individual dose
iDAC	interim Design Acceptance Confirmation for UK NPPs
IEC	International Electrotechnical Commission
IED	individual effective dose
IEEE	Institute of Electrical and Electronics Engineers
IEZ	economic dependency ratio
INEL	Idaho National Engineering Laboratory
INES	international nuclear and radiological event scale
IPCC	intergovernmental panel on climate change
IPKZ	integrated pollution prevention and control
IS RAO	integral RAO storage facility
ISC	International Seismological Centre
ISCED	international standard classification of education
ISO	International Organization for Standardization
JAVYS	company name; RAO and Decommissioning in Slovakia
J	south
JE	nuclear power plant
JE A1	NPP Bohunice A1
JE V1	NPP Bohunice 1,2
JE V2	NPP Bohunice 3,4
JESS	company name: Nuclear Energy Company of the Slovak Republic
JJV	south-south-east
JJZ	south-south-west
JV	south-east

JZ	based on the meaning: nuclear facility or south-west
k. ú.	cadastral area
kap.	chapter
KCHL	control chemical laboratory
KES	final energy consumption
KHNP	Korea Hydro&Nuclear Power company
KO	municipal waste
KP	controlled zone
KPÚTT	Regional Conservation Authority in Trnava
KRAO	liquid radioactive waste
KRH SR	Radiation Accidents Commission of the Government of the Slovak Republic
ks.	piece
KVET	combined heat and power production
KWU	company name; Kraftwerk Union
LBc	local biological centre
LER	large or early release
LERF	large or early release frequency
LEU	low enriched uranium
LLC	Limited Liability Company
LOCA	loss of coolant accident
LP	forest land
LPZ	longer-term protective-action planning zone
LRKO	environment radiation supervision laboratory
LVM	locally significant marshland
LZP	prohibited aviation area
m n.m.	above sea level
max.	maximum
MDA	minimum detectable activity
MH SR	Ministry of Economy of the Slovak Republic
MHI	Mitsubishi Heavy Industries company
min.	minimum
MIR1200	commercial name of Škoda JS/JSC Atomstroyexport/JSC OKB Gidropress PWR design
MKCH	international classification of diseases
MMA	minimum measurable activity
MOX	mixed oxide fuel
MO 3,4	Mochovce Nuclear Power Plants Unit 3 and 4
MO SR	Ministry of Defence of the Slovak Republic
MSVP	interim spent fuel storage facility
MÚSES	local territorial ecological stability system
MV SR	Ministry of Interior of the Slovak Republic
MVE	small-scale hydro power plant
MZd SR	Ministry of Health of the Slovak Republic
MŽP SR	Ministry of Environment of the Slovak Republic

N	dangerous (waste category)
n.m.	above sea level
n.l.	AD (Anno Domini)
napr.	e.g.
NATURA 2000	European Ecological Network Established by the Habitats Directive 92/43/EEC (it is no acronym)
NEA	Nuclear Energy Agency, a part of OECD
NEI	Nuclear Energy Institute
NEIL	Nuclear Electric Insurance Limited
NJF	National Nuclear Fund
NJZ	new nuclear power plant
NJZ JB	new nuclear power plant on the Jaslovské Bohunice site
NL	dangerous substances
NMS	National Monitoring Network
NMSKO	National Air Quality Monitoring Network
NO	dangerous waste
NOAEL	toxicity threshold (no observed adverse effect level)
NNO	non-dangerous waste
NPP	nuclear power plant
NR	National Council of the Slovak Republic
NRBk	trans-regional biological corridor
NSK	Nitra Self-Governing Region
NUREG	US NRC publication
NV	government regulation
O	other (waste category)
Figure	figure
OECD	Organisation for Economic Co-operation and Development
OHO	emergency response organization
OO	other waste
OSN	United Nations Organization
OÚ	District Authority
OZE	renewable energy sources
p.p.	under the surface
p.t.	under the ground
p.v.	ground water
PAZ	precautionary action zone
PD	agricultural cooperative farm
PF UK	College of Natural Sciences of Comenius University in Bratislava
PFO	site security plan
PG	steam generator
PGA	peak ground acceleration
PHM	driving propellants
Písm.	(x) [a part of a reference to a particular point in a legal regulation]
PM_{10}	dust particles of 10 µm fraction

$PM_{2,5}$	dust particles of 2.5 µm fraction
PO	primary circuit - reactor coolant system
pod.	likewise
POH	waste management plan
PP	operating procedure
PpBS	final safety analysis report
PPF	agricultural land resources
PPFO	preliminary site security plan
PR	nature reserve
PRAO	solid radioactive waste
PSHA	probabilistic seismic hazard assessment
PSA	pseudospectral acceleration
PSA	probabilistic safety analysis – in compliance with the context
PSR	periodic safety review
PTL	remelting line
PTM	puff trajectory model
PWR	pressurized water reactor
PYLL	potential years of life lost
RA	radioactive
RAL	radioactive substances
RAO	radioactive waste
RBc	regional biological centre
RBk	regional biological corridor
RDEBO	computer code name
RDEDU	computer code name
RDEMO	computer code name
RDETE	computer code name
RDOJE	computer code name
resp.	respectively
REVIHAAP	review of evidence on health aspects of air pollution
RF	Russian Federation
RfC	reference concentration
RfD	reference dose
RG	regulatory guide
RHWG	Reactor Harmonisation Working Group, a part of WENRA
RCHBO OS SR	radiation, chemical and biological protection of armed forces of the Slovak Republic
RIN	US NRC Rulemaking Issue Affirmation
RLE	review level earthquake
RMS	radiation monitoring network
RN	retention tank
RQ	risk quotient
RsC	risk-specific concentration
RsD	risk-specific dose

RTARC	computer code name
RÚ RAO	national radioactive waste repository
RÚSES	regional territorial system of ecological stability
RVM	regionally significant marshland
s.r.o.	Limited Liability Company
S	north
SBO	station blackout
SDV	screening distance value
SE	company name; Slovak Power Plants, j.s.c.
SEA	strategic environmental assessment
SEB	energy security strategy
SED	Slovak Power Dispatching Centre
SE-EBO	commercial name for SE, j.s.c. - Jaslovské Bohunice NPP
SEPS	Slovak Electricity Transmission System j.s.c.
SF	fundamental safety principles
SHMÚ	Slovak Hydrometeorological Institute
SIŽP	Slovak Environmental Inspection Authority
SKCHVU	identification code of protected bird areas
SKÚEV	identification code of special areas of conservation
SL	seismic level
SMR	standardized mortality ratio
SPL	screening probability level
spol. s r.o.	Limited Liability Company
SR	Slovak Republic
SRES	special report emission scenarios
SSC	Slovak Road Administration
SSR	specific safety requirement
SSV	north-north-east
SSZ	north-north-west
STN	Slovak technical standard
SÚJB	State Nuclear Safety Authority (of Czech Republic)
SÚRMS	Slovak Headquarters of the Radiation Monitoring Network
SUZA	name of a sludge treatment facility
SV	north-east
SVP	Slovak Water Management Company
SSR	specific safety requirements
SZ	north-west
SSG	specific safety guides
SZU	Slovak Medical University
ŠOP SR	State Nature Protection Authority of the Slovak Republic
ŠÚ SR	Statistical Office of the Slovak Republic
Tab.	table
TAMOS	Austrian disperse model (a computer code)

TDS	teledosimetry system
TE	thermal power plant
tel.	phone
TIC	time integral of concentration
t.j.	i.e.
TLD	thermoluminiscence dosimeter
TP	technical terms
TPFO	site security system hardware
TSK	Trenčín Self-Governing Region
TSÚ RAO	radioactive waste processing and treatment technologies
TTSK	Trnava Self-Governing Region
TVD	essential service water
TVN	non-essential service water
TZL	solid pollutants
tzn.	i.e.
tzv.	so-called
UCR	carcinogenic risk unit
ÚEV	sites of community importance
UHS	uniform hazard spectrum
ÚCHV	cooling water treatment plant
ÚJD SR	Nuclear Regulatory Authority of the Slovak Republic
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
ÚP	land use plan
ÚPD VÚC	Self-Governing Region land use plan documentation
ÚPN-O	Municipality land use plan
ÚPR	Self-Governing Region land use plan
UPZ	urgent protective action planning zone
ÚRSO	Network Industries Regulatory Authority
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
US NRC	United States Nuclear Regulatory Commission
USA	United States of America
ÚSES	territorial ecological stability system
USIE	unified system for information exchange in incidents and emergencies
ÚVZ SR	Public Health Authority of the Slovak Republic
V	east
V1	NPP Bohunice 1,2
V2	NPP Bohunice 3,4
VARVYR	warning and notification system name
VBK	fibre concrete container
VE	hydro power plant
VJP	spent nuclear fuel

VJV	east-south-east
VKP	significant landscape element
VN	water reservoir
VNL	selected dangerous substance
VSV	east-north-east
VT	high-pressure
VÚC	Higher-Level Territorial Unit Authority
VUJE	company name; VÚJE, j.s.c.
VÚVH	Water Management System Research Institute in Bratislava
VVER	pressurized water reactor (from Russian: Water-Water-Power-Reactor), an PWR equivalent
VYZ	a summary name covering other (except for V1 NPP) JAVYS branches - A1 NPP, TSÚ RAO, MSVP
VZ	water source
VZN	generally binding regulation
VZPS	selective detection of labour force
VZT	HVAC - heating, ventilation and air conditioning systems
WENRA	Western European Nuclear Regulators Association
WHO	World Health Organization
Z	west
Z. z.	Collection of Legal Acts of the Slovak Republic
ZaD	amendments
ZČ	source term
ZJZ	west-south-west
ZsKNV	West Slovakia regional National Committee (former)
ZSZ	west-north-west
ŽP	environment

Basic Quantities and Units

Basic Units Used in Radiation Protection and Ionizing Radiation Areas

Bq	becquerel (specific name given to the unit of activity. One becquerel equals to one radioactive transformation per second. 1 Bq = 1 s^{-1})
Gy	gray (unit of an absorbed dose. One gray equals to one Joule per kilogram. 1Gy = 1 J kg^{-1})
Sv	sievert (specific name given to the unit of equivalent dose or effective dose. One sievert equals to one Joule per kilogram. 1 Sv = 1 J kg^{-1})

Used units

A	ampere
°C	degree of Celsius
d	day
dB	decibel
h	hour
ha	hectar
Hz	herz
J	joule
K	kelvin
kg	kilogram
l	liter
m	meter
min.	minute
s	second
S	siemens
t	ton
V	volt
W	watt (hereinafter distincted among thermal power output [W_t], electric power output [W_e] and power output per hour [Wh])

Selected prefixes of units

factor	***name***	***mark***
10^{15} / 10E+15	peta	P
10^{12} / 10E+12	tera	T
10^{9} / 10E+9	giga	G
10^{6} / 10E+6	mega	M
10^{3} / 10E+3	kilo	k
10^{2} / 10E+2	hekto	h
10^{-1} / 10E-1	deci	d
10^{-2} / 10E-2	centi	c
10^{-3} / 10E-3	mili	m
10^{-6} / 10E-6	mikro	µ
10^{-9} / 10E-9	nano	n
10^{-12} / 10E-12	piko	p

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