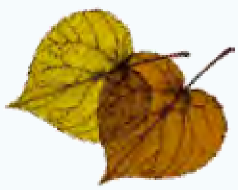
Jadrová vyraďovacia spoločnosť, a.s.

Environmental Impact Assessment Report

of V1 NPP Decommissioning



2006

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LIST OF ABBREVIATIONS

ALARA	As Low as Reasonably Achievable
AKOBOJE	Nuclear Power Plant Automatic Security Guard Complex
APB	Auxiliary Production Building
BIDSF	Bohunice International Decommissioning Support Fund
BL	Bituminisation Plant
BSC	Bohunice RAW Treatment Centre
C	Carbon Steel
CB	Civil Constructions and Buildings
CDE	Collective Dose Equivalent [manSv/year]
CDP	V1 NPP Conceptual Decommissioning Plan
CED	Collective Effective Dose
CHA	Protected Area
CHKO	Protected Country Area
CHŠP	Protected Study Area
ČFS	Pumping and Filtering Station
DF	Decontamination Factor
DG	Diesel Generator
DP	Dose Rate of Gamma Radiation in Air usually expressed in Kermy units (K_a)
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
FCC	Fibre-Concrete Container
FS	Final Shutdown
GovCo (JAVYS)	successor organisation of the SE VYZ
HP	High Pressure
HRK	Control Assemblies
HVAC	Heating, Ventilation and Air Conditioning
HVB	Main Production Building
IAEA	International Atomic Energy Agency
ICRP	International Commission of Radiological Protection

IDE	Individual Dose Equivalent [Sv/year]
IR	Ionising Radiation
IRAWSF	Interim RAW Storage Facility
ISFS	Interim Spent Fuel Storage
ISFSF	Interim Spent Fuel Storage Facility
LP	Low Pressure
LRAW	Liquid Radioactive Waste
LRKO EBO	Laboratory for Radiation Monitoring of SE EBO Surroundings in Trnava
m n.m.	meters above sea level
MH SR	Ministry of Economy of the Slovak Republic
MR	Monitor of Waste Water Pursuance
MSK	Earthquake Intensity Scale according to Medvedev-Sponheuer-Kárnik
MZ SR	Ministry of Health of the Slovak Republic
MŽP SR	Ministry of Environment of the Slovak Republic
N	Stainless Steel
NEC	Nuclear-Energy Complex
NI	Nuclear Installation
NPP	Nuclear Power Plant
NPR	National Natural Reservation
NR SR	National Council of the Slovak Republic
NRA SR	Nuclear Regulatory Authority of the Slovak Republic
PC	Primary Circuit
PSL	Proposed Standardised List of Items for Costing Purposes in the Decommissioning of Nuclear Installations
RAW	Radioactive Waste
RC	Reactor Core
RPV	Reactor Pressure Vessel
RÚ RAO	Near-surface Repository in Mochovce
SE, a.s.	Slovenské elektrárne, a.s., Bratislava
SE EBO	Bohunice NPP (branch of Slovenské elektrárne, a.s.), operator of V2 NPP
SE VYZ	Decommissioning of the Nuclear Installations, Radioactive Waste and Spent Fuel Management (branch of Slovenské elektrárne, a.s.) - GovCo, a.s. (JAVYS, a.s.), at the present time

SHMÚ	Slovak Hydro-meteorological Institute, Bratislava
SNF	Spent Nuclear Fuel
SOCOMAN	Piping Collector of Waste Water
SR	Site Release for Unrestricted Use
STN	Slovak Technical Standard
ŠPR	State Natural Reservation
TaVoS	Trnava Water Supply Company
TSÚ RAO	RAW Treatment and Conditioning Facilities
TVD	Essential Service Water
TZL	Solid Pollutants
ÚNMS SR	Authority for Standardisation, Metrology and Testing, Bratislava
ÚPKM	Institute of preventive medicine, Bratislava
ÚVZ SR	Public Health Authority of the Slovak Republic
VLLW	Very Low Level Waste
WBO	Water Biological Protection
ŽP	Environment

DEFINITIONS AND TERMS

Activity, A

Mean number of spontaneous nuclear transformations *dN* in a given energy state, in a certain amount of radioactive substance in a time interval *dt*. The activity unit is reciprocal second [s-1], termed Becquerel (Bq). *A = dn/dt*.

ALARA

Principle, according to which radiation protection is aimed at reducing the exposures of NI personnel or population to a level as low as reasonably achievable, taking into account social and economic factors, while it is nevertheless allowed to perform inevitable activities that can lead to exposure.

Collective effective dose (S)

Dose defined as the product of the average effective dose in the exposed sub-population and the number of exposed persons. The unit is man.Sv. It supersedes the collective dose equivalent which has hitherto been used.

Committed equivalent dose (HC, T) and effective dose (Ec)

Time integral of equivalent dose rate H_t , respectively of effective dose *E* caused by the intake of a radionuclide into a body by inhalation or ingestion. If not otherwise stated, the integration time for children and adults is 70 years and 50 years respectively. The unit of committed equivalent and effective dose is Sievert [Sv].

Controlled area

Area of workplace with ionising radiation sources, where specific protective measures for permanent control of exposures for persons working with ionising radiation sources are required as well as control of contamination by radioactive substances including controlled entry (*Act of NR SR No. 596/2002 Coll.*)

Critical population group

Group of persons, which is in relation with a certain source of ionising radiation, rather homogenous and representative of the population that is most exposed from this source of ionising radiation.

Effective dose (E)

Dose expressed as the summation of equivalent doses, each multiplied by the appropriate tissue weighting factors in all tissues and body organs. Effective dose allows to express local or partial body irradiation as an equivalent of uniform whole-body irradiation and thus the quantification of health impairment. The unit of effective dose is Sievert [Sv] (the same as for equivalent dose).

Equivalent dose (Ht)

Dose expressed as the product of radiation weighting factor and absorbed dose. This quantity supersedes the dose equivalent which has hitherto been used and it serves to express the different biological effects of individual forms of IR or energy of this radiation – radiation factors are determined on its basis. The unit of equivalent dose is Sievert [Sv]. In practice, it is recommended to supersede the quantity of dose equivalent by equivalent dose without any conversion.

External exposure

Personal exposure to ionising radiation originating outside of the body.

Internal exposure

Personal exposure by radionuclides occurring in the body of a given person, usually as a consequence of radionuclide intake by ingestion or inhalation.

Ionising radiation

Radiation transferring energy in the form of particles or electromagnetic waves with a wavelength up to 100 nm or a frequency of over 3.1015 Hz, which has the capability of directly or indirectly generating ions (*Act of NR SR No. 596/2002 Coll*.).

Limits and conditions

Limits and conditions of safe operation or safe decommissioning mean the document approved by the state regulatory authority regulating the nuclear safety of nuclear installations, which contains admissible values for the parameters of nuclear installation equipment and defines its operational modes or decommissioning modes *(Act of NR SR No.541/2004 Coll.).*

Measures for exposure reduction

Activity for exposure reduction for persons or reduction of exposure probability by influencing its causes, changing exposure routes or reducing the number of exposed persons during the activities leading to exposure (*Act of NR SR No. 596/2002 Coll*.).

Monitoring

Repeated measurement of quantities serving for monitoring, follow-up and evaluation of population exposure and measurement of radioactive contamination of workers or a workplace with IR sources (*Act of NR SR No. 596/2002 Coll*.).

Natural ionising radiation

Ionising radiation with an origin in natural earth or space (*Act of NR SR No. 596/2002 Coll.*).

Natural radionuclide

Radionuclide which has been formed or forms spontaneously in nature, without human intervention.

Operational events at the nuclear installation and events during the shipment of radioactive materials

Operational event is the event, which has resulted in the jeopardy or infringement of nuclear safety at the nuclear installation during its commissioning, operation, decommissioning or repository closure.

Shipment event is the event during the shipment of radioactive materials, which has caused non-conformance with the requirements on nuclear safety during the shipment of radioactive materials.

Operational events and shipment events are divided as follows:

- An event, which has caused:
  - *jeopardy of nuclear safety without direct jeopardy of safety functions*
  - *damage of safety barriers or infringement of other safety measures without direct consequences,*
  - *triggering of the limits and conditions of safe operation and safe decommissioning,*
  - *violation of limits and conditions without direct consequences on fulfilment of safety functions,*
  - *activation of safety systems or their activation due to real causes, but without direct consequences,*
  - *violation of technical conditions or shipment regulations during the shipment without direct consequences,*
  - *other infringement of the reliability of equipment requiring corrective measures for the removal of consequences,*
  - *leakage of radioactive substances or ionising radiation without exceeding the irradiation limits,*
- An incident, which has caused:
  - *jeopardy or violation of fulfilment of safety functions,*
  - *failure of safety systems or activation of safety systems due to real causes, which require measures for removal of consequences,*
  - *significant damage to or failure of safety barriers*
  - *leakage of radioactive substances or ionising radiation with exceeding the irradiation limits,*
- An accident, which has caused leakage of radioactive substances requiring the implementation of measures for population protection (*Act of NR SR No. 541/2004 Coll.*).

Personal dose

Common term for quantities characterising the extent of external and internal exposure for an individual person, namely the effective dose, the equivalent dose, and the committed effective and equivalent dose in individual organs or tissues.

Radioactive emitter

Radioactive substance containing more radionuclides than determined by the appropriate regulation.

Radioactive residue

Radioactive contamination persisting in an environment as a residue of a human activity (*Act of NR SR No. 596/2002 Coll.*).

Radioactive substance

Substance that contains one or more radionuclides (*Act of NR SR No. 596/2002 Coll.*).

Radiation accident

Unintended event caused by loss of control over IR sources that results in leakage of radioactive substances or ionising radiation into environment (*Act of NR SR No. 596/2002 Coll.*).

Radiation incident

Unintended event caused by loss of control over IR sources that can lead to exposure of persons at a workplace with IR sources (*Act of NR SR No. 596/2002 Coll.*).

Radiation protection

System of technical and organisational measures for exposure reduction (*Act of NR SR No. 596/2002 Coll.*).

Radiation protection optimisation

Procedure for achieving and maintaining the radiation protection at such a level that the risk of threat to life, health and the environment is as low as reasonably possible when taking into account economic and social factors (*ALARA principle*).

Source of ionising radiation

Radioactive emitter; an equipment which contains radioactive emitter, generator of ionising radiation or an equipment, activity of which leads to formation of radionuclides (*Act of NR SR No. 596/2002 Coll.*).

Spent fuel

Spent fuel is irradiated nuclear fuel which has been permanently retrieved from the reactor *(Act of NR SR No. 541/2004 Coll).*

Spent fuel storage (interim storage)

The removal of spent fuel to a facility enabling its isolation, environment protection and control (e.g. monitoring) with the intention of retrieval for re-processing or final storage in future (*Radioactive Waste Management Glossary, IAEA, 1993*).

Wet storage

Spent fuel is stored in water in so-called wet spent fuel storage facilities. Spent fuel is located in casks and they are stored in water pools. Water in the pool ensures heat removal and radiation shielding and the casks define geometric arrangement and thus the fuel sub-criticality (*Safety Series 117, IAEA, 1994*).

Worker with ionising radiation sources

Person exposed to radiation during a working activity that can result in exceeding some of the exposure limits determined for the population or workers by the legislation.

Workplace with ionising radiation sources

Workplace, where at least one source of ionising radiation is permanently or temporarily handled with (*Act of NR SR No. 596/2002 Coll.*).

Zero alternative

Zero alternative is the alternative of the status, which would arise if the strategic document was not accepted or the proposed activity did not take place *(Act No.24/2006 Coll.).*

PART A

INTRODUCTION

The Slovak Republic undertook a commitment to shut down units 1 and 2 of Jaslovské Bohunice V1 NPP in 2006 and 2008 respectively through the adoption of Resolution No. 801/99 of the Slovak Government of 14th September 1999, as a condition for fulfilling the Accession Agreement of the Slovak Republic to the European Union, Protocol No.9 on unit 1 and 2 of V1 NPP Jaslovské Bohunice in Slovakia.

According to the Act of NR SR No.127/1994 Coll. on *Environmental Impact Assessment*, Slovenské elektrárne, a.s. (proponent)[1], submitted the document "Complex Study of the V1 NPP Decommissioning" to the Ministry of Environment of the Slovak Republic on 26th June 2002. MŽP SR accepted this Complex Study as a Preliminary Environmental Study (Intention), i.e. as the first step of a standard EIA process, and consequently started the process of scoping specified by §12 of Act No. 127/1994 Coll. on the Assessment of Environmental Impacts as amended by Act No. 391/2000 Coll., for the assessment of impacts of the proposed activities[2].

The Scope of Assessment issued by MŽP SR on 8th October 2002 covers the environmental impact assessment of all three alternatives of V1 NPP decommissioning considered in the Complex Study of the V1 NPP Decommissioning and the so called Zero alternative (in which no action will take place).

In July 2004, a Grant Agreement (*GA 005*) for the development of Bohunice V1 NPP decommissioning documentation was established between the EBRD, as the administrator of Grant Funds provided by the Bohunice International Decommissioning Support Fund (BIDSF), and SE, a.s., as the recipient. The subject of this Grant Agreement comprises the following projects:

- B6.1: "The V1 NPP Conceptual Decommissioning Plan";
- B6.2: "The Environmental Impact Assessment (EIA) Report of V1 NPP Decommissioning".

The proponent shall perform an environmental impact assessment in accordance with Act No. 127/1994 Coll. and under the framework of the BIDSF, also in accordance with the EU EIA Directives, including preparation of the Environmental Impact Assessment Report and public consultation process. The above mentioned projects are included in BIDSF B6 project, which also covers the project B6.3. "The V1 NPP Decommissioning Stage Plan and other Documentation" and the project B6.4 "Decommissioning Database".

[1] At the present time GovCo, a.s. (Jadrová vyraďovacia spoločnosť, a.s.), Jaslovské Bohunice, which is besides other also the V1 NPP operator, has taken over the function of the proponent.

[2] The new EIA Act No. 24/2006 Coll. came into force on 1st February 2006 and it revokes the previous Act No. 127/1994 Coll. and Act No. 91/2000 Coll. According to §65, item 3 of Act No. 24/2006 Coll., environmental impact assessment commenced before February 1st, 2006 will be completed in accordance with previous regulations.

"The V1 NPP Conceptual Decommissioning Plan" and this "V1 NPP Environmental Impact Assessment Report" (after issuing the final statement of MŽP SR) will be the basis for issuing the decision on authorisation for the activity according to special regulations and for the documentation which should be developed in the frame of the B6.3 project that shall be attached to the written application for authorisation for the decommissioning stage (the Act No. 541/2004 Coll.).

The principal interconnections and mutual relations among the above mentioned projects in the frame of comprehensive B6 project and decommissioning authorisation process are shown in figure A-1.

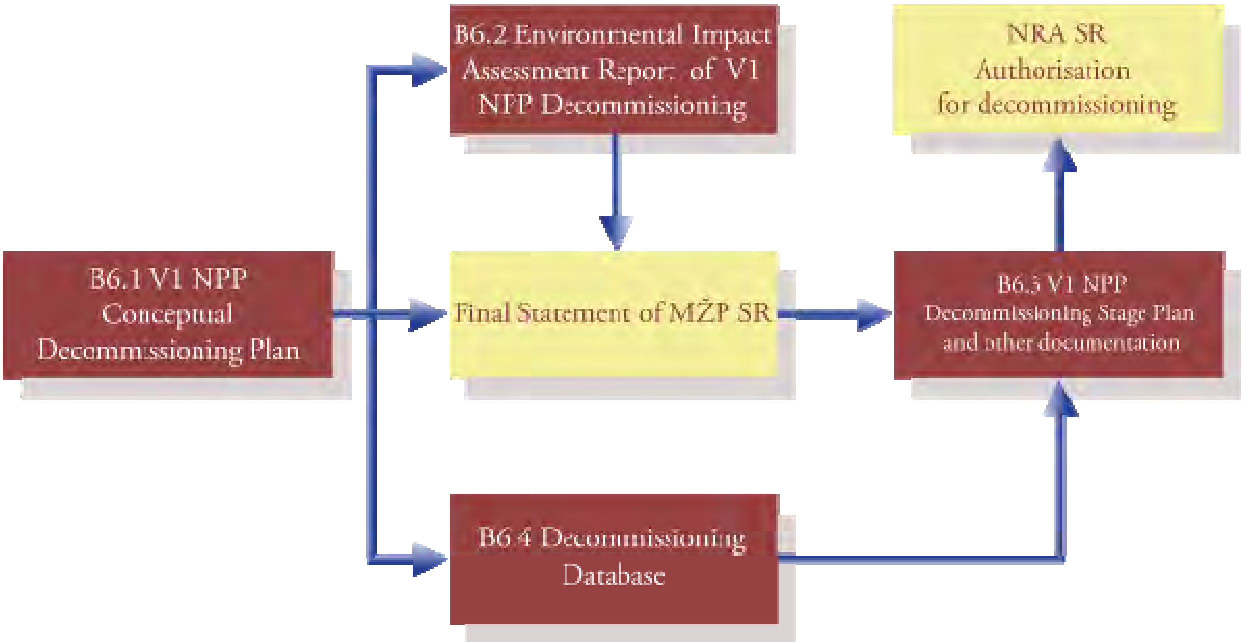


Figure A-1: The principal interconnections and mutual relations among the projects in the frame of comprehensive B6 project and decommissioning authorisation process.

I. BASIC INFORMATION ABOUT THE PROPONENT

I.1 NAME

GovCo, a.s. (Jadrová vyraďovacia spoločnosť, a.s. - JAVYS)

I.2 IDENTIFICATION NUMBER

35 946 024

I.3 ADDRESS

GovCo, a.s. (Jadrová vyraďovacia spoločnosť, a.s.)

919 31 Jaslovské Bohunice

I.4 PROPONENT REPRESENTATIVES

Ing. Stanislav Reguli

Ing. Ladislav Lörinc

II. BASIC DATA ON THE INTENTION

II.1 NAME

V1 nuclear power plant decommissioning.

II.2 PURPOSE

The purpose of the proposed activity "*V1 NPP Decommissioning*" is to achieve the status fulfilling the criteria (in accordance with appropriate legal regulations) for site release for unrestricted use. The V1 NPP decommissioning will thus be completed by the removal of all unnecessary and non-utilisable buildings and equipment and the release of its site for further use.

The goals of the assessment report are to assess and compare impacts of proposed V1 NPP decommissioning alternatives on the environment in accordance with Act No. 127/1994 Coll. and to recommend the most suitable alternative.

II.3 USER

GovCo, a.s. (Jadrová vyraďovacia spoločnosť, a.s.)
919 31 Jaslovské Bohunice

II.4 LOCATION

The activities will be carried out on the V1 NPP site (*Fig. A-2*), which is a part of the common site of SE EBO (operator of V2 NPP) and GovCo (JAVYS) in the Bohunice nuclear-energy complex.. The SE EBO and GovCo (JAVYS) sites are located in the land registry areas of four municipalities:

- Jaslovské Bohunice;
- Malženice;
- Pečeňady;
- Veľké Kostoľany.

At the NEC Bohunice site, the following nuclear installations are currently located:

- operated V1 NPP with two reactor units WWER-440 type 230 (older type);
- operated V2 NPP with two reactor units VVER-440 type 213 (newer type);
- A1 NPP being under Stage I of decommissioning – in 2008 it is expected to attain a status, after which the NPP will be decommissioned within further stages in a standard way. This nuclear installation also includes some radioactive waste management plants that are located

within the power plant, e.g. vitrification, fragmentation and high-capacity decontamination plants and several rooms modified for RAW storage in the drums;

- An Interim Spent Fuel Storage Facility originally designed for approximately 10-year storage of spent fuel prior to its shipment abroad. At a later time it was reconstructed in order to enhance safety, storage capacity and to prolong the storage period of spent fuel to approximately 50 years;
- RAW Treatment and Conditioning Facilities that consist of BSC (Bohunice RAW Treatment Centre), two bituminisation plants and discontinual bituminisation plant in building 809, facility for sludge fixation at the free area of building no.41, active water purification plant and non-operating KWU cementation plant.

In addition, two nuclear installations of experimental character owned and/or operated by VÚJE, a.s. are located at the GovCo (JAVYS) site:

- An experimental RAW Incineration Plant including a facility for ash cementation. It is currently not operated, neither is its further operation not envisaged.
- Experimental Bituminisation Plant.

Figure A-2: View of V1 NPP from the southeast.

The layout of individual nuclear installations at GovCo (JAVYS) and SE EBO site is shown in figure A-3.

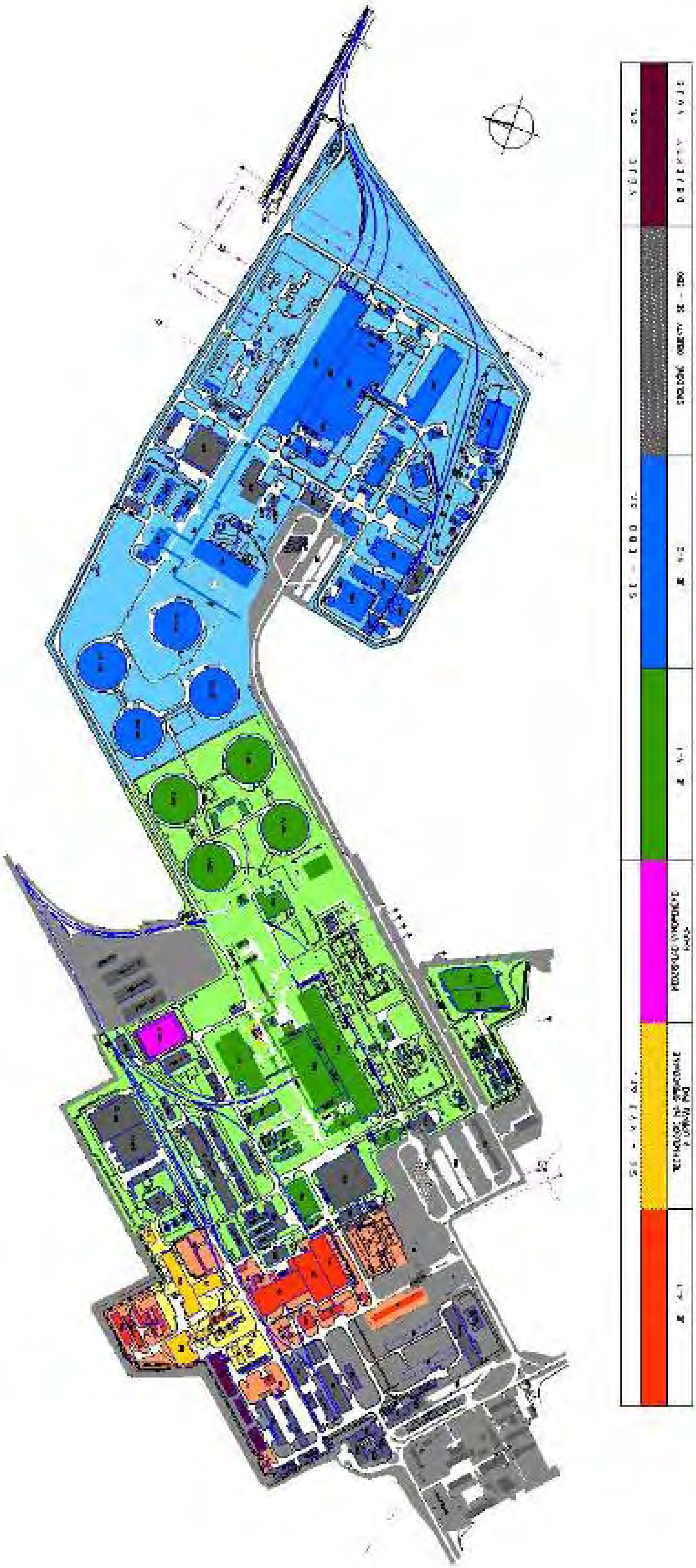


Figure A-3: Layout of buildings at GovCo (JAVYS) and SE EBO site.

II.5 REASON FOR LOCATION AT A GIVEN SITE

V1 NPP as the existing installation, is located at the GovCo (JAVYS) site which together with the SE EBO site forms a part of the NEC Bohunice site.

II.6 COMMENCEMENT AND TERMINATION DATES OF NPP V1 DECOMMISSIONING

In compliance with the proponent's instructions alternative solutions of the decommissioning were addressed in all studies, strategic and planning documents. Their initial and final status was in every case the same:

- The V1 NPP decommissioning begins with the authorisation for decommissioning issue after the fuel removal from V1 NPP and its placement into the GovCo (JAVYS) ISFS in Jaslovské Bohunice, which means that the period between the final shutdown of Unit 1 and the start of the decommissioning itself (pursuant to the Government Resolution No. 801/1999, between years 2007 and 2011) does not generally fall within the decommissioning activities, but is a part of the operation termination and a period of preparatory decommissioning activities.
- The V1 NPP decommissioning is terminated by the removal of all building structures and equipment identified for decommissioning and the releasing of the plant site for further use.

The operation termination period after the reactor final shutdown is characterised by the following activities:

- The removal of spent fuel from the reactor to the storage pool and subsequently to the interim spent fuel storage facility;
- The treatment and disposal of operational RAW;
- The decontamination of a primary circuit as a whole;
- The discharge of operational media;
- The electrical and mechanical provision and separation of systems.
- The time sequence of the operation termination after the reactor final shutdown will be as follows:

– stage no.1 (2006-2008)
  - *beginning:* removal of the last fuel assembly from the reactor core of unit 1 to the spent fuel pool of unit 1
  - *end:* removal of the last fuel assembly from the reactor core of unit 2 to the spent fuel pool of unit 2

– stage no. 2 (2008-2009)
  - *beginning*: removal of the last fuel assembly from the reactor core of unit 2 to the spent fuel pool of unit 2
  - *end*: removal of the last fuel assembly from the spent fuel storage pool of unit 1 to ISFS

– stage no. 3 (2009-2011)
  - *beginning*: removal of the last fuel assembly from the spent fuel pool of unit 1 to ISFS
  - *end*: removal of the last fuel assembly from the spent fuel pool of unit 2 to ISFS

– stage no. 4 (2011 – obtaining the authorisation for decommissioning)
  - *beginning*: removal of the last fuel assembly from the spent fuel pool of unit 2 to ISFS
  - *end*: change of authorisation – termination of the validity of the existing authorisation for operation and the coming into force the authorisation for decommissioning.

Assumed dates for the proposed activity or alternatives of the proposed activity are given in the table A-1.

Table A-1: Dates of commencement and termination of activities.

Alternative of proposed activity	*Commencement*	*Termination*
Alternative 1 (IDO)	2012	2025
Alternative 2 (SES)	2012	2063
Alternative 3 (RSE)	2012	2063
Zero Alternative	2012	Without time limitation

II.7 SIMULTANEOUSLY SUBMITTED ALTERNATIVES FOR THE PROPOSED ACTIVITY

Simultaneously submitted alternatives for the proposed activity are as follows:

- Alternative 1 - Immediate decommissioning alternative (IDO);
- Alternative 2 - Deferred decommissioning alternative with safe enclosure under surveillance for 30 years (SES);
- Alternative 3 - Deferred decommissioning alternative with reactor safe enclosure for 30 years (RSE).

These alternatives are to be compared with the Zero alternative, which represents the situation and its consequences, should the proposed activity – V1 NPP decommissioning, not take place.

II.7.1 Zero alternative

The Zero alternative is characterised as the situation and its consequences that would arise if the proposed activity did not take place. In the case of V1 NPP decommissioning, the Zero alternative is the status that would arise after the NPP shutdown without the commencement of decommissioning activities and its retention without time limitation. This means that the Zero alternative represents no further operation of the power plant.

In accordance with the Atomic Act, nuclear power plants must be operated to such an extent, that their radiation safety would be ensured and continuously monitored after the reactor final shutdown to the extent identified by the Decree of NRA SR No. 50/2006. During the operation termination period the spent fuel is removed from each unit and the operational radioactive waste is treated.

In the case of the Zero alternative, namely the following systems will have to be permanently operated:

- HVAC systems creating suitable hygienic and radiological conditions for the personnel during inspections of active rooms and technological equipment, whilst at the same time enabling the moderate heating of rooms to minimise corrosion conditions for technological equipment;
- special drain water system (collection and check for potential leakages) with waste water let down system;
- radiation monitoring of equipment and rooms using a stationary radiation monitoring system and portable devices;
- automated technological information system –(system for monitoring of equipment , system for monitoring of building barrier tightness, signalling of leaks in the controlled area, etc.);
- electronic fire protection system;
- electrical distribution systems for lighting of rooms and power supply to operating systems (permanent operation of power supply systems);
- piping distribution systems for media (water for fire fighting, drinking water for changing rooms and contamination checkpoints, etc.);
- groundwater monitoring system in the vicinity of individual buildings;
- main changing rooms and showers;
- rooms for operating personnel, from which the permanent attendance and monitoring of operating systems is ensured (in addition to walkdowns).

The maintenance and reconstruction of the aforementioned systems are simultaneously ensured. In addition, building maintenance with emphasis on the control and maintenance of barriers is necessary.

The mode of operation under the Zero alternative is similar to the activities carried out during SES, the only difference being that it lasts much longer. Basically, the duration of the Zero alternative is determined by a spontaneous decay of radioisotopes in the shutdown power plant. The Zero alternative thus means the preservation of the V1 NPP shutdown status without time limitation. This alternative does not require the availability of decommissioning investments, even if it is not limited by time. The site release for further use would be postponed to the distant future. In addition, the risk of possible leakages of radioactive substances into environment is increased. It is not an advantageous alternative with regard to the costs of maintenance, reconstruction of buildings and equipment and the institutional control which would be needed for an indefinite period of time. From the ethical point of view, it means the transfer of responsibilities to the next generations and non-conformance with the principle of sustainable development.

Hence, the Zero alternative is unacceptable for NPP decommissioning in general as well as for V1 NPP decommissioning, due to the increased radiological risks and related costs. Its continuation would be the infringement of the sustainable development principle and one of the principles of safe handling with radioactive waste. It is very probable that the implementation of the Zero alternative would lead to a re-consideration of the decision not to perform decommissioning, but in more difficult conditions (loss of operational continuity, possible loss of information, necessity to train new inexperienced personnel, abundance of financial means could be a problem, etc.).Therefore, the environmental impact of this alternative will be dealt with in an adequate manner in the assessment report.

II.7.2 Alternative 1: Immediate decommissioning alternative (IDO)

The main characteristics of this alternative are the immediate and continuous dismantling of the equipment and facilities, the **demolition of buildings back to the bottom of the foundation and the preparation of the site for other (industrial) use**.

Within the operation termination period the spent fuel is removed from the Units into the ISFS, remaining operational (historical) RAW are processed and the decontamination of the PC as a whole is carried out. Subsequently, during the decommissioning stage I, the non-active technological systems are dismantled and the non-contaminated buildings which are not intended for other purposes are demolished.

The principle sequence of further decommissioning activities is: system decontamination before continuous dismantling and decontamination after dismantling, if necessary. The RAW generated is treated and stored at all times. This is followed by the decontamination of building surfaces and the demolition of the buildings even including the hermetic areas. In this alternative the decommissioning is continuous. At the end the decommissioned site is released for other use.

Alternative 1 can be characterised by the following activities:

a) Decommissioning stage I:

- The dismantling of unrequired non-radioactive equipment and systems;
- The demolition of unrequired non-radioactive buildings;
- The treatment of RAW arising from decontamination;
- The evaluation or disposal of non-contaminated waste.

b) Decommissioning stage II:

- Pre-dismantling decontamination;
- The preparation and execution of dismantling of the contaminated and activated equipment and systems;
- The decontamination of dismantled equipment;
- The decontamination of building structures;
- The demolition of decontaminated buildings;
- The treatment of RAW arising from the decontamination, dismantling and demolition;
- The evaluation or disposal of non-radioactive waste arising from decontamination, dismantling and demolition
- Final site monitoring, cleanup and landscaping.

c) Final status:

- The site is released for industrial reuse.

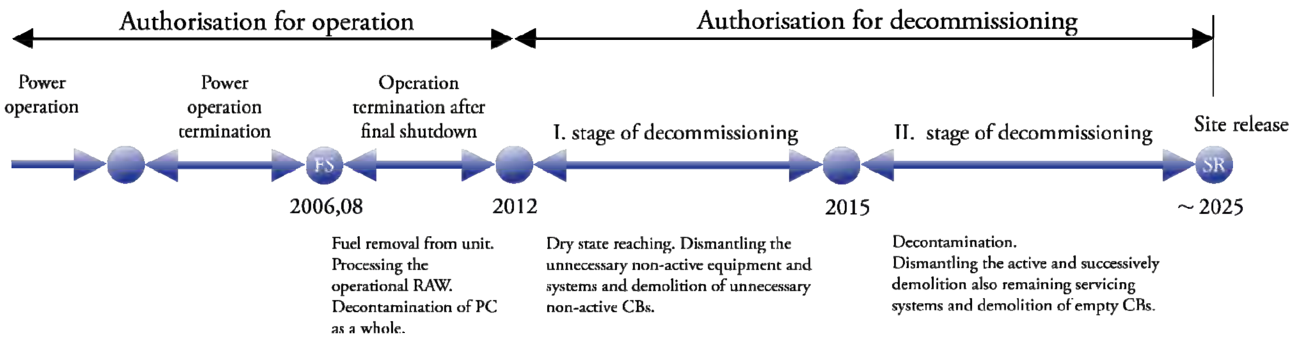


Figure A-4: Simplified scheme of Alternative 1.

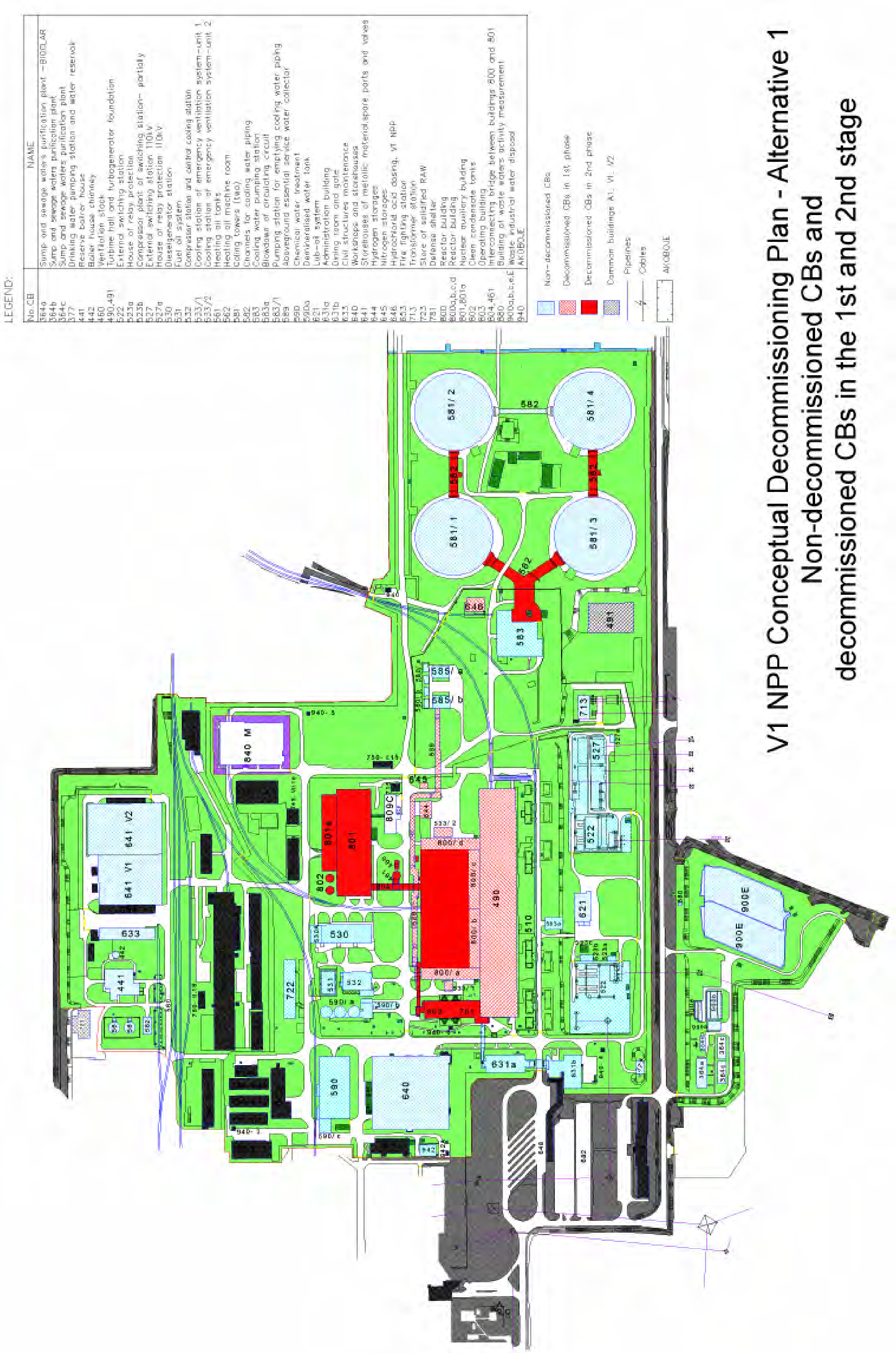


Figure A-5: Decommissioned and non-decommissioned building structures in stage I and II of Alternative 1.

II.7.3 Alternative 2: Deferred decommissioning alternative with safe enclosure under surveillance for 30 years (SES).

A basic characteristic of this alternative is the **safe enclosure of the equipment of the primary circuit.**

Before the authorisation for operation is terminated, the spent fuel is removed from each Unit, the operational RAW are processed and decontamination of the PC as a whole is carried out.

No additional internal decontamination is performed during the decommissioning stage I. No contaminated items are dismantled in the decommissioning stage I. Civil engineering corrective maintenance is performed (civil engineering preservation) and the obsolete non- contaminated CBs are dismantled and demolished. The facilities are closed as it is scheduled. Having closed the facilities, the environmental impact is regularly monitored.

After the expiration of the term of SES, the facilities are dismantled, by taking into account the radiation that could have decreased because of the natural decay of isotopes. Thus this alternative could be characterised as an interrupted decommissioning process, whereby the contaminated/activated facilities are safely enclosed and monitored during the determined time and at the end are dismantled up to the unrestricted release of the site.

Alternative 2 can be characterised by the following activities:

a) Decommissioning stage I:

- The dismantling of unrequired non-radioactive and non-utilisable equipment;
- The demolition of unrequired non-radioactive buildings;
- The “mothballing” of the equipment that would be further utilised (HVAC, special sewage system, etc.);
- The repair and maintenance of barriers;
- The surveillance of the closed equipment and facilities.

b) Decommissioning stage II:

- The plant structures with contaminated/activated equipment remain in closed state;
- Protective barriers are maintained and kept under permanent surveillance;
- Preparation for stage III.

c) Decommissioning stage III:

- Pre-dismantling decontamination;
- The preparation and execution of dismantling of the remaining equipment and systems;
- The decontamination of dismantled equipment;

- The decontamination of building structures;
- The demolition of decontaminated buildings;
- The treatment of RAW arising from the decontamination, dismantling and demolition;
- The evaluation and disposal of non-radioactive/radioactive waste arising from decontamination, dismantling and demolition;
- Final site monitoring, cleanup and landscaping;

d) Final status:

- The site is released for further reuse.

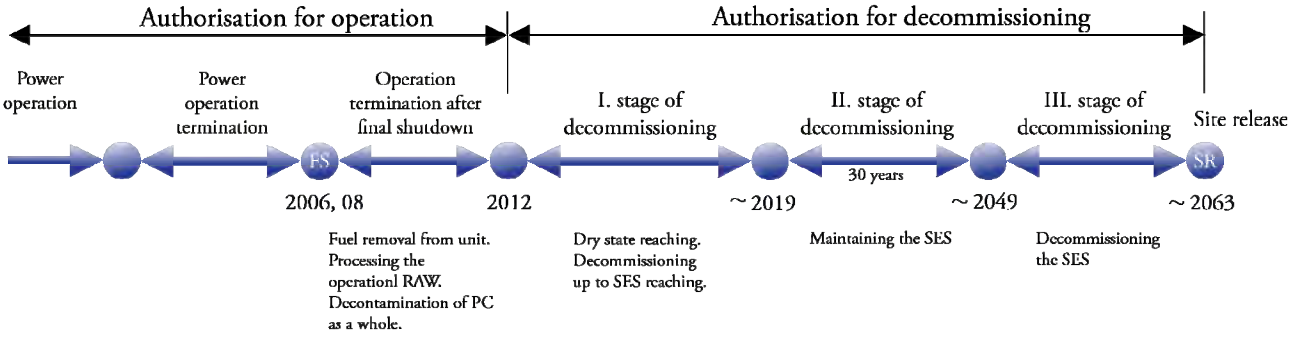


Figure A-6: Simplified scheme of Alternative 2.

During the safe enclosure under surveillance the equipment and systems which are important to safety are still operated. The maintenance of equipment and systems, electrical equipment, instrumentation and control equipment and radiation monitoring is ensured according to the programme determined in advance. In the course of 30-year period of enclosure under surveillance, it is necessary to consider equipment reconstruction including the cable and distribution systems replacement. With regard to the importance of building barriers, maintenance (replacement) of building parts (roofs, peripheral panels, foundations, structures, etc.) is ensured in regular intervals in accordance with the results of inspections carried out. The assumed maintenance intervals are stipulated in operational regulations.

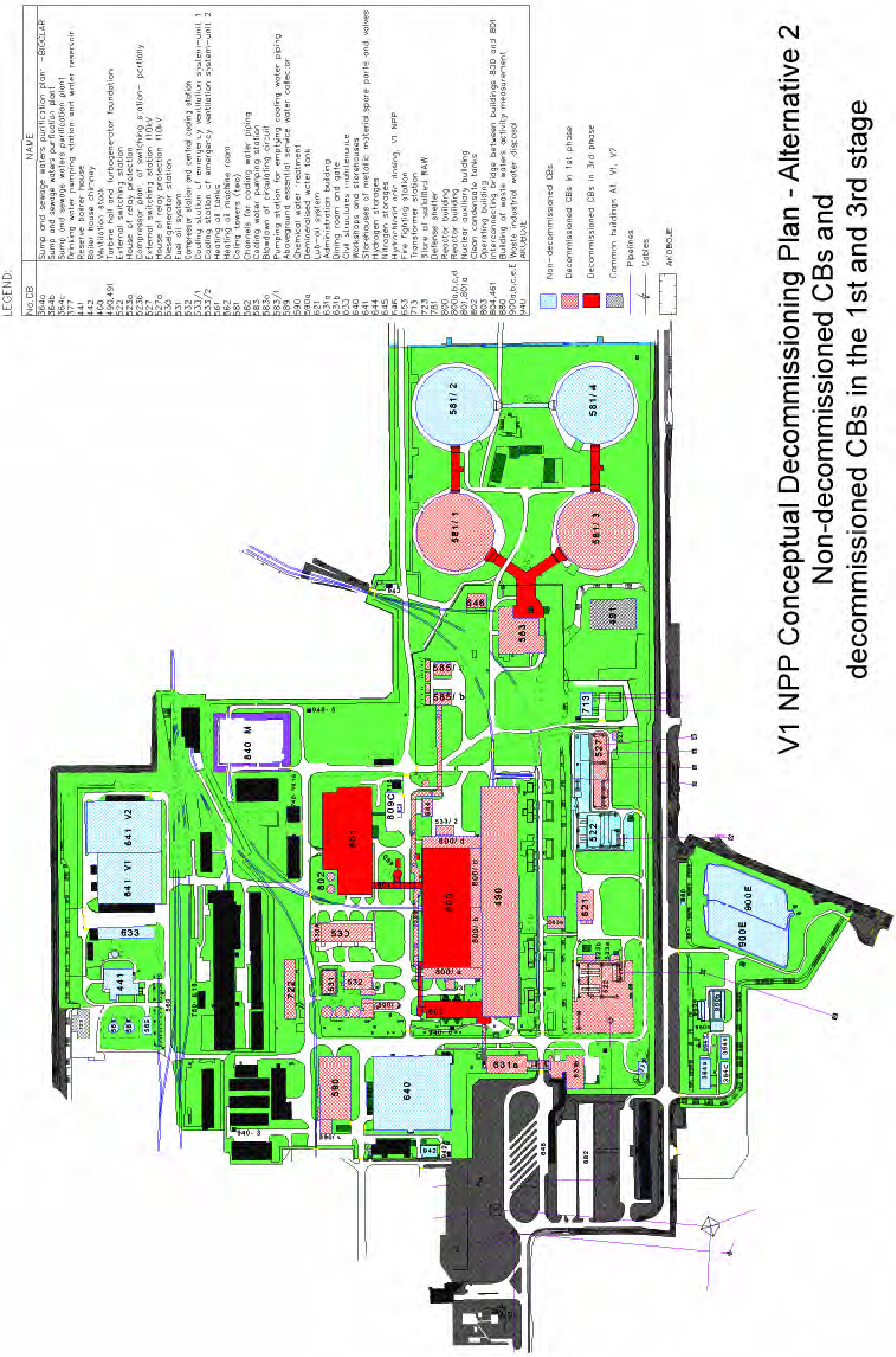


Figure A-7: Decommissioned and non-decommissioned building structures in stage I and III of Alternative 2.

II.7.4 Alternative 3: Deferred decommissioning alternative with reactor safe enclosure for 30 years (RSE)

A basic characteristic of this alternative is the **safe enclosure of the reactor in the reactor shaft**.

Before the authorisation for operation is terminated, the spent fuel is removed from the Unit, the operational RAW are processed and decontamination of the primary circuit as a whole is carried out.

Further, during the decommissioning stage I, the non-contaminated facilities are dismantled and buildings which are not intended for any further use are demolished. Pre-dismantling decontamination, the dismantling of the technological equipment (except that which will be in the RSE), the decontamination after dismantling and the processing of the waste arising are carried out successively. These activities would be followed by the decontamination of the building surfaces and the demolition of the controlled area (except the part, which will be in the RSE). The safe enclosure of the reactor meets all the requirements of environment and radiation protection.

This alternative also includes an interruption of the decommissioning process. During the time of reactor safe enclosure, two independent groups of buildings remain in the site area: the reactor shafts with the reactors and some other service CBs.

Alternative 3 can be characterised by the following activities:

a) Decommissioning stage I:

- Pre-dismantling decontamination;
- The dismantling of unrequired non-radioactive and non-utilisable equipment;
- The demolition of unrequired non-radioactive buildings;
- The dismantling of contaminated equipment;
- The demolition of the empty buildings after decontamination;
- The treatment of RAW arising from the decontamination, dismantling and demolition;
- The evaluation or disposal of non-radioactive waste arising from the decontamination, dismantling and demolition;
- The preparation of the reactor for safe enclosure;
- The construction of civil engineering facilities for the reactor safe enclosure.

b) Decommissioning stage II:

- The reactors remain in safe enclosure in closed buildings;
- The barriers are maintained and monitored;
- The preparation for stage III.

c) Decommissioning stage III:

- The preparation for the dismantling and removal of highly activated components (reactor and internals);
- The dismantling of the reactors and their internals;
- The dismantling of operational facilities of the safe enclosure and demolition of the reactor shaft;
- The treatment of RAW arising from the decontamination, dismantling and demolition;
- The evaluation or disposal of non-radioactive waste arising from the decontamination, dismantling and demolition;
- Final site monitoring, cleanup and landscaping.

d) Final status:

- The site is released for further reuse.

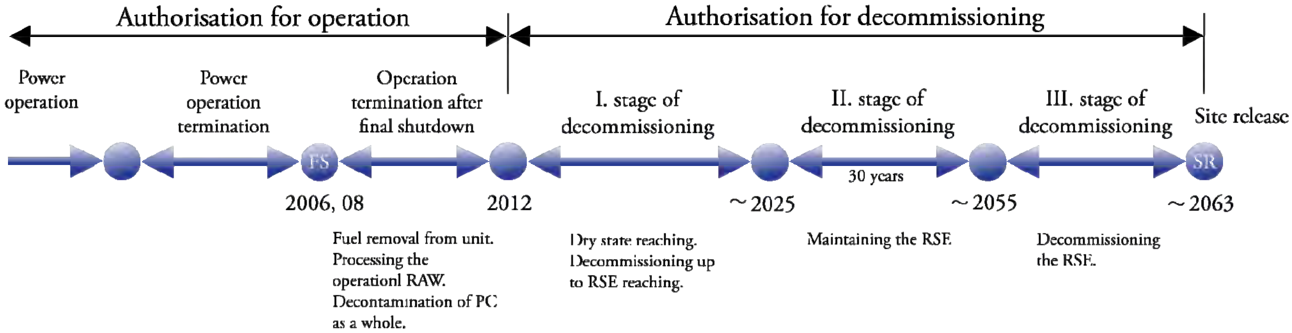


Figure A-8: Simplified scheme of Alternative 3.

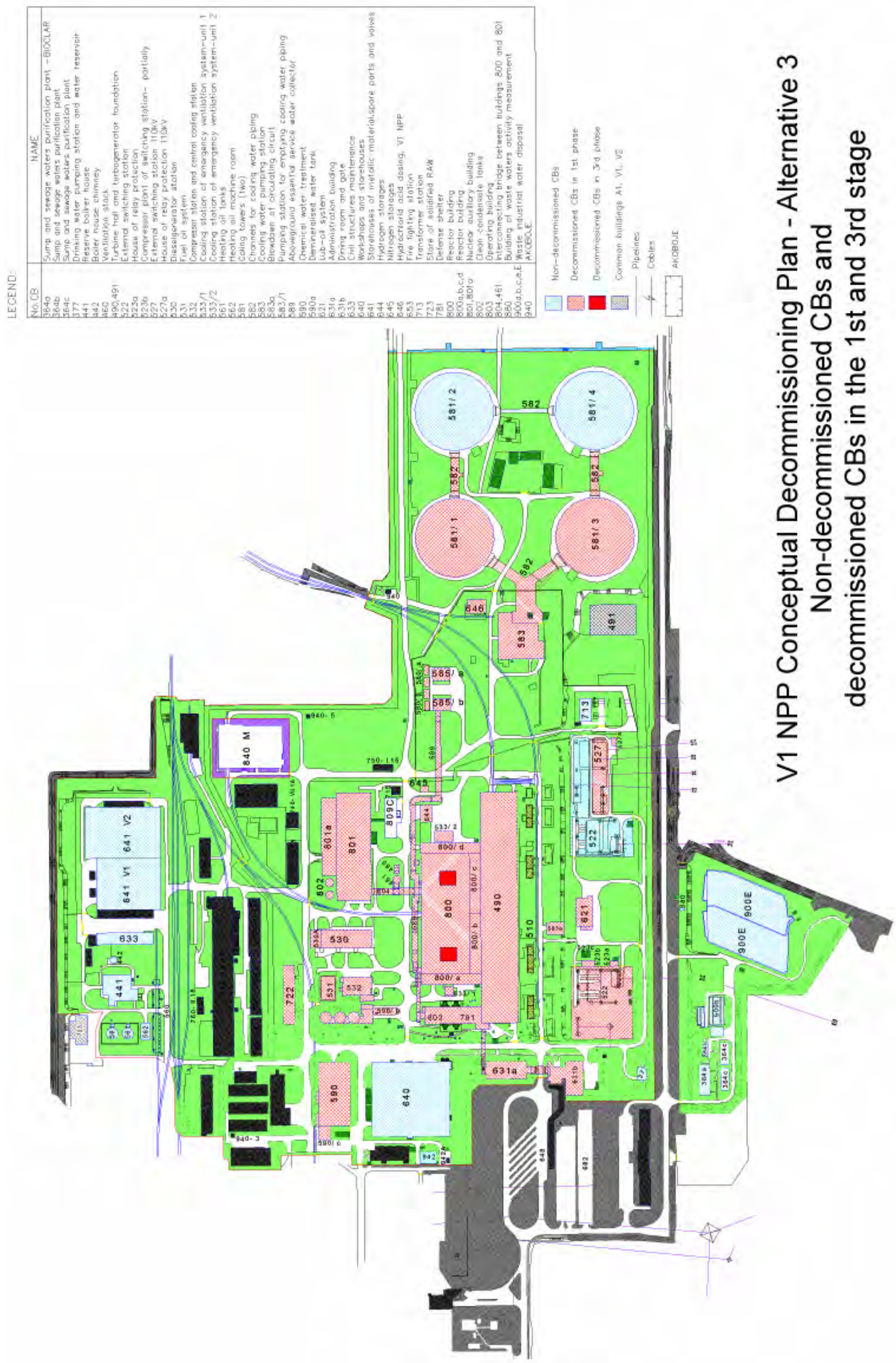


Figure A-9: Decommissioned and non-decommissioned building structures in stage I and III of Alternative 3.

II.8 DESCRIPTION OF TECHNICAL AND TECHNOLOGICAL SOLUTION – MAIN ACTIVITIES DURING V1 NPP DECOMMISSIONING

The decommissioning of nuclear power plants consists of more or less standard activities. Individual decommissioning alternatives differ in the time and scope of individual activities applied to a particular situation. Individual activities included in the decommissioning process are as follows:

- preparatory decommissioning activities;
- the decontamination of technological equipment and building surfaces;
- the dismantling of technological equipment;
- the dismantling of technological equipment forming a part of civil structures and demolition of civil structures.

In addition, during the decommissioning period, activities are carried out that are also carried out at each nuclear installation during its operating period:

- RAW management on the V1 NPP site during the decommissioning;
- radiation monitoring, i.e. the monitoring of personnel exposure and irradiation of rooms (surfaces);
- the monitoring of discharges, and the inspection of materials released to the environment;
- the monitoring of the installation's impact on the environment.

The last group of activities includes induced activities to be performed at the other nuclear installations or related external activities:

- the process of release of low-level materials to the environment;
- the RAW shipment for treatment and conditioning;
- the decommissioning RAW treatment and conditioning;
- the storage in the storage facilities and the disposal of packaged RAW forms at the repository;
- the handling with non-radioactive materials resulting from the decommissioning activities.

II.8.1 Preparatory activities for V1 NPP decommissioning

The operation termination period is the final period of NPP operation in the frame of authorisation for operation, which includes V1 NPP preparation for the final shutdown, the final shutdown itself and the establishment of the optimal conditions for the subsequent decommissioning.

Several preparatory activities have to be carried out in the operation termination period before the commencement of decommissioning.

The activities are as follows:

- The separation of V1 NPP from those other nuclear installations continuing in operation at the NEC Bohunice site;
- The preparation and implementation of V1 NPP final shutdown and operation termination;
- The evaluation of the V1 NPP condition at the commencement of decommissioning;
- Ensuring the availability of qualified personnel for decommissioning;
- The development of documentation for V1 NPP decommissioning;
- Ensuring the new and/or modified infrastructure for V1 NPP decommissioning;
- Additional tasks such as the assessment of legal, technical and other assumptions and requirements for the handover of V1 NPP for decommissioning.

The goal of the preparatory activities for decommissioning is to provide the necessary technical, organisational and financial prerequisites for the commencement of decommissioning work and to ensure the strategic planning for the whole process of V1 NPP decommissioning. Preparatory activities for decommissioning do not include preparatory activities needed for specific decommissioning activities like the design and installation of equipment for the dismantling of reactor pressure vessel and its internal parts, which will not be utilised during the decommissioning stage I.

II.8.2 Decontamination of technological equipment and building surfaces

Decontamination of equipment and buildings is one of the basic activities performed during the decommissioning of nuclear facilities. Its purpose is to reduce, to the maximum possible extent, the exposure of personnel during decommissioning activities, to prevent possible leaks of radioactive materials, to reduce contamination by enabling re-use of materials (recycling) and to facilitate handling with waste.

Equipment and its parts thereof that cannot be decontaminated to levels enabling re-use of materials not even by means of radical decontamination methods are namely the parts activated by neutron flux. Nevertheless, pre-dismantling decontamination during decommissioning may significantly reduce the amounts of radionuclides from the surfaces and so facilitate latter handling.

Decontamination during the NPP decommissioning process is carried out in several steps of this process:

- Pre-dismantling decontamination of equipment – includes decontamination of internal and external surfaces of equipment (tanks, piping, etc.) to create a favourable radiation situation for the dismantling of equipment and to reduce the formation of aerosols during dismantling;
- Pre-dismantling decontamination of building surfaces (lining and some other surfaces) – also to create a favourable radiation situation for the dismantling of equipment;

- Post-dismantling decontamination of equipment (metallic parts, surfaces of cables) – with the aim of releasing metallic waste arising during the dismantling into the environment;
- Post-dismantling decontamination of building surfaces (before demolition) – with the aim of releasing construction waste arising from the demolition of civil structures into the environment.

In the actual decommissioning process, the decontamination procedures used in individual cases are based on the actual measured level and nature of contamination directly before their performance . The number of decontamination cycles is also determined according to the measured values.

II.8.3 Dismantling of technological equipment

For the dismantling of technological equipment, common mechanic's tools and standard manufactured equipment such as oxygen-acetylene cutting sets, plasma cutting sets, hydraulic shears, circular saws, grinding and scarifying machines and cutting saws are used.

When dismantling radioactive equipment, the level of radiation next to dismantled equipment shall be monitored. Dismantling technologies are supplemented with containers provided with shielding, special exhaust sets, shipment shielding and so on. For special cases, remotely controlled manipulators are provided as well as personal protective means corresponding to the character of work performed.

Dismantling work is carried out in accordance with prepared schedules and procedures with an emphasis on continual adherance to ALARA principles. The plans include measures preventing the spreading of radioactive substances within NPP facilities and in their vicinity. Dismantled materials are moved from the place of dismantling to the place of further handling by means of hoists, rollers or manually or by using shipment means existing within the room.

II.8.4 Dismantling of technology forming a part of the civil structures and demolition of civil structures

By “Technological equipment forming a part of civil structures” the built-in steel items such as steel doors, stairs, foot bridges, hatches, crane runways, etc. are meant. To demolish civil structures, core drilling machines, diamond tools (saw, rope), hydraulic spreaders, hydraulic cutting machines, explosive charges, air picks, oxygen-acetylene cutting sets, water jet, etc. are used.

The initial status of civil structures to be demolished is as follows:

- The surfaces of civil structures shall not be contaminated;
- Civil structures shall be handed over for demolition without technological equipment;
- In the frame of dismantling, steel structures, crane runways, etc. shall be removed;
- Civil structures shall be disconnected from underground services.

Steel linings are expected to be decontaminated to a level enabling their release to the environment, i.e. they will be removed without any special measures being taken.

II.8.5 Activities performed simultaneously with decommissioning

II.8.5.1 RAW management at V1 NPP during decommissioning

Large pieces of metallic waste from dismantling are fragmented to sizes suitable for their further handling. It is anticipated that a central fragmentation workplace will be established in the reactor hall designed for the fragmentation of large pieces from V1 dismantling. In addition, fragmentation will also be performed in situ during the dismantling work. After the fragmentation of non-decontaminable RAW to suitable dimensions, RAW will be shipped to the Bohunice RAW Treatment Centre to obtain packaged RAW suitable for disposal or temporary storage in the case of a later disposal. Separated non-metallic compactable waste will be pre-compacted at V1 NPP and will subsequently be transferred for the treatment to BSC.

Equipment for treatment of historical liquid RAW (i.e. evaporator in combination with ion-exchange filters) where liquid RAW is concentrated into smaller volumes is operated for as long as decontamination work is carried out. Concentrates or spent ion exchangers are then shipped in special containers for further treatment and conditioning to “RAW Treatment and Conditioning Facilities”.

II.8.5.2 Dosimetric measurements

The control of personnel exposure for staff involved in decontamination and dismantling work is performed on the same scope as during the operation. This means that the persons involved are provided with personal exposure monitoring devices (dosimeters) to measure external exposure and measurements of internal contamination with radionuclides are also executed, partly within periodic medical examinations, partly directly after more risky work (e.g. work with an increased risk of radioactive aerosol inhalation). Work is performed in accordance with valid regulations for work at nuclear installations and in the controlled area.

Rooms and surfaces are controlled in a scope appropriate to the relevant stage of decommissioning. As structures are demolished step by step, stationary radioactivity measuring devices in individual rooms will be removed and replaced by portable ones. Teams performing dismantling work in radioactive rooms will be provided with a dosimetry specialist who will control radiation prior to, during and after dismantling work by a portable device and depending on the current situation, he/she will guide the work.

II.8.5.3 Monitoring of discharges and control of materials released to environment

In the case of any substances leaving the radioactive rooms of the plant or its controlled area, proof must be proved - by metrologically correct measurements - that they meet the limits and conditions for liquid and gaseous discharges (authorised discharge limits) or, in the case of materials released to the environment, that they meet the relevant limits specified by the appropriate legislative regulations.

To monitor gaseous discharges during the plant decommissioning, stationary devices used during its operation are suitable. These devices can be simply modified also to measure altered quantities in limits and conditions applicable to the decommissioning – after the shipment of spent fuel, it is not necessary to limit and measure short-lived fission products in gaseous discharges such as iodine and noble gas isotopes. The gaseous discharges are monitored in an analogous manner after the central HVAC system shutdown. The monitoring of liquid discharges from the Jaslovské Bohunice nuclear installations is performed in a multistage manner, i.e. the discharges of the given equipment are measured (in accordance with the principle of monitoring at the source) as well as those from the whole site. Even if one stage is eliminated, the final monitoring station (CB 880 – waste waters activity measurement and CB 368 – station of waste water activity measurement) remains in operation as long as there are any nuclear installations at the site.

Devices designed to measure the activity of materials released to the environment must be put into operation prior to the initiation of decommissioning and approved by the regulatory authority (Public Health Authority of the Slovak Republic). The devices will have to differentiate between the low radioactivity of materials and the background radioactivity, to determine radioactivity of surfaces inaccessible for direct measurements and to determine the content of radionuclides which are safety-important but immeasurable.

II.8.6 External activities – decommissioning waste management

II.8.6.1 Process of release of materials to environment

The release of materials to the environment is in general considered to be:

- The placement of these materials in dump sites designed for non-radioactive materials, if they fulfil the conditions for release according to the valid regulations;
- Their recycling and subsequent use (e.g. metallic materials as a part of scrap for remelt, concrete debris for crushing and subsequent use in building materials – to enable recycling of non-radioactive building materials, the erection of a recycling plant is planned).
- Other manners of utilisation/management of individual kinds of waste in accordance with legislative documents in the field of waste management.

II.8.6.2 RAW shipment for treatment and conditioning

Decommissioning RAW will be shipped within the NEC Bohunice site in approved containers in the same way as RAW from the operation. Shipments will be carried out in accordance with the relevant approved operating procedure.

II.8.6.3 Treatment and conditioning of RAW arising from V1 NPP decommissioning

RAW arising from decommissioning activities will be conditioned using only "RAW Treatment and Conditioning Facilities" in Jaslovské Bohunice. RAW will be conditioned into a packaged form. The package used exclusively at the present time is a fibre-concrete container (FCC) reinforced with steel fibres with an internal volume of 3.1 m^3 which is used to dispose of conditioned RAW in the NSR in Mochovce.

II.8.6.4 Storage and disposal of RAW packaged forms after conditioning

An Interim RAW Storage Facility for the decommissioning RAW will be built at the SE VYZ site around the area of pool no. 1 of building 38 (it is currently in the phase of design preparation after a successful EIA process). It is assumed that it will be used for the long-term storage of packaged RAW which cannot be disposed of at the Near Surface Repository in Mochovce, i.e. RAW that will have to be disposed of in another type of repository (a deep repository). If necessary, this storage facility will also be used as a buffer storage for packaged RAW awaiting shipment to the NSR in Mochovce.

II.8.6.5 Non-radioactive decommissioning waste management

Non-radioactive waste from decommissioning will be managed according to the Act on Waste and related regulations. There are no plans to establish new dump sites for non-radioactive decommissioning waste releasable into the environment with regard to its level of contamination. For a temporary waste storage before its further management, the buffer storage/gathering places on the site will be operatively prepared and utilised.

II.9 TOTAL COSTS

The total costs for individual alternatives of the proposed activity are presented in the following table:

Table A-2: Total costs for individual V1 NPP decommissioning alternatives

Alternative of the proposed activity	*Costs* [SKK mill.]*
Alternative 1 (IDO)	17 624.48
Alternative 2 (SES)	15 809.93
Alternative 3 (RSE)	15 435.07
Zero Alternative	90.00 per year

*In the case of Zero alternative the annual costs necessary for operation (energy and media), barrier integrity control, radiation protection, maintenance and work are given.

II.10 LIST OF AFFECTED MUNICIPALITIES

The possible impacts of the proposed activities on natural and anthropogenic components of the environment and the population will be evaluated in the affected area, which represents the first threatened zone, i.e. an area around the power plant within a 5 km radius (figure A-10). In case of social and economic impacts, a broader area will be assessed.

The affected area comprises of 8 villages:

- Jaslovské Bohunice, Malženice and Radošovce belonging to the district of Trnava;
- Žlkovce and Ratkovce belonging to the district of Hlohovec;
- Veľké Kostoľany, Nižná and Pečeňady belonging to the district of Piešťany.

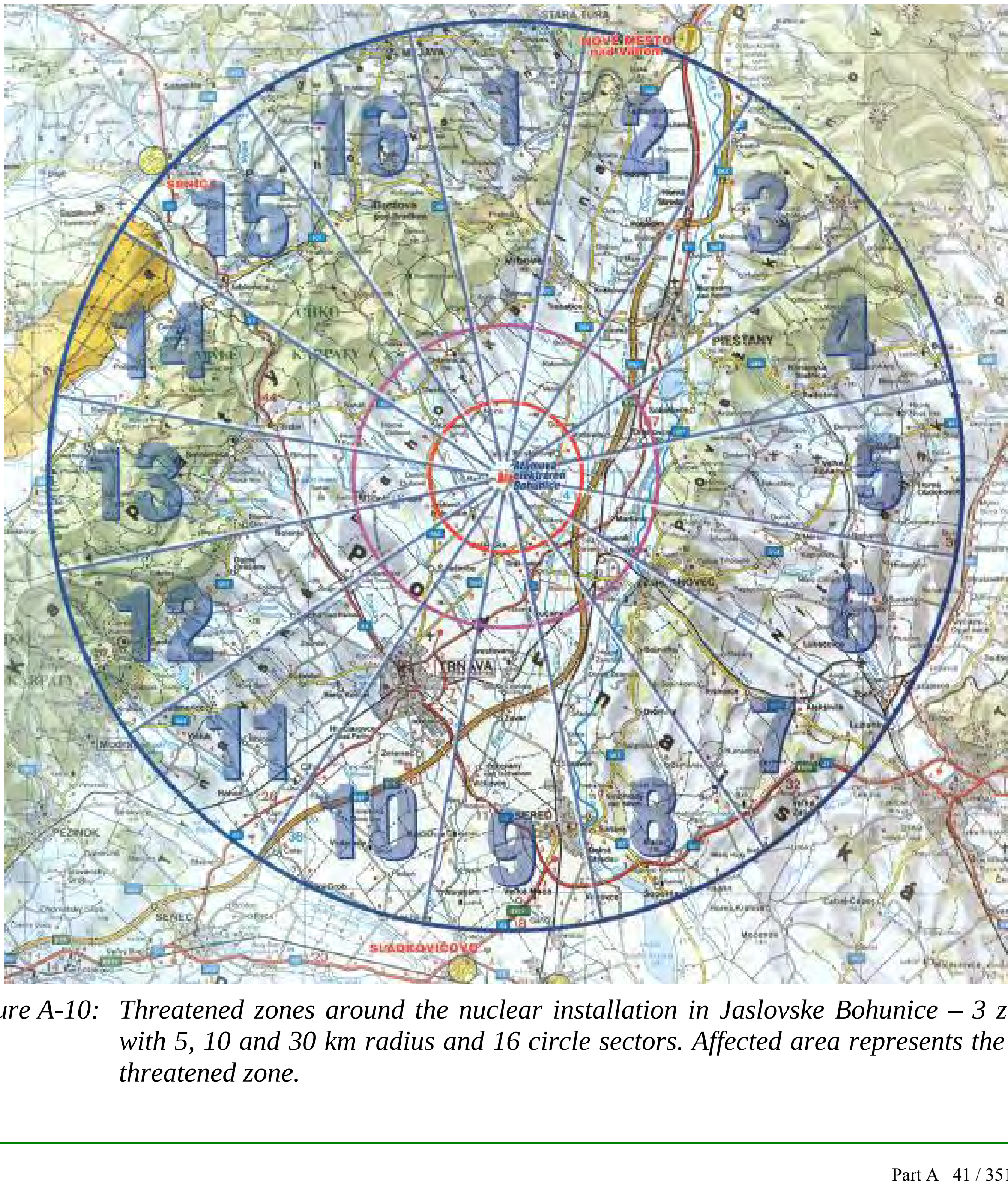


Figure A-10: Threatened zones around the nuclear installation in Jaslovske Bohunice – 3 zones with 5, 10 and 30 km radius and 16 circle sectors. Affected area represents the first threatened zone.

II.11 AFFECTED AUTHORITIES

The affected authorities are **especially**:

Regional Office of the Environment Trnava
Kollarova 8
917 77 Trnava

District Office of the Environment in Trnava
Kollarova 8
917 77 Trnava

Ministry of Health of the Slovak Republic
Chief Hygienist of the Slovak Republic
Trnavska 52
826 45 Bratislava

Ministry of Environment of the Slovak Republic
Environmental Risk Management Section
Namestie Ludovita Stura 1
812 35 Bratislava

Ministry of Environment of the Slovak Republic
Water Protection Department
Namestie Ludovita Stura 1
812 35 Bratislava

Ministry of Environment of the Slovak Republic
Geology and Natural Resources Department
Namestie Ludovita Stura 1
812 35 Bratislava

National Labour Inspectorate
Spitalska 8
815 07 Bratislava

Regional Office of Public Health
Limbova 6
917 09 Trnava

Regional Directorate of Fire and Rescue Service
Vajanskeho 22
917 77 Trnava

Regional Office of Civil Defense of the Ministry of Interior of the SR in Trnava
Kollarova 8
917 01 Trnava

II.12 AUTHORISATION AUTHORITY

Nuclear Regulatory Authority of the Slovak Republic[3]
Bajkalska 27
P.O.Box 24
82007 Bratislava

and/or
Okruzna 5
918 64 Trnava

II.13 STANDPOINT ON TRANSBOUNDARY IMPACTS IN THE INTENTION

The contribution of V1 NPP decommissioning to radiological impacts (leakages and radiation) is negligible in comparison with common or emergency radiological impacts of NPP units, TSU RAO or ISFS installed at the NEC Bohunice site. No significant impacts (if they are relevant at all) are expected in any of the stages of any of the decommissioning alternatives that would have transboundary effects with regard to the distance of the affected area from state boundaries (*figure A-11*). All impacts of radiation character will be restricted to the site of the decommissioned power plant, some non-radiological impacts will mainly influence the affected municipalities and socio-economic impacts will affect broader area (districts of Trnava, Piešťany and Hlohovec).

[3] According to the provisions of the new Act No. 541/2004 (the Atomic Act) the Nuclear Regulatory Authority fulfills the role of the civil constructions office for constructions of nuclear facilities, so its role in the EIA process is changing from the affected to the authorisation authority. The new Act came into force recently: on December 1st, 2004.

Figure A-11: Distance of GovCo (JAVYS) and SE EBO from state boundaries

PART B

I. REQUIREMENTS FOR INPUTS

I.1 LAND

I.1.1 Total land requirement

According to the listing from the land registry in 1992, the area of the common site of GovCo (JAVYS) and SE EBO in Jaslovské Bohunice is the property of SE, a.s. Bratislava and GovCo (JAVYS) and its size is 121.4 ha. The common site is divided into the site administered by GovCo (JAVYS) and the site administered by SE EBO.

All activities in the alternatives for V1 NPP decommissioning are limited to the NEC Bohunice and the taking of no additional land is assumed.

I.1.2 Protected areas, natural beauties and monuments

No protected areas, natural beauties and monuments are located on the territory of the proposed activity. Detailed information on protected areas, natural beauties and monuments in the potentially affected area is presented in Part C, Chapter II.3.11.

I.1.3 Protected zones

The site, in which the nuclear installations in Jaslovské Bohunice are located, neither belongs to, nor overlaps with any protected zone. The whole site of the nuclear installations of GovCo (JAVYS) and SE EBO as well as the areas of ISFSF and HVB of V1 and V2 NPPs are fenced-in and protected by a special system of physical protection – AKOBOJE. Threatened zones are described in a greater detail in Part C, Chapter 1.

I.2 WATER

I.2.1 Potable water

The NEC Bohunice site is supplied with potable water from two branches of the distribution line of TaVoS, a.s. Piešťany from the water sources with area protection integrated in the declared zones of hygienic protection, i.e.: zone of hygienic protection of 2nd degree, water source Piešťany – Veľké Orvište, $Q_v = 460\ dm^3.s^{-1}$ and zone of hygienic protection of 2nd degree, water source Dobrá Voda, Dechtice, $Q_v = 60\ dm^3.s^{-1}$. Water from the group water piping supplies water reservoirs at A1 NPP, V1 and V2 NPPs (2 x 250 dm^3 at each NPP) at NEC Bohunice site. The route from Dobrá Voda serves as a reserve route for a potable water inlet.

Except it, four wells designated as HB1 to HB4, are situated between the village of Jaslovské Bohunice and NEC Bohunice site; they serve for supplying the A1 NPP with well water. Both the water pipings and inlets from the wells are inter-connected.

In 2005, the supply of potable water from TaVoS Piešťany was 284 692 m^3. The supply of potable well water from former SE VYZ ground water sources did not take place in 2005.

The demand for potable water had a decreasing trend in previous years, but a higher demand has been registered in the last two years (table B-1).

Table B-1: Trends of potable water consumption [m^3] at the NEC Bohunice site in 2001 −2005 period.

	TAVOS, a.s. Piešťany	*SE VYZ wells*	*Potable water in total*
2001	265 470	11 183	276 653
2002	264 740	6 181	270 921
2003	243 238	–	243 238
2004	255 960	–	255 960
2005	284 692	–	284 692

Source: Environmental Report of SE EBO and SE EBO V1 NPP for the year 2005.

I.2.2 Cooling water

The industrial cooling water for the cooling circuits is supplied from the Sĺňava water dam. The actual supply was 41 244 000 m^3 in 2005, from which the former SE VYZ consumed 874 004 m^3.

I.2.3 Water source, location of intake installation

In the submitted alternatives, the same sources of surface and ground water are used as in the Zero alternative. The performance of activities in the alternatives will not require new water sources.

I.2.4 Water consumers

The following planned decommissioning activities are taken into account for the estimation of water consumption for individual decommissioning alternatives:

Drinking water consumption consists of water consumption for personal hygiene (water in the personnel hatches in the controlled area and water in classic sanitary facilities outside the controlled area).

Service water is used for the cooling of technological equipment and in heat exchangers.

Demineralised water is used for the decontamination (pre-dismantling and post-dismantling decontamination and decontamination of building surfaces).

RAW treatment and conditioning will take place in TSÚ RAO (BSC and other facilities). In spite of existing inter-connections, these facilities will work in an autonomous manner and they will treat and condition waste from all installations in Jaslovské Bohunice.

I.3 OTHER RAW MATERIAL AND ENERGY SOURCES

I.3.1 Type and requirements

Table B-3 contains the requirements for raw materials and energy for the individual V1 NPP decommissioning alternatives according to PSL item groups, which are presented in table B-2 together with a numeral identification (only the identification number will be used in further descriptions). The following activities in particular contribute to this consumption:

- the decontamination of contaminated equipment and building surfaces,
- the dismantling of technological equipment in contaminated and non-contaminated buildings,
- the demolition of buildings,
- waste management.

Table B-2: PSL item groups and numbers of PSL item groups

Number of PSL item group	*PSL item group*
01	Decommissioning preparation
02	Operation shutdown
03	Provision of equipment and materials
04	Dismantling
05	Treatment, storage and disposal of RAW
06	Protection, surveillance and maintenance of the site
07	Demolition, restoration and landscaping of the site
08	Project management, engineering support
09	Research and development
10	Fuel and nuclear materials
11	Other costs

Table B-3: Proportion of PSL item groups of type and consumption of raw materials and energy for individual alternatives

PSL item group no.	*Electricity*	*Demi water*	*Steam*	*Oil*	*Bitumen*	*Cement*	*Com-pressed air*	*Oxygen*	*Acetylene*
	[kWh]	*[m^3]*	*[t]*	*[t]*	*[t]*	*[t]*	*[Nm^3]*	*[Nm^3]*	*[Nm^3]*
Alternative 1									
01	0	0	0	0	0	0	0	0	0
02	72 800	800	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0	0
04	1 774 356	16 175	1 142	7	0	0	167 578	245 472	15 185
05	674 297	2 757	40 385	497	293	1 639	100 234	74 497	4 966
06	0	0	0	0	0	0	0	0	0
07	155 332 631	0	0	1 100	0	0	49 553	679 825	43 509
08	0	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0	0

10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
Total	**157 854 084**	**19 732**	**41 527**	**1 604**	**293**	**1 639**	**317 364**	**999 795**	**63 660**
Alternative 2									
01	0	0	0	0	0	0	0	0	0
02	72 800	800	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0	0
04	1 449 666	14 255	1 089	7	0	0	167 578	245 985	15 218
05	602 320	2 736	35 913	371	270	1 421	72 388	66 848	4 457
06	0	0	0	0	0	0	0	0	0
07	59 788 447	0	0	906	0	0	73 168	970 575	62 117
08	0	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
Total	**61 913 233**	**17 791**	**37 002**	**1 284**	**270**	**1 421**	**313 134**	**1 283 408**	**81 791**
Alternative 3									
01	0	0	0	0	0	0	0	0	0
02	72 800	800	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0	0
04	1 773 976	16 185	1 143	7	0	0	167 881	246 010	15 220
05	684 111	2 752	39 488	377	293	1 637	100 154	81 541	5 436
06	0	0	0	0	0	0	0	0	0
07	59 789 197	0	0	907	0	0	73 168	970 575	62 117
08	0	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
Total	**62 320 084**	**19 738**	**40 630**	**1 290**	**293**	**1 637**	**341 203**	**1 298 126**	**82 772**

Titles of PSL item groups are given in table B-2. Source: CDP.

I.3.2 Provision of the energy and raw materials

The supply of energies (electricity, demineralised water and steam) will be provided from SE EBO sources. Other raw materials will be ordered at selected suppliers.

I.4 REQUIREMENTS FOR SHIPMENT AND OTHER INFRASTRUCTURES

The implementation of the proposed activity does not require any special infrastructure supplementation resulting from the performance of work in the context of the alternatives submitted. The existing infrastructure will be used. However, the expected amounts of raw materials and waste for shipment will require the reconstruction of access roads in addition to their usual maintenance, so that they can bear the anticipated loads. Shipment activity, which will be necessary in the frame of submitted alternatives, will be ensured by own means and by supplier means respectively.

The shipment infrastructure of the affected and broader areas is described in a greater detail in Part C, Chapter II.3.

I.4.1 Material shipment

The final activity of the waste management during the NPP decommissioning is the shipment of conditioned contaminated or non-contaminated waste:

- To a conventional/industrial waste dump – only uncontaminated waste, which cannot be used as a secondary raw material, will be thus shipped,
- To the salvage – only uncontaminated waste, which can be used as a secondary raw material,
- Hazardous waste will be separated in the course of decommissioning and it will be directly shipped to specialised treatment organisations, where it will be handled in accordance with the valid regulations,
- To the near-surface repository – radioactive waste, which is conditioned to the final form in FCC,
- To the VLLW disposal facility – non-metallic VLLW,
- To the interim RAW storage facility – conditioned radioactive waste in FCC which is unacceptable for near-surface repository Mochovce and very low level metallic waste in ISO containers for decreasing the activity by spontaneous natural decay of radionuclides.

I.4.1.1 Shipment of materials to waste dumps

Shipments to waste dumps will be carried out with trucks of 10 t loading capacity. The distance to the waste dump from V1 NPP is approximately 15 km.

I.4.1.2 Shipment of materials to the salvage

The shipment of metallic raw materials will be carried out directly to the exploiting company using a railway wagon of 25 t or 50 t loading capacity in order to avoid repeated loading and unloading of big amounts of a material. The distance to the exploiting company is approximately 200 km. However, the shipment by trucks to companies nearer to the decommissioning site is not excluded.

I.4.1.3 Shipment of radioactive waste to NSR Mochovce and VLLW Repository

Treated and packaged intermediate and low level RAW conditioned in FCC will be shipped to the NSR. Very low level non-metallic waste will be shipped to the VLLW repository, which is intended to be built on the site or nearby the RÚ RAO (contingently at another officially approved place according to the results of BIDSF project C9-1). The shipment will be carried out using a combination of railway and truck. The distance of railway shipment to NSR is approximately 74 km plus the truck shipment about 4 km.

I.4.1.4 Shipment of radioactive waste to the Interim RAW Storage Facility

Radioactive waste determined for shipment to and storage in the interim RAW storage facility at the GovCo (JAVYS) site will be inserted into a container.This shipment will be carried out using a vehicle with semi-trailer up to 30 t loading capacity or by special vehicles for ISO and FCC containers. These vehicles are or they will be classified as officially approved means of shipment.

I.4.1.5 Shipment of materials to V1 NPP on-site Buffer Storage/gathering places

Non-radioactive building materials will be shipped before their further management by trucks to the interim buffer storage/gathering places established on V1 NPP site during the decommissioning period.

I.5 LABOUR REQUIREMENTS

Anticipated labour requirements issue from individual expected activities and their time sequence in the context of a given decommissioning alternative and from the labour requirements for each individual activity. Table B-3 contains data on labour and the collective effective doses for individual activities of submitted V1 NPP decommissioning alternatives.

Table B-4: Main parameters for individual decommissioning alternatives

Item	Alternative 1		Alternative 2		Alternative 3	
	Labour [10^3 hours]	CED [manSv]	Labour [10^3 hours]	CED [manSv]	Labour [10^3 hours]	CED [manSv]
Preparatory activities	1 233.0	0.0141	1 233.0	0.0141	1 198.7	0.0094
Procurement of equipment and asset recovery	60.1		60.1		61.1	
Decommissioning management and support	4 424.0	1.4984	4 550.1	1.4697	4 553.7	1.4956
Operation termination	287.2	0.9776	287.2	0.9776	287.2	0.9776
Primary circuit decontamination	6.5	0.1922	6.5	0.1922	6.5	0.1922
Total	6010.80	2.6823	6010.80	2.6823	6107.20	2.6748
STAGE I						
Pre-dismantling decontamination					78.3	1.3420
Dismantling	740.7		1283.5		2 275.9	3.2031
Post-dismantling decontamination					533.1	4.1302
Decontamination of buildings					323.8	0.5470
Demolition	681.6		717.3		2 293.6	
RAW management	6.5	0.0317	18.7	0.0423	261.7	1.0923
Non-RAW management	99.4		134.0		234.1	
Site restoration and landscaping	34.7		34.7		110.9	
RSE preparation			163.4	0.0408	96.7	0.0484
Stage I total	1562.9	0.0317	2351.6	0.0831	6208.1	10.363
STAGE II						
Pre-dismantling decontamination	78.3	1.3420				
Demolition	1233.4	3.9031				
Post-dismantling decontamination	535.2	4.1945				
Decontamination of buildings	328.0	0.5964				

Item	*Alternative 1*		*Alternative 2*		*Alternative 3*	
	Labour [10³ hours]	*CED [manSv]*	*Labour [10³ hours]*	*CED [manSv]*	*Labour [10³ hours]*	*CED [manSv]*
Demolition	4719.9					
RAW management	271.2	1.276				
Non-RAW management	182.7					
Site restoration and landscaping	104.0					
RSE and its keeping			999.1	0.0075	181.7	0.0019
Preparatory activities III			216.1	0.0014	158.1	0.0024
Stage II total	7452.7	11.312	1215.2	0.0089	339.8	0.0043
STAGE III						
Pre-dismantling decontamination			51.9	0.4268		
Demolition			1073.7	0.2309	81.1	0.0483
Post-dismantling decontamination			508.0	3.8302	10.4	0.0003
Decontamination of buildings			156.4	0.0220	4.2	0.0494
Demolition			1662.4		86.5	0.0000
RAW management			191.9	0.9179	22.9	0.0933
Non-RAW management			105.6		3.1	0.0000
Site restoration, landscaping and release			104.0		27.7	0.0000
Stage III total	0	0	3853.9	5.4278	235.9	0.1913
Total	**15 026.492**	**13.8778**	**13 498.389**	**8.1734**	**12 891.113**	**13.2333**

Source: CDP

I.6 BUILT-UP AREA REQUIREMENTS

No alternatives for the proposed activity will lead to any changes in the existing built-up area of the Jaslovské Bohunice site of nuclear installations.

The common site of GovCo (JAVYS) and SE EBO in Jaslovské Bohunice is divided into the part administered by GovCo (JAVYS) and and the part administered by SE EBO. The site consists of built-up area (buildings), concrete surfaces (roads, pavements, parking lots) and grass areas. Activities in the submitted alternatives are limited only to the site administered by GovCo (JAVYS) and SE EBO. The implementation of the proposed activity can result in changes to the proportions of the given areas, but the activity will not require the enlargement of the existing common site of GovCo (JAVYS) and SE EBO (see Part A, figure A-3).

I.7 LIST OF V1 NPP CIVIL CONSTRUCTIONS AND BUILDINGS TO BE DECOMMISSIONED

The list of V1 NPP civil constructions and buildings to be decommissioned differs depending on the particular alternatives. For alternative 1 this list is given by reusing the released V1 NPP site for a new nuclear power plant *(V1 NPP Redevelopment, 2004)*. This list is based on the possibility of preserving a higher number of CBs for the purpose of erecting a new nuclear power plant. For alternatives 2 and 3, the list of civil constructions and buildings not to be decommissioned and to be decommissioned is identical and it is based, in principle on the list in *V1 NPP Conceptual Decommissioning Plan (2006)*, in which the list of civil constructions and buildings to be decommissioned and not to be decommissioned for particular alternatives was accepted by the Client.

I.7.1 List of V1 NPP civil constructions and buildings for Alternative 1

The set of V1 NPP civil structures is defined by SE EBO directive No. PM-01 from 01.06.2000. From this set of V1 NPP civil structures, those civil structures covering the needs of the entire NEC Bohunice site and civil structures, which can be further used, have been selected. These structures will be preserved in alternative 1 and they will not be decommissioned. The list of non-decommissioned or partially decommissioned CBs for alternative 1 is given in table B-5.

Table B-5: Civil structures, which will not be decommissioned and which will be partially decommissioned for alternative 1

CB number	*CB name*	*Extent of decommissioning*
321	Fence of industrial waste waters disposal area	-
340	External lighting	-
341	External lighting of waste waters disposal area	-
351	Lighting trenches and channels, including cabling	50%
352+MSVP	Low voltage trenches and channels, including cabling	50%
360	Rain sewerage	50%
P360	Final sewage collector from V1 NPP into SOCOMAN	-
361	Sewage drainage	50%
362	Industrial drainage	50%
364a,b,c	Sump and sewage waters purification plant- BIOCLAR, pumping station, sludge fields	-
367	Drainage channels	-
368	Waste water activity measurement station	-
370	Drinking water inlet line	-
371	Drinking water piping	50%
372	Fire fighting and service water piping	50 %
377	Drinking water pumping station and water reservoirs	-
400	Piping trenches	-
400a	Raw water piping Ø 1200 A1 NPP - V1 NPP	-
401	Essential service water channels	50 %
441	Reserve boiler house	-
442	Boiler house chimney	-
510	Foundations for transformers, including oil tank	-
522	External switching station 220 kV, 110 kV	-
523a	House of relay protections.	-
523b	Compressor plant of switching station	-
526	Safety fence of switching station	-
527	110 kV switching station	-
527a	House of relay protections 110 kV	-
530,530A	Diesel generator station with additional building DG 5	-
531	Fuel oil system	-
532	Compressor station and central cooling station	-
560	Building for discharging of chemicals	-

CB number	*CB name*	*Extent of decommissioning*
561	Heating oil tanks	-
562	Heating oil machine room	-
563	Channel for heating oil piping	-
571	Fence of Pečeňady pumping station	-
573	Pumping and filtering station Pečeňady	-
574	Inlet channel Ø 1400 from Dudváh river	-
575	Traffic roads at Pečeňady pumping and filtering station	-
578	Discharge line Ø 800 Pečeňady - V1 NPP	-
579	Structures in the path of Pečeňady discharge line - V1 NPP	-
580/a	Essential service water cooling towers - Unit 1	-
580/b	Essential service water cooling towers - Unit 2	-
581	Cooling towers, No. 1 to 4	-
582	Channels for cooling water piping	50 %
583	Cooling water pumping station	-
583/1	Pumping station for emptying cooling water piping	-
583a	Blow down of circulating circuit	-
585/a	Essential service water pumping station - Unit 1	-
585/b	Essential service water pumping station - Unit 2	-
590	Chemical water treatment	-
590a	Demineralised water tanks	-
590B	Building of emergency feed water pumps	-
590b	Building of demineralised water tanks	-
590c	H_2SO_4 dosing station at V1 NPP	-
621	Lub-oil system	-
631a, 780	Administration building and civil defence shelter	-
631b,c	Dining room and gate	-
633	Civil structures maintenance	-
640	Workshops and storehouses of electrical and connecting material	-
641	Storehouses of metallic material, spare parts and valves	-
653	Fire fighting station	-
656	Unloading ramp	-
660	Outside railway siding	-
663	Securing and announcing devices at outside railways siding	-
670	Internal railway siding, including all tracks	-
680	External traffic roads under SE EBO administration	-
682	Parking lot, bus platform	-
683	Road connection of industrial waste water disposal	-
690	Internal roads, including courts and courtyards	-
701	Garages	-
703	Diesel oil and petrol station	-
713	Transformer station	-
722	REKO V1 - site establishing (building used for V1 NPP reconstruction)	-
792	Fire fighting equipment of buildings	-
880	Building for activity measurement of waste waters	-
881	Intermediate spent fuel storage - Probes for monitoring common waters	-
900a,b,c,e,E	Waste industrial water disposal	-
920	110 kV line Madunice - V1 NPP	-
921	110 kV line Malženice - V1 NPP	-
922	220 kV line A1 NPP - V1 NPP	-

CB number	CB name	Extent of decommissioning
924	Extension of 110 kV switching station HC Madunice	-
940	AKOBOJE civil structures	-
942	V1 NPP guard-room 1	-

Source: CDP

Other civil structures specified in the above mentioned SE EBO directive, are to be disabled and decommissioned. For the purpose of this assessment report, they are divided into two groups in an analogical manner as in the *Conceptual V1 NPP Decommissioning Plan*, depending on the fact whether they are contaminated or not:

- radioactive structures containing activated or contaminated equipment,
- non-radioactive civil structures.

The overview of civil structures of V1 NPP, to be decommissioned or to be partially decommissioned for alternative 1, is presented in table B-6.

Table B-6: V1 NPP civil structures to be decommissioned or to be partially decommissioned for alternative 1

CB number	CB name	Extent of decommissioning
	Contaminated CBs	
460	Ventilation stack	100%
800	Reactor building	100%
801,801a	Nuclear auxiliary building, including extension, additional building and penthouse	100%
803, 781	Operating building and civil defence shelter	100%
804, 461	Interconnecting bridge between buildings 800 and 801, air duct to the ventilation stack	100%
	Non-contaminated CBs	
350+MSVP	Trenches and channels for power cables	100%
351	Lighting trenches and channels, including cabling	50%
352+MSVP	Low voltage trenches and channels, including cabling	50%
353+MSVP	Grounding trenches	100%
360	Rain sewerage	50%
361	Sewage drainage	50%
362	Industrial drainage	50%
371	Drinking water piping	50%
372	Fire fighting and service water piping	50%
401	Essential service water channels	50%
401/M/1	Clean piping channel, turbine hall - interim spent fuel storage	100%
490, 491	Turbine hall and turbogenerator foundations	100%
533/1	Cooling station for emergency ventilation system - Unit 1	100%
533/2	Cooling station for emergency ventilation system - Unit 2	100%
573-2	Water reservoirs of washing water at Pečeňady pumping and filtering station	100%
573-3/1	Discharge line for washing water reservoirs	100%
573-3/2	Waste from washing water reservoirs	100%

CB number	*CB name*	*Extent of decommissioning*
582	Channels for cooling water piping	50%
589	Aboveground essential service water collector	100%
644	Hydrogen storage	100%
645	Nitrogen storage	100%
646	Hydrochloric acid dosing of V1 NPP	100%
800a	Cross side electrical building - Unit 1	100%
800b	Longwise side electrical building - Unit 1	100%
800c	Longwise side electrical building - Unit 2	100%
800d	Cross side electrical building - Unit 2	100%
802	Clean condensate tanks	100%

Source: CDP

I.7.2 List of V1 NPP civil constructions and buildings for Alternatives 2 and 3

From the set of V1 NPP civil structures defined by SE EBO directive No. PM-01, the civil structures covering the needs of the entire NEC Bohunice site have also been selected to be preserved after V1 NPP decommissioning in alternatives 2 and 3 and upon agreement with the Client they will not be decommissioned. The CBs, which will not be decommissioned and which will be partially decommissioned for alternatives 2 and 3 are listed in the table B-7.

Table B-7: V1 NPP civil structures not to be decommissioned or to be partially decommissioned for alternatives 2 and 3

CB number	*CB name*	*Extent of decommissioning*
321	Fence for industrial waste waters disposal area	-
341	External lighting of waste waters disposal area	-
351	Lighting trenches and channels, including cabling	50 %
352+MSVP	Low voltage trenches and channels, including cabling	50 %
353+MSVP	Grounding trenches	50 %
360	Rain sewerage	50%
P360	Final sewage collector from V1 NPP into SOCOMAN	-
361	Sewage drainage	50%
362	Industrial drainage	50%
364a,b,c	Sump and sewage waters purification plant – BIOCLAR, pumping station, sludge fields	-
367	Drainage channels	-
368	Station for waste water activity measurement	-
370	Drinking water inlet line	-
371	Drinking water piping	50%
372	Fire fighting and service water piping	50%
377	Drinking water pumping station and water reservoirs	-
400	Piping trenches	50%
400a	Raw water piping Ø 1200 A1 NPP – V1 NPP	-
441	Reserve boiler house	-
442	Boiler house chimney	-
560	Chemicals discharging building	-
561	Heating oil tanks	-

CB number	CB name	Extent of decommissioning
562	Heating oil machine room	-
563	Channel for heating oil piping	-
571	Fence for Pečeňady pumping station	-
574	Inlet channel Ø 1400 from Dudváh river	-
575	Traffic roads at Pečeňady pumping and filtering station	-
581	Cooling towers No. 2 and 4	-
633	Civil structures maintenance	-
640	Workshops and storehouses for electrical and connecting material	-
641	Storehouses for metallic material, spare parts and valves	-
653	Fire fighting station	-
656	Unloading ramp	-
660	Outside railway siding	-
663	Securing and announcing devices at outside railways siding	-
670	Internal railway siding, including all tracks	50%
680	External traffic roads under SE EBO administration	-
682	Parking lot, bus platform	-
683	Road connection of industrial waste water disposal	-
690	Internal roads, including courts and courtyards	50%
701	Garages	-
703	Diesel oil and petrol station	-
713	Transformer station	-
792	Fire fighting equipment of buildings	-
880	Building for waste waters activity measurement	-
881	Intermediate spent fuel storage - Probes for monitoring common waters	-
900a,b,c,e,E	Waste industrial water disposal	-
920	110 kV line Madunice - V1 NPP	-
921	110 kV line Malženice - V1 NPP	-
924	Extension of 110 kV switching station HC Madunice	-
940	AKOBOJE civil structures	50%
942	V1 NPP guard-room 1	-

Source: CDP

Other civil structures specified in the above mentioned SE EBO directive, are to be disabled and decommissioned. The list of V1 NPP civil structures to be decommissioned or to be partially decommissioned for alternatives 2 and 3 is given in table B-8.

Table B-8: V1 NPP civil structures to be decommissioned or to be partially decommissioned for alternatives 2 and 3

CB number	CB name	Extent of decommissioning
	Contaminated CBs	
460	Ventilation stack	100%
800	Reactor building	100%
801, 801a	Nuclear auxiliary building, including extension, additional building and penthouse	100%
803, 781	Operating building, civil defence shelter	100%
804, 461	Interconnecting bridge between buildings 800 and 801, air duct to the	100%

CB number	*CB name*	*Extent of decommissioning*
	ventilation stack	
	Non-contaminated CBs	
340	External lighting	100%
350+MSVP	Power cables trenches and channels	100%
351	Lighting trenches and channels, including cabling	50%
352+MSVP	Low voltage trenches and channels, including cabling	50%
353+MSVP	Grounding trenches	50%
360	Rain sewerage	50%
361	Sewage drainage	50%
362	Industrial drainage	50%
371	Drinking water piping	50%
372	Fire fighting and service water piping	50%
400	Piping trenches	50%
401	Essential service water channels	100%
401/M/1	Clean piping channel, turbine hall - interim spent fuel storage	100%
490,491	Turbine hall and turbogenerator foundations	100%
510	Foundations of transformers, including oil tank	100%
522	External switching station 220 kV, 110 kV	100%
523a	House for relay protections.	100%
523b	Compressor plant for switching station	100%
526	Safety fence of switching station	100%
527	110 kV switching station	100%
527a	House for relay protections 110 kV	100%
530,530A	Diesel generator station with additional building DG 5	100%
531	Fuel oil system	100%
532	Compressor station and central cooling station	100%
533/1	Cooling station for emergency ventilation system - Unit 1	100%
533/2	Cooling station for emergency ventilation system - Unit 2	100%
573	Pumping and filtering station Pečeňady	100%
573-2	Water reservoirs of washing water at Pečeňady pumping and filtering station	100%
573-3/1	Discharge line for washing water reservoirs	100%
573-3/2	Waste from washing water reservoirs	100%
578	Discharge line Ø 800 Pečeňady - V1 NPP	100%
579	Structures in the path of Pečeňady discharge line - V1 NPP	100%
580/a	Essential service water cooling towers - Unit 1	100%
580/b	Essential service water cooling towers - Unit 2	100%
581	Cooling towers No. 1 and 3	100%
582	Channels for cooling water piping	100%
583	Cooling water pumping station	100%
583/1	Pumping station for emptying cooling water piping	100%
583a	Blow down of circulating circuit	100%
585/a	Essential service water pumping station - Unit 1	100%
585/b	Essential service water pumping station - Unit 2	100%
589	Aboveground essential service water collector	100%
590	Chemical water treatment	100%
590a	Demineralised water tanks	100%
590b	Building for emergency feed water pumps	100%
590B	Building for demineralised water tanks	100%
590c	H_2SO_4 dosing station at V1 NPP	100%
621	Lub-oil system	100%

CB number	CB name	Extent of decommissioning
631a,780	Administration building and civil defence shelter	100%
631b,c	Dining room and gate	100%
644	Hydrogen storage	100%
645	Nitrogen storage	100%
646	Hydrochloric acid dosing of V1 NPP	100%
670	Internal railway siding, including all tracks	50%
690	Internal roads, including courts and courtyards	50%
722	REKO V1 - site establishing (building used for V1 NPP reconstruction)	100%
800a	Cross side electrical building - Unit 1	100%
800b	Longwise side electrical building - Unit 1	100%
800c	Longwise side electrical building - Unit 2	100%
800d	Cross side electrical building - Unit 2	100%
802	Clean condensate tanks	100%
922	220 kV line A1 NPP - V1 NPP	100%
940	AKOBOJE civil structures	50%

Source: CDP

II. DATA ON OUTPUTS

II.1 ATMOSPHERE

II.1.1 Main point sources of atmospheric pollution in GovCo (JAVYS) site

The main point sources of atmospheric pollution are the ventilation stacks. The following ventilation stacks are located on the V1 NPP site:

- The main ventilation stack (building 460), to which the HVAC systems of buildings 800, 801, 803, 804 via 461 lead;
- Three ventilation stacks from a new gas boiler plant.

HVAC systems in the V1 NPP buildings are designed in such a way that air exhausted from the rooms of V1 NPP buildings is directed from the areas with lower possible surface contamination (corridors and stairways) to the areas with higher possible surface contamination (compartments). In this way, the spreading of contamination by air is prevented. Exhausted air passes through high efficiency particulate air filters (the filtration decreases the level of discharged radioactive aerosols up to 10 000-fold) to the ventilation stack, where it is continually monitored (activity monitoring of alpha, beta and gamma aerosols) and it is discharged to the higher parts of the atmosphere in an organised manner.

The other point sources of atmospheric pollution in GovCo (JAVYS) site are:

- The A1 NPP ventilation stack,
- The BSC ventilation stack,
- The ISFSF ventilation stack,
- The ventilation stack of building No. 44/10.

The minimisation of the impact of gaseous discharges on the environment is achieved by the implementation of the limitation principle, i.e. the adherence to the authorised limit values of gaseous discharges results in no exceeding of the limit of exposure for an individual from the critical population group. The determination of limit values is based on the calculation of personal exposure when considering all probable ways of exposure.

The annual limit values for gaseous discharges from GovCo (JAVYS) and SE EBO into the atmosphere, as determined by the Decree No. HH SR/3380-1/2003/SOŽP of the Public Health Authority of the Slovak Republic, Office of Health Protection Against Radiation, are presented in table B-9.

Table B-9: Limits of annual gaseous discharges of radioactive substances from GovCo (JAVYS) and SE EBO.

Noble gases arbitrary mixture	*^{131}I radioisotope (in gaseous and aerosol form)*	*Mixture of radionuclides with a long half-time in aerosols*	*Mixture of ^{89}Sr and ^{90}Sr in aerosols*	*Mixture of radionuclides emitting α-radiation (^{238}Pu, $^{239+240}$Pu and ^{241}Am)*
[Bq.year^{-1}]	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**
4.0×10^{15}	1.3×10^{11}	1.6×10^{11}	3.0×10^{8}	5.0×10^{7}

Source: Decree No. HH SR/3380-1/2003/SOŽP

The annual limit values for gaseous discharges from V1 NPP into the atmosphere, as determined by Decree No. SOZPŽ/2401/2006 of the Public Health Authority of the Slovak Republic, Office of Health Protection Against Radiation, are presented in table B-10.

Table B-10: Limits of annual gaseous discharges of radioactive substances from V1 NPP.

Noble gases arbitrary mixture	*^{131}I radioisotope (in gaseous and aerosol form)*	*Mixture of radionuclides with a long half-time in aerosols*	*Mixture of ^{89}Sr and ^{90}Sr in aerosols*	*Mixture of radionuclides emitting α-radiation (^{238}Pu, $^{239+240}$Pu and ^{241}Am)*
[Bq.year^{1}]	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**	**[Bq.year^{-1}]**
2.0×10^{15}	6.5×10^{10}	8×10^{10}	1.4×10^{8}	2.0×10^{7}

Source: Decree No. SOZPŽ/2401/2006

On the basis of the balance of gaseous discharges in 1999 – 2005 presented in summarised annual reports on nuclear safety and impact of the NEC Bohunice on the environment (table B-11), it can be stated that the values in the individual years are significantly below the limit values (0.07 – 20 % of authorised limit).

Table B-11: Discharges of radioactive substances from V1 NPP into the atmosphere in 1999 – 2005 period

Year	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Noble gases [TBq]	8.750	9.290	15.406	22.759	8.674	31.305	8.350
Gamma aerosols[MBq]	218.550	702.130	175.652	130.309	149.342	112.929	194.269
^{131}I radionuclide[MBq]	80.730	673.180	658.266	2516.654	270.838	3675.742	347.450

Source: Radiation protection at SE EBO and SE VYZ and impact of SE EBO and SE VYZ sites on the environment, 2001 –2005 period.

SE EBO operated the following sources of non-radioactive air pollution in 2005:

- V1 NPP start-up and back-up boiler plant – big source of air pollution,
- Gas boiler plant at the kindergarten at Spojná Street, Trnava – medium source of air pollution,
- Gas boiler plant of 740-IX.1 building - medium source of air pollution,
- V1 and V2 NPP diesel generators - medium source of air pollution,
- Diesel oil and petrol station - medium source of air pollution,

- Diesel oil storage tank of LRKO Trnava – small source of air pollution,
- Conventional waste dump site in Žlkovce – small source of air pollution,
- Dump site for non-radioactive sludge in Pastuchov – small source of air pollution.

Table B-12: Operation of big and medium sources of air pollution and amount of discharged emissions in SE EBO in 2005.

Name of the boiler plant	Number of hours of operation	Fuel consumption	Discharged emissions into the atmosphere /$t.year^{-1}$/					
			TZL	SO_2	NO_x	CO	ΣC	CO_2
V1 NPP start-up and back-up boiler plant (mazut)	739	659.00 t	1.9111	21.088	5.6015	0.42835	0.07908	2 049.49
Gas boiler plant of building no. 740-IX.1 (natural gas)	1 474.5	159 720 m^3	0.0127776	0.001533312	0.2491632	0.1006236	0.0167706	–
Gas boiler plant of the kindergarten in Spojná street, Trnava (natural gas)	4 548	29 493 m^3	0.00235944	0.00083133	0.04600908	0.01858059	0.003096765	–
V1 and V2 NPP diesel generators (diesel oil)	172	65.87 t	0.093535	0.001871	0.32935	0.052696	0.007509	–
Diesel oil and petrol station: – (diesel oil) – (petrol)	– –	133.911 m^3 35.406 m^3	–	–	–	–	0.0114017	–

Source: Environmental Report of SE EBO and SE EBO V1 NPP for the year 2005.

II.2 WATER

The pollution of discharged water due to activities in the nuclear installations in GovCo (JAVYS) and SE EBO is strictly limited and controlled. The limits are derived from potential effects on the environment and population and they are unchangeable for any activity inside a nuclear installation. Therefore the considerations for annual values of liquid discharges during the operation and proposed activity are the same as applied in the case of the Zero alternative.

II.2.1 Total quantity of waste water discharged

Authorisation no. KÚ-OŽP-1/2003/01139/Cá from 25th June 2003, supplemented by Decree No. KÚŽP-1/00349/2005/Fr from 22nd June 2005, for waste water discharge was issued by Regional Office, Department of Environment in Trnava on for the common site of A1, V1 and V2 NPPs in Jaslovské Bohunice, as the waste water from both enterprises is discharged to common recipients. SE EBO is the administrator of the Decree pursuant to § 77, section 8 and 9 of Act No. 364/2004 Coll. on Water.

Besides the volume, discharged water is also monitored from the point of view of mass activity of corrosion and fission products and tritium. Other parameters identified by the given authorisation for waste water discharge are tracked and recorded by SE EBO.

In the sense of valid legislation, duty to carry out the sampling of discharged waste water and its analysis by a certified laboratory, will come into force on January 1st 2007.

In 2005, waste water discharged from SE EBO site and from ČFS Pečeňady complied with the decrees issued. The permitted limit values of discharged waste water were not exceeded in the tracked period. The trends for the amounts of discharged waste water to the recipients in the period 2001 − 2005 are presented in table B-13 and average values of the pollution of waste water discharged to Váh and Dudváh River recipients in 2001 − 2005 period are presented in table B-14 and B-15.

Table B-13: Trend for amounts of waste water discharged to the recipients in 2001 −2005 period.

Year	*Váh River*		*Dudváh River*		*ČFS Pečeňady*		*Total*	
	Limit [m^3]	*Actual value [m^3]*	*Limit [m^3]*	*Actual value [m^3]*	*Limit [m^3]*	*Actual value [m^3]*	*Limit [m^3]*	*Actual value [m^3]*
2001	15 673 392	9 476 413	1 135 300	727 075	1 642 500	1 642 500	18 451 192	11 845 988
2002	15 673 392	10 887 861	1 135 300	617 508	1 642 500	1 642 500	18 451 192	13 147 869
2003	15 673 392	9 629 281	1 135 300	567 604	1 642 500	1 642 500	18 451 192	11 839 385
2004	15 673 392	9 746 438	1 135 300	560 978	1 642 500	822 195	18 451 192	11 129 611
2005	15 673 392	9 240 307	1 135 300	552 975	1 642 500	773 685	18 451 192	10 566 967

Source: Environmental Report of SE EBO and SE EBO V1 NPP for the year 2005.

Table B-14: Average values for the pollution of waste water discharged to the Váh River recipient in the period 2001-2005

	Units	*2001*	*2002*	*2003*	*2004*	*2005*
Biochemical oxygen demand	[mg .l^{-1}]	1.57	2.18	2.02	1.75	1.72
Chemical oxygen demand Cr	[mg.l^{-1}]	6.99	7.24	12.83	19.85	21.10
Insoluble substances	[mg.l^{-1}]	9.82	14.99	6.60	7.80	5.66
Soluble substances	[mg.l^{-1}]	663.58	731.38	763.50	758.27	732.17
Ammonia nitrogen	[mg.l^{-1}]	0.67	0.40	0.52	0.50	0.27
Nitrates	[mg.l^{-1}]	21.48	21.65	24.29	23.06	29.27
Sulphates	[mg.l^{-1}]	187.65	216.42	241.36	236.46	212.98
Chlorides	[mg.l^{-1}]	41.95	55.99	61.06	56.87	59.14
Non-polar extractable substances	[mg.l^{-1}]	0.28	0.23	0.15	0.04	0.03
Total phosphates	[mg.l^{-1}]	1.11	1.12	1.27	1.19	1.04
Iron	[mg.l^{-1}]	0.21	0.26	0.17	0.16	0.15
Hydrazine hydrate	[mg.l^{-1}]	0.02	0.02	0.02	0.02	0.02
Detergents	[mg.l^{-1}]	0.03	0.03	0.02	0.02	0.02
Acidity, basicity - pH		8.60	8.69	8.65	8.72	8.60

Source: Environmental Report of SE EBO and SE EBO V1 NPP for the year 2005.

Table B-15: Average values for the pollution of waste water discharged to the Dudváh River recipient in the period 2001 −2005

	Units	2001	2002	2003	2043	2005
Biochemical oxygen demand	[mg .l^{-1}]	0.44	0.61	3.19	–	–
Chemical oxygen demand	[mg .l^{-1}]	7.12	7.35	11.31	18.31	16.63
Insoluble substances	[mg.l^{-1}]	7.20	6.69	11.12	9.64	8.31
Soluble substances	[mg.l^{-1}]	771.36	782.05	411.85	416.45	414.94
Ammonia nitrogen	[mg.l^{-1}]	0.37	0.49	0.24	–	–
Nitrates	[mg.l^{-1}]	25.90	27.79	17.43	–	–
Sulphates	[mg.l^{-1}]	220.44	249.63	123.15	118.03	103.99
Chlorides	[mg.l^{-1}]	28.58	30.99	25.30	23.41	22.90
Non-polar extractable substances	[mg.l^{-1}]	0.16	0.13	0.31	0.09	0.07
Total phosphates	[mg.l^{-1}]	–	–	0.80	0.82	0.85
Iron	[mg.l^{-1}]	0.15	0.19	0.67	0.29	0.30
Hydrazine hydrate	[mg.l^{-1}]	0.02	0.05	0.02	0.02	0.02
Detergents	[mg.l^{-1}]	0.03	0.03	0.03	–	–
Acidity, basicity - pH		8.75	8.74	8.60	8.54	8.49

Source: Environmental Report of SE EBO and SE EBO V1 NPP for the year 2005.

On the basis of the balance of liquid discharges in the period 2002-2005 presented in summarised annual reports on radiation safety and the impact of the NEC Bohunice site on the environment (table B-16), it can be stated that the values in the individual years are significantly below the limit values (0.07 – 37% of the authorised limit).

Table B-16: Discharges of radioactive substances from V1 NPP into the hydrosphere in the period 2002 −2005

Year	2002	2003	2004	2005
Corrosion and fission products [MBq]	54.857	45.138	35.811	52.229
Trícium [GBq]	7891.221	6771.247	7772.733	7207.415

Source: Radiation protection at SE EBO and SE VYZ and impact of SE EBO and SE VYZ sites on the environment for the perid 2001 −2005.

II.3 TECHNOLOGICAL PROCESS PRODUCING WASTE WATER

The system of separate rain sewerage, sewage drainage and industrial sewage is built in GovCo (JAVYS). Rain sewerage leads away precipitation water from building roofs, roads and consolidated areas. The drainage of the railway sidings, overflows from cooling towers, rinsing water from the wells, water from the turbine hall, auxiliary boiler plant and garages (via the gravitational oil separator), water from washing plant (after purification at alpha 2.2 waste water purification plant) are emptied into this system. The recipient of this waste water from the whole site is Dudváh River, to which the Manivier open canal is emptied. This canal empties into the Dudváh River behind the village of Žlkovce at river-km 10.1.

After the dosimetric control, technological waste water (including waste water with a radioactivity lower than determined limits for discharge) and sewage waste water are led away by the final piping collector SOCOMAN (serving for water except precipitation), which leads them away in a gravitational manner via the Drahovský canal (river-km 2.2) in the land registry area of Madunice village into Váh River (river-km 101.8). The collector passes along the right bank of Manivier canal in 10.8 km distance to the margin of Žlkovce, where it crosses to its left bank. It crosses the Dudváh River and it passes to the right bank outlet with a back-water gate in the land registry area of Madunice. The piping capacity is 497 l/s.

II.3.1 Waste water purification and discharge system

Water from the rain sewerage flows via the building of dosimetric monitoring with a continual measurement of mass activity of corrosion and fission products and tritium in the waste water (waste water activity measurement – building 880 of V1 NPP). Then the water flows via retention tanks serving for water accumulation in case of incidents, excessive waste water pollution and accidents. The rain sewerage water empties into Dudváh recipient via Manivier.

The sewage water from the GovCo (JAVYS) buildings is led away by sewage drainages into the mechanical and biological water treatment plant MB ČOV V1 NPP (BIOCLAR), which is at the present time administered by GovCo (JAVYS). The cleaned waste water flows to the SOCOMAN collector. The low level radioactive sewage empties into SOCOMAN piping collector.

Small amounts of waste water which is suspected to be contaminated by oil products is also led into the industrial sewage.Therefore the industrial sewage is led to a gravitational oil separator. After cleaning the water to the residual content of oil products at about 2 $mg.l^{-1}$ (maximum 20 $mg.l^{-1}$) the waste water is led to the treatment of additional cooling water for V2 NPP by clarification.

The check-up point for the continuous sampling of waste water mass gamma radioactivity discharged into the Váh recipient is the measurement building 368 for GovCo (JAVYS) and the measurement building 880 for V2 NPP (the radioactivity measurement stations are equipped with MR-100 monitors).

In addition, the activity monitoring and measurement of the amount of technological waste water led away by the SOCOMAN collector is performed in the following extent:

- the summarised measurement of all waste water from V1 and A1 NPP site led away by SOCOMAN in building 368,
- the summarised measurement of all waste water from the common site of A1 NPP, V1 NPP and V2 NPP in Jaslovské Bohunice led away by SOCOMAN in building 614.

The following principles apply to the discharge of waste water from V1 NPP site:

- Water from individual buildings of V1 NPP can be discharged only after the monitoring of mass activity of tritium and of corrosion and fission products.

- Waste water from individual buildings of V1 NPP can be discharged either into the SOCOMAN collector, which empties into the Váh recipient or into the rain sewerage, which empties into Manivier channel and Dudváh recipient. The principle of preferential discharge of waste water into the SOCOMAN collector applies, because of the installed equipment that automatically closes the collecting piping at building 590 in advance, when the investigation level of radioactivity is exceeded. In this way, it is possible to prevent the leakage of radioactive water outside the GovCo (JAVYS) and SE EBO sites.

The radioactivity of discharged waste water is monitored on the discharge waste water system by means of the pipe collector of SOCOMAN at the boundary of the GovCo (JAVYS) and SE EBO sites. Pollution indicators are measured from the samples taken in building 614.

II.3.2 Nature of the water recipient

Information from SHMÚ from Hlohovec profile (river-kilometre 100.7) presented in table B-17, shows a relatively stable condition of water quality parameters in the Váh River recipient.

Table B-17: Quality parameters of the Váh River water, Hlohovec profile, kilometre 100.7

	Parameters	*Unit*	*2000*	*QC*	*2001*	*QC*	*2002*	*QC*	*2003*	*QC*
A	***Oxygen regime***			**III**		**III**		**III**		**III**
1	***Dissolved oxygen***	[mg.l^{-1}]	9.14	II	11.13	II	10.75	I	10.55	I
2	***Biochemical oxygen demand***	[mg.l^{-1}]	3.09	III	3.17	III	3.28	III	3.32	III
5	***Chemical oxygen demand Cr***	[mg.l^{-1}]	9,83	II	7,46	II	7,67	I	7,58	I
		[mg.l^{-1}]	9.83	II	7.46	II	7.67	I	7.58	I
B	***Basic physico-chemical parameters***			**II**		**II**		**III**		**III**
1	***Water reaction – pH***		8.03	II	8.25	II	8.21	III	8.11	III
2	***Water temperature***	[°C]	11	I	10.41	I	11.53	III	11.6	III
3	***Dissolved substances***	[mg.l^{-1}]	257	II	257	II	230	I	251	I
4	***Conductivity***	[mS.m^{-1}]	39.925	II	39.083	II	37.142	II	40.183	II
9	***Chlorides***	[mg.l^{-1}]	11.94	I	10.42	I	9.11	I	11.93	I
10	***Sulphates***	[mg.l^{-1}]	41.53	I	31.28	I	30.29	I	36.66	I
C	***Nutrients***			**II**		**II**		**II**		**II**
1	***Ammonia nitrogen***	[mg.l^{-1}]	0.344	II	0.073	II	0.095	I	0.145	I
3	***Nitrate***	[mg.l^{-1}]	1.432	II	1.614	II	1.541	II	1.461	II
7	***Total phosphorus***	[mg.l^{-1}]	0.095	II	0.1058	II	0.0833	II	0.0833	II
5	***Total nitrogen***	[mg.l^{-1}]					2.178	II	2.157	II
D	***Biological parameters***			**III**		**III**		**IV**		**IV**
1	***Saprobic index of biosestone***	[mg.l^{-1}]	2.175	III	2.186	III	2.022	III	2.013	III
2	***Saprobic index of macrozoobentose***	[mg.l^{-1}]			2.41		2.465	IV		IV
E	***Microbiological parameters***			**IV**		**IV**		**V**		**V**
1	***Coliform bacteria***	[KTJ.l^{-1}]	56	IV	76	IV	378	V	213	V
	Non-classified parameters									
	Oxygen saturation	[%]	81.61		97.87		98.38		93.97	
	Insoluble substances 105 °C	[mg.l^{-1}]	13		27		7		21	
	Nitrite nitrogen	[mg.l^{-1}]	0.02		0.0112		0.0274		0.0234	
	Ammonia ions	[mg.l^{-1}]	0.443		0.093		0.123		0.187	
	Nitrite ions	[mg.l^{-1}]	0.0656		0.0367		0.09		0.0767	
	Nitrate ions	[mg.l^{-1}]	6.34		7.15		6.82		6.47	
	Soluble substances after ignition	[mg.l^{-1}]	180		171		144		170	

Insoluble substances after ignition	[mg.l^{-1}]	6	18	13	21
Total alkalinity	[nmol.l^{-1}]	3.033	3.263	2.959	3.125
Abiosestone (quant).	[%]	18			

QC – quality class Source: SHMÚ

II.3.3 Limit values for waste water pollution

Authorisation no. KÚ-OŽP-1/2003/01139/Cá from 25th June 2003, supplemented by Decree No. KÚŽP-1/00349/2005/Fr from 22nd June 2005, for waste water discharge was issued by Regional Office, Department of Environment in Trnava on for the common site of A1, V1 and V2 NPPs in Jaslovské Bohunice, as the waste water from both enterprises is discharged to common recipients. SE EBO is the administrator of the Decree pursuant to § 77, section 8 and 9 of Act No. 364/2004 Coll. on Water.

Table B-18 contains the maximum concentration and balance values for the individual parameters of pollution discharged from the common site of GovCo (JAVYS) and SE EBO in Jaslovské Bohunice to the Váh River recipient. Table B-19 contains the same values for the Dudváh River recipient according to the above mentioned decree of Regional Office, Department of Environment in Trnava.

Table B-18: Maximum concentration and balance values for individual parameters of pollution discharged – Váh River

Parameter	*Unit*	*Concentration values*	*Balance values [kg.day^{-1}]*	*Balance values [t.year^{-1}]*
Biochemical oxygen demand	[mg .l^{-1}]	8	343.51	125.38
Chemical oxygen demand Cr	[mg.l^{-1}]	30	1 288.22	470.20
Insoluble substances	[mg.l^{-1}]	20	858.82	313.47
Soluble substances	[mg.l^{-1}]	1 000	42 940.79	15 673.39
Ammonia nitrogen	[mg.l^{-1}]	4	171.75	62.69
Nitrate nitrogen	[mg.l^{-1}]	50	2 147.04	783.67
Sulphates	[mg.l^{-1}]	350	15 029.28	5 485.69
Chlorides	[mg.l^{-1}]	100	4 294.08	1 567.34
Non-polar extractable substances	[mg.l^{-1}]	0.35	15.01	5.48
Total phosphates	[mg.l^{-1}]	1.5	64.41	23.51
Iron	[mg.l^{-1}]	2	85.86	31.34
Hydrazine	[mg.l^{-1}]	2	85.26	31.34
Detergents	[mg.l^{-1}]	0.5	21.48	7.84
Acidity, basicity - pH		6 – 9	–	–

Source: Authorisation no. KÚ-OŽP-1/2003/01139/Cá supplemented by Decree No. KÚŽP-1/00349/2005/Fr

Table B-19: Authorised concentration and balance values for individual parameters of pollution discharged – Dudváh River

Parameter	Unit	Concentration values	Balance values [kg.day-1]	Balance values [t.year-1]
Chemical oxygen demand Cr	[mg.l^{-1}]	30	93.31	34.06
Insoluble substances	[mg.l^{-1}]	15	46.65	17.03
Soluble substances	[mg.l^{-1}]	1 000	3110.41	1135.3
Sulphates	[mg.l^{-1}]	350	108.86	397.35
Chlorides	[mg.l^{-1}]	100	311.04	113.53
Non-polar extractable substances	[mg.l^{-1}]	0.3	0.933	0.34
Total phosphates	[mg.l^{-1}]	2	6.22	2.27
Iron	[mg.l^{-1}]	2	6.22	2.27
Hydrazine	[mg.l^{-1}]	2	6.22	2.27
Acidity, basicity - pH		6 – 9	–	–

Source: Authorisation no. KÚ-OŽP-1/2003/01139/Cá supplemented by Decree No. KÚŽP-1/00349/2005/Fr

The annual limit values for liquid discharges from GovCo (JAVYS) and SE EBO into the hydrosphere, as presented in Decree no. HH SR/3380-1/2003/SOŽP of the Public Health Authority of the Slovak Republic, Department of Health Protection against Radiation are contained in table B-20.

Table B-20: Annual limit of radioactivity and mass radioactivity of radionuclides discharged in waste water from GovCo (JAVYS) and SE EBO into the Váh and Dudváh Rivers

Discharge type	Váh River	Dudváh River
Tritium ^{3}H [Bq.year^{-1}]	4.37 x 10^{13}	4.37 x 10^{11}
Other fission and corrosion products [Bq.year^{-1}]	3.8 x 10^{10}	3.8 x 10^{8}
Tritium ^{3}H [Bq.m^{-3}]	1.95 x 10^{8}	1.95 x 10^{8}
Other fission and corrosion products [Bq.m^{-3}]	3.7 x 10^{4}	3.7 x 10^{4}

Source: Decree No. HH SR/3380-1/2003/SOŽP

The limit values of radioactivity and mass radioactivity of radionuclides discharged from V1 NPP in waste water into the hydrosphere, as presented in Decree No. SOZPŽ/2401/2006 of the Public Health Authority of the Slovak Republic are contained in table B-21.

Table B-21: Annual limit of radioactivity and mass radioactivity of radionuclides discharged from V1 NPP in waste water into Váh and Dudváh River

Discharge type	Váh River	Dudváh River
Tritium ^{3}H [Bq.year^{-1}]	2.0 x 10^{13}	2.0 x 10^{11}
Other fission and corrosion products [Bq.year^{-1}]	1.3 x 10^{10}	1.3 x 10^{8}
Tritium ^{3}H [Bq.m^{-3}]	1.95 x 10^{8}	1.95 x 10^{8}
Other fission and corrosion products [Bq.m^{-3}]	3.7 x 10^{4}	3.7 x 10^{4}

Source: Decree No. HH SR/3380-1/2003/SOŽP

II.4 SUMMARY DATA ON THE MATERIAL INVENTORY OF V1 NPP

II.4.1 Material inventory for Alternative 1

II.4.1.1 Material inventory from the dismantling of the technological part for Alternative 1

Table B-22 shows the inventory of materials gained from dismantling of the technological part in accordance with *V1 NPP Conceptual Decommissioning Plan (2006).*

The given values are valid for the whole V1 NPP, i.e. **for both units**. In the columns where no values are indicated, the respective values are equal to zero. Values for partially decommissioned buildings represent only the determined percentage of the decommissioned building.

Table B-22: Balance of materials gained from dismantling of the technological part for alternative 1

CB number	*Stainless steel [t]*	*Carbon steel [t]*	*Non-ferrous metals [t]*	*Other [t]*
Contaminated structures				
460		4		1
800 without reactors	3 993.5	3 991	196	226.12
800 reactors	349.5	580		186.88
801, 801a	730.0	416	79	69
803, 781	90.0	253	30	25
804, 461	5.0			5
Contaminated structures total	**5 168**	**5 244**	**305**	**513**
Non-contaminated structures				
350 + ISFSF		41	852	576
351 (50%)			5	6
352 + ISFSF (50 %)			6	8
353 + ISFSF				
360 (50 %)				
361 (50 %)				
362 (50 %)				
371 (50 %)				
372 (50%)				
401 (50%)		160.5	1	2.5
401M/1		20		2
490,491	10	12 165	475	430
533/1		7	1	1
533/2		7	1	1
573-2,573-3/1,573-3/2		4		
582 (50%)				
589		389	4	3
644	51	2	7	2
645	50	20	3	1
646	2	26	10	25
800a,b,c,d	2	2 790	380	435
802		51	1	10
Non-contaminated structures total	**115**	**15682.5**	**1746**	**1502.5**
Non-contaminated and contaminated structures total	**5 283**	**20 926.50**	**2 051**	**2 015.50**

Source: CDP

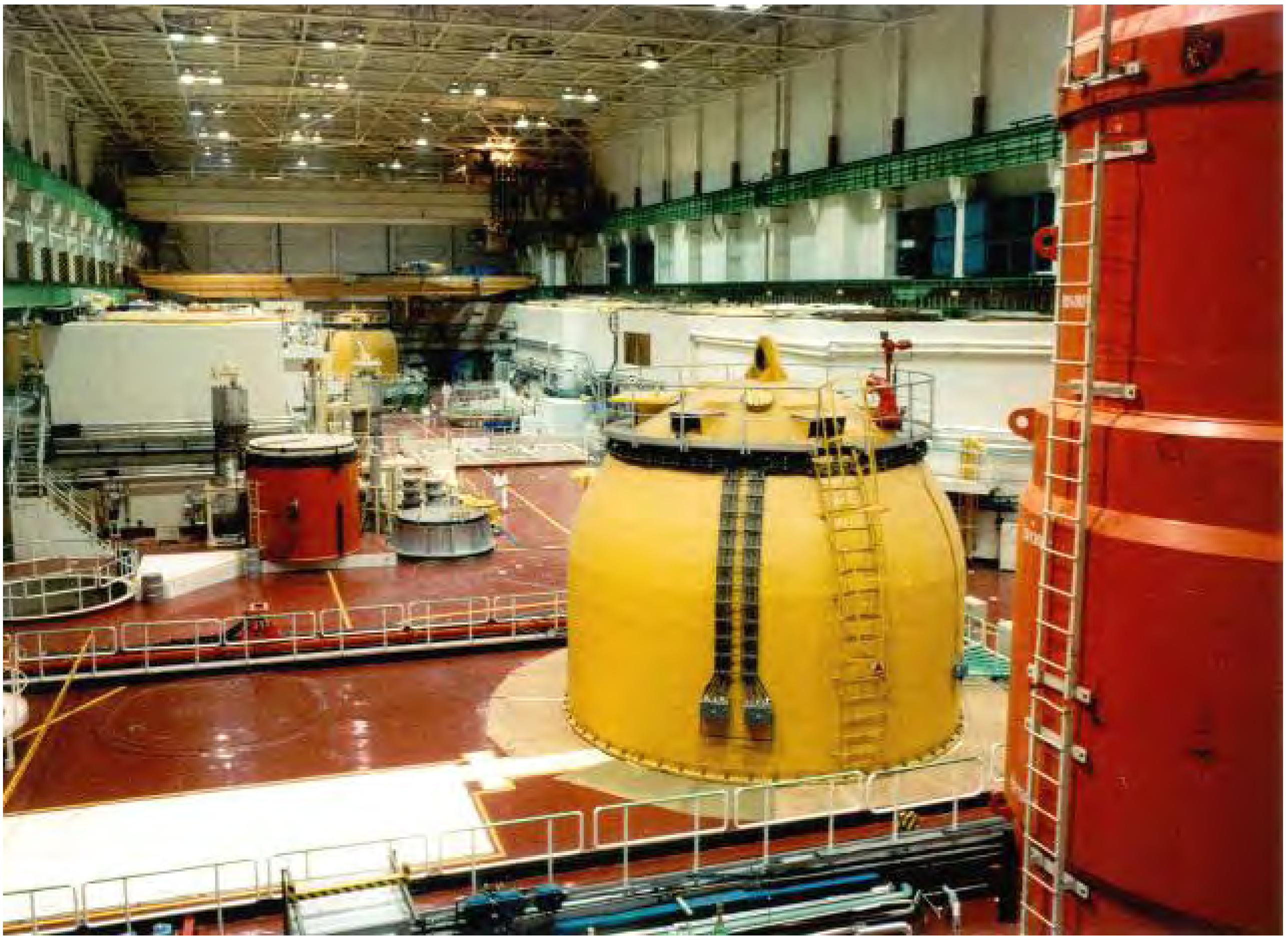


Figure B-1: View of the V1 NPP reactor hall

II.4.1.2 Inventory of building materials gained during the demolition of civil structures for Alternative 1

Table B-23 shows the inventory of building materials gained during the demolition of CBs in accordance with the *V1 NPP Conceptual Decommissioning Plan (2006).* The given values are valid for the whole V1 NPP, i.e. **for both units**. In the columns in which where no values are indicated, the respective values are equal to zero. The values for partially decommissioned buildings represent only the determined percentage of the decommissioned building.

Table B-23: Inventory of building materials arising during the demolition of CBs for both units for alternative 1

CB No.	Concrete			Reinforced concrete						Steel	Prefabricates	Masonry	Peripheral walls		Lining		Hermetic and protective doors	Special canali-sation	Non-ferrous metals	Other
				Total concrete + steel			Steel, part from that													
	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total				Panels	Feal	S	C				
	m^3	m^3	m^3	m^3	m^3	m^3	t	t	t	t	t	m^3	m^2	m^2	m^2	m^2	t	t	t	t
Contaminated structures																				
460	767	85	852	450	627	1 077	38	54	92	23		30						1		2
800 whole	1 926		1 926	27 000	25 316	52 316	4 026	3 774	7 800	1 438	3 000	7 000	3 800	0	15 865	6 666	850	40	69	380
out of that the reactor shaft	126		126	3 300	1 100	4 400	1 310	440	1 750						1 400					
801, 801a	2 810		2 810	5 200	9 097	14 297	449	800	1 249	264	1 135	1 026	2 530		7 372	646	70	13	11	61
803, 781	630	339	969	2 000	2 148	4 148	200	200	400	1 319	1 040	683	3 600	8 000				8	3	223
804, 461	195		195	50	2 270	2 320	6	294	300	250		30	720							6
Contaminated structures total	**6 328**	**424**	**6 752**	**34 700**	**39 458**	**74 158**	**4 719**	**5 122**	**9 841**	**3 294**	**5 175**	**8 769**	**10 650**	**8 000**	**23 237**	**7 312**	**920**	**62**	**83**	**672**
Non-contaminated structures																				
350 + ISFSF	210	466	676							119	8625									98
351 (50%)										14	4									139
352 + ISFSF (50%)	11	20.5	31.5							9	90									
353 + ISFSF	3	1	4							162	78									
360 (50%)				20	10	30	1	0.5	1.5	1.5										
361 (50%)				20	10	30	1	0.5	1.5	1.5										
362 (50%)				20	10	30	1	0.5	1.5	1.5										
371 (50%)	20	5	25		5	5				6										
372 (50%)	20	5	25							7.5										
401 (50%)	20	11.5	31.5	250	308	558	29	36	65	21		4								4
401M/1	360	280	640							10										
490, 491	4 920		4 920	34 385	10 660	45 045	2 300	714	3 014	6 450	2 100	1 200	15 755						7	450
533/1				111	138	249	6	8	14	9										1
533/2				181	221	402	10	13	23	8										1

CB No.	Concrete			Reinforced concrete						Steel	Prefabricates	Masonry	Peripheral walls		Lining		Hermetic and protective doors	Special canali-sation	Non-ferrous metals	Other
				Total concrete + steel			Steel, part from that													
	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total				Panels	Feal	S	C				
	m^3	m^3	m^3	m^3	m^3	m^3	t	t	t	t	t	m^3	m^2	m^2	m^2	m^2	t	t	t	t
573-2, 573-3/1, 573-3/2				82	192	274	5	18	23	8	9	60								1
582 (50%)	50	6.5	56.5	700	62.5	762,5	14	1.5	15.5											5
589	50	510	560	70	1 101	1 171	9	134	143	425			2 550							3
644	55	50	105		20	20		2	2	7		124								4
645		35	35		20	20		2	2	2	4	22								4
646	65	65	130		240	240		20	20	20	400	150							1	24
800a,b,c,d	680	1 538	2 218	1 830	14 668	16 498	264	2 116	2 380	1 790		1 376	11 620						8	200
802	14		14	6	170	176	1	11	12	1	14	15								1
Non-contaminated structures total	**6 478**	**2 994**	**9 472**	**37 675**	**27 836**	**65 511**	**2 641**	**3 077**	**5 718**	**9 073**	**11 324**	**2 951**	**29 925**	**0**	**0**	**0**	**0**	**0**	**16**	**935**
Non-contaminated and contaminated structures total	**12 806**	**3 418**	**16 224**	**72 375**	**67 294**	**139 669**	**7 360**	**8 199**	**15 559**	**12 367**	**16 499**	**11 720**	**40 575**	**8 000**	**23 237**	**7 312**	**920**	**62**	**99**	**1 607**

Source: CDP

II.4.2 Material inventory for Alternatives 2 and 3

II.4.2.1 Material inventory from dismantling of the technological part for Alternatives 2 and 3

Table B-24 shows the inventory of materials gained from dismantling of the technological part in accordance with the *V1 NPP Conceptual Decommissioning Plan (2006)*. The given values are valid for the whole V1 NPP, i.e. **for both units**. In the columns where no values are indicated, the respective values are equal to zero. The values for partially decommissioned buildings represent only the determined percentage of the decommissioned building.

Table B-24: Balance of materials gained from dismantling of the technological part for alternatives 2 and 3

CB number	*Stainless steel*	*Carbon steel*	*Non-ferrous metals*	*Other*
	[t]	*[t]*	*[t]*	*[t]*
Contaminated structures				
460		4		1
800 without reactors	3 993.5	3 991	196	226.12
800 reactors	349.5	580		186.88
801,801a	730.0	416	79	69.00
803,781	90.0	253	30	25.00
804,461	5.0			5.00
Contaminated structures total	**5 168.0**	**5 244**	**305**	**513.00**
Non-contaminated structures				
340				
350+ISFSF		41	852	576
351 (50%)			5	6
352+ISFSF (50%)			6	8
353+ISFSF (50%)				
360 (50%)				
361 (50%)				
362 (50%)				
371 (50%)				
372 (50%)				
400 (50%)				
401		321	2	5
401M/1		20		2
490,491	10	12 165.00	475	430
510		606	632	16
522+527		108	16	44
523a, b,527a		21	5	6
526				
530,530A,531		609	50	31
532		139	5	6
533/1		7	1	1

CB number	Stainless steel [t]	Carbon steel [t]	Non-ferrous metals [t]	Other [t]
533/2		7	1	1
573		464	7	6
573-2, 573-3/1, 573-3/2		4		
578, 579		5		
580a,b		138	6	11
581 (cooling towers 1 and 3) 582		29	1.5	12
583		1 093.00	5	7
583a		1		
583/1		3		
585a,b		99	10	1
589		389	4	3
590,590a,590B,/b	3	706	51	33
590c	20	40	1	5
621		32	2	2
631a,780		42	15	8
631b		10	2	8
644	51	2	7	2
645	50	20	3	1
646	2	26	10	25
670 (50%)				
690 (50%)				
722		2		1
800a,b,c,d	2	2 790.00	380	435
802		51	1	10
922				
940 (50%)		15.5		1
Non-contaminated structures total	**138**	**20 005.5**	**2 555.5**	**1 703**
Non-contaminated and contaminated structures total	**5 306**	**25 249.5**	**2 860.5**	**2 216**

Source: CDP

II.4.2.2 *Inventory of building materials gained during the demolition of civil structures for Alternatives 2 and 3*

Table B-25 shows the inventory of building materials gained during the demolition of CBs in accordance with the *V1 NPP Conceptual Decommissioning Plan (2006).* The given values are valid for the whole V1 NPP, i.e. **for both units**. In the columns where no values are indicated, the respective values are equal to zero. Values for partially decommissioned buildings represent only the part of the decommissioned building determined by the extent of decommissioning.

Table B-25: Inventory of building materials arising during the demolition of CBs for both units for alternatives 2 and 3 (1)

CB No.	Concrete			Reinforced concrete						Steel	Prefabricates	Masonry	Peripheral walls		Lining		Hermetic and protective doors	Special canali-sation	Non-ferrous metals	Other
				Total concrete + steel			Steel, part from that													
	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total				Panels	Feal	S	C				
	m^3	m^3	m^3	m^3	m^3	m^3	t	t	t	t	t	m^3	m^2	m^2	m^2	m^2	t	t	t	t
Contaminated structures																				
460	767	85	852	450	627	1 077	38	54	92	23		30						1		2
800 whole	1 926		1 926	27 000	25 316	52 316	4 026	3 774	7 800	1 438	3 000	7 000	3 800	0	15 865	6 666	850	40	69	380
out of that the reactor shaft	126		126	3 300	1 100	4 400	1 310	440	1 750						1 400					
801, 801a	2 810		2 810	5 200	9 097	14 297	449	800	1 249	264	1 135	1 026	2 530		7 372	646	70	13	11	61
803, 781	630	339	969	2 000	2 148	4 148	200	200	400	1 319	1 040	683	3 600	8 000				8	3	223
804, 461	195		195	50	2 270	2 320	6	294	300	250		30	720							6
Contaminated structures total	**6 328**	**424**	**6 752**	**34 700**	**39 458**	**74 158**	**4 719**	**5 122**	**9 841**	**3 294**	**5 175**	**8 769**	**10 650**	**8 000**	**23 237**	**7 312**	**920**	**62**	**83**	**672**
Non-contaminated structures																				
340	310	550	860							180	20									4
350 + ISFSF	210	466	676							119	8625									98
351 (50%)										14	4									139
352 + ISFSF (50%)	11	20.5	31.5							9	90									
353 + ISFSF (50%)	1.5	0.5	2							81	39									
360 (50%)				20	10	30	1	0.5	1.5	1.5										
361 (50%)				20	10	30	1	0.5	1.5	1.5										
362 (50%)				20	10	30	1	0.5	1.5	1.5										
371 (50%)	20	5	25		5	5				6										
372 (50%)	20	5	25							7.5										
400 (50%)																				50
401	40	23	63	500	616	1 116	58	72	130	42		8								8
401M/1	360	280	640							10										

CB No.	Concrete			Reinforced concrete: Total concrete + steel			Reinforced concrete: Steel, part from that			Steel	Prefabricates	Masonry	Peripheral walls		Lining		Hermetic and protective doors	Special canali-sation	Non-ferrous metals	Other
	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total				Panels	Feal	S	C				
	m^3	m^3	m^3	m^3	m^3	m^3	t	t	t	t	t	m^3	m^2	m^2	m^2	m^2	t	t	t	t
490, 491	4 920		4 920	34 385	10 660	45 045	2 300	714	3 014	6 450	2 100	1 200	15 755						7	450
510	140	145	285	400	850	1 250	34	72	106	5	50								1	2
522, 527	595	500	1 095	200	698	898	13	46	59	168	143	35							5	10
523a,b, 527a	118		118	20	62	82	2	4	6	3		76	336						2	6
526		30	30		6	6		1	1	8	20									0
530, 530A, 531	320	173	493	950	1 135	2 085	113	136	249	481	150	1 247	1 905			18			8	231
532	291	200	491	192	200	392	16	17	33	10	20	792							1	15
533/1				111	138	249	6	8	14	9										1
533/2				181	221	402	10	13	23	8										1
573		29	29	1 051	3 238	4 289	63	194	257	148	914	20								9
573-2, 573-3/1, 573-3/2				82	192	274	5	18	23	8	9	60								1
578, 579	80	80	160		3	3		1	1		5	28								
580a, b	402		402	400	322	722	30	24	54	35	198	20								10
581 (towers 1 and 3)	900	2 200	3 100	10 025	7 905	17 930	650	1 080	1 730	144	12 600								1	2 800
582	100	13	113	1400	125	1525	28	3	31											10
583	3 200	680	3 880	5 000	2 050	7 050	425	175	600	501	782	1 900							1	26
583a	25	50	75		2	2				10			75							4
583/1	8	1	9	60	3	63	5		5	4										2
585a, b	580		580	1 398	507	1 905	105	38	143	19		110	1 060							2
589	50	510	560	70	1 101	1 171	9	134	143	425			2 550							3
590, 590a, 590B,/b	2 000	544	2 544	2 000	1 003	3 003	165	83	248	117	709	598							1	148
590c	26	100	126		320	320		20	20	6		110								45
621	129		129	40	56	96	1	1	2	16	165	280	289							5
631a, 780	520	90	610	260	800	1 060	22	68	90	40	39	773		6 000					20	50

CB No.	Concrete			Reinforced concrete						Steel	Prefabricates	Masonry	Peripheral walls		Lining		Hermetic and protective doors	Special canali-sation	Non-ferrous metals	Other
				Total concrete + steel			Steel, part from that													
	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total	Below -1 m	Above -1 m	Total				Panels	Feal	S	C				
	m^3	m^3	m^3	m^3	m^3	m^3	t	t	t	t	t	m^3	m^2	m^2	m^2	m^2	t	t	t	t
631b, c	139		139	252	480	732	22	41	63	363	1 800	170	159	600					20	50
644	55	50	105		20	20		2	2	7		124								4
645		35	35		20	20		2	2	2	4	22								4
646	65	65	130		240	240		20	20	20	400	150							1	24
670 (50%)		15	15							187.5	395									5
690 (50%)		3650	3650								950									600
722	20	136	156		7	7		1	1	8		39								512
800a, b, c, d	680	1 538	2 218	1 830	14 668	16 498	264	2 116	2 380	1 790		1 376	11 620						8	200
802	14		14	6	170	176	1	11	12	1	14	15								1
922	68	43	111							27									1	2
940 (50%)	10	115	125							60	180	16.5							1	2
Non-conta-minated structures total	**16 428**	**12 342**	**28 770**	**60 873**	**47 853**	**108 726**	**4 350**	**5 117**	**9 467**	**11 554**	**30 425**	**9 170**	**33 749**	**6 600**	**0**	**18**	**0**	**0**	**78**	**5 534**
Total	**22 756**	**12 766**	**35 522**	**95 573**	**87 311**	**182 884**	**9 069**	**10 239**	**19 308**	**14 848**	**35 600**	**17 939**	**44 399**	**14 600**	**23 237**	**7 330**	**920**	**62**	**161**	**6 206**

(1) – Materials under the level -1 m are not demolished.

Source: CDP

II.5 INVENTORY OF RADIOACTIVE AND HAZARDOUS MATERIALS

From the point of view of the kind of radioactive isotopes and the process of their formation, the following radioactive materials can be found at V1 NPP:

- Materials activated in the reactor core area (reactor pressure vessel, reactor internals, shielding assemblies, absorbing and connecting parts of control rods, parts of in-core measurement, water biological protection, concrete of reactor shaft, etc.),
- Materials contaminated with activated corrosion products of primary circuit materials and impurities in the coolant,
- Materials contaminated with fuel fission products.

Data on activity and isotopic composition of individual groups of materials can be obtained from:

- Theoretic calculation using dedicated computing codes for activation calculation for models of contamination spreading in NPP facilities, respectively,
- Activity measurement of surface contamination of samples extracted from internal and external surfaces of primary circuit equipment and building surfaces,
- The analysis of decontamination solutions after decontamination of primary circuit equipment,
- The re-calculation of dose rate measurement received from equipment.
- Hazardous material is represented namely by asbestos, the amount of which is estimated to about 10 tons, a smaller amount of waste contaminated by oil from the lub-oil system, fluorescent tubes and other waste containing mercury, lead storage batteries, etc..

II.5.1 Internal contamination of technological equipment after the Final Shutdown

II.5.1.1 Authentic isotopic composition of internal surface contamination

Isotopic composition also belongs to the important information about equipment contamination, with regard to natural radioactive decay of nuclides over a period of time and thus a decrease of contamination and also with regard to the need to determine dose load during the handling of contaminated material.

It is supposed that the predominant contaminants in the case of V1 NPP are ^{137}Cs and ^{60}Co. ^{60}Co represents corrosion products in the primary circuit and ^{137}Cs as the fission product on the other side gives information about fuel assembly tightness during NPP operation.

From the dose load point of view, it is necessary to consider that ^{60}Co causes 4-times greater dose rate per activity unit than ^{137}Cs. The supposed ratio between ^{137}Cs and ^{60}Co for V1 NPP is assumed as 10 % of Cs and 90 % of Co. It is an average value of ratios of radioisotopes significant from the point of view of dose load caused by ^{60}Co and ^{137}Cs. The ratios of radioisotopes were established from real measurements of the surface activity of internal surfaces in samples cut out from primary circuit piping taken during the V1 NPP reconstruction.

II.5.1.2 List of equipment located in building 800 essential from the point of view of pre-dismantling decontamination

Table B-26 shows an overview of data related to the equipment located in building 800 that will undergo a decontamination process before its dismantling.

It is assumed to apply chemical or electrolytic methods for the decontamination of equipment before dismantling. The decontamination method used for the equipment is chosen according to the type of surface. The semi-dry electrolytic method is used mostly for large area surfaces. The table also indicates the levels of contamination of inner surfaces for the primary side of equipment after performing the whole primary circuit decontamination if the particular equipment undergoes this decontamination.

Figure B-2: View of the V1 NPP turbine hall

Table B-26: Pre-dismanlting decontamination of CB 800 equipment in V1 NPP (source: CDP)

Identifier	*Name*		*Chemical decontamination*				*Electrolytic decontamination*	
		Contamination	*Mass*	*Number of loops*	*Area*	*Volume*	*Mass*	*Area*
		[kBq/cm^2]	*[kg]*	*[pcs]*	*[m^2]*	*[m^3]*	*[kg]*	*[m^2]*
DTC 01.2	**Primary side of steam generator**	20	396 108	12	30 150	147.50		
DTC 01.3	**Main circulation pump**	0.2 ÷ 30					602 400	2 400
DTC 01.4	**Main isolation valve**	30					172 800	168
DTC 01.5	**Primary piping**	20					144 389	540
DTC 01.6	**Pressurizer system**	10 ÷ 20	16 200	2	124	6.30	237 000	220
DTC 01.6	**Pressurizer bubbler tank**	0.2 ÷ 1.1	20 950	4	210	4.80		
DTC 03.2	**Primary coolant purification system**	2 ÷ 30	49 900	2	1 895	37.20		
DTC 03.3	**Primary charging and boron control system**	10 ÷ 20	14 557	2	160	5.40	10 000	86
DTC 11.2-3.6	**Controlled leak cooling system**	10 ÷ 20	3 400	2	88	1.10		
DTC 03.6	**Controlled leak collection system**	10 ÷ 15	320	2	88	0.07		
DTC 03.6	**Primary coolant drainage system**	10 ÷ 15	890	8	270	0.24		
DTC 03.1	**Control rod test stand**	2	1 500	2	23	1.00		
DTC 03.4	**Spent fuel pool cooling system**	0.2 ÷ 2	41 540	2	1 404	22.40		
DTC 11.4	**Spent fuel pool purification station**	0.2 ÷ 2	31 000	2	250	32.00		
DTC 03.4	**Spent fuel pool make-up system**	0.2 ÷ 2	3 800	2	27	2.50		
DTC 11.2	**Primary coolant drainage purification station**	2 ÷ 20	2 600	2	25	0.50	22 000	44
DTC 11.3	**Purification station of uncontrolled leaks**	20 ÷ 40	1 200	4	50	2.00	4 780	44
DTC 11.6	**Boric acid regeneration station**	2 ÷ 40	1 100	1	40	0.60	2 330	35
DTC 02.3	**Spent fuel pool**	0.2 ÷ 2					9 500	400
ŠK1, 2	**Special canalisation**	0.5 ÷ 2					5 100	125
VZT	**Air distribution systems**	1.1 ÷ 2					70 000	2 620
VBO1, 2	**Biological water shield**	0.5 ÷ 2					100 000	400
OV1, 2	**Sampling system**	0.5 ÷ 2	2 000					
DTC 14.2	**Safety injection system**	0.2 ÷ 2	92 000	4	220	10.00	53 000	1 300
DTC 14.2	**Emergency leak recovery**	0.2 ÷ 2	1 700	4	18	0.50		
DTC 14.2	**Spray system**	0.2 ÷ 2	96 000	4	2 880	33.30		
	Emergency ventilation of room R045	0.01÷0.2	2 000	12	35	2.00		
	Sum		**778 765**	**73**	**37 957**	**309.40**	**1 433 299**	**8 382**

II.5.1.3 List of equipment located in buildings 800, 801A and 804 essential from the point of view of pre-dismantling decontamination

Table B-27 shows an overview of data related to the equipment located in buildings 801, 801a and 804 that will undergo a decontamination process before dismantling. It is assumed that chemical or electrolytic methods for the decontamination of equipment before dismantling will be applied.

Table B-27: Data on equipment located in buildings 801, 801a and 804 that will undergo decontamination before dismantling at V1 NPP

Identifier - Name	*Contamination*	*Chemical decontamination*				*Electrolytic decontamination*	
	[kBq/cm²]	*Mass [kg]*	*Number of loops [pcs]*	*Surface area [m²]*	*Volume [m³]*	*Mass [kg]*	*Surface area [m²]*
DTC 11.3 – Purification station of uncontrolled leaks	1-2	87 800	4	950	22.0	76 000	770
DTC 11.6 – Boric acid regeneration station	2 – 100	4 100	3	70	4.4	42 330	311
TC 24 – RAW depository	2 – 100	12 220	10	68	9.5	365 000	4 460
DTC 11.2 – Primary coolant drainage purification station	2 – 100	5 800	2	43	1	42 000	511
DTC 11.8 – Gas purification station	20 - 50	3 600	4	60	2.5	7 500	95
ŠK1, 2 – Special canalisation	0.5 – 2					1 300	35
VZT – Ventilation systems	0.1 – 1.1					21 000	800
Sum		**113 520**	**23**	**1 191**	**39.4**	**555 130**	**6 982**

Source: CDP

II.5.1.4 List of equipment located in building 803 essential from the point of view of pre-dismantling decontamination of inner surfaces

The contamination of equipment located in building 803 relates to the following systems given in table B-28.

Table B-28: Data on equipment located in building 803 that will undergo decontamination before dismantling at V1 NPP (Source: CDP)

Identifier – Name	*Contami-nation [kBq/cm²]*	*Carbon steel*		*Stainless steel*		*Bitumen pipe*		*Plastic (Novodur) pipe*	
		Mass [kg]	*Surface area [m²]*	*Mass [kg]*	*Surface area [m²]*	*Mass [kg]*	*Surface area [m²]*	*Mass [kg]*	*Surface area [m²]*
TC 31 Special laundry	0.01-0.1	-	-	20 800	93	-	-	-	-
TC ŠK Special canalisation	0.01-0.1	1 660	450	5 100	95	5 200	140	1 000	32

II.5.1.5 Contamination of inner surfaces in building 804

Located in the bridge connecting the operating building to the main production building there are some pipelines with radioactive media belonging mainly to the process system PS 11. The mass and contaminated surface of these pipes are included in CB 801.

II.5.2 Contamination of building surfaces

The contamination of building surfaces is indicated in the *V1 NPP Conceptual Decommissioning Plan (2006)*. The following table B-29 shows the data on the assumed size of the contaminated outer surfaces after the power plant final shutdown which will undergo chemical and semi-dry electrolytic decontamination and washing – off.

Table B-29: Contamination of outer surfaces after the plant final shutdown

	Surface area [m^2]	*Surface contamination [Bq/m^2]*	*Total activity [Bq]*
Stainless steel lining			
Main production building	15 865	$1x10^4$	$1.59x10^8$
Auxiliary production building	7 372	$1x10^4$	$7.37x10^7$
Carbon steel lining			
Main production building	6 666	$1x10^4$	$6.67x10^7$
Auxiliary production building	646	$1x10^4$	$6.46x10^6$
Surfaces with epoxy coating			
Main production building	1 130	$1x10^4$	$1.13x10^7$
Auxiliary production building	232	$1x10^4$	$2.32x10^6$
Stack	2 540	$6\ x10^3$	$1.52x10^7$
Operating building and civil defence shelter	30	$1x10^4$	$3.00x10^5$
Bridges	35	$1x10^4$	$3.50x10^5$

Source: CDP.

The amount of radioactive concrete produced by the mechanical decontamination of building surfaces is given in table B-30.

Table B-30: Data on radioactive concrete produced by the mechanical decontamination of building surfaces

	Surface area [m^2]	*Volume of concrete [m^3]*	*Specific activity*		*Total activity [Bq]*
			[Bq/m^3]	*[Bq/kg]*	
Main production building – CB 800					
Scarifying the contaminated flooring and walls	8 626	86.26	$5x10^5$	217	$4.31x10^7$
Cutting out the special canalisation gullies and penetrations – 376 pcs	180 (cut area)	94	$5x.10^5$	217	$4.69x10^7$
Auxiliary production building – CB 801					
Scarifying the contaminated flooring and walls	6 340	63.4	$5x10^5$	217	$3.17x10^7$
Cutting out the special canalisation gullies and penetrations – 68 pcs	48 (cut area)	17	$5x10^5$	217	$8.48x10^6$

	Surface area [m^2]	Volume of concrete [m^3]	Specific activity [Bq/m^3]	Specific activity [Bq/kg]	Total activity [Bq]
Bridges – CB 804					
Scarifying the contaminated flooring and walls	20	0.2	$5x10^5$	217	$2x10^5$
Operating building and civil defence shelter- CB 803 + 781					
Cutting out the special canalisation gullies and penetrations – 24 pcs	6 (cut area)	1.3	$5x 10^5$	217	$6.50x10^5$

Source: CDP

II.5.3 Inventory of activated materials

II.5.3.1 Reactor and reactor internals

The complete data on reactor, reactor internals and external shieldings has been prepared and taken over from the *V1 NPP Conceptual Decommissioning Plan (2006)* and supplemented by the experience from Greifswald NPP decommissioning. The data on specific mass induced activity of individual activated components of the reactor are based on the calculations of activation of the WWER 440 reactor components of Loviisa NPP in Finland, because the activation calculations for V1 NPP do not yet exist. The value of internal contamination of the primary circuit 3.00 E+08 Bq/m^2 was conservatively selected for the contamination level of reactor internals and the 30-year operation of the reactor was considered in calculations of activation, what is a slightly more conservative assumption when compared with the reality (28 years). The data used are summarized in table B-31.

Table B-31: Input data for two V1 NPP reactors and their components at the time of final shutdown and media discharge

Name of the component	*Material type*	*Weight (t)*	*Internal area (m^2)*	*Internal contamination (Bq/m^2)*	*Induced activity (Bq/t)*
RPV (core area) – lining	N - steel	8.674	60	$3.00{\cdot}10^8$	$6.84 \cdot 10^{10}$
RPV (core area) – basic material	C - steel	78.066	60	-	$1.12 \cdot 10^{10}$
RPV (aside core area) – lining	N - steel	33.452	253.8	$3.00{\cdot}10^8$	$6.84 \cdot 10^8$
RPV (aside core area) – basic material	C - steel	301.068	253.8	-	$1.12 \cdot 10^8$
Core barrel (core area)	N - steel	46.700	103	$3.00{\cdot}10^8$	$6.15 \cdot 10^{11}$
Core barrel (aside core area)	N - steel	29.600	232	$3.00{\cdot}10^8$	$6.15 \cdot 10^9$
Reactor core basket (core area)	N - steel	35.200	47	$3.00{\cdot}10^8$	$1.98 \cdot 10^{12}$
Reactor core basket (aside core area)	N - steel	9.640	26.5	$3.00{\cdot}10^8$	$1.00 \cdot 10^{11}$
Reactor cavity bottom - activated part	N - steel	14.300	50	$3.00{\cdot}10^8$	$5.91 \cdot 10^9$
Reactor cavity bottom – remaining part	N - steel	31.640	221	$3.00{\cdot}10^8$	$5.91 \cdot 10^7$
Protecting tube system – bottom plate	N - steel	13.360	36	$3.00{\cdot}10^8$	$1.43 \cdot 10^{11}$
Protecting tube system – activated part	N - steel	40.860	1430	$3.00{\cdot}10^8$	$1.43 \cdot 10^8$
Reactor lid – lining	N - steel	127.140	32	$3.00{\cdot}10^8$	$1.00 \cdot 10^6$*
Reactor lid – basic material	C - steel	91.260	32	-	$1.63 \cdot 10^5$*
Shielding assemblies (72 pieces from 2 units)	N - steel	20.880	92	$3.00{\cdot}10^8$	$1.33 \cdot 10^{13}$

Name of the component	Material type	Weight (t)	Internal area (m^2)	Internal conta-mination (Bq/m^2)	Induced activity (Bq/t)
Absorbing part of control rods (173 pieces)	N - steel	20.800	208	$3.00 \cdot 10^8$	$1.36 \cdot 10^{13}$
Connecting parts of control rods (173 pieces)	N - steel	9.000	52	$3.00 \cdot 10^8$	$1.49 \cdot 10^{13}$
In-core measurement	N - steel	4.000	30	$3.00 \cdot 10^8$	$4.43 \cdot 10^{10}$
Water biological protection (core area)	C - steel	25.320			$6.44 \cdot 10^9$
Water biological protection (aside core area)	C - steel	96.600			$2.00 \cdot 10^7$*
Thermal shielding – mixture of crushed cast iron, serpentinite rubble and boron carbide	C - steel	172.880			$2.47 \cdot 10^8$
Thermal shielding – steel plate (core area)	C - steel	1.240			$4.97 \cdot 10^9$
Thermal shielding – steel plate (aside core area)	C - steel	7.720			$2.10 \cdot 10^7$*
Thermal shielding – glass fibres + fabric	other material	14.000			$1.20 \cdot 10^6$*
Activated reactor shaft concrete	concrete	240.000			$8.20 \cdot 10^4$

* Expert judgement Source: CDP.

II.5.3.2 Dummy assemblies of V1 NPP

Dummy assemblies, protecting the reactor pressure vessel against reduction of its resistance to embrittlement, have been installed at V1 NPP as follows:

- At unit 1 in 1992 in a quantity of 36 pieces and the replacement of which is not anticipated till the shutdown of V1 NPP unit 1 in 2006.
- At unit 2 in 1985 in a quantity of 36 pieces and the replacement of which is not anticipated till the shutdown of V1 NPP unit 2 in 2008.

Taking into account that the weight of one dummy assembly is 290 kg, their total weight is 72 x 290 kg = 20.88 t (see table B-31).

II.5.3.3 Absorbing parts of control rods of V1 NPP and connecting parts between absorber and fuel part

Based on the information provided by SE EBO, at the time when V1 NPP units will be finally shut down, the following numbers of activated absorbing parts of the control rods will exist:

- in 2006 at unit 1, 89 pieces in total,
- in 2008 at unit 2, 84 pieces in total.

The weight of one absorbing part of a control rod is 0.12 t. The total weight of the activated absorbing parts of control rods, at both V1 NPP units, will thus be 20.8 t.

It is assumed, that the weight of an irradiated connecting part of one assembly is 0.052 t. Then total weight of these parts is thus 173 x 0.052 t = 9 t (see table B-31).

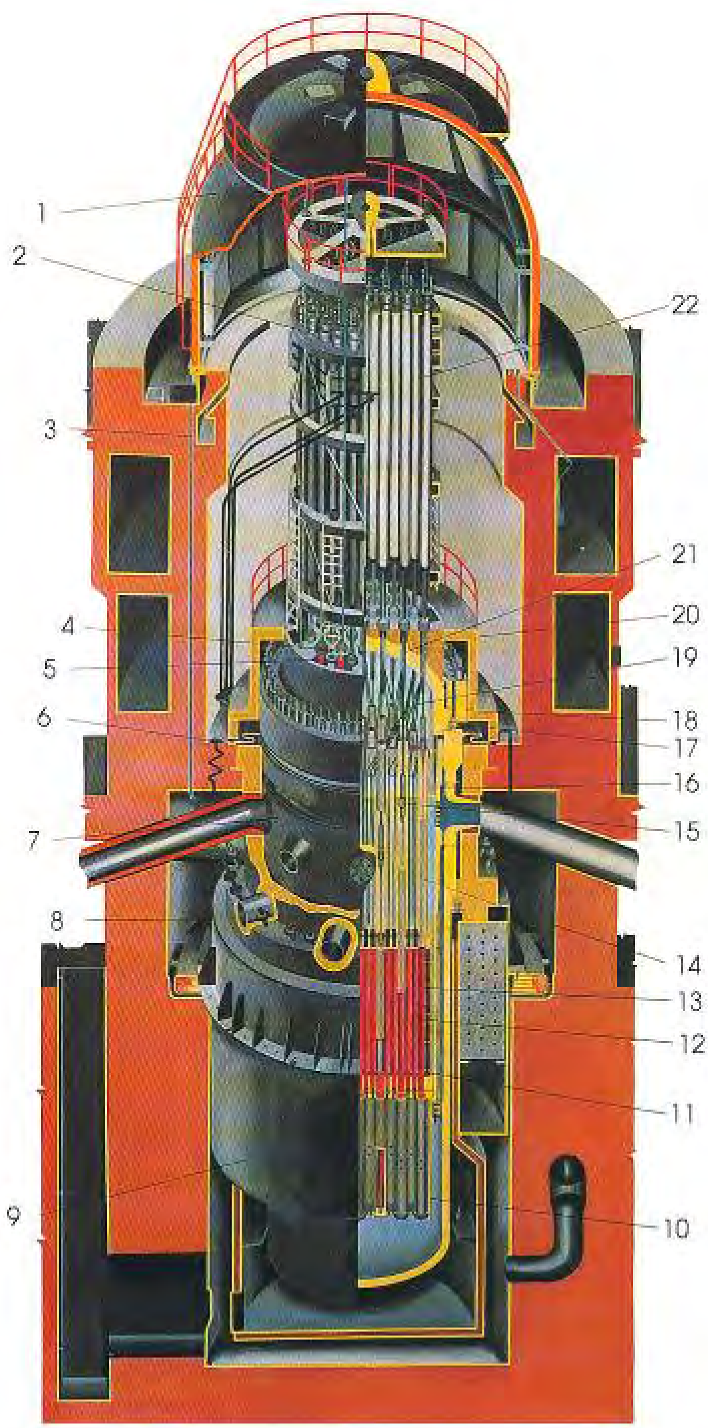


Figure B-3: *WWER 440 V230 type reactor. 1 – protective lid, 2 – upper block, 3 – ionising chamber channel, 4 – channels of in-core measurement of neutron flux, 5 – temperature measurement channels, 6 – membrane valve, 7 – reactor body, 8 – main circulating pipes, 9 – tank of water biological protection, 10 – shaft bottom, 11 – reactor core basket, 12 – fuel assemblies, 13 – fuel part of control rods, 14 – absorbing part of control rods, 15 – connecting rod, 16 – block of protective tubes, 17 – sealing ring, 18 – thrusting ring, 19 – temperature measurement channels, 20 – thermal insulation, 21 – rack rod, 22 – control rod drives.*

II.5.3.4 Parts of In-Core measurement

According to Finnish experience in Loviisa NPP, the estimated weight of the activated parts of measuring channels and thermocouples of both units is 4 t.

II.5.3.5 Activated part of water biological protection steel box (inner wall) and reactor pressure vessel thermal shielding

The WBO is basically a ring shaped vessel, located around the reactor pressure vessel in the area of the reactor core. Its main dimensions and weight are:

- height 4 950 mm,
- internal diameter ∅ 4 140 mm,
- outer diameter ∅ 6 100 mm,
- total weight 60 960 kg.

From the point of view of the specific induced activity of activated WBO, it can be assumed that this material will be ranked among the intermediate to low level radioactive materials, where the most exposed parts are the vessel and reinforcing ribs inside WBO in the area of the reactor core with a 50 cm overhang above and below its boundaries. The data expected immediately after the final shutdown are summarised in the table B-31.

Thermal shielding is an insulating layer on the reactor pressure vessel. It consists of several mixtures in various combinations. Glass cloth and glass fibres are used on the nozzle level, crushed cast iron, serpentine rubble and boron carbide are used below the nozzle level. Steel plate and fibre glass matting are used on the reactor core and reactor bottom levels. Data expected immediately after the final shutdown are summarised in the table B-31.

II.5.3.6 Activated concrete

The weight of activated reactor shaft concrete of both units is 240 t (100 m^3). It is assumed that concrete is activated in the reactor core area up to a depth of 500 mm (see table B-31).

II.5.4 Very Low Level Waste

Very low level radioactive waste can be defined as a radioactive waste, which cannot be cleared from regulatory control, but on the other hand, its low activity makes its disposal in lower engineered disposal facilities (e.g. without using expensive FCC containers) or less equipped disposal facilities (e.g. on-site disposal) possible. Activities of radioisotopes up to centuplicate of the exemption/clearance values can be preliminarily considered as typical ones of this class of waste.

It is assumed for the calculation that VLLW like contaminated concrete debris and soil and other non – metallic solid RAW in CB 800 and CB 801 will be present in the amounts given in the following table B-32.

Table B-32: Data on very low level waste

CB	*Concrete debris [m^3]*	*Soil and other non-metallic RAW [m^3]*
CB 800	100	50
CB 801	50	50

Source: CDP.

Besides this, 994 tons of very low level steel and 13 tons of very low level non-ferrous metals will arise. These will be stored in ISO containers in the interim RAW storage facility and after a certain time period and fulfilling the conditions, they will be released into the environment.

II.5.5 Waste releasable to the environment

SE EBO is both the producer and disposer of the conventional waste and sludge and it operates two dump sites:

- *Dump site for non-radioactive sludge in Pastuchov*. It has been operated since 1982 and is designed to dispose of exclusively sludge from the cooling water treatment. In 2005, about 7640 t of sludge was disposed of there (860 tons were applied by agricultural co-operative farms in the region to improve the quality of farmland).

- *Dump site for solid municipal waste in Žlkovce*. It belongs to the Class III dump sites. In 2005, 2617 t of waste were disposed of there, out of this 601 t from nuclear installations, the rest from nearby villages.

In 2005, SE EBO produced 12 616.937 tons of waste (of which 12 512.32 tons were of O category waste and 104.62 tons of N category waste) and the former SE VYZ produced 1 236.95 tons of waste (of which 1234.311 tons were of O category waste and 2.639 tons of N category waste)

The V1 NPP decommissioning itself will be a source of non-radioactive waste which can be released into the environment. The maximum amount of non-utilisable waste which is to be dumped applies to alternatives 2 and 3, i.e. approximately 7 900 tons (see table B-34) which will be produced over the period of 22 years.

Such non-radioactive waste can be divided into two groups:

Utilisable materials. These will be materials from the demolition of civil structures and metallic materials from the dismantling and demolition. Building materials (concrete, reinforced concrete, panels, etc.) will be recycled and, in accordance with current prices, may be offered to potential customers. Metallic materials from dismantling and demolition will be shipped to a salvage All utilisable materials (recycling, salvage) are considered to be secondary raw materials.

Non-utilisable materials are waste that are classified as other waste according to the Decree no. 284/2001 Coll. (glass wool, building debris, residues from demolition, etc.). These materials will be shipped to a suitable dump site. No new dump sites are preliminarily planned to be built to accommodate this waste. The categorisation of this waste is given pursuant to the current Waste Catalogue in table B-33.

Table B-33: Categorisation of waste releasable to the environment

Material	*Waste type number*
Glass wool	17 06 04
Zinc coated sheet	17 04 05
Metal	17 04 05
Non-ferrous metals	17 04 01
Ingots from remelt	17 04 07
Concrete	17 01 01
Reinforced concrete	17 09 04
Building steel structures	17 04 05
Prefabricated elements	17 01 07
Masonry	17 01 02
Feal	17 04 02
Panels	17 01 07
Steel	17 04 05
Other waste	17 01 07 (09 04)

After seperation, Category N materials will be directly handed over to the specialised organisations in order to handle them in accordance with the valid regulations.

Amounts of non-radioactive waste that, in accordance with applicable regulations, can be released to the environment, was divided into three basic groups in the Conceptual Decommissioning Plan:

- metals,
- recyclable building materials (building rubble),
- waste that can be disposed of at the dump sites for non-radioactive waste.

The estimated amounts of such waste are given in table B-34.

Table B-34: Non-radioactive waste from V1 NPP decommissioning [t]

	Alternative 1	*Alternative 2*	*Alternative 3*
Metals [t]	55 996	61 004	59 867
Recyclable building materials [t]	418 125	318 734	318 599
Waste to be dumped [t]	3331	7 855	7 883

Source: CDP.

II.5.6 Radioactive waste

In the Conceptual Decommissioning Plan, the amounts and volumes of the decommissioning RAW were estimated. Liquid RAW includes concentrates and spent ion-exchange sorbents that will be shipped in a requested packaged form to the RAW Treatment and Conditioning Facilities for final conditioning by cementation or bituminisation.

As far as solid RAW is concerned, it includes the following groups:

- soft compactable waste,
- incinerable waste,
- small metallic debris,
- metal waste,
- pellets from high-pressure compacting,
- concrete,
- ventilation system filters,
- sand, anthracite, charcoal,
- low and medium level radioactive reactor parts,
- reactor core area materials,
- biological shielding, instrumentation, control rods,
- shielding assemblies.

The same packaged forms are envisaged for all radioactive waste, – standard fibre-concrete containers with an internal volume of 3.1 m^3. Amounts of disposable as well as non-disposable RAW in NSR are converted to the number of such containers (table B-35). Package assemblies not disposable in NSR will be temporarily stored in the RAW interim storage facility.

Table B-35: Production of packaged forms from V1 NPP decommissioning

	Alternative 1	*Alternative 2*	*Alternative 3*
Number of FCC disposable in NSR Mochovce	1038	886	1050
Number of FCC not disposable in NSR Mochovce	44	30	30

Source: CDP.

II.5.6.1 Methods of radioactive waste management

Use of the following methods of RAW management is considered in the course of preparation and implementation of the decommissioning:

- water evaporation,
- bituminisation of concentrates and sorbents,
- cementation of concentrates, sorbents, sludge and of some other solid RAW,
- incineration,
- low-pressure compaction,
- high-pressure compaction,
- fragmentation of metallic items,
- decontamination,
- sorting,
- recycling of cables and conductors,
- measurement and excavation of contaminated soil.

The input data for available RAW treatment and conditioning methods are given in table B-36.

Table B-36: Considered methods and relevant input data for RAW management

Evaporation	Waste treatment capacity	SUF of labour hours needed	Water consumption	Steam consumption	Electricity consumption	Inlet salinity	Outlet salinity		
	m^3/h	h/m^3	m^3/m^3	t/t	kWh/m^3	g/kg	g/kg		
	0.5	2.2	0	1.1	0	5	200		
Bituminisation of concentrates	Waste treatment capacity	SUF of labour hours needed	Water consumption	Steam consumption	Electricity consumption	Inlet salinity	Bitumen consumption	HNO_3 consumption	Density of bituminisation product
	m^3/h	h/m^3	m^3/m^3	t/m^3	kWh/m^3	g/kg	t/m^3	l/m^3	kg/m^3
	0.06	22.5	4.4	4.5	300	200	0.509	2.59	1290
Cementation of concentrates	Waste treatment capacity	SUF of labour hours needed	Water consumption	Steam consumption	Electricity consumption	Inlet salinity from CB 801	Inlet salinity for the process	Cement consumption	Lime consumption
	m^3/h	h/m^3	m^3/m^3	t/m^3	kWh/m^3	g/kg	g/kg	t/m^3	t/m^3
	0.375	12	0.1	0.61	10	200	425	0.8	0.03
Incineration and processing the ash and water	Waste treatment capacity	SUF of labour hours needed	Washing water consumption	Steam consumption	Diesel oil consumption	Electricity consumption	Salinity of washing water	Demi water consumption	Amount of ash
	t/h	h/t	m^3/t	t/t	t/t	kWh/t	g/kg	m^3/t	t/t
	0.04	85.7	0.20	1.2	0.01	2000	130	0.6	0.07
	Ash amount in drum	Cement consumption	Lime consumption	Reduction factor of ash compaction	No. of drums in FCC container				
	t/pc	t/t of waste	t/t of waste		pc				
	0.15	0.125	0.033	3	20				
LP compaction	Waste treatment capacity	SUF of labour hours needed	Electricity consumption	Reduction factor					
	kg/h	h/t	kWh/t						
	850	8	2	5					
HP compaction	Waste treatment capacity	SUF of labour hours needed	Electricity consumption	Consumption of CP for grouting	Amount of metal in drum	Reduction factor	No. of drums in FCC container		
	kg/h	h/t	kWh/t	m^3/t	t/pc		pc		
	700	10	5	0.407	0.3	2.5	20		

Final fragmentation	Waste treatment capacity	SUF of labour hours needed	Electricity consumption for C-steel	No. of workers on the shift	Acetylene consumption	Oxygen consumption	Compressed air consumption	Electricity consumption for S-steel	Max. amount of metal in FCC
	kg/h	h/t	kWh/t		Nm^3/t	Nm^3/t	Nm^3/t	kWh/t	t/pc
	571.4	7	10	2	1	15	20	40	6.6
Sorting	Waste treatment capacity	SUF of labour hours needed	Electricity consumption	No. of workers on the shift					
	kg/h	h/t	kWh/t						
	6.2	327	10	3					
Cementation of reinforced concrete from reactor shaft	Waste treatment capacity	SUF of labour hours needed	Ratio of outlet and inlet volume	Cement consumption	Electricity consumption				
	m^3/h	h/m^3		t/m^3	kWh/m^3				
	0.375	23	1.7	0.8	15				
Cementation of sorbents and sludge	Waste treatment capacity	SUF of labour hours needed	Ratio of outlet and inlet volume	Cement consumption	Electricity consumption				
	m^3/h	h/m^3		t/m^3	kWh/m^3				
	0.375	15	1.2	0.8	10				
Cementation of sand	Waste treatment capacity	SUF of labour hours needed	Ratio of outlet and inlet volume	Cement consumption	Electricity consumption				
	m^3/h	h/m^3		t/m^3	kWh/m^3				
	0.375	12	1	0.5	10				
Secondary RAW rise during decommissioning	Rise of combustible waste	Rise of compactable waste	Rise of small piece metallic waste						
	kg/h	kg/h	kg/h						
	0.027	0.021	0.067						
Grouting the OTH+CM+ filters by cementation product	Waste treatment capacity	SUF of labour hours needed	Electricity consumption	Amount of metal in drum	No. of drums in FCC container	Reduction factor by compaction	Amount of material in drum		
	kg/h	h/t	kWh/t	t	pc		t		
	0.375	2	4	0.2	20	3	0.15		

Volume of cementation product from concentrates [m^3/m^3 of concentrate at salinity 200kg/m^3]… 0.944.
Volume of bituminisation product from concentrates [m^3/m^3 of concentrate at salinity 200 kg/m^3]… 0.56.

Source: CDP.

II.5.6.2 Conditioning before the final disposal at Near-Surface Repository and storage in the Interim RAW Storage Facility

Intermediate products in the following forms will arise from radioactive waste treatment:

- drums with cemented or bituminised RAW,
- pellets - products after the high–pressure compaction of activated or contaminated metallic components, compactable non-metallic solid RAW and ash arising from incineration of combustible RAW,
- free/loose material without outer package - activated concrete and non-compactable activated or contaminated large dimension metals.

Intermediate products of RAW treatment and RAW pieces will be conditioned by their cementation in FCC to the packaged form suitable for disposal. VLLW, such as contaminated concrete debris and contaminated soil, and compactable non-metallic solid RAW will be disposed at the VLLW disposal facility. Some of the VLL contaminated metallic components will be stored in the interim RAW storage facility in ISO containers or in other suitable containers and after a spontaneous radioactive decay of radionuclides, they will be released into the environment after fulfilling the limits.

II.5.6.3 Package assemblies for the Near-Surface Repository and Interim RAW Storage Facility

At the present time, the only acceptable packaged form for NSR Mochovce is the radioactive waste fixed in cement matrix in a fibre concrete container (figure B-4).

The FCC container (manufactured by VYZKONT, s.r.o., Trnava under the licence of Sogefibre company, France) is made of fibre concrete, which consists of cement, aggregates, sand, filling, siliceous light ashes, superplasticizer, water and dispersed metallic fibres. The fibre concrete container has a cubic shape with outer dimensions of 1.7 x 1.7 x 1.7 m. It consists of the following parts:

- container body,
- container lid,
- two plugs.

The FCC parameters are given in table B-37. After filling with the waste (drums, compacts or loose waste) and grouting of the container with a cement mixture, the body of the container with the lid and plugs are sealed with a mixture of the same composition as used for the container production.

It is possible to insert 6 MEVA drums or 4 drums plus 8 pellets after high pressure compaction of compactable waste to one FCC.

The final product of the RAW conditioning is the fibre concrete container filled with a cement mixture or solid waste grouted with a cement mixture. Radioactive waste fixed in cement matrix, stored in a fibre concrete container with a long-term integrity in NSR Mochovce, represents safe storage jeopardizing neither humans nor the environment.

Table B-37: Properties and parameters of FCC

Property - parameter	*Note -identification*	*Value*
Effective height	H_u	1.43 m
Effective width	$Š_u$	1.45 m
Effective length	L_u	1.45 m
In each point	fibre concrete thickness lid thickness bottom thickness	100 mm min. 145 mm 125 mm
Effective volume	V_u	about 3.0 m^3
Weight	body lid plug	3 500.0 kg 690.0 kg 25.0 kg
Total weight		about 4 240 kg
Compression strength (after 28 days)		> 50.0 MPa
Bending strength (after 28 days)		> 4.5 MPa
Shrinkage (after 28 days)		< 350.0 mm/m
Water tightness (after 7 days)		no leaks
Diffusion coefficient of tritium water for 2 cm thickness		> 1.5 x 10^{-3} cm^2/day
Diffusion coefficient of Cs for 1 cm thickness		> 1.0 x 10^{-3} cm^2/day
Nitrogen permeability		> 5x 10^{-18} m^2
Radiation resistance		Total absorbed dose 10^6 Gy without significant changes of mechanical properties
Gas tightness	before the test after the test	0.619 atm cm^3 s^{-1} 0.615 atm cm^3 s^{-1}
Loading test by alternating thermal cycles		20% relative decrease of strength
Drop test from 1.2 m height on the bottom edge	total weight: 11 510 kg	lid move: 1 - 3 mm (damaged edges out of container body, without weight changes)

Maximum weight of filled container must not exceed **15 000 kg.** Source: VYZKONT, s.r.o., Trnava

ISO containers will be used for the storage of low level RAW in the interim RAW storage facility at GovCo (JAVYS) site. Parameters of the ISO container are presented in table B-38.

Table B-38: Parameters of ISO container

Parameter	*Value*
Width	2.438 m
Height	2.438 m
Length	6.058 m
Maximum weight with filling	24 t
Number of drums	50 pcs

Source: CDP.

Compactable solid RAW is compacted in so called MEVA drums. Compacts arising are inserted into containers and grouted with a cementation mixture from the cementation plant. The parameters of the MEVA drum are presented in table B-39:

Table B-39: Parameters of MEVA drum

Parameter	*Value*
Material	Galvanised coating
Material thickness [mm]	1.5
External height [mm]	805
Internal diameter [mm]	575
Effective volume [dm^3]	200
Drum weight [kg]	15
Maximum filling weight [kg]	360

Source: CDP.

Figure B-4: Insertion of RAW packaged form (FCC) to the storage chamber of near-surface repository in Mochovce

II.5.6.4 Treatment and handling of non-radioactive waste

Certain proportion of uncontaminated waste will arise from the dismantling of the facilities and from the demolishing of the construction part of the nuclear power plant. This waste includes:

- metallic equipment from dismantling after decontamination (or without it) to the level suitable for release into the environment (steel, non-ferrous metals from contaminated cables, etc.) for recycling and reuse,
- construction waste from the demolished buildings (after their contingent precedent decontamination),
- equipment parts after their dismantling and separation.

The purpose of the decontamination, separation, temporary storage and of the other activities is to obtain the highest possible amount of uncontaminated waste. That part of this waste, which fulfills the appropriate limits, will be released to the environment after various conditioning methods and recycling (steel, non-ferrous metals and various construction materials - concrete, masonry).

It is assumed that a certain amount of special materials (asbestos, anti-fire coating material of electric cables, waste contaminated by oil from lub-oil system, fluorescent tubes, lead storage batteries, etc.) will arise. These will be directly shipped to specialised organisations to handle them in accordance with the valid regulations. A separate part consists of uncontaminated construction materials left in the ground without their removal below a level of – 1.00 m, if this is the case in the decommissioning alternative.

II.5.6.5 Types of uncontaminated waste

Uncontaminated material will consist of the following waste:

Recyclable metallic waste:

- non-ferrous metals (aluminium, copper, brass, lead, etc.), e.g. from window frames, peripheral walls,
- carbon and stainless steel (pipes, sheets from sheeting, linings, parts of the equipment, hermetic and protective doors, crane lines and their parts, sewage pipings, steel wires and so on),
- steel structures from buildings.

Recyclable building material:

- concrete,
- reinforced concrete,
- prefabricates,

- masonry,
- aggregate (staircases),
- peripheral panels.

Usable material – collection and shipment to the salvage:

- electric installation copper cables,
- electric installation aluminium cables.

Other and special material destined for the conventional waste dump:

Other waste:

- wood (wooden products),
- glass, glass fibres from equipment insulation,
- ceramic material (electric installation, sanitary ware, etc.),
- roof coverings (bitumen, etc.),
- roof thermal insulation, water-proof insulation,
- plastic (polystyrene, PVC, polyacrylate, PE, polypropylene, PESL, etc.) from floorings,
- rubber materials,
- small waste – means of personal protection, textile, paper,
- other unsorted garbage from the demolition,
- anti-fire coating material of electric cables – materials without harmful substances,
- non-recyclable compound cables – low-current, bus cables (annunciation ones and others).

Special material:

- anti-fire coating material of electric cables (containing antimony dioxide, asbestos),
- asbestos material,
- material contaminated by oil (soil),
- fluorescent tubes, lead storage batteries, etc.

Uncontaminated building material under a level of -1.00 m - not excavated (if this is the case in the decommissioning alternative):

- concrete,
- reinforced concrete.

II.6 NOISE AND VIBRATIONS

The activities in the submitted alternatives are mostly carried out in enclosed areas. Such technological equipment, which is not and will not be the source of excessive noise, will be used. Those activities, which do not cause excessive noise will be carried out in outside areas. They are represented by common working activities and shipment; the shipment means used are common motor vehicles.

The recycling of construction materials will result in a noise similar to the noise of stone crushing in a stone quarry. In such a case, measures will be taken to decrease possible excessive noise, e.g. shielding, covering the equipment, etc.

The demolition work will only be of a temporary nature, hence it will not significantly infringe on the comfort of living of the population in the affected municipalities.

II.7 RADIATION AND OTHER PHYSICAL FIELDS

The activities anticipated to be carried out in the frame of the individual alternatives on the V1 NPP site will not significantly affect magnetic, thermal or other fields on SE EBO and GovCo (JAVYS) sites and in their surroundings.

The implementation of the submitted alternatives will result in the status, in which sources of radioactivity which currently contribute to the radiation level on the site, will be finally removed or significantly reduced.

II.7.1 Data on dose rates in the groups of rooms and radiation load of personnel

The level of radiation in the rooms and spaces is determined by the following factors:

- The activity of the given technological systems,
- The tightness of the equipment, which influences the surface contamination of the rooms.

Based on the survey of the present radiation situation in V1 NPP buildings, it is advantageous to classify those rooms of the buildings, which are important from the point of view of decommissioning. The classification is based both on dose rate and surface contamination. The categories of classification approximately match the categories of accessibility (*table B-40*).

Table B-40: Classification of the rooms according to the radiation level during power operation

Building	*Category*	*Accessibility*	*Dose rate during power operation*	
			Average [μGy/h]	*Maximum [μGy/h]*
Reactor building 800	1	serviced	1	25
	2	semi-serviced	100	1 000
	3	non-serviced	1 000	200000
Auxiliary production building 801	1	serviced	0.3	30
	2	semi-serviced	10	180
	3	non-serviced	1 000	50000

Source: CDP.

During the operation termination period as well as during decommissioning, the average and maximum dose rates are diminishing in the rooms:

- of the first category, where the dose rate is induced mainly by radiation of the neighbouring first and second category rooms. The dose rate decreases proportionally with the decrease of radiation in the neighbouring spaces.
- of the second category, by approximately one order of magnitude, as a result of discharge of the operational radioactive substances (media).
- of the primary circuit (3rd category) by one or two orders of magnitude, partly because of the discharge of the media, partly because of the decontamination of the whole primary circuit (DF=10), should it be carried out.
- of the first category of the auxiliary production building, by about two orders of magnitude, resulting from the processing of the waste accumulated during the operation (in the operation termination period).

At the beginning of the operation termination period, external surface contamination will be the same as during the operation in all categories of the rooms. In those rooms where the radioactive media will be discharged, the fact that the radiation level will be successively decreased depending on the elapsing of time, shall be taken into account for the case of deferred dismantling.

In the case of unknown value of dose rate, an average dose rate of 20 μGy/h was used for calculation.

From the point of view of the personnel radiation load (CED) in the course of V1 NPP decommissioning, the following activities are significant:

- decontamination,
- dismantling,
- RAW management.

The performance of these activities may lead to external exposure of workers. This will be the main source of personnel radiation load. Another source – internal contamination by inhalation – can be eliminated in such a way that the workers will be equipped with protective means (respirators, scafanders). The magnitude of personnel radiation load is a collective effective dose (CED), which represents the sum of individual doses of all workers participating in the individual activities during the decommissioning (see table B-41).

Table B-41: Share of PSL item groups on CED, radioactivity of gaseous and liquid discharges

PSL item	*Collective effective dose [manSv]*	*Radioactivity of gaseous discharges [Bq]*	*Radioactivity of liquid discharges [Bq]*
Alternative 1			
01 Decommissioning preparation	0.014094	3 524	86 980
02 Operation shutdown	1.169794	292 448	7 219 298
03 Provision of equipment and materials	0	0	0
04 Dismantling	11.28209	2 561 697	63 237 335
05 Treatment, storage and disposal of RAW	1.159296	295 782	7 301 584
06 Protection, surveillance, maintenance of the site	0.0166	4 150	102 443
07 Demolition, restoration and landscaping of the site	0	0	0
08 Project management, engineering support	0.012528	3 132	77 316
09 Research and development	0	0	0
10 Fuel and nuclear materials	0.22336	55 840	1 378 450
11 Other costs	0	0	0
Total	**13.87776**	**3 216 573**	**79 403 407**
Alternative 2			
01 Decommissioning preparation	0.015503	3 876	95 678
02 Operation shutdown	1.169794	292 448	7 219 298
03 Provision of equipment and materials	0	0	0
04 Dismantling	5.771283	1 442 821	35 617 065
05 Treatment, storage and disposal of RAW	0.960176	240 044	5 925 657
06 Protection, surveillance, maintenance of the site	0.023542	5 886	145 289
07 Demolition, restoration and landscaping of the site	0	0	0
08 Project management, engineering support	0.009763	2 441	60 255
09 Research and development	0	0	0
10 Fuel and nuclear materials	0.22336	55 840	1 378 450
11 Other costs	0	0	0
Total	**8.173422**	**2 043 355**	**50 441 692**
Alternative 3			
01 Decommissioning preparation	0.011797	2 949	72 806
02 Operation shutdown	1.169794	292 448	7 219 298
03 Provision of equipment and materials	0	0	0
04 Dismantling	10.61488	2 612 380	64 488 472
05 Treatment, storage and disposal of RAW	1.185654	302 371	7 464 245
06 Protection, surveillance, maintenance of	0.017304	4 326	106 792

PSL item	*Collective effective dose [manSv]*	*Radioactivity of gaseous discharges [Bq]*	*Radioactivity of liquid discharges [Bq]*
the site			
07 Demolition, restoration and landscaping of the site	0	0	0
08 Project management, engineering support	0.01055	2 637	65 106
09 Research and development	0	0	0
10 Fuel and nuclear materials	0.22336	55 840	1 378 450
11 Other costs	0	0	0
Total	**13.23334**	**3 272 952**	**80 795 170**

Names of PSL item groups are given in table B-2. Source: CDP.

II.8 HEAT, ODOUR AND OTHER OUTPUTS

The submitted alternatives do not contain activities, which would present a significant thermal burden of the NEC Bohunice site surroundings and they will not be a source of odour in any of the stages of decommissioning.

II.9 SUPPLEMENTARY DATA

II.9.1 Expected incurred investments resulting from preparatory decommissioning activities

The expected incurred investments namely consist in implementation of preparatory decommissioning activities.

More detailed information on incurred investments is presented in *V1 NPP Conceptual Decommissioning Plan (2006)* and they are included in the total costs for decommissioning in individual alternatives.

The operation termination is the final period of plant operation under the authorisation for operation. This includes the preparation for V1 NPP final shutdown, V1 NPP final shutdown and establishment of the optimum conditions for its subsequent decommissioning. In this operation termination period, before the beginning of decommissioning, it is necessary to carry out some preparatory activities:

- The separation of V1 NPP from those other nuclear installations at the NEC Bohunice site remaining in operation.
- The preparation and implementation of V1 NPP final shutdown and termination of operation.
- The assessment of V1 NPP status at the beginning of decommissioning.
- The assurance of the availability of qualified personnel for decommissioning.
- The development of V1 NPP decommissioning documentation.

- The provision of new and/or modified infrastructure for V1 NPP decommissioning.
- Other tasks, such as the assessment of legal, technical and other preconditions and the requirements for handover of the V1 NPP for decommissioning.

The objective of the preparatory decommissioning activities is to provide the necessary technical, organisational and financial preconditions to start the decommissioning work and to provide a strategic planning for the whole decommissioning of V1 NPP. The preparatory decommissioning activities do not include those preparatory activities necessary for specific decommissioning activities, e.g. the design and installation of equipment for dismantling of the reactor pressure vessel and its internals, which will not be implemented in the first decommissioning stage. Such preparatory activities are to be considered as decommissioning activities in the course of detailed decommissioning planning.

Because the CDP describes the current situation only (as of the year 2005), those preparatory decommissioning activities identified are not necessarily the final ones. Changes in the input conditions (e.g. further development of the reference documents used) are to be considered during the elaboration of future decommissioning documentation.

For contingent problems to be further identified, appropriate projects will be suggested and the corresponding financial resources for their implementation will have to be assigned. The source of financial means can be the state budget, new grants from BIDSF or other financial sources.

II.9.1.1 Pre-decommissioning activities covered by BIDSF projects

In the frame of BIDSF, various projects are being carried out. They are divided into three groups as follows:

- Pre-decommissioning activities related mainly to V1 NPP system modification (A-projects):
  - a) PMU Consultant, phase 1 and 2 (project A1.1, A1.2),
  - b) Report on Bohunice V1 NPP decommissioning and historical waste management strategy (project A1.1, document 8),
  - c) Development of comprehensive documentation necessary for V1 NPP decommissioning licensing phase and decommissioning implementation phase (project A2.1),
  - d) Document configuration management system (project A2.2),
  - e) Reconstruction of area protection system AKOBOJE (project A3-A),
  - f) Reconstruction of the public warning and notification system (project A3-B),
  - g) Relocation of emergency response centre (project A3-C),
  - h) Provision of suitable decontamination facilities (project A4),

i) Modification (separation) of the power supply system of V1 NPP and V2 NPP and SE VYZ (project A5-A),

j) Modification of heating and steam distribution system (project A5-B1),

k) Reliable heat and steam supply: Reconstruction of the auxiliary boiler station at the Bohunice site (project A5-B2),

l) Modification of cooling and service water systems and raw water inlet system (project A5-C),

m) Replacement of operating fluids of the V1 NPP, V2 NPP and SE VYZ (project A5-D),

n) Spent fuel management (project A5-E),

o) Casks for spent fuel storage (project A5-F).

- V1 NPP decommissioning documentation preparation (B-projects):

a) The V1 NPP conceptual decommissioning plan (project B6.1),

b) The environmental impact assessment report of V1 NPP decommissioning (project B6.2),

c) The V1 NPP decommissioning stage plan and other documentation (project B6.3),

d) Decommissioning database (project B6.4),

- Pre-decommissioning activities related to RAW management (C-projects):

a) Treatment of metallic waste (project C7-A),

b) Treatment of historical waste, sludge and sorbents (project C7-B),

c) Treatment and conditioning of historical waste (project C7-C),

d) Additional transport means for liquid historical RAW from the V1 NPP to the existing treatment facilities (project C7-D),

e) Interim storage of RAW at Bohunice site (project C8),

f) Enlargement of the national repository at Mochovce (project C9),

g) Clearance of decommissioning materials (project C10),

h) Very low level waste disposal facility (project C11),

i) Refurbishment of the radiation protection monitoring equipment (project C12).

II.9.1.2 Preparatory decommissioning activities not covered by BIDSF projects

Activities not covered by BIDSF are namely:

- Ensuring the availability of experienced operation personnel till the end of V1 NPP operation termination period,
- Deep geological repository planning and implementation,
- Measures in the electrical transmission system incurred by V1 NPP final shutdown (financing claimed by Slovak electrical transmission system - SEPS),
- Technologies for historical solid waste retrieval,
- The reorganisation of V1 NPP management and personnel structure to facilitate decommissioning,
- The personnel training for new tasks in connection with V1 NPP decommissioning,
- The decommissioning management support system,
- The provision of sufficient buffer storage places for decommissioning materials,
- The shipment and storage means for decommissioning,
- Mobile working and protection (safety) equipment for decommissioning,
- The categorisation of equipment for decommissioning,
- The implementation of physical modifications of buildings and equipment.

II.9.2 Significant landscaping and encroachments upon countryside

No significant landscaping and encroachments upon countryside are anticipated in the whole course of decommissioning in any of submitted alternatives. On the contrary, site restoration will take place after the demolition of decommissioned unnecessary and unusable buildings.

II.10 SUMMARY OF MAIN PARAMETERS FOR INDIVIDUAL ALTERNATIVES

The summary of characteristic parameters for the individual decommissioning alternatives is presented in table B-42.

Table B-42: Summary of main parameters for alternatives 1, 2 and 3

Parameter	*Alternative 1*	*Alternative 2*	*Alternative 3*
Total costs [SKK mill.]	17 624.48	15 809.93	15 435.07
Collective effective dose [manSv]	13.8778	8.1734	13.2333
Duration of the decommissioning process under authorisation for decommissioning [year]	14	52	52
Labour hours needed [10^3 hours]	15 026.5	13 498.4	12 891.1
Amount of liquid RAW (at 200 g/dm^3 salinity) [m^3]	1 930	1 774	1 931

Parameter	Alternative 1	Alternative 2	Alternative 3
Radioactivity of gaseous discharges [Bq]	$3.22 \cdot 10^6$	$2.04 \cdot 10^6$	$3.27 \cdot 10^6$
Radioactivity of liquid discharges [Bq]	$7.94 \cdot 10^7$	$5.04 \cdot 10^7$	$8.08 \cdot 10^7$
Amount of released metals to the environment [t]	55 996	61 004	59 867
Amount of recyclable construction waste [t]	418 125	318 734	318 599
Amount of non-utilisable waste [t]	3 331	7 855	7 883
Number of FCC for NSR [pcs]	1 038	886	1 050
Number of FCC for IRAWSF [pcs]	44	30	30
Time load of the site by radioactivity [year]	13.7	51	51

Source: CDP.

The relatively small difference between CED for the alternatives 1 and 3 stems from the fact that the reactor together with the reactor internals will in both cases be decommissioned remotely (by a manipulator) and thus the radiation load resulting from the decommissioning of the reactor and reactor internals will be low.

The average value of the radioactivity of discharges during the power operation of V1 NPP is about 160 MBq for aerosols and about 65 MBq for corrosion and fission products in liquid discharges. These values result from appropriate values published in the SE, a.s. Reports on Environment in 2001 to 2005 obtained from the former SE EBO. These discharges represent about 0.1% and 0.2% of the stipulated annual limit values for the radioactivity of gaseous and liquid discharges for the NEC Bohunice site as a whole, which are as follows:

- Aerosols – 1.6×10^{11} Bq,
- Corrosion and fission products in liquid discharges – 3.8×10^{10} Bq.

The environmental impact of the decommissioning results mainly from:

- The extent of equipment operated in controlled area and way of its operation,
- The amounts of RA materials that are dismantled,
- The method of management with RAW generated during decommissioning.

The principal source of radioactive discharges will be the treatment and conditioning of RAW, decontamination of RA material and dismantling. The gaseous and liquid discharges will be generated, depending on used technologies. However, time distribution of amounts of generated discharges will also depend on the decommissioning alternative selected.

The distribution of radioactive discharges over a period of time is generally similar to the distribution of radiation load for personnel. The highest amounts are produced during the dismantling of contaminated and activated equipment, during decontamination work and RAW management, i.e. in Alternative 1 stage II, Alternative 2 stage III and Alternative 3 stage I.

For alternative 1, the estimated average annual activity value of liquid discharges represents about 5.6 % and the respective value for gaseous discharges represents 0.1 % of the appropriate measured annual values for V1 NPP power operation. The respective average annual radioactivity values for alternatives 2 and 3 are comparably lower than for alternative 1 due to the safe enclosure period with very low annual radioactivity values of liquid and gaseous discharges.

In general, the radioactivity of discharges from the V1 NPP decommissioning, independently of the chosen alternative, is much lower than during the power operation. The estimated maximum annual value of radioactivity of liquid discharges represents about 13.8% and the respective value of gaseous discharges represents 0.23% of the corresponding annual values measured for the V1 NPP power operation.

III. SUMMARY OF PART B

The EIA report provides in this Part B the clear and unambiguous information on submitted intention in the alternative solution. It defines the requirements on inputs and outputs and their direct impacts on the environment for each alternative of the proposed activity.

This part contains the comprehensive information on land, water and its sources, the raw material and energy sources, the requirements for transport and other infrastructure, the requirements for labour, the built-up area requirements, the list of the V1 NPP civil constructions and buildings to be decommissioned and so on.

Further the data are given on outputs and their potential direct impacts on the environment, namely: the discharges into the atmosphere and hydrosphere (which have to be in compliance with the authorised limits for the whole site and for the individual nuclear installations), the character of the waste waters and their purification, the limit values of waste water pollution, the summary data on the material inventory (amounts, kind, contamination, radionuclide composition of the contamination, etc.) and also for individual CBs of the V1 NPP. This part also provides the inventory of radioactive and hazardous materials, the activated materials, the very low level waste, the waste releasable to the environment, the radioactive materials and their management. Attention is also devoted to the noise, vibrations and radiation (dose rates in the rooms and the radiation load of personnel).

The information on incurred investments resulting from the preparatory decommissioning activities is also given in this part B.

PART C

I. CHARACTERISATION OF THE BOUNDARIES OF THE AFFECTED AREA

The demarcation of the boundaries of the affected area stems from the localisation of proposed activities in the Intention, their character, possible impact on population, on built-up area of the municipalities and on the surrounding country. The extent of the affected area is determined in such a way so that villages with areas belonging to the first threatened zone defined by the Decree of Ministry of Interior of the Slovak Republic No. 300/1996 Coll. are primarily included. This Decree is aimed at population protection in the course of production, shipment, storage and handling with hazardous substances. Its annex No. 2 *Break-up of threatened zones and assumed threatened zones and method of their delineation* establishes “areas” (30 km radius around the nuclear installations in Jaslovské Bohunice), “zones” (three ones with 5, 10 and 30 km radius) and “sectors” (16 sectors of a circle) (see Part A, figure A-6).

The first threatened zone, i.e.the circle of 5 km radius, is used due to the following reasons:

- The environmental impact assessments of nuclear installation decommissioning (but also of other nuclear activities) at the site have been performed and accepted in this zone according to Act No. 127/1994 Coll. up to now.
- This zone is sufficient for the emergency planning regulations for all installations in Jaslovské Bohunice; contingent incidents or accidents in the decommissioned NPP without the pressure system of the primary circuit, with removed spent fuel and with a minimal amount of stored unconditioned radioactive waste can only affect the site, contingently the adjacent area of the power plant.
- A different demarcation of areas around all nuclear installations at the NPP site in Jaslovské Bohunice, related to the environmental impact assessment issues, is not available.

The long-term monitoring of the components of the environment in the area of approximately 30 km radius is carried out in order to assess the impact on environment of nuclear installations being operated.

Possible impacts of the proposed activities on natural and anthropogenic components of the environment and on the population will be evaluated in the affected area. However, the restriction to the area of these villages is insufficient for the judgement of potential social and economic impacts of the V1 NPP decommissioning. Therefore it is necessary to consider a larger region, in accordance with the study called “Proposal of territorial and economic development of Trnava region after 2005 with regard to the shutdown of V1 NPP and its impacts on social situation in the region”, submitted by the Ministry of Labour, Welfare and Family of the Slovak Republic on the basis of SR Government resolution No. 974 issued on November 29th, 2000.

Similarly the characteristics and impacts on the environment will be assessed in the broader areas, the so called areas of interest, which represent the demarcated broader area from the geographical, regional, geological but also hydro-geological, phyto-geographical and zoo-geographical points of view.

II. CHARACTERISATION OF CURRENT ENVIRONMENTAL CONDITIONS

The area borders of interest are defined by natural conditions of the broader area of the nuclear-energy complex Jaslovské Bohunice (NEC Bohunice). These conditions are reflected in the mutual overlapping of geographical, regional, geological, but also hydro-geological, phyto-geographical and zoo-geographical divisions of the broader area. Natural conditions are specified by their geological structure copied by geomorphology. Consequently, we define the borders of the broader area of NEC Bohunice from regional geological and geo-morphological points of view. The broader area of NEC Bohunice comprises Blatnianska priehlbina Depression and Trnavská pahorkatina Upland, having a triangular configuration. Malé Karpaty and Považský Inovec Mts. build the natural margins. The southern border is formed by the Modra – Sereď line.

II.1 GEOLOGICAL ENVIRONMENT

II.1.1 Geological structure

According to the regional geological division, the NEC Bohunice area belongs to the Blatnianska priehlbina Depression, which is a part of the Trnavsko-dubnícka panva Basin, itself belonging to the Podunajská panva Basin. The units mentioned belong to the intra-mountain basins of the West Carpathians. The Blatnianska priehlbina Depression is flanked by the Považský Inovec core mountains from the east. To the west the situation is more complicated, considering that the margin of Blatnianska priehlbina Depression is built by Malé Karpaty Mts., with the following sub-areas from SW to NE: Pezinské Karpaty Mts., Brezovské Karpaty and Čachtické Karpaty Mts. Between the Pezinské Karpaty Mts. and the Čachtické Karpaty Mts., the Senica part of the Viedenská panva Basin extends directly to Blatnianska priehlbina Depression (Figure C-1).

Three tectonic units – Tatricum, Fatricum and Hronicum principally form the geological structure of the core mountains (Figure C-2). Tatricum is the externmost, the lowermost and relatively the most autochthonous unit of the Inner West Carpathians. Fatricum and Hronicum overlie Tatricum in the thrust position in the core mountain belt. During Tertiary, the Inner West Carpathians were in the zone of back arc extension and consequently the block of the West Carpathians was divided by faults to a system of depressions (e.g. Blatnianska priehlbina Depression) and horsts (e.g. Malé Karpaty Mts., Považský Inovec Mts.). Arisen depressions including the Blatnianska priehlbina Depression were consecutively filled by Tertiary and Quaternary sediments. The broader area of NEC Bohunice can be divided according to the age and lithology into pre-Tertiary, Tertiary and Quaternary rocks.

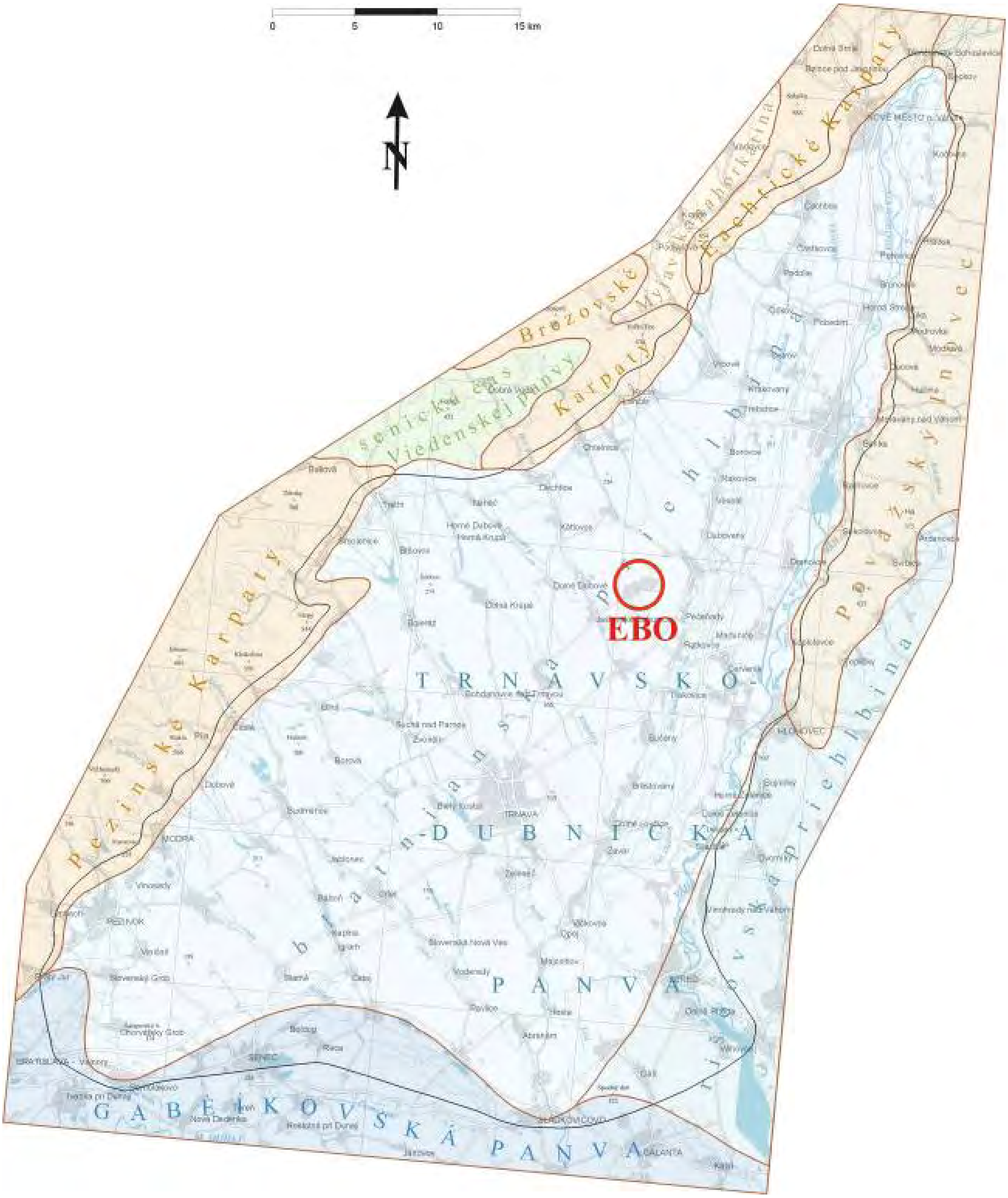


Figure C-1: Regional geological division (adapted according to Maglay et al., in press).

Pre-Tertiary rocks outcrops can be found in the core mountains edging the Blatnianska priehlbina Depression and at the same time they build the basement of the Tertiary sediments in this depression. They are represented by the tectonic units of Tatricum, Fatricum and Hronicum. Tatricum is built by crystalline represented by Modranský granitoidný masív (Modra Granitoid Massive), which is composed by biotitic granodiorites to tonalites. Metamorphosed rocks of Modra Massive (harmónska séria; Harmónska Series) are mostly built by phylites, consisting of chloritic-, sericitic-, siliceous shales, meta-sandstones, biotitic phylites, amphibolites, metamorphosed limestones, hornfels and cordieritic shales penetrated by granitoides. These rocks are of Palaeozoic (Devonian – Carboniferous) age. Crystalline is within the Tatric unit overlaid by orešianska sukcesia (Orešany Succession) comprising Lower Triassic quartzites, chert-limestones, siltstones, clay shales, sandstones and Cretaceous conglomerates.

The Hronicum tectonic unit builds the NE part of the Pezinské Karpaty Mts., the Brezovské Karpaty Mts. and the Čachtické Karpaty Mts. It represents an innerly complicated structure composed of several different lithofacial partial units, which consist of various chronologically and lithologically different types of dolomites and limestones.

The geological and tectonic structure of the Považský Inovec Mts., which flanks the major part of the Blatnianska priehlbina Depression from the east, is more complicated than the Malé Karpaty Mts. structure. That is particularly caused by the presence of Upper Cretaceous sediments (shales, rarely sandstones and conglomerates) infolded to Tatric crystalline. Such a position of Upper Cretaceous sediments is unique within the West Carpathians. With respect to the geological structure, the Považský Inovec Mts. are divided into three blocks: southern – Hlohovecký block, middle – Bojniansky block and northern - Selecký block. Tatricum in the region of the Považský Inovec Mts. is represented by granitoid rocks (biotitic leukogranodiorites to tonalites) cropping out in the Hlohovecký block north of Hlohovec town as well as by chloritic-muscovitic mica schist in the Selecký block. Mesozoic rocks are represented by metamorphosed Triassic and Jurassic limestones (Tribečská succession) and by Upper Cretaceous sandstones, shales, marlstones and conglomerates of Belická succession.

Fatricum is represented by two different facies developments. Shallow water facial development is present in the Selecký block near Beckov (Beckovská succession). This facies is represented by Middle Triassic limestones, shales and dolomites of Carpathian Keuper, by Lower- and Middle Jurassic sandy-, nodular and crinoidal limestones, by Lower Cretaceous chert limestones and by crinoidal limestones and marlstones of Upper Cretaceous. The deep water development of Fatricum is present in the Bojniansky block in small occurrences to the east of Piešťany town. It is represented by Middle Triassic dolomites and dark shales, by Carpathian Keuper strata, by Upper Triassic to Lower Jurassic organodetritic limestones and shales and by marly limestones of Upper Jurassic to Lower Cretaceous.

Hronicum is, similarly as in the case of Malé Karpaty Mts., built by several facial developments. Hronicum occurs mainly near Ducové, Hrádok and Kálnica. In Beckov it forms the castle rock basement and it is represented by Middle- and Upper Triassic limestones and dolomites.

The pre-Tertiary basement of the Blatnianska priehlbina Depression was reached by several deep wells, which penetrated tectonic units of Tatricum, Fatricum and Hronicum (Fig. C-3). The maximum depth of the basement lies in the central part of the Blatnianska priehlbina Depression. In this part the S-2 (Suchá) borehole penetrated 3 500 m of Tertiary filling, and the basement was not reached. Rock sequences of Tatric crystalline were reached by wells especially in the southern part of the region. In this part crystalline shales prevail over granitoid rocks. Fatricum was reached by KB-1, Tr-1, M-1 and VK-1 boreholes. Middle Triassic dolomites, Carpathian Keuper, Upper Triassic to Lower Jurassic dark pelites and limestones and argillaceous limestones of Lower Cretaceous were identified here. Hronicum tectonic unit occurs mainly by the NW margin of the Blatnianska priehlbina Depression and was reached by the Krupá- (Kr-1, Kr-3 a Kr-4) and Dubová- (D-1 a D-2) borehole series. A more continuous layer sequence was found at the depth interval of 1 515 to 1 790 m in Tr-1 (Trakovice) borehole.

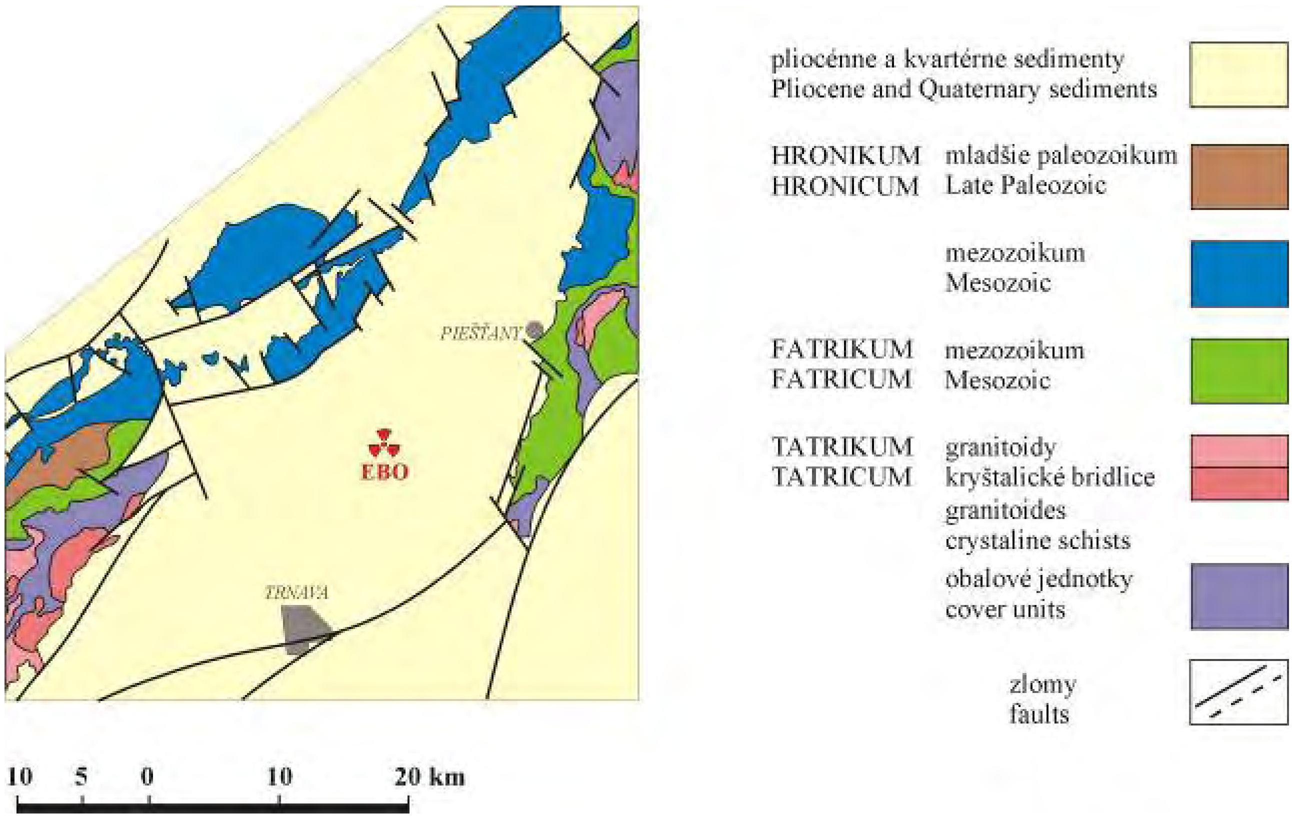


Figure C-2: Simplified geological situation

Tertiary sediments together with Quaternary sediments occupy significant parts of the broader NEC Bohunice area. Palaeogene sediments are present only as denudation remnants near Lúka comprising Eocene sandstones, clay shales and conglomerates of Hutianska Formation. Neogene sediments are rather lithologically monotonous, consisting predominantly of conglomerates, clay shales, sandstones, gravels, sands, variegated clays and less of tuffs and tuffites (see table C-1).

Quaternary sediments represent the youngest period of geological development in the area of interest and cover the Blatnianska priehlbina Depression almost continuously. Their thickness reaches up to 35 m. The increase in thickness is generally observed from north to the south. The Eolian loess sediments and loess loams of Pleistocene age are dominantly genetic as well as lithologic types. Quaternary (Lower Pleistocene to Holocene) fluvial and prolluvial watercourse sediments are similarly significant as Eolian sediments, considering the genesis, mass volume, area extent, stratigraphy, altitude and place of occurrence. They are represented especially by gravel, sandy gravels, loamy gravels, sandy loams, flood loams and humic loams.

The dominant part of the Blatnianska priehlbina Depression belongs to engineer-geological zones of loess sediments, fluvial deposits and to the combined zone of loess sediments on fluvial deposits.

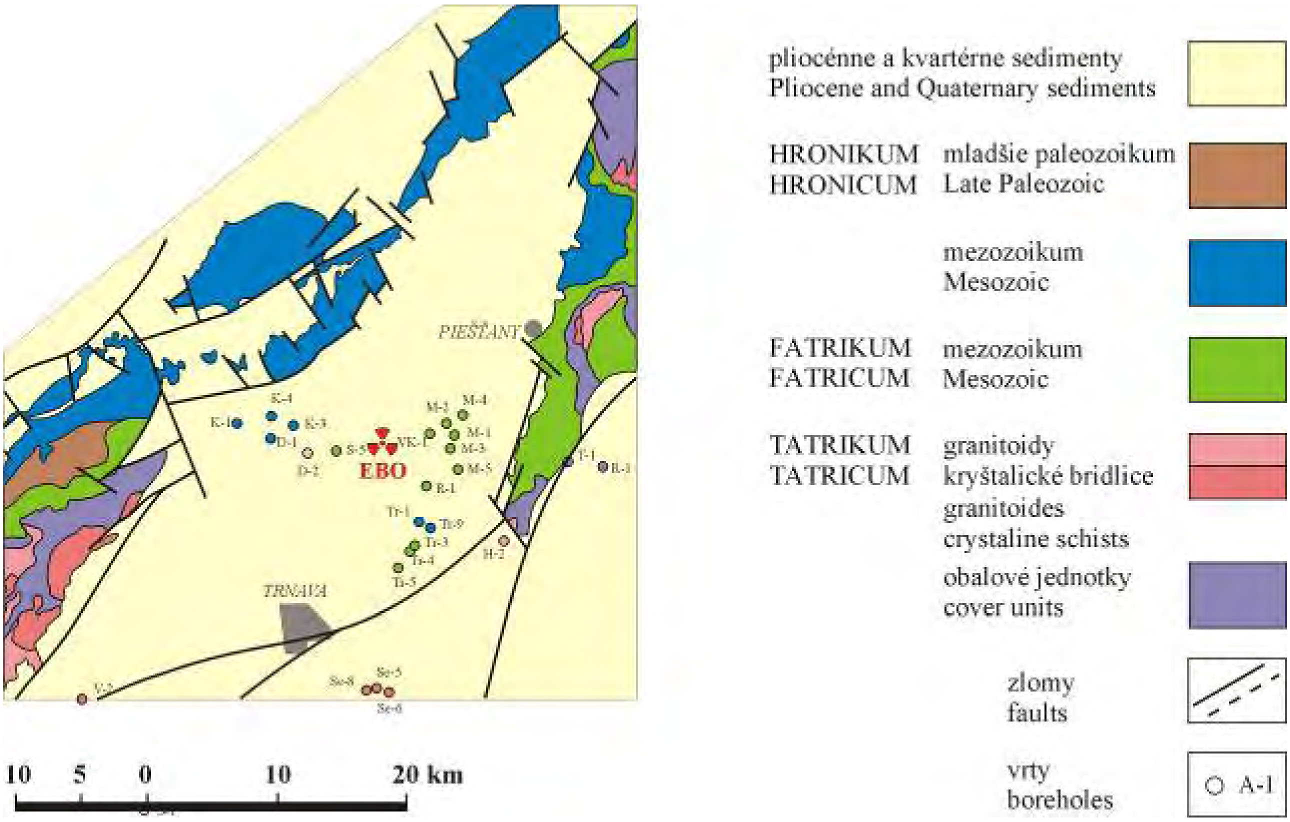


Figure C-3: Localisation of deep boreholes

Table C-1: Simplified lithostratigraphic table of Neogene sediments in Blatnianska priehlbina Depression

Epoch	*Stage*	*Name of lithostratigraphic unit*	*Lithology*	*Thickness (m)*
PLIOCENE		Kolárovo Fm., Volkovce Fm.,	gravels, sands, coaly shales	70
MIOCENE	Pontian	Beladice Fm.	breccie, conglomerates, gravels, sands, clays, sandstones, lignites	500
	Pannonian	Ivánka Fm.	conglomerates, sandstones, variegated clays, gravels, sands, clays, lignites	150
	Sarmatian	Vráble Fm.	silts, clays, sands, gravels, lignites	250
	Badenian	Báhoň Fm.	conglomerates, sandstones, clays, coal	1000
		Špačince Fm.	conglomerates, breccia, gravels, pelites, tuffs, tuffites, limestones	2500
	Karpatian	Lakšáre Fm.	conglomerates, clay shales, sandstones, riodacite tuffs, sands	800
	Ottnangian	Bánovce Fm.	clay shales, siltstones, sandstones	50
	Eggenburgian	Čausa Fm.	conglomerates, clay shales, siltstones	200

The geological structure of the near surroundings (r = 5 km) and of the NEC Bohunice site base is built by Quaternary sediments situated directly in hanging of Neogene (Pliocene) rocks. They are composed of several lithogenetic types and can be divided into the following categories:

- Humic loams, clays and landfills which do not build a continuous surface. Their thickness is variable and ranges from 0.5-1.5 m up to a maximum of 5 m. These are loose soils with a high content of organic matter, and they are not convenient for foundation.
- Loess represents a continuous horizon of variable thickness from 5 to 15 m. At a depth of approximately 4.5-7.0m below the terrain, they can be regarded as subsiding soil. Sagging of loess in higher positions is minimal. In deeper parts the loess is subsiding due to hanging wall pressure and increased humidity respectively.
- The thickness of clays in the footwall of loess reaches from 1.0 to 6.0 m. These are clays of high plasticity and predominantly of stiff to firm consistency with a high content of calcareous concretions. They could probably belong to Neogene sediments. Clays are expandable.
- The formation of alternating gravels and sands of a thickness from 6 to 25 m. Gravels are predominantly medium-grained. In the upper part there are pebbles 5 cm in diameter and in the lower part up to 10 cm in diameter, rarely up to 40 cm. Pebbles are fully reworked.

- The gravel matrix is represented by middle- to coarse-grained sand. The sand layer is locally situated as the uppermost layer within the sandy gravel formation and almost continuously in the middle of gravel layer. Sandy gravel formation is of high compactness.
- Clayey and sandy layers occur at a the depth of approximately 26 to 41 m below the terrain surface. These are middle- to high plastic clays. Sandy layers comprise mostly fine- to middle grained sand. Alternating of these layers is irregular; locally sand forms only lenses. The consistency is firm.

Table C-2: Basic characteristics of the foundation soils in the NEC Bohunice area (STN – Slovak Technical Standard; $\tilde{\nu}$ Poison's ratio, w – soil humidity, w_l – soil humidity to liquid limit, w_p – soil wetness to plasticity limit, Ip –plasticity index, Ic –consistency index, γ - unit weight, ρ - volumetric weight, n – porosity, Sr – degree of saturation, φ_{ef} – effective internal friction angle, c_{ef} – effective cohesiveness, φ_r – residual internal friction angle, C_r – residual cohesiveness, E_{def}/E_{oed} – deformation modulus.

	LOESS	*CLAYS*	*GRAVELS*	*SANDS*	*NEOGENE*
STN 731001	F6 /Cl/	F8 /CH/	G3 /G-F/	S3 / S-F/	F8 / CH/
ν	0.4	0.4	0.25	0.30	0.40
w [%]	13.70-19.5 /16.62/	11.90-25.30 /19.12/			16.40-29.4 /23.33/
w_l [%]	31.30-38.90 /35.73/	38.30-65.20 /46.55/			71.90-92.20 /79.86/
w_p [%]	18.16-22.42 /20.65/	13.80-23.06 /19.36/			16.50-29.43 /22.84/
I_p	9.97-20.54 /15.08/	16.73-43.30 /26.86/			49.82-66.83 /58.85/
I_c	1.01-1.65 /1.36/	0.76-1.28 /1.04/			0.89-1.13 /1.05/
γ **[$kN.m^3$]**	17.5-21.00 /19.11/	19.10-20.80 /19.97/	19.00-19.50	17.5-18.00	20.00-20.97 /20.51/
ρ **[$g.cm^3$]**	2.72	2.70-2.71			2.74-2.76
n [%]	35.77-49.60 /44.91/	31.00-42.50 /37.76/			33.75-39.56 /37.25/

	LOESS	*CLAYS*	*GRAVELS*	*SANDS*	*NEOGENE*
S_r [%]	34.30-95.10 /59.75/	67.87-92.48 /85.25/			86.80-100.00 /93.11/
φ_{ef} [°]	24.89		30-35	28-30	12.95
c_{ef} [Mpa]	0.556		0	0	62.33
φ_r [°]	28.73				23.27
C_r [Mpa]	0.0306				0.107
E_{def}/E_{oed} [Mpa]	5-7 / 11-15	9-13 / 20-36	60-80 / -	15-17 / -	8-11 / 22-32

II.1.2 Geodynamic features

II.1.2.1 Landslides and erosion

Slope movements in the Blatnianska priehlbina Depression are rare and only of local significance. The reason is a particularly low energy of the relief. Within the Slovak landslides registration, 8 landslides of total land area of 6.85 km^2 have been registered in this region. These landslides are mostly situated in marginal parts of the depression on the contact with core mountains, where the relief energy increases. The most significant landslides are in the southern part of the affected area close to Vištuk and between Hlohovec and Sereď. The majority of local landslides is localised on the western slopes of Považský Inovec Mts. - Teplička, Koplotovce, Lúka, Hrádok and Rakoľuby. Only one landslide has been registered on the eastern slopes and foothills respectively of Malé Karpaty Mts. near Horné Orešany.

In the area between Hlohovec and Sereď the most widespread frontal landslide occurs and it is built by a system of partial landslides, which are re-activated in various sections of an 18 km broad slide area; the length of landslides does not exceed 700 to 800 m. Landslides affects mostly clayey-sandy sediments of Upper Miocene (Pontian) age. The current landslide activity is subjected to monitoring; obtained data are documented. The current water- and eolian erosion is applied only negligibly in the Blatnianska priehlbina Depression. The majority of the region belongs to an area with minimal erosion or even without any erosion. Marginal parts of the Blatnianska priehlbina Depression on the junction with the core mountains can be designated as areas of weak to medium erosion.

II.1.2.2 Seismicity

Within the recent tectonic regime the Blatnianska priehlbina Depression including the NEC Bohunice site is affected by field stress, the compressive component of which is oriented perpendicular to older Neogene and Pleistocene structures and runs in NW – SE direction. This stress orientation causes the tectonic and subsequently associated seismic activity of subsiding fault structures, which are oriented mostly transversal to the axis of the Blatnianska priehlbina Depression, i.e. in a NW – SE direction. Fault structures cause the origin of the neo-tectonic elevation and depression blocks. The seismicity of the given region is focused on the Dobrá Voda area, where the second strongest earthquake on Slovak territory was registered. For the NEC Bohunice area, 6° to 7° of MSK scale of seismic hazard in macro-seismic intensity values was calculated with respect to 475- year return period. The epicentres of registered earthquakes are shown in figure C-4. In the sense of STN 73 0036 it is necessary to design the building constructions in this area so that they can resist against the seismic event mentioned.

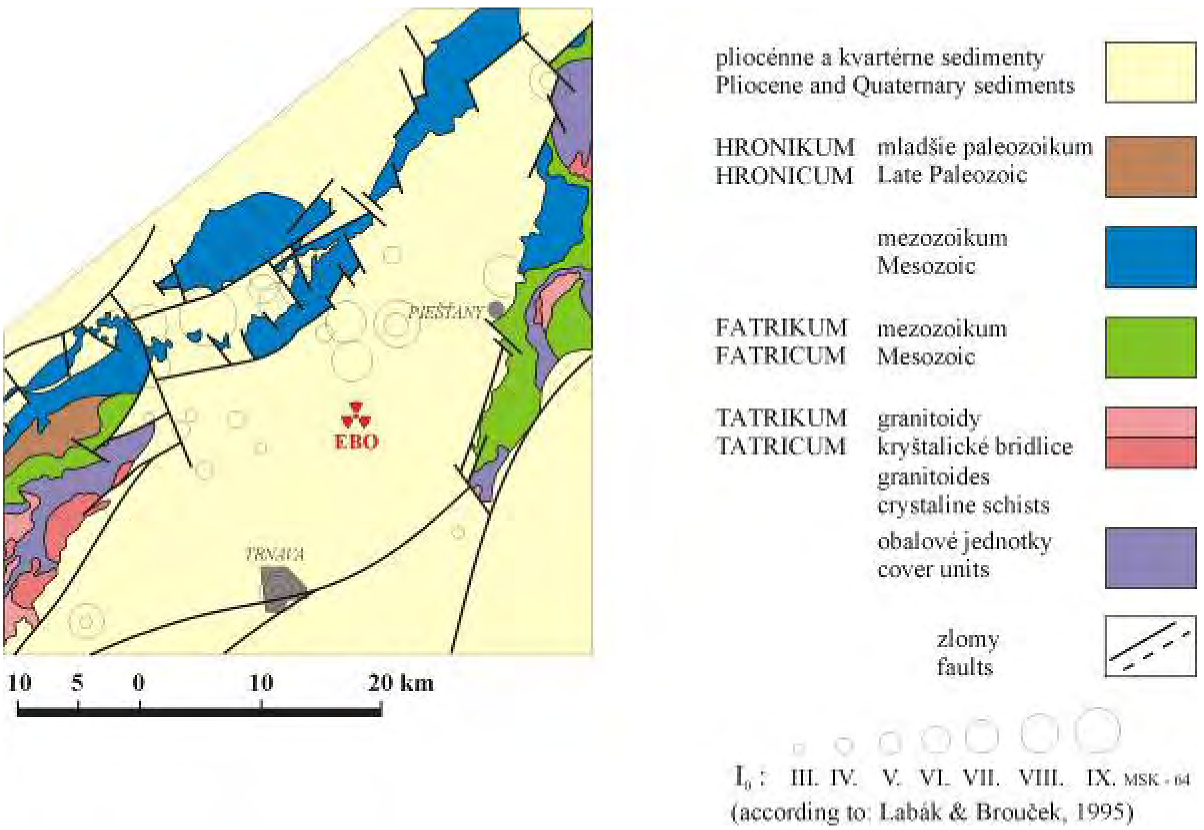


Figure C-4: Epicentres of registered earthquakes

II.1.2.3 Soil sagging

Soil sagging represents the most significant geo-barriers in the Blatnianska priehlbina Depression region. The term sagging is understood as a sudden volume reduction due to wetness or overloading. In the region, there are two classes of sagging soils distinguished. Highly sagging soils – typical and sandy loess belong here. Typical loess is characterised by the absence of stratification. They are primarily calcareous having capillary conductivity. The dominant granularity varies between 20 and 63 µm. Sandy loess are less stratified and only little calcareous. The bimodal granularity ranging from 20 to 60 µm and 200 to 500 µm is characteristic. Highly sagging soils occur especially in the western part of the region. In the surroundings of NEC Bohunice they are localised near Žlkovce. Sagging soils occur in a broad belt running near the western margin of the region.

II.1.3 Deposits of raw materials

In respect of economically important raw material deposits, the region of the Blatnianska priehlbina Depression is rather uninteresting. These deposits are represented especially by energy- and building materials. However, only the building material -mainly sandy gravels and brick loams deposits- is of economic significance. A few deposits of pure dolomites and limestones, occurring on the margins of Malé Karpaty and Považský Inovec Mts. are also of economic significance.

II.1.3.1 Energy raw materials

Natural combustible gas as well as non-hydrocarbon gas deposits are localised within the Badenian sediments. They are mostly registered as non-balanced reserves.

Table C-3: Overview of energy raw material deposits

Kind of raw material	*Deposit name*	*District*
natural combustible gas	Horná Krupá	Trnava
natural combustible gas	Špačince	Trnava
natural combustible gas	Nižná	Piešťany
natural combustible gas	Madunice	Hlohovec
natural combustible gas	Trakovice	Hlohovec
natural combustible gas	Cífer	Trnava
natural combustible gas	Sereď	Trnava
non-hydrocarbon gases	Sereď	Trnava
non-hydrocarbon gases	Špačince	Trnava

II.1.3.2 Non-metallic raw materials

The deposits of non-metallic raw materials occur on the periphery of the affected area, on the margins of the Malé Karpaty and Považský Inovec Mts. In respect of their geological environmental character, they belong to pre-Tertiary geological formations.

Table C-4: Overview of non-metallic raw material deposits

Kind of raw material	*Deposit name*	*District*
decoration stone	Chtelnica – Malé Sekalky	Piešťany
dolomite	Hubiná	Piešťany
feldspar	Hlohovec	Hlohovec
dolomite	Hrádok	Nové Mesto nad Váhom
dolomite	Lúka	Nové Mesto nad Váhom

II.1.3.3 Building raw materials

Building raw material deposits are of the most practical and economic importance in the given region. They are situated mainly along the Váh River (sandy gravels).

Table C-5: Overview of building material deposits

Kind of raw material	Deposit name	District
building stone	Moravany	Piešťany
building stone	Jalšové	Hlohovec
building stone	Lúka II	Nové Mesto nad Váhom
sandy gravel	Hlohovec – Svätý Peter	Hlohovec
sandy gravel	Koplotovce	Hlohovec
sandy gravel	Madunice	Hlohovec
sandy gravel	Hubiná	Piešťany
sandy gravel	Hrádok	Nové Mesto nad Váhom
sandy gravel	Beckov - Prúdiky	Nové Mesto nad Váhom
sandy gravel	Nové Mesto nad Váhom	Nové Mesto nad Váhom
brick loam	Boleráz	Trnava
brick loam	Hlohovec	Hlohovec

II.1.4 Geomorphologic relations

In the sense of geomorphologic division (Fig.C-5), the main part of the region belongs to the sub-region of Trnavská pahorkatina Upland. The margins are represented by the sub-regions of the Pezinské-, Brezovské- and Čachtické Karpaty Mts. and by the sub-region of Bielokarpatské predhorie in the north. The eastern margin is formed by the Považský Inovec Mts., from which a thin belt of one sub-region – Inovecké predhorie between Beckov and Hlohovec- extends to our region. The NEC Bohunice site belongs to the Trnavská tabuľa Table, being flanked by the Podmalokarpatská pahorkatina Upland from the western part and by the Dolnovážska flood plain from the eastern part.

The actual relief shape as well as the area distribution of individual relief forms are mostly a result of endogenous vertical geodynamic movements of structural-tectonic blocks (subsiding basin parts and elevating mountains). The structural relations and physical properties of various sedimentary and magmatic rocks of the region, as well as their different morphologic resistance were finally affected mainly by specific factors of climate in Pleistocene and Holocene periods.

At the present time, the erosion base is situated in the Váh flood plain after reaching the Podunajská rovina Plain at an altitude of about 120 m above sea level (a.s.l.). The total Quaternary vertical erosion effect in the affected area of the Trnavská pahorkatina Upland is about 110 m in the northern part and about 60 m in the southern part: the highest area of the Trnavská pahorkatina Upland in the northern part reaches an altitude of about 300 m a.s.l. (Kozinec 327 a.s.l.); in the central part it is about 250 – 270 m a.s.l. (Šarkan, 275 m a.s.l., Suchovský háj, 238 m a.s.l.), and in the southern parts it is about 180 m a.s.l. (Šalaperská hora, 174 m a.s.l.). In the Trnavská tabuľa Table, this effect is considerably lower and reaches values only of about 15 – 20 m.

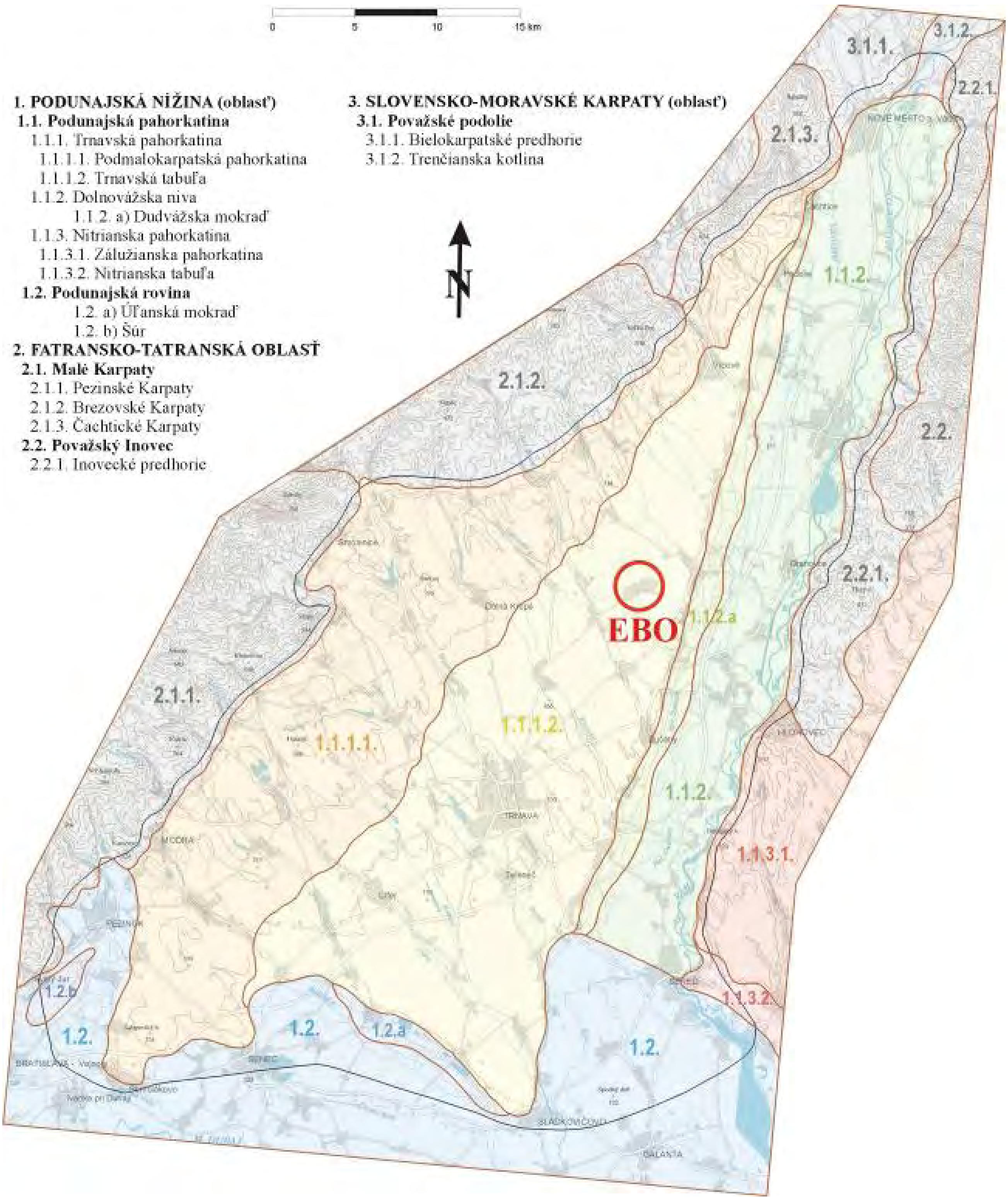


Figure C-5: Geomorphologic division (adapted according to Maglay et al., in press).

Within the Trnavská pahorkatina Upland, the morpho-tectonically differentiated, little to moderate undulated relief, to the north strongly undulated dell relief of undulated upland with average slopes of inclination up to 6°; in the northern part to 14° accompanied by a recent weak fluvial process and with moderated slope movement resulting occasionally in mud hole erosion and landslides was developed on the Podmalokarpatská pahorkatina Upland.

The Trnavská tabuľa Table as a part of the Trnavská pahorkatina Upland represents morpho-tectonically less differentiated, flat to moderately undulated and moderately dell relief of fluvial-eolian plain to table upland with an average slope inclination of up to 2°. A recent fluvial, partly mud hole erosive process with minor lithology effect has also been observed. In the eastern margin of the Pezinské Karpaty Mts. a characteristic relief of fluvial upland with an average inclination of 14° - 24° occurs on crystalline structures. A similar relief type of fluvial plain with moderate effect of lithology was developed in an adjacent part of the Brezovské and Čachtické Karpaty Mts.

In contrast, in the adjacent part of the thin belt of the Inovecké predhorie, a morpho-tectonically less differentiated, strong undulated, little to moderate truncated relief of fluvial upland with average slope inclination of 18° occurs. This relief type is affected by a strong fluvial process supported by movement of slope masses (solifluction, flux, hill wash etc.) with transition to chuckhole erosion.

The horizontal relief dissection varies strongly. It ranges from 0 to 0.5 km/km^2 in plain parts of the lowland and reaches values from 1.75 to 3.5 km/km^2 in marginal parts of the Malé Karpaty and Považský Inovec Mts.

II.1.5 Climatic conditions

The whole investigated region belongs to a warm region (T) with 50 or more summer days on average and with daily air temperature maximums ≥ 25°C. The warm climatic region is divided into sub-regions, T1 – comprises broader surroundings of Trnava town, T2 – area of the Trnavská tabuľa Table and Dolnovážska niva, T4 -the Podmalokarpatská pahorkatina Upland and lower margin of Dolnovážska niva and Inovecké predhorie, T6 – the Brezovské Karpaty and Inovecké predhorie Mts. According to the data of the Slovak Hydro-meteorological Institute, which is situated close to the NEC site in Jaslovské Bohunice, the climatic conditions result from long-time weather regime. The climatic regime depends on the frequency of atmospheric conditions and circulation of air masses. Observations and measurements of local climate have been carried out since 1959.

Table C-6: Climatic regions of the area of interest. Explanations: lz – Konček's moisture index

	Warm region T	
Sub-region	***Characteristics of sub-region***	***Climatic values***
T1	warm, very dry, with mild winter	January > -3 °C, lz < -40
T2	warm, dry, with mild winter	January > -3 °C, lz = -20 to -40
T4	warm, very dry, with mild winter	January > -3 °C, lz = 0 to -20
T6	warm, moderately humid, with mild winter	January > -3 °C, lz = 0 to 60

II.1.6 Precipitation

In the lowland part of the Váh River drainage area,a minimum of precipitation falls in comparison with other local drainage areas. Due to the southern advection being rich in humidity, the maximum precipitation falls in May and June; minimum of precipitation falls in January due to the more frequent stagnation of relatively less humid air masses. A minimum of precipitation days (over 1 mm) is also observed in this region; less of them occur in the summer half year (IV.-IX.), then in the colder season (X.-III.). In the lowland part of the Váh River drainage area, the snow cover appears at the beginning of December or in November near the mountains and disappears approximately in the first half of March. As a period of snow cover, a number of days with a snow thickness of at least 1 cm is understood.

The average total precipitations in the region range in interval of 525 – 700 mm, with an absolute total precipitation maximum in the range <200-250 mm. Most of the total precipitations occur in the summer months (about 60 mm in July). In this period, precipitations are combined with storms. The lowest total precipitations are concentrated in the winter months (in January it is about 20 – 50 mm).

The number of days with snow cover ranges from 35 to 60 days from the Trnava region to the sub-mountainous parts of the Malé Karpaty and Považský Inovec Mts. According to Slovak Technical Standard (STN 73 0035), Jaslovské Bohunice site belongs to the II. snow region with a basic snow loading of 0.69 $kN.m^{-2}$. The climatic moisture indicator reaches values of 10 – 20 cm (including the investigated region) in the lowland part of Váh River drainage area. In the summer half year it is 20 – 30 cm. In the case of centennial rainfall (65 $dm^3.s^{-1}.ha^{-1}$), precipitation to the whole area of V1 NPP (18.2 ha) is about 1.18 $m^3.s^{-1}$ of rain water. This quantity cannot overload the canalisation system, the capacity of which reaches 2.36 $m^3.s^{-1}$.

The annual relative air moisture run shows a strong maximum in December and minimum in April. The daily minimal values are reached at about 2:00 PM, the highest ones before sunrise. During the periodical course of the day, 100% air moisture can occur at any day or night period (fog) and can continue for several hours (mostly at night). The regular daily course of vapour pressure is copying the air temperature; in summer a twice-daily course can be observed.

From the point of view of wetness, the average values of the annual moisture indicator in the region are negative or balanced and range from -150 to 0 mm. The average annual values of radiation dry index reach values from 1.25 to 1.50.

II.1.7 Temperature

According to the dynamic-climatic evaluation of the air temperature in the Danube Basin, there are anti-cyclonal situations about 0.8°C warmer than cyclonal situations. In the annual course the anti-cyclonal situations cause a temperature rise in the period from March to September. In winter, the coldest weather is brought by the north-eastern cyclone and the warmest weather by the south-western cyclone. In summer, the coldest weather is brought by the northern anti-cyclone and the warmest weather by the southern anti-cyclone. The average annual amplitude reaches higher values of almost 4°C during anti-cyclonal situations than during cyclonal situations. The highest daily amplitudes are reached in summer (12.6°C) and the lowest ones in winter (6.5°C). In the course of the year, air mass temperatures depend on their geographical origin and transformations. Sea air masses are 0.6°C warmer within the annual temperature run than in the case of continental air masses. Continental air masses reach on average 2.5°C higher air temperature amplitudes when compared to sea air. The highest temperature occurs during the periodical course of the day at about 2:00 PM, the lowest value occurs before sunrise. The average temperature in January lies in interval from about –1.8 to -3°C and in July it reaches values from 18 to 20 °C.

The terrain configuration does not offer preconditions for the creation of frequent and long lasting inversions. Short-term night inversions occur in summer, long-term whole day inversions occur in winter. Night temperature inversions occur during about 100 days in a year and day-long inversion occurs during about 50 days in a year. Inversion occurrence is closely connected with fog occurrence, with an average occurrence during 32.5 days (maximum – 9.2 days in December).

II.1.8 Wind conditions

In the surroundings of NEC Bohunice western and south-western winds prevail. The maximum windblast in the 1961-1990 period reached 32.6 $m.s^{-1}$. Approximately once in 30 years the momentary wind velocity in this region reaches the upper limit of anemographic registration (40 $m.s^{-1}$), as in the case of Jaslovské Bohunice (1.3.1990, 10.13 AM); the western wind reached 39.4 $m.s^{-1}$ at this time. According to the Slovak Technical Standard STN 73 0035 Jaslovské Bohunice belongs to the area of the IInd windy region, where the ultimate wind pressure reaches the value of 0.45 $kN.m^{-2}$.

Table. C-7: Climatic parameters of affected area (average values in 1961 – 1990 period).

Climatic parameter	*Region*	*Jaslovské Bohunice*
number of sunny days	60 – 70	57.9
number of frosty days	100 – 110	96.6
number of icy days	30 – 40	27.9
average number of days with precipitations 1 mm and more	80 – 90	
average number of days with precipitations 0.1 mm and more		141.2
total precipitations		548
total precipitations during vegetation period	300 – 350	302
total precipitations in winter period	200 – 300	
average humidity		76 %
average temperature	9.3 °C	9.4 °C

II.1.9 Air

II.1.9.1 Emissions

The affected area belongs to the least loaded regions within Slovakia from the point of view of air pollution. Thanks to convenient orographic and climatic conditions the region is well aerated and pollutants emitted are consequently dispersed (Table C-8 to C-11). The air quality is namely affected by large industrial sources existing in the affected area, besides long-distance transfer. Due to this reason, the most increased concentration of pollutants is observed in the surroundings of the major sites (especially the towns of Trnava and Hlohovec).

The majority of solid pollutants (TZL) comes mainly from small stationary sources. Sulphur dioxide emissions (SO_2) are mostly produced by large and small stationary sources in the affected area. The most important source of nitrogen oxides (NO_x) and carbon oxide (CO) in the region is the traffic. The biggest polluters in Trnava region are given in table C-12 according to the amount of emissions.

Table C-8: Amount of emissions (TZL) from stationary sources in the period. 1998-2001

District	*TZL emissions (t/year)*				*Specific regional TZL emissions (t/year x km^2)*			
	1998	*1999*	*2000*	*2001*	*1998*	*1999*	*2000*	*2001*
Hlohovec	290	265	265	20	1.086	0.993	0.992	0.075
Piešťany	174	167	167	20	0.457	0.438	0.440	0.052
Trnava	511	493	494	197	1.085	1.047	1.049	0.417

Table C-9: Amount of emissions (SO_2) from stationary sources in the period.1998-2001

District	*TZL emissions (t/year)*				*Specific regional TZL emissions (t/year x km^2)*			
	1998	*1999*	*2000*	*2001*	*1998*	*1999*	*2000*	*2001*
Hlohovec	437	260	260	21	1.637	0.974	0.975	0.079
Piešťany	201	161	160	4	0.528	0.423	0.421	0.011
Trnava	1090	914	916	215	2.314	1.941	1.944	0.457

Table C-10: Amount of emissions (NO_x) from stationary sources in the period. 1998-2001

District	*TZL emissions (t/year)*				*Specific regional TZL emissions (t/year x km^2)*			
	1998	*1999*	*2000*	*2001*	*1998*	*1999*	*2000*	*2001*
Hlohovec	154	163	163	115	0.577	0.610	0.609	0.431
Piešťany	153	143	143	117	0.402	0.375	0.375	0.306
Trnava	1199	916	880	715	2.546	19.450	1.868	1.517

Table C-11: Amount of emissions (CO) from stationary sources in the period 1998-2001.

District	*TZL emissions (t/year)*				*Specific regional TZL emissions (t/year x km²)*			
	1998	*1999*	*2000*	*2001*	*1998*	*1999*	*2000*	*2001*
Hlohovec	522	500	500	256	1.955	1.873	1.874	0.959
Piešťany	489	472	472	62	1.283	1.239	1.240	0.164
Trnava	1289	1224	1233	1236	2.737	2.599	2.618	2.624

The emissions show a decreasing trend concerning for all basic pollutants. Such a decreasing trend is observed due to legislative and technological actions for air protection and also due to the stagnation of industrial activities in the region. The most contaminated area is the surrounding area of Trnava town.

Table C-12: Ranking of the largest polluters in the Trnava region according to the amount of emissions in 2004

	Solid substances		*SO_2*	
	Operator	**District**	**Operator**	**District**
1.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda
2.	AMYLUM SLOVAKIA s.r.o., Boleráz	Trnava	Slovenské cukrovary a.s., Sereď	Galanta
3.	ŽOS Trnava a.s.	Trnava	Johns Manville Slovakia a.s., Trnava	Trnava
4.	Zlieváreň Trnava s.r.o.	Trnava	Wienerberger Slov.tehelne s.r.o., enterprise Boleráz	Trnava
5.	Slovenské cukrovary a.s., Sereď	Galanta	Baňa Záhorie a.s., boiler plant Čáry	Senica
6.	Považský cukor a.s., Trenčianska Teplá, enterprise Trnava	Trnava	ON SEMICONDUCTOR Slovakia a.s., Piešťany	Piešťany
7.	Johns Manville Slovakia a.s., Trnava	Trnava	Co-operative farm, Siladice	Hlohovec
8.	Cooperative farm, Jaslovské Bohunice	Trnava	SH ENERGO a.s., Senica	Senica
9.	Mach-Trade s.r.o, Sereď	Galanta	Tehelňa Gbely s.r.o., Gbely	Skalica
10.	AGROPODNIK a.s., Trnava	Trnava	Zlieváreň Trnava s.r.o.	Trnava
	NO_x		*CO*	
	Operator	**District**	**Operator**	**District**
1.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Wienerberger Slov.tehelne s.r.o., enterprise Boleráz	Trnava
2.	Johns Manville Slovakia a.s., Trnava	Trnava	Zlieváreň Trnava s.r.o.	Trnava
3.	AMYLUM SLOVAKIA s.r.o., Boleráz	Trnava	BEKAERT Hlohovec a.s.	Hlohovec
4.	Slovenské cukrovary a.s., Sereď	Galanta	Johns Manville Slovakia a.s., Trnava	Trnava
5.	SH ENERGO a.s, Senica	Senica	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda

6.	Trnavská teplárenská a.s., Trnava	Trnava	INA Skalica s.r.o., Skalica	Skalica
7.	SWEDWOOD SLOVAKIA s.r.o., o.z. Trnava	Trnava	I.D.C. Holding a.s., Pečivárne Holíč	Galanta
8.	Považský cukor a.s., Trenčianska Teplá, enterprise Trnava	Trnava	Považský cukor a.s., Trenčianska Teplá, enterprise Trnava	Trnava
9.	BEKAERT Hlohovec a.s.	Hlohovec	SWEDWOOD SLOVAKIA s.r.o., o.z. Trnava	Trnava
10.	SOUTHERM s.r.o., Dunajská Streda	Dunajská Streda	Medea-S s.r.o., Sládkovičovo	Galanta

II.1.9.2 Imissions

Regional air pollution represents the pollution of the atmospheric limit layer of the countryside in a sufficient distance from local industrial and communal sources. The atmospheric limit layer is a layer of mixing, reaching from the surface to an altitude of about 1000 m. Regionally the industrial air pollutants are more or less regularly dispersed in a vertical direction in the whole limit layer and the level of ground concentrations is lower than in the towns.

On a regional scale, mostly pollutants from combustion processes, SO_2, NO_X, hydrocarbons and heavy metals are present. They remain in the air for several days and therefore they can be transported to several thousand kilometres away from their source.

Oxidation products of primary gas components, like sulphates can be vertically moved to the middle troposphere, where they take part in the global circulation. No measuring station is situated in affected area, therefore data from the nearest measurement station in Topoľníky, which is a member of the Slovak regional measurement stations, was used. From all the regional stations, the highest concentrations of lead (Pb), nickel (Ni), chrome (Cr) and zinc (Zn) were obtained from the Topoľníky station (table C-13).

Table C-13: Average annual concentrations of air pollutants at Topoľníky station in 2002.

Station	*Dust* $\mu g/m^3$	SO_2S $\mu g/m^3$	NO_2N $\mu g/m^3$	HNO_3N $\mu g/m^3$	SO_4^{2-}-S $\mu g/m^3$	NO_3N $\mu g/m^3$		O_3 $\mu g/m^3$
Topoľníky	23.3	2.92	2.82	0.14	1.69	1.19		47
	Pb ng/m^3	*Mn* ng/m^3	*Cu* ng/m^3	*Cd* ng/m^3	*Ni* ng/m^3	*Cr* ng/m^3	*Zn* ng/m^3	*As* ng/m^3
	17.9	8.33	4.41	0.55	1.98	3.56	27.6	1.69

Source: SHMÚ.

583 mm of precipitations with a pH value of 4.6 fell at the Topoľníky measurement station in 2002. This is the second most acid precipitation value after the Chopok station within the Slovak regional measurement station network.

According to EMEP Programme measurements, Slovakia is situated on the south-eastern margin of a region with the most polluted air and with the most acid precipitations in Europe. The trend of regional air pollution and chemical composition of precipitations corresponds to the European trend of air pollutants emissions.

II.1.9.3 Ground ozone

Most of the atmospheric ozone (appr. 90 %) is contained in the stratosphere (11-50 km), the rest in the troposphere. Stratospheric ozone protects our biosphere against the lethal ultra-violet (UV-C) radiation and considerably decreases UV-B radiation, which is capable of initiating many unfavourable biological effects (e.g. skin cancer, eye cataract). An increased concentration of troposphere (ground) ozone in the industrial part of northern hemisphere was observed till the end of 80-ties in quantities of about 1 $\mu g.m^{-3}$ annually. Increased ground ozone concentration is related to the increase of ozone precursors (NO_X, CO) resulting from traffic, industry and from power production. From the beginning of the 90s ground ozone concentrations more or less stagnated in Europe, which is also confirmed by the measurements in Slovakia. Increased ozone concentrations in the free troposphere make the greenhouse effect more intensive and in the atmosphere limit of 0 – 2 km, they negatively affect human health (especially the respiratory system), plant vegetation (mainly agricultural and forest plants) and various materials.

The threshold value of ground ozone for population warning is IH_{1h}=240 $\mu g.m^{-3}$, for population information it is IH_{1h}=180 $\mu g.m^{-3}$. The ground ozone concentration target value for human health protection is in conformity with European Union (IH_{1h}=120 $\mu g.m^{-3}$; 8 hours average) according to Slovak legislation for air protection. This concentration must not be exceeded during more than 25 days per year over a period of three years in average.

Short-time ozone imission limits for vegetation protection are IH_{1h}=200 $\mu g.m^{-3}$, IH_{1h}=65 $\mu g.m^{-3}$. The target value of exposure index for vegetation protection AOT 40 is estimated at 18 000 $\mu g.m^{-3}.h$ (on average over five years) according to Slovak Ministry of Environment Decree No. 705/2002 Coll. on air quality, in accordance with EU Regulation on ozone in external environment.

The annual average value of ground ozone concentration measured at Topoľníky measurement station is 47 $\mu g.m^{-3}$. The daily average value (09:00-16:00 CET) during the vegetation period (April – September) measured at this station is 77 $\mu g.m^{-3}$.

The average exposure index AOT 40 for vegetation protection in the period from 1998 to 2002 measured at Topoľníky station is 9 258 $\mu g.m^{-3}.h$, i.e. the limit value of exposure index (18 000 $\mu g.m^{-3}.h$) was not exceeded. According to the monitoring results it can be stated that the target value of ground ozone for vegetation protection is currently being exceeded in the whole Slovak territory except intra-urban areas. The exceeding of the target value of ground ozone concentration for human health protection IH_{1h}=120 $\mu g.m^{-3}$ and short-term exceeding of the imission limit for vegetation protection IH_{1h}=65 µg.m^{-3} was registered at Topoľníky measurement station (table C-14).

Table C-14: Number of exceeded imission limits at the measurement station in Topoľníky in the period from 2001 to 2002. Explanations: numbers in the lower row express the number of days on which the limit was exceeded.

Station	*IH_{1h} = 240 µg/m^3*		*IH_{1h} = 180 µg/m^3*		*IH_{1h} = 120 µg/m^3*		*IH_{1h} = 200 µg/m^3*		*IH_{1h} = 65 µg/m^3*	
Topoľníky	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
	0	0	0	0	8	26	0	0	39	65

Source: SHMÚ.

II.1.9.4 Streams

The affected area belongs to the Váh River drainage area, which flows east from this area. It is included in the affected area, because the piping collector SOCOMAN drains most of the sewage water from NEC Bohunice area through the Drahovský canal directly to the Váh River. Only minor parts of sewage water are discharged through the Manivier canal into the Dudváh River. Both rivers, Váh and Dudváh flow from north to south.

The Dudváh River drains the affected area with direct contact to NEC Bohunice site. From the Malé Karpaty Mts. it is saturated by the streams Holeška, Chtelnička, Blava, Krupiansky potok, Trnávka with affluents of Parná, Gidra and several other less substantial yielding affluents. Its water level lies at an altitude of 157 m a.s.l. in the northern part and in the southern part at 138 m a.s.l. From the right side, the affected area is drained by the creeks Chtelnička, Blava, Krupiansky potok and the man made canal Manivier.

There are not any natural lakes or artificial water reservoirs situated in the affected area. In the broader area, there are water reservoirs built on the Dudváh River stream inflows: Chtelnica on Chtelnička stream, Dolné Dubové, Dolná Krupá and Sĺňava near the town of Piešťany.

The water reservoir Sĺňava is exploited as a superficial water source supplying the common site of GovCo (JAVYS) and SE EBO in Jaslovské Bohunice. The water is pumped using the pumping station in Pečeňady and it is used for the production of service and de-mineralised water.

II.1.9.5 Precipitation - drainage conditions

The most important indicators for the evaluation of water sources are the precipitation – drainage conditions, representing at the same time also the input data for stream condition balancing within the State Water-managing Balance (ŠVHB; table C-15). The trend of precipitations as well as of water drainage quantity has mostly an increasing character in the affected drainage areas.

Table C-15: Average quantities of precipitations and runoff in Váh drainage area in the years 1998 and 2002. Explanations: N – normal, V – humid (Hydrologic annual report – superficial streams).

Drainage area	*Partial drainage area*	*Area of drainage area (km^2)*	*Total precipitations mean value(mm)*		*% of normal*		*Character of precipitation period*		*Annual runoff*		*% of normal*	
			1998	**2002**	**1998**	**2002**	**1998**	**2002**	**1998**	**2002**	**1998**	**2002**
Váh	Váh	14 268	894	961	106	114	N	V	312	333	88	94
SR		49 014	820	841	108	110	N	N-V	224	219	86	84

The long – term average flow volume of the Dudváh River in the estuary to the Danube represents 195.8 m^3/s (including the Malý Dunaj and Nitra rivers). March, April (maximum), May, June and July represent the above standard water-bearing months in comparison with the long-term monthly average flow. The lowest water-bearing month is January on the Váh River. Runoff regime types are represented by a transition from snow type – in the mountainous area to rain-snow type in the upland-lowland area. The possibility of increased water runoff capacity through water reservoirs on Váh River drainage area is one of the best in Slovakia from a hydrological point of view.

The qualitative water management balance determines the relation between water sources and water requirements and defines the situations, when and where the water demands are not sufficiently covered by water sources (table C-16).

A balance status is evaluated by a three-stage scale:

- active,
- strained,
- passive.

Table C-16: Quantitative water management balance in 2001. Explanations: Q_{month} – average monthly flow volume, MPP – minimal necessary flow volume in $m^3 s^{-1}$, C – net flow volume, ENP – flow volume influenced by water reservoirs, watersheds and water transfer objects.

Balanced profile	*Period*	*Water request (m^3/s)*	*Q_{month} (m^3/s)*		*Source capacity*	*Balance index*
		MPP	*C*	*ENP*		
Váh Hlohovec	non-vegetation	24.36	60.39	88.51	64.15	3.63 A
	vegetation	24.57	144.49	127.77	103.20	5.20 A
Váh Sereď	non-vegetation	24.41	61.21	89.33	64.92	3.66 A
	vegetation	24.85	145.39	128.67	103.82	5.18 A

Source: SHMÚ.

The quality of surface waters is evaluated according to the result summarisation of classifications in the sense of Slovak Technical Standard; STN 75 7221 classifies the water quality in 8 groups of indicators: (group A – oxygen regime; group B – basic physical-chemical parameters; group C – nutrients; group D – biological parameters; group E – microbiological parameters; group F – micro pollutants; group G – toxicity; group H – radioactivity). Using the limit values, the above mentioned STN classifies water in five classes according to its quality: class I – very pure water to class V – strongly polluted water; classes II, III, IV represent acceptable water quality. The quality of surface water in the Váh River drainage area is presented in table C-17.

Table C-17: Quality of surface water in Váh River drainage area in the period from 2000 to 2001.

Stream – sampling location	*Stream length (km)*	*Number of measurements*	*Surface water quality and indicators of individual groups*						
			A	**B**	**C**	**D**	**E**	**F**	**H**
Váh - Hlohovec	100.70	24	III	II	II	III	IV		
Horný Dudváh – Veľké Kostoľany	18.80	13	II	III					II
Manivier – Žlkovce (NEC Bohunice)	0.50	23	I	IV					II
Horný Dudváh – Trakovice	11.00	13	I	III					II
Váh – above Sereď	81.00	24	III	II	II	III	IV	II	

The quality of the upper stream part of the Dudváh River is ranked as IIIrd class with corresponding basic physical-chemical indicators (specific conductivity, pH value, water temperature). The water reaction - pH value in the Manivier water affluent corresponds to IVth class of water quality. Regarding the relatively low runoff volume of the Dudváh River's upper part and its affluent, the low water quality of this stream does not influence the water quality in the Váh River.

The Trnávka stream reaches only the 5th class of water quality considering the oxygen indicators group (O_2, biological oxygen consumption in five days – BSK_5 and chemical oxygen consumption – $CHSK_{Mn}$), nutrients content (phosphate- and total phosphorus) and microbiological indicators (coliform bacteria). This is caused mostly by industrial and communal sewage waters.

The amendment of standard STN 75 7221 "Water quality and Classification of surface water quality" led to the re-classification of water quality indicators as well as the modification of limit values of water quality classes, therefore it is not possible to express general long-term trends in water quality.

II.1.10 Water reservoirs

II.1.10.1 Swimming water

The most significant water recreation localities were the subject of the project. Localities were selected with respect to the possibility of recreational use, object capacity, type of locality and pollution possibility. The limit values considered for water quality in recreation areas were the values for IIIrd quality class according to STN 75 7221.

Table C-18: Monitoring of water quality for swimming. Explanations: Ch. – chemical indicators, MB. – microbiological indicators, B. – biological indicators, non-org. – non organised recreation, VN – water reservoir., ŠT – gravel deposit lake.

Locality	*Water quality classes according to STN in 2001*			*Exceeded biological indicators in 2001*	*Authorisation for operation in 2002*	*Locality type*
	Ch.	**MB.**	**B.**			
Suchá nad Parnou	V	IV	III	Cyanophytae	non-org.	VN
Zelená Voda	III	II	II	–	non-org	ŠT

The new Act of the Ministry of Health of the Slovak Republic No. 126/2006 Coll. on public health, which defines the swimming water came into force in the year 2006. This Act supersedes the Decree No. 30/2002 Coll. on the requirements on swimming water, on the quality inspections of swimming water and on the swimming areas in the wording of the Decree of the Ministry of Health of the Slovak Republic No. 146/2004 Coll. A legal regulation covering the requirements for swimming water quality has not yet been issued.

The quality of water in natural swimming areas is not satisfactory. The most frequently exceeded values were the limit values of water oxygen regime, water colour and transparency, pH value, total phosphorus content, coliform bacteria, thermo-tolerant coliform bacteria, faecal streptococci, chlorophyll content, numbers of algae, sea-grass contents, saprobe index, mercury, phenols and non-polar extractible substances. The exceeded values indicate an increased degree of water euthrophisation, caused by agricultural activities and particularly by communal contamination, while the pollutants come to water reservoirs via flushing from the surroundings, by percolation into sub-surface waters filling the gravel-sandy lakes, and by the drainage of communal sewage waters into natural streams without purification, filling water reservoirs.

II.1.11 Ground water

There are several territorial units characterised by similar hydrogeological properties or by permeability type and character of ground water circulation (hydrogeological complexes) in the affected area.

Hydrogeological complexes consist of hydrogeologically more homogenous units – hydrogeological units divided on the basis of permeability type, ground water circulation character, filtration parameter values and of lithostratigraphy.

II.1.11.1 Hydrogeological complex of neogene basin structures

The hydrogeological complex of Neogene basin structures of the Blatnianska priehlbina Depression is characterised by sediments with different size of intergranular permeability, by low values of hydraulic gradients and by alternation of more and less permeable layers. This causes a frequent presence of artesian horizons with different piezometric levels (“pressure elevation”). With respect to low permeability and low hydraulic gradients there is a very low ground water flow having high natural protective ability of less permeable horizons. However the permeability of Neogene sediments shows high vertical and lateral variability.

Estimation of the mean flow capacity T in the Neogene sediments of the Trnavská pahorkatina Upland ranges from $3.0x10^{-4}$ $m^2.s^{-1}$ to $3.0x10^{-3}$ $m^2.s^{-1}$, which are relatively high values within Slovakia. Considering the permeability, mainly the youngest Neogene hydrogeological unit – variegated sands and clays of Pliocene age (Volkovské and Kolárovské formations) is interesting. Other lithostratigraphic units – hydrogeological units can be characterized by the alternation of clays, claystones, silts, siltstones, sands, sandstones, gravels, conglomerates and by lignite seems of various thickness. The occurrence of stratigraphically older sediments is limited to the marginal part of the Danube Basin along Pezinské Karpaty Mts.; in the direction to the basin centre they are continuously covered by successively coarser younger sediments mainly of Ivánske-, Beladické-, Volkovské- and Kolárovské formations.

The hydrogeological complex of the Neogene basin structures with intergranular permeability shows, in spite of the relatively many hydrogeological units, a relatively schematic regime and ground water circulation, which is characteristic for all stratigraphic members of Danube Basin sedimentary filling. The exact regime and circulation conditions of ground water in Neogene sediments seem to be locally very complicated with respect to lithology and tectonics. The alternation of impermeable clayey and silty zones with sandy-, sandstones – and gravel collectors often causes a confined ground water surface and therefore its supply and circulation is limited. Hydrogeological isolators also create an impermeable basement for water movement in Quaternary sediments and influence its circulation. Infiltration – of the ground water supply – is possible at the places where permeable Neogene sediments outcrop the surface or they are in direct contact with ground water of other hydrogeological complexes.

The significance of Neogene sediments from a water management viewpoint is limited only to local water consumption centres with respect to the water supply for human sites. Considering the slow circulation and high level of natural protection, this ground water represents potentially strategic reserves with a minor influence of environmental changes or even ecological disasters.

II.1.11.2 Hydrogeological complex of eolian quaternary sediments regarded as regional isolators

Eolian sediments – loess and sandy loess represent a dominant cover formation in the Trnavská pahorkatina Upland. Considering their granulometric composition – silty particles with admixtures of sand and clays, they are only a very little permeable. Loess has a character of regional hydrogeological isolator. A relatively thick unsaturated ground water zone, often in a depth of more than 10 m, is developed in loess. These properties determine the hydrogeological complex of eolian Quaternary sediments as an important protective element in relation to underlying collectors and, on the other hand, they serve as geological environment with less interaction with ground water. Therefore no hydrodynamic test results performed in hydrogeological boreholes situated in loess are available. Silty particles with admixtures of sand and clays are only a very little water-permeable , the mean flow capacity T values are estimated at the level of $< 1x10^{-2}$ $m^2.s^{-1}$. In such situations the ground water level is bound to underlying fluvial gravels of Pleistocene fluvial terraces and reaches a considerable depth of between 6.0 and 5.0 m below the terrain.

II.1.11.3 Hydrogeological complex of polygenetic quaternary sediments with intergranular permeability

Prolluvial sediments – sandy gravels with fragments in a form of fluvial cones (Pleistocene) are distributed close to the marginal parts of the mountains (Pezinské-, Brezovské- and Čachtické Karpaty Mts.) in the estuaries of highland streams into the Danube Lowland. Fluvial cones are most extended in the vicinity of Pezinok, Horné Orešany and Smolenice. They reach a thickness of about 12 to 15 m, in the case of multi-generational fluvial cones up to 25 m and more (Hanzel et al., 1999). Prolluvial sediments play a very important role enabling a direct transfer of ground water, but also of surface water from mountainous part of the region into the sediments of neighbouring lowland areas especially in sections with the appropriate hydraulic properties. In some areas situated on mountain roots, the streams on prolluvial sediments are characterised by lowered outflow volumes, while most of the water infiltrates directly to fluvial cones. Reaching the lowland, some streams- especially small streams behind the marginal faults- often disappear completely during the period of low flow volumes. The hydrogeological complex of prolluvial sediments in the Trnavská pahorkatina Upland can be hydraulically characterised on the basis of results from 17 hydrogeological boreholes. The mean flow volume value T is estimated to $2.7x10^{-3}$ $m^2.s^{-1}$, the mean value of filtration coefficient k = $8.0x10^{4}$ $m.s^{-1}$. The flow volume coefficient T ranges in interval from $1.8x10^{-5}$ to $2.8x10^{-2}$ $m^2.s^{-1}$, the filtration coefficient k ranges in interval from $8.0x10^{-6}$ to $4.7x10^{-3}$ $m.s^{-1}$.

Delluvial sediments, i.e. loam-stony-, and stony debris and weathering crust in connection with elluvial weathering crust on crystalline between Pezinok and Bratislava are the most wide-spread Quaternary sediment types with regard to volume and area. On the western slopes of the Pezinské Karpaty Mts. they reach up to 8.0 m on average and in the eastern part of Pezinské Karpaty Mts. they often reach up to between 10 and 15 m. In terrain depressions they can reach up to 30 m and more (Hanzel, 1999). According to the evaluation of 10 hydrogeological boreholes within the Trnavská pahorkatina Upland region, the estimated flow volume mean value T = $8.7x10^{-4}$ $m^2.s^{-1}$ and the mean value of filtration coefficient k = $2.1x10^{-4}$ $m.s^{-1}$ for the hydrogeological complex of delluvial sediments.

II.1.11.4 Hydrogeological complex of quaternary fluvial deposits of intergranular permeability

The hydrogeological complex of Pleistocene fluvial terrace sediments, consisting of loamy sandy gravels covered by loess, was tested on 148 hydrogeological boreholes within the region of the Trnavská pahorkatina Upland. The estimated mean flow volume value is 2.3×10^{-2} $m^2.s^{-1}$, the mean filtration coefficient value is 3.7×10^{-3} $m.s^{-1}$.When comparing with other regions, where the filtration parameters of the fluvial terrace sediments compared with Holocene alluvia are lower by about one order, i.e. tenfold less, the Pleistocene fluvial terraces of Trnavská pahorkatina Upland show high values of permeability comparable with "T" and "k" parameters of Holocene fluvial gravels.

Holocene gravel – sandy fluvial alluvia and sediments of local streams flood plains and of the dominant Váh River recipient had a primary importance for the drinking water supply of the population in the past. In total 386 hydrogeological boreholes were evaluated and hydrodynamically tested. The estimated value of the mean filtration coefficient $k = 1.2 \times 10^{-2}$ $m.s^{-1}$ and of transmissivity $T = 3.5 \times 10^{-2}$ $m^2.s^{-1}$ for this hydrogeologic complex is very high when compared to the whole Slovak conditions. In this set of data it is however necessary to distinguish the alluvia of Váh supplying streams and the Váh alluvium itself.

II.1.11.5 Springs and spring areas

In the affected area, the natural ground water springs are concentrated mostly in strong lithological dividing lines situated on the margins of the Malé Karpaty and Považský Inovec Mts. Almost all more abundant springs are used for the population drinking water supply. The following are the most important sources of natural ground water springs: Dechtice (yield >100 $l.s^{-1}$, trapped), Čachtice (yield >100 $l.s^{-1}$, trapped), Ratnovce (yield 10-50 $l.s^{-1}$, trapped), Piešťany-Banka (yield 2-10 $l.s^{-1}$, trapped), Jalšové (yield 2-10 $l.s^{-1}$, trapped), Tepličky (yield 2-10 $l.s^{-1}$, trapped), Hlohovec (yield 2-10 $l.s^{-1}$, trapped) and Brestovany (three springs yielding 2-10 $l.s^{-1}$, non-trapped, observed). Besides the above mentioned relevant natural springs, there are a lot of springs yielding <2 $l.s^{-1}$ of water. The springs trapped and used for population drinking water supply fulfil the required quality criteria.

II.1.11.6 Thermal and mineral springs

Besides common ground water, there are two important thermal spring areas in the affected area. They are situated near the town of Piešťany. The most important is the Trajan well, containing a calcium-sulphate water type yielding 35 $l.s^{-1}$ of water. The Piešťany mineral springs represent the sulphate-bicarbonate, calcium-, magnesium-, sulphuric-, and hypotonic thermals of 67 to 69°C water temperature. This water contains about 1500 mg of mineral components and free gas – mainly hydrosulphide (H_2S) in one litre of water. The most active components of these thermal waters in regard to their medical effect are hydrosulphide, calcium sulphate and Radium emanation. The origin of the Piešťany thermal springs and their mineral (chemical) composition is conditioned by geological structure of south-western slopes of Považský Inovec Mts., representing the infiltration area of these sources. Most of the springs rising out in the Spa Island (Piešťany) are trapped in depths of 50-60 m in a special manner. This prevents the mixing of surface water with the thermal mineral springs, and at the same time protects the constant temperature and chemical composition of the springs. The total capacity of the trapped thermal springs in Spa Island is more than 3 million litres per day.

The mineral water in the Koplotovce area is exploited from five wells. The first of them – the hydrogeological KB-1 borehole originally reached a flow volume of 14.50 $l.s^{-1}$ after penetrating a depth of 118 m, which was stabilised continuously to 13.50 $l.s^{-1}$. After creating a neighbouring discharge R-1 borehole, the flow volume was fixed at the value of 3.50 $l.s^{-1}$. After the technical modification, it is not possible to measure its flow volume. After drilling to a depth of 118m, the KB-2 borehole reached the yield 4.30 $l.s^{-1}$ with an artesian overflow of 30 cm, but after filling the borehole with dolomitic flour at a depth of 79.5 – 118 m, the flow volume dropped to 2.50 $l.s^{-1}$. It is apparent that by performing an ideal filtering of a part of a borehole, the flow volume would be considerably higher. The R-1 borehole is impassable between 98.00 m – 162.00 m after reaching 162.00 m, however permeable with a long-term stabilised flow volume of 10 $l.s^{-1}$. The flow volume of 2.70 $l.s^{-1}$ was observed in the R-2 borehole after reaching the depth of 250 m, however it was fixed to 3.50 $l.s^{-1}$ successively. This borehole is sealed due to the aforementioned problems, but if necessary it can be re-vitalised. The prospecting PK-36 borehole yielded a fixed 0.14 $l.s^{-1}$ water flow volume after reaching a depth of 130.0 m. However, this water still brings up a lot of iron particles. The temperature of water flowing from the KB-1 borehole has been fixed at 23.8 °C for a long time. The water temperature of the KB-2 borehole was originally 23.3°C, actually it is 25.0°C. This temperature increase probably indicates that deeper – at a depth of about 600 – 900 m – in Mesozoic rocks of the Váh depression, a temperature of even more than 35°C can be reached. A steady state temperature in the R-1 borehole is 23.8°C and 22.2°C in the R-2 borehole. Only the water in the PK-36 borehole does not reach a temperature at which it can be classified as thermal water – it reaches only 16.5°C. The content of solids, i.e. the total mineralisation of the Koplotovce area water is different in particular sources and it is only successively stabilized.

The mineralisation in the KB-1 borehole shows a decreasing trend – the original mineralisation of 3005 $mg.l^{-1}$ decreased to 2351 $mg.l^{-1}$ (1980), the current value is 2305 $mg.l^{-1}$. The original mineralisation in the KB-2 borehole decreased from 2980 $mg.l^{-1}$ to 2915 $mg.l^{-1}$ in 1980. Its current value should be only of 2630 $mg.l^{-1}$ according to A. Rebro. The total mineralisation in the R-1 borehole is stabilized at a value of 2370 $mg.l^{-1}$. The water mineralisation in the R-2 borehole has successively increased from the original 900$mg.l^{-1}$ to 1094 $mg.l^{-1}$ since 1983. The total mineralisation in the PK-36 borehole reaches a steady state value of about 2070 $mg.l^{-1}$. When comparing with the Piešťany area waters, the mineralisation of the Koplotovce area waters reaches significantly higher values. The characteristic mineralisation value for the Piešťany area water is only 1450 $mg.l^{-1}$. Carbon dioxide and hydrosulphide are the most important components of the Koplotovce mineral waters. When comparing to the Piešťany area waters, where the carbon dioxide is practically absent, its value in the Koplotovce area waters reaches approximately

900-1000 mg.l^{-1}. On the contrary, the hydrosulphide content is lower – only about 1.5-3.5 mg.l^{-1}. Fluorine occurs in the KB-2 borehole in a higher amount (2.2 mg.l^{-1}).

Both spring areas are gas bearing, trapped and exploited. Besides these important spring areas, there are also few less significant mineral water sources in the affected area.

II.1.11.7 Protected regions from water management viewpoint

The protected regions from a water management viewpoint are mainly situated in the surroundings of the important ground water sources connected to local water pipeline network. Especially the 2nd zone of ground water hygienic protection is concerned. Besides these protection zones, there is a widespread area around the Piešťany spa defined as 2nd protection zone – a natural medical source, spreading on the Váh River flood plain.

II.1.12 Soil conditions

On the Trnavská pahorkatina Upland and marginal mountains territory, there are various soil types present in various sub-types and often in transitional forms (figure C-6). Orthic Luvisols represent the strongly prevailing soil type near the western margin of the region. The substantial part of the Trnavská tabula Table region is covered by Vaplic Chernozems mostly in the Dudváh flood plain on the right side of the Váh River; stream valleys are filled by Fluvi-gleic Phaeozems, this being the third most frequent soil type. The thin belt of Váh flood plain is characterised by the occurrence of Eutric Fluvisols. On the margins of the Malé Karpaty and Považský Inovec Mts., mostly Rendzinas and Calcaric Regosols, but also Eutric Cambisols and Eutric Lithosols are developed. The humus content in the majority of the soils is rather high (over 2.3 %) in the affected area, soils with a moderate humus content (1.8 – 2.3%) are represented less.

Almost the whole part of the affected area is characterised by high productivity soils (high soil valuation). Soil valuation ecological units (BPEJ) are the principal mapping and appreciating units and provide by their characteristics the basic soil information. These units were created on the basis of specific simplified climatic categories, exposure to compass points, soil types and slope-range, of skeleton, soil depths, granularity and soil forming substrates. Most of them belong the classes 1 to 4, which are particularly protected by Act No. 220/2004 Coll. The rest is represented by soils of moderate productivity (classes 5 – 7). Types other than agricultural soils are present only on a negligible scale.

Chemical soil degradation can be caused by hazardous inorganic or organic elements; they can originate from natural or anthropogenic sources and they have a toxic effect on soil in a certain concentration. The toxic effects are evaluated according to Slovak Ministry of Agriculture Decree No. 521/1994 – 540. According to the above-mentioned Decree, only a negligible part of the region belongs to the A, A1 category – moderately contaminated soil.

Mechanical degradation depends on several endogenous and exogenous exact factors and on the soil type in a given locality. Cohesiveness, adhesiveness and consistency are the most important endogenous factors concerning of mechanical degradation. According to their skeleton and adhesiveness, the soils in the affected area are regarded as soils well resistant to mechanical, but also chemical degradation.

Exogenous factors of mechanical soil degradation comprise relief, precipitations and wind effect. The degree of potential water erosion in the affected area is weak (0.05 – 0.5mm/year) to moderate (0.51 – 1.5 mm/year), at the Trnavská tabula margins the erosion is rather strong (1.51 – 5.00 mm/year) due to the higher energy of relief. Eolian erosion affects the area only locally. Moderately exposed areas lie along the Biskupický canal, on the left side of the Váh River between Sĺňava and Leopoldov and in the surroundings of Veľké Kostoľany. The area to the south of Pobedim is strongly affected by eolian erosion.

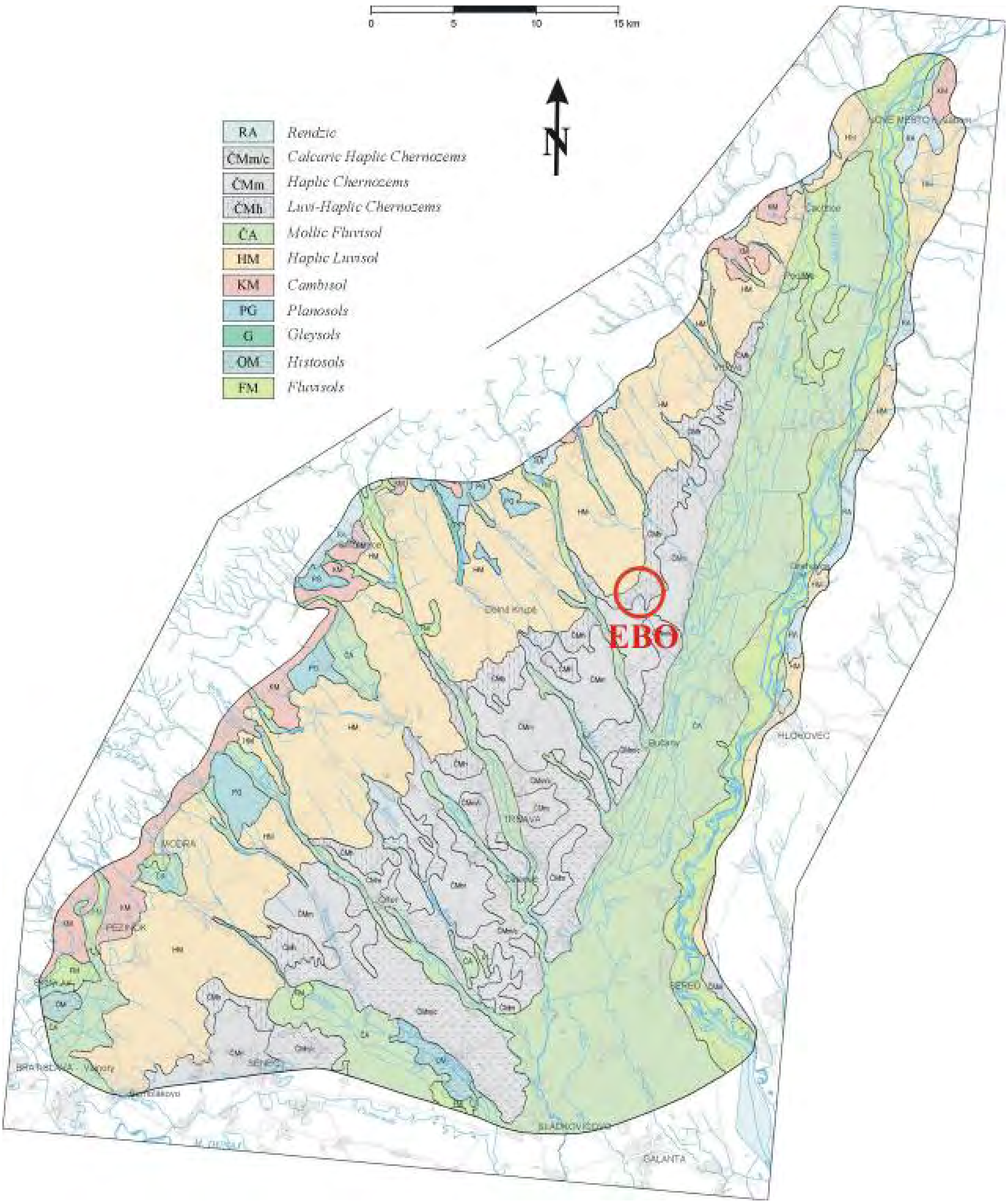


Figure C-6: Simplified map of soil types (adapted according to Maglay et al., in press).

II.1.13 Fauna and Flora

II.1.13.1 Fauna

According to zoogeographical divisions a prevailing part of the affected area (Blatnianska priehlbina Depression and Trnavská pahorkatina Upland respectively) belongs to the steppe province of Pannonian section. Margins of the area belong to the broad-leaved forest province of the sub-Carpathian section (terrestrial bio-cycle). Considering the limnic bio-cycle, the area is a part of Pont-Caspian province and the border between the Middle- and West Slovak part crosses the region in NW-SE direction.

The most widespread biotope in the region are cultural steppes, groves and preserved remnants of flood plain forests and coastal vegetation along the streams.

Invertebrates in the affected area are represented by important and protected species as: Singing grasshoppers (*Saga pedo pedo*), Praying mantis (*Mantis religiosa*), Red cicada (*Tibicina haemabodes*) and Stag beetles (*Lucanus cervus*). Water-receptive invertebrates are represented by Mayfly group (*Ephoron virgo*). Several species of mollusca, amphibians and reptiles live in the flood plain forests. Zoogeographically and faunistic important species are e.g. Lizards group (*Lacerta viridis*), Reptiles group (*Natrix tesselata*) and Carpathian salamander (*Triturus montandoni*). At the same time they also represent the endangered species. The variety of fish species living in streams flooded down from Male Karpaty Mts. is rather poor. The fish species abundance in the Dudváh River is influenced by the adjacent Váh River. Thirty-eight of the original 48 fish species are regularly observed here. Cyprinids group (*Carassius carassius*), Cyprinids group (*Alburnoides bipunctatus*) and Cyprinids group (*Pelecus cuttreatus*) belong to the endangered species. Danude Roach (*Rutilus pigus*) and Perches group (*Gymnocephalus schraetser*) belong to the endemic species. The water reservoir Kráľová negatively influences the fish migration. Amphibians are represented by 12 species. The most abundant representatives of vertebrates are birds – about 250 species, of which about 110 are nest-building species. According to bio-topical fixation the avifauna is divided into three groups: birds living on cultural steppes, birds living on plain groves and birds living in water- and swamp environment. Zoogeographically important, endemic and protected bird species do not occur in the affected area, however endangered species of Imperial Eagle (*Aquila helica*) can be found. Mammals are, in comparison to birds, less represented, mainly petit species can be found. Neither protected and important species, nor endemic and relict species occur here. Game animals are represented by all important species. The faunistic protected areas are mainly in marginal parts of the affected area (3rd threatened zone) as listed in table C-19.

The Váh River represents a bio-corridor of over-regional importance, the rivers and streams Dudváh, Trnávka, Gidra, Parná, Blava and Krupiansky potok represent bio- corridors of regional importance.

Table C-19: Overview of faunistic protected areas

Name	*File no.*	*Category*	*Protected subject*
Hlboča	34	national natural reservation	preserved dry environment and thermophillic fauna species
Dubník	39	national natural reservation	ornithological locality
Síňava	155	protected area	protection of water environment birds

II.1.13.2 Flora

The affected area (Trnavská pahorkatina Upland and Blatnianska priehlbina Depression) phytogeographically represents a northern promontory of Danube Basin district, which is a part of the Eupannonian xero-thermal flora (*Eupannonicum*) division and together they belong to the region of Pannonian flora (*Pannonicum*). Malé Karpaty and Považský Inovec Mts., which flank a substantial part of the affected area, belong to West Carpathian flora (*Carpaticum occidentale*). The mountains represent the districts in pre-Carpathian flora divisions (*Praecarpaticum*).

The Danube Basin is characterised by the transformation of normal natural vegetation to alternative natural vegetation (meadows and pastures), namely to cultural vegetation (agro-cenosis). The Willow-poplar flood plain forests occurring together with aquatic swamp vegetation are dominant. These are present mainly in the intra-seawall space of Váh River.

The Pre-Carpathian flora represents a transition between thermophillic Pannonian flora and flora of the highland (central) Carpathians (*Eucarpaticum*). Two vegetation zones are present according to height zoning.

The Oak zone is characterised by an altitude of 300 m a.s.l., at average temperature over 8.0°C, annual precipitations to 600 mm and the growing season exceeds 180 days.

Beech-oak zone occurs in 200 – 500 m a.s.l. altitude, the average temperature is 6° - 8.5°C , annual precipitations are 600 - 700 mm and the growing season ranges from 165 to 180 days. Considering the geomorphologic character of the region, many plant species occur in non-forest associations of stones, debris, spring areas, meadows and pastures. These associations belong to the most vulnerable ones.

Considering the differences in activities of individual territorial administrations in large-scale protected areas and the territorial-administration segmentation, it is not possible to list the exact index and number of protected plant taxons in the Trnava region and consequently in the affected area.

Phytogeographical important plant species are the following ones: Corn Mignonette (*Reseda phyterima* L.) and Peremnial Honesty (*Lunaria rediviva* L.). Among the endangered species there is an unconfirmed occurrence of the Field Speedwell (*Veronica argestris* L.) species in the Trnavské rybníky Lakes and Biskupický kanál localities. Protected areas are shown in table C-20.

The associations of softwood flood plain forests (Salicion albae) belong to the basic biotopes in the affected area, which are present mostly in Váh River Holocene flood plain in permanent reach of ground water level. Most of these areas are currently used as agricultural land or they belong to inundation areas of intra-sea wall space. Coastal willow bushes (Salicion triandrae) are locally present. Remnants of flood plain willow-poplar associations together with alternative subsidiary associations are preserved north of the Leopoldov to Malé Vážky locality, which partly reaches to the affected area on its south-eastern margin.

Table C-20: Overview of floristic protected areas

Name	*File no.*	*Category*	*Protected subject*
Hlboča	34	national natural reservation	preserved forest associations
Dubník	39	national natural reservation	preserved forest associations
Sedliská	149	natural reservation	protection of xero-thermal vegetation of steppe character
Bolehlav	13	natural reservation	samples of beech-oak and oak-beech vegetation zones
Chríb	53	natural reservation	xero-thermal associations of spinifex steppe
Lančársky Dubník	810	natural reservation	xero-thermal associations on former pastures
Holý vrch	132	natural reservation	protection of arid- and thermophillic vegetation
Všivavec	786	protected area	thermophillic associations of Malé Karpaty Mts. foothills
Dedova jama	899	protected area	remnant of original flood plain forest
Lipový sad	92	protected area	outplanting of lime trees in the historical centre of Beckov
Kočovský park	940	protected area	historical park
Malé Vážky	99	protected area	protection of aquatic biocenosis
Brehové porasty Dubovej	16	natural monument	valuable faunistic coastal vegetation

Associations of ash-elm and oak-elm forests (Ulmenion) were spread on the broad Váh and Dudváh river flood plains as well as on the flood plains of larger creeks (Blava). They are bound to higher and relatively drier zones of flood plains, where superficial floods occur regularly and for a short time. Only remnants of them are currently preserved in the agricultural land area of the Dudváh River flood plain.

The coastal alder- and ash-alder flood plain forests (Alnenion glutinoso-incanae) and coastal associations of willow bushes continue in the alluvia of thin flood plains of middle- and upper stream parts to associations of willow-poplar flood plain forests. They are associated to flood plains within the grasp of streaming ground water or they are influenced by frequent superficial floods, e.g. near Dolná Krupá, Jaslovské Bohunice and in the surroundings of Nižná – northwards to Ratkovce.

The Pannonian oak-hornbeam forests are regarded as the most arid forest type (Ulmeto-Querceta), this type of forest occurs in the Dudváh River drainage area in the affected area. On marginal loess-island hills it transforms to xerophilous associations (Eu-Quercion pubescentis). Forests occurring in the broader area belong to the Convallario-Quercetum roboris association. These associations occur in central and southern hilly-land part of the region, in the contact with lowland ash-elm-oak flood plain forests and xerophillic Pontic-Pannonian forests.

Oak-Quercus cerris forests belong to the sub-xerophillic to xerophillic forests developed on the illimerised Orthic Luvisols on loess or the degraded Haplic Chernozems from loess. They currently represent the second growths often with dominant locust, in wine yards, fruit groves and fields with more demanding plant cultures.

Bushes represented the natural association on fields being a natural bio-corridor and bio-barrier. Due to the transition to high-capacity agricultural land use, they were mostly removed. The stream coastal bushes in the agricultural land are of coastal willow type (Calystegio-Salicetum triandrae). In several localities – mainly on small lots - , anthropogenic bushes (Anthrisco-Lycetum halimifoliae) occur, often along traffic communications and also in intra-urban areas.

II.2 LANDSCAPE

The structure of the current landscape is formed by landscape components forming during geological development and by anthropogenic landscape components. The overbalance between individual landscape structural types, i.e. the ratio of afforested areas, agricultural productive areas, built-up areas and territorial infrastructure is the characteristic feature for the current status of the landscape structure.

II.2.1 Natural landscape components

The geological environment and land relief represent the landscape forming elements, which were preserved from the original nature in unchanged or little changed form.

Water streams in the affected area have a partly to completely modified appearance. The dominant water stream – the Váh River, which formed the Dudváh River flood plain, is actually regulated. Its right side stream inflows Chtelnička (Výtok), Blava, Dubovský and Krupský potok and Manivier canal are regulated to a various extent along their streams. In the past, these streams were active in the forming of the Trnavská pahorkatina Upland relief (chuckholes, valleys) and of Dudváh flood plain relief (fluvial cones). The original various form-rich drainage areas of these streams are currently modified with regard to agricultural machines use.

Forest biotopes currently represent only the remnants in marginal parts of the region. The present vegetation is to more than 90 % represented by specific farm crop monocultures.

The soils were transformed from forest- and steppe soil types to agricultural soil types, in which the original substratum is mostly preserved as well as organic components to a certain extent.

The air conditions and climate are currently modified by the increasing volume of emissions originating from industrial technologies and traffic. They are at the same time one of the most dynamic natural elements, the transformation of which is very hard to register in open landscape.

II.2.2 Anthropogenic landscape components

The settlement structure and building of villages started up on the basis of pre-historic settlement. The current rural architecture formed in the period of last 500 – 700 years and current built-up structure (except sacral buildings and historical monuments) have formed mostly in last 50 to 80 years. Specific building element in the affected area is the area of the NEC Bohunice, representing a closed industrial zone surrounded by agricultural land.

The traffic network developed in the course of history in connection with the development of the village structure connecting the individual villages with the administration centres - Trnava, Hlohovec, Leopoldov and Piešťany. After the building of the NEC Bohunice, the communication network was expanded by two road communications (NEC Bohunice - Jaslovské Bohunice, NEC Bohunice - Žlkovce) and one railroad from Veľké Kostoľany to NEC Bohunice area.

The technical infrastructure developed during the last century (electricity-, power and products distribution, water supply-, and canalisation system). The building of the NEC Bohunice is connected with the construction of the Manivier canal and the covered Socoman canal for waste water discharge. The air power distribution system connecting the NEC Bohunice with national and international power distribution system as well as the hot water distribution system supplying the towns of Trnava and Hlohovec with heat were built simultaneously.

II.2.3 Landscape scenery

In the past, the original farmland was characterised by individual fields separated by balks and groves. They preserved the relation between natural landscape elements, increased biodiversity and created a characteristic landscape scenery. Such scenery existed in harmony with village structure, i.e. residential houses and farmyards in the affected area. Churches were the vertical land dominants; church towers outreached the surrounding buildings.

The agricultural production development caused the integration of fields and created new land dimensions. Land scenery became simpler. On the other hand, the land monumentality was increasing mainly due to the increasing colour contrast between the farmland and built-up areas as well as between the seasonal vegetation periods.

The NEC Bohunice site was incorporated to the already modified land scenery. The nuclear power plants created a new dominant in the landscape. A new dynamic element was introduced into the static land projection – ascending vapour from the cooling towers. The silhouette of the cooling towers outreaches all original land dominants. From the compositional point of view, the above-ground power networks are a disturbing land scenery element from certain viewing angles.

II.2.4 Territorial system of ecological stability

The ecological stability represents the ecological system's overall resistance against stress situations, i.e. against external effects or its capability to return to its original state after the expiry of these effects without the necessity to perform any corrective measures. For the ensurance of land ecological stability it is necessary to isolate the ecologically disturbed areas by the application of eco-stabilising elements (creation of bio-centres and bio-corridors). The ecological stability of the affected area is characterised by a 13-stages scale ranging from –1 to 11. A smaller scale number indicates an increasing ecological instability. It is possible to ensure a sustainable ecological stability by the creation of a so called territorial system of ecological stability. It represents an irregular network of important land elements, which represent and preserve the ecological stability by their character and location.

The evaluation of the regional ecological stability is based on the appreciation of land-ecological importance criteria being specific for each land type.

The characteristics of the area ecological stability evaluation are expressed by the following complex table of ecological stability (see table C-21).

Table C-21: Complex table of ecological stability according to Jančura [63]

No. of ecological stability	*Natural and agricultural land*		*V_{ke} No.*	*Built-up areas*	*V_{ke} No.*
-1	-		-	Vegetation in closed built-up area	1
0	Region without continuant cultural plants	Proportion of eco-stabilising elements to 1%	1	Vegetation in new, open built-up area	2
1		Proportion of eco-stabilising elements from 1% to 3%	2	Vegetation of industrial-, agricultural, waste deposits and transportation surfaces	3
2		Proportion of eco-stabilising elements from 3% to 10%	3	Vegetation in new, open built-up area	4
3		Proportion of eco-stabilising elements over 10%	4	Vegetation in semi-open built-up area	5
4	Water areas and streams (rivers)		5	Vegetation in older open built-up area	6
5	Region with natural vegetation and continuant cultural plants	Vineyards, poplar mono-cultures	1	Garden-suburb vegetation	7
6		Fruit groves, coniferous mono-cultures	2	Vegetation of agglomerated villages	8
7		Locusts, mixed coniferous-broadleaved forests, humid meadows, willow-poplar ass.	3	Urban parks and cemeteries (less older trees)	9b
8		Mixed broadleaved-locust forests, semiarid meadows, coastal alders, acid beeches	4	Urban parks and cemeteries (more older trees)	9a
9		Aquatic and swamp associations, bushes, acid oaks, limestone beeches	5	Forest park vegetation	10
10		Xero-thermal meadows, elm-oaks	6	-	-
11		Xero-thermal oaks	7	-	-

The natural landscape in the affected area is represented by the original vegetation of flood plain forests and coastal stream vegetation. With respect to woody plants distribution, the area belongs to the 8th ecological stability rank and to the 3rd – 4th rank of land-ecological importance V_{ke} – mixed broadleaf-locust forests and coastal alder trees.

The vegetation in the built-up area of the affected region belongs to the 6th rank of ecological stability (vegetation of agglomerate townships) with the 6th to 8th rank of land-ecological importance.

Table C-22: Overview of bio-centres and bio-corridors (region of Blatnianska priehlbina Depression)

Bio-centre of over-regional significance	*Bio-centre of regional significance*	*Bio-corridor of over-regional significance*	*Bio-corridor of regional significance*
NPR Dubník	Sĺňava	**Váh River**	Dudváh
	Gravel pits in Váh alluvium		Trnávka
	Orešany		Gidra
	Boleráz water reservoir		Parná
	Horná Krupá		Blava
	Brestovianske háje		Krupiansky potok
	Vlčkovský háj		

The farmland outside intra-urban areas consists of arable land integrated to acres up to 500 ha, which is with regard to cultural plant growing ranked at the –1st to 1st ecological stability rank and to the 1st – 2nd rank of land-ecological importance.

Based on the above-mentioned facts and on the land types size in the affected area, it can be stated that 12.11 % of the region belongs to the 8th rank of ecological stability; 1.99 % to the 5th – 6th rank and 0.72 % of the region to the 9th rank of ecological stability; as much as 84.3 % of the region must be assigned to the -1st rank of ecological stability. This part of the region can be denoted as ecologically instable with intensive land use. Several negative features indicate this situation:

- Dustiness, even dust storms in arid, non-vegetation period.
- The low regional retention ability accentuated by soil and rock basement character.
- The blowing away and out-flowing of humus components from the soil and consequently the decrease of nutrients.
- Seasonal soil erosions due to storm rainfalls.
- The low biodiversity due to few natural biotopes in the region.

These negative phenomena as presented exist due to the vegetable production intensification in this agriculturally most productive region.

A solution for this situation could be an appropriate modification of the amelioration and agro-technical practices or possibly the creation of an ecologically balanced landscape and revitalisation of arborous vegetation along the stream areas, which are less effective for vegetable production.

II.3 POPULATION AND ITS ACTIVITIES, INFRASTRUCTURE AND CULTURAL-HISTORICAL HERITAGE OF THE AREA

In this assessment report, the population in two assessed areas that correspond to threatened zones is followed:

- the population of the area affected by the proposed activities, i.e. in a 5 km circle from the NEC Bohunice site (1st threatened zone),
- the population of the area demarcated by a circle of 30 km radius (3rd threatened zone).

II.3.1 Population of affected villages

There are 8 municipalities of countryside character situated in the affected area:

- Jaslovské Bohunice, Malženice and Radošovce belonging to the district of Trnava,
- Žlkovce and Ratkovce belonging to the district of Hlohovec,
- Veľké Kostoľany, Nižná and Pečeňady belonging to the district of Piešťany.

II.3.1.1 Number of inhabitants in affected municipalities

According to the census in 2004, 8103 inhabitants lived in the above mentioned municipalities – 4089 females and 4014 males. The slight prevalence of females in the municipalities of the affected area corresponds to the Slovak average values. The data on the numbers of inhabitants of affected municipalities from the census in 2004 is presented in table C-23.

Table C-23: Number of inhabitants of affected municipalities at the end of 2004

Municipality	*Total*	*Males*	*Females*
Jaslovské. Bohunice	1 848	927	921
Malženice	1 266	625	641
Radošovce	401	192	209
Žlkovce	648	321	327
Ratkovce	288	147	141
Pečeňady	477	230	247
Veľké Kostoľany	2 658	1 320	1 338
Nižná	517	252	265
Total	**8 103**	**4 014**	**4 089**

II.3.1.2 Age structure of inhabitants of affected municipalities

From the total number of 8103 inhabitants of the municipalities in the affected area in 2004, 18.2% were in pre-productive age (0-14 years), 63.1% in productive age (15-59 years old males, 15-54 years old females) and 18.8% in post-productive age (males older than 60 years and females older than 55 years). The age structure of the inhabitants of affected municipalities is presented in table C-24.

Table C-24: Age structure of inhabitants of affected municipalities in 2004.

Municipality	*Age of inhabitants in 2004*		
	Pre-productive age	*Productive age*	*Post-productive age*
Jaslovské Bohunice	313	1 232	303
Malženice	252	804	210
Radošovce	78	238	85
Žlkovce	104	412	132
Ratkovce	47	187	54
Pečeňady	80	287	110
Veľké Kostoľany	511	1634	513
Nižná	88	315	114
Total	**1 473**	**5 109**	**1 521**

There was a decrease in the number of inhabitants of pre-productive age, an increase in the inhabitants of productive age and a mild increase in the inhabitants of post-productive age in the affected municipalities. A similar trend of population growth can be observed on a national scale (the pre-productive age represented 17.1%, the productive age represented 63.9% and the post-productive age represented 19.0% on 31st of December 2004 as well as a persisting decrease in the absolute and relative representation of children in the population can be observed).

II.3.1.3 Economic activity and employment rate of inhabitants in affected municipalities

From the total number of 7682 inhabitants of affected municipalities, 3815 inhabitants, i.e. 49.7% were economically active. The economic activity of inhabitants in the individual affected municipalities in 2001 is presented in table C-25.

Table C-25: Economic activity of population in affected municipalities.

Municipality	*Total*	*Males*	*Females*
Jaslovské Bohunice	894	478	416
Malženice	568	310	258
Radošovce	186	99	87
Žlkovce	281	149	132
Ratkovce	141	76	65
Pečeňady	225	127	98
Veľké Kostoľany	1 253	701	552
Nižná	267	139	128
Total	**3 815**	**2 079**	**1 736**

The economic activity of the inhabitants of the municipalities in the affected area corresponds with the situation in other regions of Slovakia, where there is a higher employment rate in agriculture and industry in the municipalities with countryside character as well as the fact that the number of commuters is indirectly proportional to the size of municipality.

From the point of view of the unemployment rate, the region constantly maintains a rate under the Slovak average level. At the end of 2004, 36 000 unemployed persons were registered in this region, i.e. 12.5% unemployment rate (according to the selective detection of workforce), which means 5.6 percentual points less than the Slovak average (18.1%).

II.3.2 Population of broader assessed area

The broader assessed area is identical with the threatened zone in the case of a nuclear accident, which is determined by Annex No.2 of the Decree of MV SR No. 300/1996 Coll., Part B 1.1 for Jaslovské Bohunice NPP. The defined threatened zone currently comprises Trnava region (districts of Trnava, Piešťany, Hlohovec, Galanta, Senica), Trenčín region (districts of Nové Mesto nad Váhom and Myjava), Nitra region (districts of Nitra and Topoľčany) and Bratislava region (district of Pezinok).

In a circle of a 30 km radius from the NEC Bohunice site there are 202 municipalities for which some impacts of the proposed activity are assessed. A total of 385 991 inhabitants lived there according to the census in 2001. 9228 (2.4%) of the inhabitants lived in the 1st threatened zone (5 km radius), 51 060 (13.3%) inhabitants lived in the 2nd zone (annulus with 5 km and 10 km radius) and 325 703 (84.3%) lived in the 3rd zone (annulus with 10 km and 30 km radius) of such demarcated area.

II.3.2.1 Health status of the population

The health status of the population is affected by a number of factors including economic and social conditions, nutritional habits, lifestyle, health care as well as the environment. The environmental pollution impact on human health has not been well recognised up to now, but it particularly influences the following indicators of population health status:

- the life expectancy at birth;
- the total death rate (mortality);
- the suckling and neonatal (perinatal) mortality;
- the number of risk pregnancies and live births with congenital malformations;
- the structure of death causes;
- the number of allergic diseases, cardiovascular and oncological diseases;
- the hygienic situation;

- drug addiction, alcoholism and smoking;
- the status of disablement and disability,
- occupational diseases and professional poisonings.

The *mean life expectancy at birth* is a principal indicator of the living conditions of the population and mortality rates. The life expectancy at birth is an important demographic indicator, which is defined as a number of years that a newborn person has the chance to live, when corresponding to the mortality of a given population in a followed year (Table C-26).

Table C-26: Mean life expectancy at birth in the districts around the NEC Bohunice site (approx. 30 km radius) in 2000

District	*Males*	*Females*
Galanta	68.53	77.05
Hlohovec	69.31	77.44
Piešťany	71.15	77.89
Senica	68.79	76.01
Trnava	69.16	77.00
Trnava Region	69.18	76.88
Myjava	69.23	76.31
Nové Mesto n/V	69.94	77.28
Trenčín Region	70.06	78.04
Nitra	69.47	77.83
Topoľčany	69.02	77.25
Nitra Region	68.43	76.94
Senec	68.37	76.47
Bratislava Region	71.12	77.97
Slovak Republic	68.82	76.79

Source: ÚZIŠ

The *birth rate (natality)* is the number of children born per 1 000 inhabitants of middle status. The lowest birth rate in the Slovak Republic is in the Bratislava, Trenčín, Nitra and Trnava Regions. The birth rate in none of the districts of mentioned regions reached Slovak average value in 2002 (table C-27).

Table C-27: Natality in the districts around the NEC Bohunice site (approx. 30 km radius) in 1998 – 2002 (‰)

District	*1998*	*1999*	*2000*	*2001*	*2002*
Galanta	10.03	8.97	9.16	7.92	8.13
Hlohovec	9.15	10.15	9.67	8.82	8.45
Piešťany	8.64	8.56	8.55	7.49	7.78
Senica	9.50	10.05	8.99	8.80	8.48
Trnava	8.88	9.06	8.75	8.16	8.01
Trnava Region	9.54	9.35	9.05	8.31	8.21
Myjava	8.33	8.16	7.59	7.22	6.91
Nové Mesto n/V	9.03	9.00	8.61	7.64	7.29
Trenčín Region	9.23	9.15	8.98	8.11	7.93

District	1998	1999	2000	2001	2002
Nitra	9.68	9.78	9.20	8.82	8.33
Topoľčany	8.98	9.33	8.74	8.03	8.44
Nitra Region	9.33	9.22	8.82	8.10	8.14
Senec	8.95	8.40	8.95	8.23	7.49
Bratislava Region	7.93	7.66	7.93	7.70	7.61
Slovak Republic	10.68	10.42	10.21	9.51	9.45

Source: ŠÚ SR

The *abortion rate* is another important demographic indicator influencing the population growth. The general abortion rate is a number of abortions per 1 000 females in reproductive age (15 – 49). Environmental factors have a certain impact on abortion rate as the harmful substances in air, water and food negatively affect especially pregnant women.

Number of spontaneous abortions per 1000 females in reproductive age in Trenčín and Trnava regions is significantly lower than the Slovak average value. Similarly, the numbers of ectopic pregnancies per 1000 females in reproductive age in Trnava region are significantly below the Slovak average value (table C-28).

Table C-28: Spontaneous abortions and ectopic pregnancies in the districts around the NEC Bohunice site (approx. 30 km radius) in 1998 and 2002

District	Spontaneous abortions				Ectopic pregnancy			
	1998		2002		1998		2002	
	Abs.	(‰)	Abs.	(‰)	Abs.	(‰)	Abs.	(‰)
Galanta	78	3.13	103	4.08	12	0.48	9	0.36
Hlohovec	36	2.98	18	1.49	2	0.17	6	0.50
Piešťany	12	0.72	26	1.54	2	0.12	1	0.06
Senica	50	3.10	44	2.69	4	0.25	4	0.24
Trnava	113	3.30	61	1.76	11	0.32	17	0.49
Trnava Region	448	3.02	410	2.74	3	0.10	1	0.03
Myjava	17	2.22	19	2.48	4	0.52	4	0.52
Nové Mesto n/V	45	2.75	38	2.31	4	0.24	8	0.49
Trenčín Region	481	2.97	411	2.53	74	0.46	66	0.41
Nitra	131	3.00	106	2.41	1	0.02	8	0.18
Topoľčany	74	3.79	63	3.21	8	0.41	13	0.66
Nitra Region	755	4.00	602	3.17	71	0.38	66	0.35
Senec	22	1.63	31	2.26	1	0.07	1	0.07
Bratislava Region	348	1.98	350	2.00	9	0.05	14	0.08
Slovak Republic	5 549	3.86	4 759	3.28	472	0.33	406	0.28

(‰) per 1 000 females in reproductive age Source: ÚZIŠ

The *number of live births with congenital malformation* is closely related to the abortion rate. The number of children born with congenital malformations in Trnava region is higher than the Slovak average value (table C-29).

Table C-29: Live births with congenital malformation in the districts around the NEC Bohunice site (approx. 30 km radius) in 1998 – 2002

District	*1998*		*2000*		*2002*	
	Total	*Per 10 000 live births*	*Total*	*Per 10 000 live births*	*Total*	*Per 10 000 live births*
Galanta	16	169.1	50	575.4	56	729.2
Hlohovec	19	408.6	6	135.4	7	182.8
Piešťany	16	297.4	20	366.3	26	523.1
Senica	19	295.5	14	256.9	24	466.0
Trnava	24	205.1	32	289.3	32	314.7
Trnava Region	133	248.2	147	294.8	166	367.2
Myjava	12	444.4	4	179.4	6	298.5
Nové Mesto n/V	15	272.7	14	254.5	14	303.0
Trenčín Region	128	216.9	121	221.4	130	271.3
Nitra	30	190.0	24	159.7	28	205.6
Topoľčany	12	162.2	16	247.3	17	272.0
Nitra Region	156	224.8	168	266.4	154	265.8
Senec	11	255.2	6	131.3	12	305.3
Bratislava Region	99	196.6	100	204.3	85	186.4
Slovak Republic	1322	223.6	1349	244.6	1409	277.1

Source: ÚZIŠ

The sensitive indicator of the hygienic and cultural standard of the population as well as of health care is the *neonatal mortality* (the number of children who die by the 28th day per 1 000 live born children) and *suckling mortality* (the number of children who die in the 1st year of life per 1 000 live born children). Newborn deaths in the first days of life have mostly intrinsic causes such as congenital malformations, mother diseases, etc., while external causes like infections and injuries prevail in a later period. The neonatal and suckling mortality in the Trnava region is lower than the Slovak average value, but the values for Trnava district are considerably lower. This mortality is lower than the Slovak average value in the other regions (table C-30).

Table C-30: Neonatal and suckling mortality in the districts around the EBO site (approx. 30 km radius) in 1998 – 2002

	Neonatal mortality				*Suckling mortality*			
District	*1998*	*2000*	*2002*	*2004*	*1998*	*2000*	*2002*	*2004*
Galanta	2.11	4.60	2.60	1.30	3.16	8.06	5.21	5.00
Hlohovec	4.77	6.77	5.22	4.60	4.77	9.03	5.22	9.20
Piešťany	5.42	5.50	2.01	3.80	5.42	5.50	4.02	5.70
Senica	0.00	3.67	0.00	5.10	0.00	5.51	0.00	6.90
Trnava	6.24	5.43	8.85	2.60	8.03	9.04	10.82	6.10
Trnava Region	4.76	4.81	4.20	3.20	6.29	6.82	5.75	6.10
Myjava	4.05	4.48	4.98	9.80	8.10	8.97	4.98	9.80
Nové Mesto n/V	1.73	1.82	6.49	0.00	1.73	3.64	6.49	0.00
Trenčín Region	4.79	2.38	2.92	2.20	6.57	4.39	5.43	4.20
Nitra	3.80	7.32	2.20	5.50	4.44	8.65	2.94	6.20
Topoľčany	0.00	9.27	3.20	0.00	3.00	15.46	3.20	0.00

District	Neonatal mortality				Suckling mortality			
	1998	2000	2002	2004	1998	2000	2002	2004
Nitra Region	4.49	4.60	2.76	3.20	7.03	6.19	4.14	5.10
Senec	6.64	0.00	10.18	1.80	6.64	2.19	12.72	5.40
Bratislava Region	3.06	3.88	3.51	2.80	5.91	5.52	5.05	4.80
Slovak Republic	5.38	5.39	4.68	3.90	8.79	8.58	7.63	6.80

Source: ŠÚ SR, ÚZIŠ

One of the basic characteristics of the population health status reflecting the economic, cultural, living and working conditions is also the *death rate (mortality)*. The gross death rate (number of deaths pre 1 000 inhabitants of middle status) depends not only on the above mentioned factors, but also depends directly on the age structure of the population. Mortality and natality have a key position in the population development as they represent principal factors of reproduction, i.e. the replacement of the deceased individuals with live born children. Both demographic phenomena contribute to the age structure differently. Data on the death rate is given in table C-31.

Table C-31: Mortality in the districts around the NEC Bohunice site (approx. 30 km radius) in 1998 – 2002

District	1998	1999	2000	2001	2002
Galanta	10.54	10.65	10.63	10.27	10.71
Hlohovec	9.18	9.91	10.11	9.96	10.62
Piešťany	10.06	10.12	10.49	10.47	9.99
Senica	10.97	10.91	10.77	10.40	10.65
Trnava	9.74	9.75	9.98	9.28	9.21
Trnava Region	10.00	10.08	10.05	9.85	9.95
Myjava	12.1	11.96	12.19	11.56	11.45
Nové Mesto n/V	11.70	10.95	11.35	10.52	10.44
Trenčín Region	9.77	9.35	9.45	9.19	9.42
Nitra	10.21	9.76	9.88	9.35	9.51
Topoľčany	9.99	11.13	10.87	10.15	9.50
Nitra Region	11.43	11.32	11.26	11.19	10.90
Senec	10.39	10.63	10.62	10.00	9.86
Bratislava Region	9.29	9.19	9.46	9.27	9.22
Slovak Republic	9.86	9.71	9.76	9.66	9.58

Source: ŠÚ SR

The substantial part of mortality is focused on the 5 most frequent causes of death as follows: cardiovascular diseases, cancer, respiratory diseases, gastrointestinal diseases and external causes of death. In 2004, these five groups of diseases covered 93.6 % of all male deaths and 93.4 % of all female deaths. Of course, there are differences in causes of death dependent on the gender.

Mortality caused by cardiovascular diseases, namely ischaemic heart disease, dominates in the whole country as well as in the above mentioned regions. The mortality caused by malignant neoplasms follows, while the highest share belongs to the neoplasms of the respiratory system (table C-32).

Table C-32: Mortality according to causes of death per 100 000 inhabitants in the districts around NEC Bohunice site (approx. 30 km radius) in 2002

Death cause	*GA*	*HC*	*PN*	*SE*	*TA*	*TA Region*	*MY*	*TN*	*TN Region*	*NR*	*TO*	*NR Region*	*SC*	*BA region*	*SR*
Neoplasms	251.9	211.9	216.1	219.0	225.2	228.7	226.9	234.2	221.8	245.9	226.8	249.6	223.1	232.4	213.9
Malignant neoplasm of stomach	20.1	17.4	15.7	11.5	9.4	14.0	24.1	16.9	13.6	19.6	13.5	13.1	13.6	13.7	14.2
Malignant neoplasm of bladder	2.1	2.2	4.7	3.3	3.1	3.6	13.7	6.2	5.6	5.5	2.7	4.9	3.8	4.5	4.6
Malignant neoplasm of respiratory organs	44.5	39.7	21.9	44.5	34.6	41.0	37.8	32.8	36.2	42.2	28.3	41.0	45.8	38.4	37.6
Malignant neoplasm of breast	13.8	15.5	16.7	18.1	14.2	15.4	10.3	16.9	14.6	16.5	20.2	18.4	11.4	19.7	14.0
Diseases of cardiovascular system	606.6	595.9	582.5	645.4	470.9	547.3	711.6	497.7	521.5	444.0	518.4	561.9	535.8	482.1	521.8
Ischaemic heart disease	335.6	339.9	263.1	296.4	266.2	281.0	405.7	285.7	296.4	165.7	167.4	182.6	305.1	282.3	277.1
Cerebrovascu-lar diseases	105.9	94.9	137.8	131.7	67.7	96.9	202.8	79.8	89.5	111.3	89.1	141.9	83.9	55.9	88.5
Diseases of respiratory system	52.9	64.0	70.5	52.7	73.2	62.6	34.4	63.0	45.3	75.2	74.2	78.1	47.7	40.9	54.2
Pneumonia	33.9	48.6	43.8	39.5	50.4	42.3	27.5	39.9	26.3	40.4	41.8	46.1	28.6	23.0	31.5
Diseases of gastrointesti-nal system	58.2	68.4	47.0	46.1	63.0	55.7	41.2	44.4	46.3	74.6	37.8	69.6	69.1	57.6	51.9
Diseases of liver	32.8	41.9	26.6	21.4	38.6	31.4	27.5	25.7	25.8	47.1	25.6	45.1	34.3	31.9	29.9
External causes	58.2	81.7	43.8	60.9	46.5	55.6	65.3	55.9	56.9	51.4	41.8	62.5	51.5	54.8	56.2
Shipment accidents	19.1	28.7	12.5	19.8	14.2	17.6	27.5	12.4	14.4	13.4	12.2	15.6	15.3	13.7	14.5
Self-inflicted injuries	22.2	24.3	20.4	18.1	10.2	17.2	17.2	14.2	14.1	6.1	4.1	12.2	15.3	12.7	13.3
Total	1071.3	1061.7	999.1	1065.3	920.6	994.8	1144.8	972.4	941.6	951.0	950.4	1090.1	985.8	922.2	958.1

Source: ŠÚ SR

From the point of view of population morbidity, diseases of the cardiovascular system are dominant. This is caused by the decrease in mortality from other diseases, especially infectious ones. The age of the population is rising and the occurrence of cardiovascular system diseases in an older population is more frequent. The increase in cardiovascular system diseases is also caused by civilisational factors such as a lack of physical activity, stress, environmental pollution, incorrect nutrition, smoking, alcohol, drug addiction, etc.

In the Trnava region similar to in the whole Slovak Republic, the rapid increase in allergic diseases has been observed, especially seasonal or perennial allergic rhinitis, bronchial asthma, but also dermo-respiratory syndrome and food allergy (table C-33).

Table C-33: Number of allergic diseases in Trnava Region in 1999 − 2002

Allergy	*1999*	*2000*	*2001*	*2002*
Allergic rhinitis, seasonal	5 693	7 857	7 228	15 837
Allergic rhinitis, perennial	5 595	7 765	4 696	10 135
Bronchial asthma	2 958	4 114	3 362	5 738
Dermo-respiratory syndrome	1 344	1 470	1 519	2 538
Food allergy	602	775	272	951

Source: ÚZIŠ

II.3.2.2 Epidemiological situation (survey)

Contagious diseases

In 2004, 1 case of typhoid fever was reported, which is the same result as in 2003 in the group of alimentary infections. The incidence of salmonellosis, shigellosis, diarrhoea and gastroenteritis of probably infectious origin was reduced in 2004 in comparison with 2003. On the contrary, the number of other bacterial infections with the Campylobacter infection dominating and of other bacterial food poisonings was increased. The incidence of alimentary infections was accompanied by numerous small to medium- scale epidemics. Three major epidemics in the range from 103 to 125 cases were registered. In 2004, there was a reduction in the group of viral hepatitis compared with 2003. The positive trend of viral hepatitis A and hepatitis B was influenced by vaccination against both types of hepatitis in selected risk population groups. Despite the descending trend, morbidity from viral hepatitis A is still the highest. The proportion of viral hepatitis A cases represented 77.9 % out of all viral hepatitis, the proportion of viral hepatitis B was 14.3 %, the proportion of viral hepatitis C was 2.6 % and the proportion of non-specified viral hepatitis was 5.3 %.

Venereal diseases

Venereal diseases have a specific position in the group of contagious diseases, firstly because they are usually transmitted by sexual intercourse and secondly because their manifestation in infected persons is more or less inconspicuous and thus they are not forced to seek medical assistance. These facts are the reasons why it is so difficult to fight against venereal diseases because not all infected persons are found and cured. In 2004, there were 779 cases of venereal diseases reported in the Slovak Republic, including members of the military forces, Ministry of Interior and foreigners, which represents an increase of 102 cases, i. e. by 13.1 %. Men represented 414 cases (53.1 %) and women represented 365 cases (46.9 %).

Tuberculosis

The number of tuberculosis cases has been decreasing in Slovakia since 1960. In 2004, there was the lowest level of morbidity from tuberculosis, namely 13.1 cases per 100 000 inhabitants. More males are affected by tuberculosis – 15.8 cases per 100 000 in comparison with females - 10.5 cases per 100 000 inhabitants. Morbidity from tuberculosis sank by 5.2 % in comparison with 2003. The total decrease of tuberculosis is mainly influenced by a 60 % reduction of relapses in comparison with 2003. An approximately 18 % decrease was registered in the group of bacteriologically proved tuberculosis cases.

Cardiovascular diseases

Mortality, deaths: The gradual reduction in the mortality rate from cardiovascular diseases (Chapter IX of International Classification of Diseases), recorded from the half of nineties was also confirmed in 2004. The 28 128 deaths caused by cardiovascular diseases correspond to the gross mortality rate of 522.9 per 100 000 inhabitants. Compared to 2003, it is less by 82 deaths, gross mortality dropped only by 0.4 %. In the scope of standardised mortality (European standard), the decrease in years compared is 3.1 %. This status was a reflection of almost the same standardised mortality drop in dominant age groups, and not only in the productive population from 25 to 64 years (-2.5 %), but also in the post-productive population of persons older than 65 years with a 3.3 % decrease. The reduction of standardised mortality in 2004 (in given age groups) corresponds with 4 386 deaths of 25 – 64 age group, which was 108 deaths less than in 2003, and 23 700 deaths in the older population, which was 773 deaths less than in 2003.

Incidence of malignant tumours

A further rise in the incidence of malignant tumours was recorded in Slovakia in 2002 according to the data of National oncological registry, where the data has been stored and analysed since 1968. 11 665 new cases of disease in males were reported in 2002. It represents 446.7 cases in gross values and 364.4 cases in standardised values (using the world standardised population excluding the impact of age structure changes of the population over a period of time, i.e. the increase of patients in older age groups in developed countries) per 100 000 males. 11 097 new cases were recorded in females, 401.0 cases in gross values and 261.5 cases in standardised values of incidence per 100 000 females in the same year. There were 21 622 newly confirmed invasive and in situ malignant tumours in total in both genders in 2002. This is 1 140 cases more than in 2001, where the major share is allocated to females – 745 cases. It seems that the optimistic results in the previous year did not indicate stabilisation or even retreat, but apparently this was caused by a reduced discipline in the mandatory reporting of oncologic diseases. The first place in males is occupied by malignant tumours of windpipe, bronchi and lungs (C33 and C34) with 1 823 cases representing 15.6 % share, the second place belongs to other tumours of skin than melanoma – 1 754 cases and 15 % share, the third place belongs to colorectal tumours (C18 – C21) with 1 722 cases and 14.8 % share, the fourth place belongs to prostate tumours with 1 000 cases and 8.6 % share, the fifth place belongs to 729 neoplasms of the oral cavity and attached regions of oropharynx (C00 – C14) representing 6.2 % of all newly diagnosed oncological diseases in a given year. Further important localisations of tumours were stomach (588 cases and 5 % share), urine bladder (456 cases and 3.9 % share), kidney, renal pelvis and ureter (C64 to C66) (398 cases and 3.4 % share), pancreas (347 cases and 3 % share), and finally larynx (299 cases and 2.6 % share). Female neoplasms were dominated by breast cancer with 1945 cases and 17.5 % share, followed by other skin neoplasms other than melanoma – 1 892 cases and 17.0 % share, colorectal neoplasms with 1 293 cases and 11.7 % share, 714 corpus uteri neoplasms with 6.4 % share, 551 cervix uteri neoplasms with 5 % share. The next places are occupied by 448 malignant tumours of the ovary (4 %), 387 stomach tumours (3.5 %), 361 neoplasms of the windpipe, bronchi and lungs (3.2 %), 342 neoplasms of the kidney, renal pelvis and ureter (2.4 %), and finally 279 cases of malignant melanoma (2.5 %). Excluding skin neoplasms other than melanoma with positive clinical course and low lethality (therefore they are not registered in many countries), the first place in both genders goes to colorectal tumours, and their incidence has been growing since 1995.

Diabetes mellitus

There were 287 304 diabetics registered in 2004, treated in 183 diabetological out-patient clinics. 5.3 % of the population suffer from diabetes, females represent 56.2 % and males 43.8 %. The 27 047 newly registered patients represent 9.4 %. 18 049 patients were dismissed, out of whom 7 687 died. The structure of the treatment was as follows: diet 30.8 %, oral antidiabetics 47.6 %, and insulin 21.6 %. The highest incidence of diabetic patients was in the age group from 50 to 69 years, i. e. 52.5 % of the total number of registered patients.

Congenital anomalies

There were 1 394 cases of congenital anomalies reported in 2004, of which 1 335 cases were in live births, 26 cases in dead-born babies and 33 cases of prenatally diagnosed congenital disorders followed by legally induced abortion. The incidence of congenital anomalies was 248.4 cases in the group of live births. The most frequently reported congenital anomalies were combined disorders, congenital anomalies of cardiac septums and hypospadia.

Occupational diseases, professional poisonings and other work-related health impairment

The occurrence of occupational diseases, professional poisonings and other work-related health impairments is an important indicator of working condition standards. There were 613 newly reported cases in 2004. That is an increase of 62 cases in comparison with 2003, i. e. by 10.1 %. Males represent 68.4 % (419 cases) and females represent 31.6 % (194 cases). The most frequently reported occupational disease was the disease from a long-term unilateral overload of limbs (215 cases), which represents 35.1 % of the newly registered occupational diseases. The second place of reported occupational diseases belongs to diseases of bones, joints, tendons and nerves of the extremities due to work with vibrant tools and equipment (124 cases – 20.2 %). The third place goes to the diseases transmitted from animals to humans (64 cases – 10.4 %). Another very frequent disease is the group of skin diseases – dermatoses (46 cases – 7.5 %). The most frequent professional diseases in males were diseases from long-term unilateral overload of limbs (146 cases – 23.8 %), which represent an increase of 40 cases in comparison with 2003. Vibration diseases were the second most frequent disease in males with 122 cases and 19.9 %. The third position belongs to diseases transmitted from animals (33 cases and 5.4 %). The other diseases occurring in males were ear disturbances caused by noise (30 cases and 4.9 %) and finally silicosis including miners‘ pneumoconiosis (25 cases and 4.1 %). The most frequent female professional diseases were diseases from long-term unilateral overload of limbs, which were found out in 69 females, i. e. 11.3 % of the newly registered occupational diseases, which represents an increase of 21 cases compared to 2003. The second most frequent occupational disease in females is the group of diseases transmitted from animals to humans and parasitic diseases (31 – 30 cases, representing 5.1 – 5.0 % of the total number of newly registered occupational diseases).

Drug addiction – treatment of addicted patients

There were 2 315 drug addicted patients treated in health care facilities in 2004, including 10 foreigners. Of this number, males represented 1 833 cases (79.2 %) and females represented 482 cases (20.8 %). There were 39 drug addicted patients younger than 14 years (36 boys and 3 girls) who represented 1.7 % of the total number. The most numerous group of addicted patients treated was the age group from 20 to 24 years (597 males and 134 females) which represented 31.6 % of the total number. In 2004, heroin was the predominantly used drug (987 cases), it was used by 42.6 % of the total number of drug addicted patients.

Suicides and suicide attempts

487 suicide cases were reported in 2004, of which 409 males and 78 females. It represents 15.7 males and 2.8 females per 100 000 inhabitants. The number of suicides decreased by 52 cases compared to 2003. The number of cases in males was reduced by 38 and by 14 cases in females. 955 suicide attempts were reported in 2004 (466 males and 489 females). Compared to 2003, it is a reduction of 245 cases.

II.3.2.3 Assessment of the potential impacts of NEC Bohunice

The health status of the population in the broader assessed area has also been thoroughly monitored and assessed on the basis of the follow-up of all basic demographic and epidemiological parameters since 1993. Results of this monitoring are presented in the summary annual reports on monitoring the health status of the population and the environment of the surroundings of the NEC Bohunice, which are elaborated by the companies VÚJE, a.s. Trnava and Environment, a.s. Nitra for SE EBO.

When assessing the health status of the population, routine data, demographic statistics, data on reproductive health, mortality, specific mortality on malignant tumours and leukaemia, data on tuberculosis incidence and chronic lung diseases are taken into account. The above-mentioned indicators are further evaluated by special statistic methods. The indicators used are shown in table C-34.

Table C-34: Indicators used for assessment of population health status.

Data group	*Indicator*
Demography	% of children 10-14 years old
	% of inhabitants in productive age from 15 to 59 years
	% of inhabitants over 60 years
	% of females in fertile age from 15 to 49 years
	average age of inhabitants
	average age of males
	average age of females
Reproductive health	Number of newborns per 1000 inhabitants
	Number of newborns per 1000 fertile females
	Number of children with birth weight under 2500 g per 1000 newborns
	Number of spontaneous abortions per 1000 conceptions
Mortality	Gross mortality of males
	Gross mortality of females
	Indirectly standardised mortality of males and females
	Directly standardised mortality, premature mortality, etc.
Malignant tumours	% of deaths caused by malignant tumours
	% of deaths caused by leukaemia
Tuberculosis	Incidence of confirmed cases
Chronic lung diseases	Incidence of chronic lung diseases

Data is evaluated in 214 villages in an approximately 30 km radius from the NPP and they are compared with average values in the Slovak Republic.

Tuberculosis is usually associated with economic poverty and bad living and hygienic conditions. Anybody can be incidentally infected, but a higher number of tuberculosis cases in one place confirms the previous premise or means that an unknown source of infection occurs at such place. Therefore it is surprising that there is a very high relative occurrence of tuberculosis in Veľké Kostoľany and Madunice, where a high standard of living is assumed. It is a long-term matter, unusual for the given location.

While the trend of tuberculosis incidence in the close surroundings of the NEC Bohunice has been considerably unfavourable in comparison with the trend in the broader area (up to 30 km) and the whole Slovak Republic in the last three years, there is no reason to assume that this trend can have any connection with the operation of the NEC Bohunice, except the fact that there is an accumulation of people in this area.

The analysis showed that mortality from leukaemia has been stable for a long time in a national as well as local scale and it does not show any trend or extremes. The distribution of mortality according to the type of leukaemia has been incidental for a long time in the whole territory of Slovakia. This means that operation of the NEC Bohunice has not caused increased mortality on leukaemia in their surroundings either in the past or at the present time. Employees living in the evaluated location were also included into the population of NPP surroundings. We can state that there has not been a higher mortality from leukaemia even among employees in comparison with the rest of the Slovak population.

A comprehensive statistical evaluation of the demographic and medical data led to the following conclusions:

- higher share of older inhabitants,
- lower share of children and lower relative number of newborns,
- higher share of spontaneous abortions,
- higher mortality as the consequence of higher number of older inhabitants,
- considerably lower premature mortality characterised by all parameters,
- higher mortality on cardiovascular diseases and malignant tumours.

The whole area of the NEC Bohunice reached the values analogical to the national values in all parameters followed in 2000. The area of the NEC Bohunice ± 10 km resembles to a bigger city from the demographic and medical point of view (small number of retired persons, low birth rate, higher number of spontaneous abortions, relatively low premature mortality, relatively more deaths from lung cancer), which can be explained by the existence of developed industry, which is associated with the population age structure, education and economic force. The area of the NEC Bohunice ± 30 km more resembles the healthy countryside (older inhabitants, but without premature mortality).

Available demographic data and data on population health status in the surroundings of NPP do not differ from the average values for the population in the Slovak Republic. With regard to the fact that data on the parameters of health status before the commencement of NPP operation are not available, it is not possible to evaluate its changes as a consequence of eventual activities in the NPP. On the basis of available data, its statistical evaluation and the data from expert literature, such changes are not assumed.

It can be stated that neither the direct analysis of data on contamination of the environment in the surroundings of the NEC Bohunice, nor the monitoring of the population health status in the vicinity of the NEC Bohunice demonstrated an association between the population health status and the NPP operation. The increments of annual radiation dose represent the values of 4 orders lower than the assumed background values from natural and artificial sources, therefore they can be considered as negligible.

II.3.3 Seats and built-up area of the municipalities

The basic forms of buildings and living in the municipalities of the affected area are the family houses of countryside type with building accessories. These are re-built and enlarged original farms or newly built houses on the lots in urban areas. Apartment houses are much less frequent. The built-up area of the municipalities also includes buildings of the farms, farmyards, storehouses, maintenance buildings or the buildings for supplementary production of the farms.

II.3.4 Industrial production

Industrial production in the affected area is mostly aimed at electricity production from the nuclear fuel in GovCo (JAVYS) and in SE EBO. Power production in V1 NPP and V2 NPP ranges from about 11 to 12 billion kWh in the last couple of years, representing about 49% of electrical energy produced in the Slovak Republic. The new enterprise of industrial character at the NEC Bohunice site is the company GovCo (JAVYS) aimed at decommissioning the first Czecho-Slovak A1 NPP, at the RAW management and at V1 NPP operation.

The other industrial and civil engineering production in affected municipalities has a supplementary character. From the industrial-production facilities, it is possible to mention compressor stations in the Malženice and Veľké Kostoľany, the pumping station of service water for the NEC Bohunice in Pečeňady, the site of Agrostav, s.r.o. in Malženice and the bitumen mixture production plant in Veľké Kostoľany. The biggest polluter of the environment is the bitumen mixture production plant in Veľké Kostoľany, then partially the Agrostav, s.r.o. Trnava in Malženice and the pumping station of service water in Pečeňady (when cleaning the filters).

II.3.5 Agricultural production

The share of agricultural soil was 70.95 % of the total soil area in the Trnava region in 2002; the share of forest areas was 15.72 % and the share of non-agricultural and non-forest areas was 13.33 %.

The agricultural production is the second most predominant production business in the affected area together with the power production in GovCo (JAVYS) and SE EBO. It is namely aimed at vegetable production on a prevailing arable land. Grains, corn, sugar-beet, oil-plants, technical plants, root crops and vegetables to lesser extent, are grown on arable land. Permanent grass growths represent only a minute share of the agricultural soil. There are good conditions for the growing of field vegetables, the development of vineyards, fruit production and the growing of hops in the region.

The production capability of the agricultural soils is very good. The soils are represented by the most fertile soil types. Their agronomic value is lowered by the lack of dampness in the vegetation period, therefore irrigation systems were built in this area to act as a stabilisation factor.

The concentrated breeding of cattle and swines was and is typical for animal production in the affected area.

II.3.6 Forestry

Forests on the territory of Trnava region cover a 62 876.21 ha area, representing 15.74% of the total area of the region. The occurrence of forests within the region changes according to geomorphologic conditions. There are 31.59% of forests in more hilly northern districts (Senica) with a decreasing occurrence in southern districts (4.24% - Galanta). The low occurrence of forests in the region is caused namely by agricultural use.

The wood species composition in the forests of the Trnava region depends on the localisation within the region as well as on the altitude. The prevailing part of the forests consists of broadleaved wood species reaching 74.12% of the growth area, except the district of Senica, where conifers cover 51.77% of the area. On the contrary, conifers cover only 1.93% of the growth area in the district of Dunajská Streda and 3.26% in the district of Galanta. The dominant wood species among conifers in the region is pine. In the case of broadleaved trees, the dominant species are oaks (21.88%), beeches (16.35%) and poplars (8.44%). The following vegetation zones are present in the region:

- oak zone,
- beech-oak zone,
- oak-beech zone,
- fir-beech zone,
- spruce-beech-fir zone.

The areas identified for afforestation in the region were 1046.02 ha, representing 1.66% of total growth area. The area of wellies in the districts is as follows: Senica (342.56 ha), Dunajská Streda (295.81 ha), Galanta (110.04 ha), Skalica (105.08 ha), Trnava (104.40 ha), Hlohovec (45.83 ha) and Piešťany (42.30 ha). In 2002, 760.73 ha of the region area were afforested by artificial restoration and 128.78 ha were afforested by natural restoration, representing 16.93% of the total afforestation area.

II.3.7 Transport and transport areas

Three principal types of transport exist in the districts of Trnava, Hlohovec and Piešťany belonging to the affected area: road, railway and air transport. The road network consists of the roads of 1st, 2nd and 3rd class and the D 61 highway Bratislava-Trnava-Piešťany-Trenčín. Among the railway tracks it is necessary to mention the tracks Bratislava-Trnava-Žilina, Leopoldov-Hlohovec-Nitra, Trnava-Sereď, Trnava-Jablonica-Kúty and Leopoldov-Sereď. Neither the above-mentioned tracks nor the D 61 highway cross the affected area.

The public road communications in the affected area consist only of state roads of 1^{st}, 2^{nd} and 3^{rd} class. The road of 1^{st} class Trnava-Leopoldov crosses the marginal part of the area (in a short section southeast of Malženice). The roads of 2^{nd} class Trnava-Špačince-Dolné Dubové-Dechtice, Trnava-Malženice-Pečeňady-Veľké Kostoľany and roads of 3^{rd} class Malženice-Jaslovské Bohunice-Kátlovce, Špačince-Jaslovské Bohunice-NEC Bohunice, Žlkovce-NEC Bohunice and Veľké Kostoľany-Nižná-Kátlovce also cross the area. Municipal and local communications are connected to the above mentioned state communications in the built-up area of intra-urban areas and in the land registry areas.

The road connection to the NEC Bohunice site comes from two directions – a connection via Jaslovské Bohunice to Trnava and the communication to Žlkovce to the road of 1^{st} class Bratislava-Trenčín (approximately 5.5 km). The connection to the railway network is ensured by an independent railway siding, which was originally built for A1 NPP needs and currently it serves for the whole NEC Bohunice site. A siding of 8.1 km in length is connected to the railway track in the direction Piešťany-Trnava-Bratislava and it ends at the railway station Veľké Kostoľany, where the stabling siding for its operation is located. Personal as well as material shipment to SE EBO and GovCo (JAVYS) sites in Jaslovské Bohunice is carried out via these communications.

The public personal transport in the whole affected area is ensured by SAD (Slovak Bus Transportation Company). No transport areas of a special importance are located in the affected municipalities.

The quality and condition of road communications as well as shipment intensity (number of passages via the communications) are different in the affected area. They usually have a decreasing trend with the road class or with the function of the municipal communication – street (transit, main, side, access road, etc.).

The transit communications via the historical centres of the municipalities are especially valid collision points of car transport.. This namely concerns the roads of 2^{nd} class via Malženice and Veľké Kostoľany. According to the information of the Municipal Office in Jaslovské Bohunice, individual and mass personal transport and material transport to NEC Bohunice act as a factor with an adverse impact on the environment in the area.

The military airport in Piešťany, which was also used for civil transport, the flying club airport in Boleráz capable of normal operation and the airport in Trnava used for agricultural purposes are located in 30 km zone around the NEC Bohunice. The international airport of general M.R.Štefánik in Bratislava is located in the zone over 30 km. The NEC Bohunice site itself is protected against any type of air operation by a protective air corridor LK P29 (cylinder with 2 km radius with the centre in point E: 48 29 33, N: 17 40 47 and with the altitude 1200 m MSL/GND above the sea level).

II.3.8 Transmission lines and pipelines

The affected area is characterised by a dense network of electrical above-ground and cable lines, especially above-ground 400 kV very high voltage, 100 kV very high voltage and high voltage lines. The most significant line is the southern branch of the "electrical artery" in the direction of the NEC Bohunice – western margin of the Malženice village. Another significant branch is the eastern branch of very high voltage in the direction NPP Bohunice – northern margin of Pečeňady village – Madunice.

These lines and their protective zones represent certain limits and directional barriers from the point of view of further development of the area.

Besides the above mentioned very high voltage and high voltage distribution lines of national and regional importance, electrical distribution lines for individual villages as well as for civil engineering assemblies and buildings located outside intra-urban areas are also located in the affected area.

Part of the electrical distribution lines and telecommunication networks runs in the cable lines in the earth. The network of local and remote connecting cables has an amplification station in Malženice.

The other group of power lines is represented by hot water distribution lines removing thermal energy from the NEC Bohunice (in the form of hot water) to Trnava, Leopoldov and Hlohovec, where it is used for the heating of the buildings. The hot water distribution line NEC Bohunice – Trnava runs in the direction of the NEC Bohunice site – western and southern margin of Malženice, then it passes along the state road of 2^{nd} class no.504 to the northern margin of Trnava, where it is connected to municipal distribution lines through the reduction and heat exchange stations. The hot water distribution line to Leopoldov and Hlohovec has the following route: NEC Bohunice site – northern margin of Pečeňady – northern margin of village Červeník – Hlohovec.

Both hot water distribution lines are above-ground distribution pipes DN 500, isolated and equipped with horizontal and vertical compensators, placed on concrete foundations in the height that enables crossings for small animals or crawling under the pipes for bigger animals. From the functional point of view or area development point of view, these hot water distribution lines and their protective zones are much greater barrier than the above mentioned electrical distribution lines.

Routes of the following product lines can be found in the 10 km zone from the NEC Bohunice:

- transit gas pipeline (3xDN 1200, 1xDN 1400) from Russia to the countries of Western Europe,
- VVTL gas pipeline from distribution node Špačince to Nové Mesto nad Váhom,
- international gas pipeline Bratstvo (1xDN 700) – Ukraine – Slovak Republic – Czech Republic,
- Považský gas pipeline (1xDN 300) – Bratislava – Trnava – Trenčín,
- two parallel oil pipeline routes (1xDN 700 and 1xDN 500),

- product line PS (1xDN 300) with the pumping station in Bučany and with the crossing through the Váh River between Hlohovec and Leopoldov coming from the company Slovnaft, a.s. Bratislava to the terminal of the Administration of State Mass Reserves of the Slovak Republic – Slovnaft, a.s. Bratislava (Product line PS 21 Kľačany), which is 18 km distant from NEC Bohunice.

II.3.9 Services and civil infrastructure

A basic civil infrastructure proportional to the size of municipality (schools, local and state administration, shops, public catering, playgrounds, etc.) is built in the municipalities. Conditions for short-term daily recreation can be found within the residential houses area and sport playgrounds of the schools and municipalities. The whole affected area does not have suitable conditions for weekend recreation and holiday recreation. The nearest recreation areas for weekend and holiday recreation are the area of Sĺňava near Piešťany and the protected country area Malé Karpaty.

The municipalities are connected to the group water distribution line Veľké Orvište with other supplementary water sources. NEC Bohunice is also supplied with drinking water from this water distribution line. Service and cooling water is supplied from the water reservoir Sĺňava via the pumping station in Pečeňady.

Only the Jaslovské Bohunice municipality has the sewage system built together with the local sewage treatment plant. Another sewage treatment plant is built at the site of the former local military base. Sewage treatment plants are built or are being built in Pečeňady, Ratkovce and Žlkovce.

II.3.10 Recreation and tourism

The most important recreational facility in the surroundings of the Intention is the Sĺňava water reservoir near Piešťany, which is situated over the waste water outlet point of the nuclear installations in Jaslovské Bohunice and therefore waste water pollution cannot be manifested.

II.3.11 Cultural and historical sights and remarkable places

Archaeological findings confirm settlement in the affected area already in the Neolite. According to these findings, several pre-historical cultures and all historical periods in Central Europe occurred on this territory. According to preserved historical sights, a certain period of prosperity in the villages can be registered in 18th – 19th century. Among more the important cultural-historical sights in the given area, it is necessary to mention the late Gothic mansion in Jaslovské Bohunice from the end of the 18th century with a historical park of 4.0 ha area, which is a protected natural monument.

II.4 CONTAMINATION, VULNERABILITY AND TOLERABILITY OF THE ENVIRONMENT

The term vulnerability means the relative rate of environment capability to respond to external pressures or changes without degradation of the environmental quality. Tolerability of environment means the environment capability to resist against a certain load without disturbing the stability of the natural system.

II.4.1 Characteristics of pollution sources and their impact on environment

Sources of the pollution of rock basement, surface and ground water, soil as well as sources of devastation of fauna and flora are assessed in the affected area. Air pollution sources are followed in the broader area of the NEC Bohunice site.

Main environment pollution sources in the affected area are:

- NEC Bohunice characterised as production – technical facilities producing common emissions, waste water, sludge, solid waste as well as radioactive waste with the possibility of the contamination of air, surface and ground water, soil and rock basement.
- Cooperative farms with plant and animal production, which produce odour substances, waste water, sludge and solid waste mostly of organic origin with the possibility of the contamination of air, surface and ground water, soil and rock basement.
- Civil infrastructure operations, local economic services, residential buildings and other buildings and facilities in the area, which produce emissions in a lesser extent, waste water, sludge and solid waste mostly of communal character with the possibility of the contamination of air, surface and ground water, soil and rock basement.

II.4.2 Limit values for radioactive discharges to atmosphere and hydrosphere from SE EBO and GovCo (JAVYS)

The amount of authorised radioactive substances discharged from GovCo (JAVYS) and SE EBO is determined by annual limits. The aim of the limit values for discharges is to ensure that the summarised discharges of radioactive substances to the environment from all sources at the site during normal and specific operational conditions do not exceed the annual exposure limit of 0.25 mSv/year in an individual from a critical group of population due to radioactive discharges to the atmosphere and hydrosphere during the NPP operation.

The limit values of the radioactive substance discharges are determined separately for the atmosphere and hydrosphere. The limit values of discharges to the hydrosphere are determined separately for the Dudváh recipient and the Váh recipient.

The annual limit values for gaseous discharges from SE EBO and GovCo (JAVYS) into the atmosphere, as determined by the Decree no. HH SR/3380-1/2003/SOŽP of the Public Health Authority of the Slovak Republic, Department of Health Protection against Radiation, are presented in table B-9.

The annual limit values for gaseous discharges from V1 NPP into the atmosphere, as determined by Decree No. SOZPŽ/2401/2006 of the Public Health Authority of the Slovak Republic, Department of Health Protection against Radiation, are presented in table B-10.

The annual limit values for liquid discharges from SE EBO and GovCo (JAVYS) into the hydrosphere, as presented in Decree no. HH SR/3380-1/2003/SOŽP of the Public Health Authority of the Slovak Republic, Department of Health Protection against Radiation are contained in table B-20.

II.4.3 Air pollution

II.4.3.1 Non-radioactive air pollution of the affected area

With regard to the fact that all affected municipalities are supplied with gas, local sources of air pollution (domestic heating places and boiler rooms using solid fuel or heating oil in the civil infrastructure buildings, local economic services, private companies, etc.) are reduced. Heat supply for Jaslovské Bohunice is provided from the nuclear installations in Jaslovské Bohunice by means of hot water distribution system from V2 NPP to Trnava. Electrical energy is preferentially used as a supplementary source for the preparation of service water, cooking, etc. in the village.

The most serious problem of air pollution in the affected area is the high dustiness resulting from the increased transport intensity and from the fields in a dry non-vegetation period in a windy weather. Another serious and specific source of air pollution are the nuclear installations in Jaslovské Bohunice, where the following air pollution sources are operated:

- the start-up and reserve V1 NPP boiler plant (big source of pollution) with thermal output 67 MW,
- the incineration plant of Bohunice RAW treatment centre.

Detailed information on air in the broader assessed area (emissions, imissions and ground ozone) is also provided in Part C, chapter II.1.9 of this report.

II.4.3.2 Radioactive discharges from GovCo (JAVYS) and SE EBO to the atmosphere

Discharges to the atmosphere are controlled by an automated monitoring system. The values measured are compared with the authorised limits. The limit values for emissions containing radioactive substances discharged to the atmosphere were approved by the regulatory authority as authorised limits for the individual discharges (the ventilation stacks drawing off emissions from A1 NPP, V1 NPP, V2 NPP and ISFSF).

The activities of the discharged radioactive substances (noble gases, aerosols, strontium, iodine ^{131}I, transuraniums, tritium ^{3}H and carbon ^{14}C) via the ventilation stacks are detected by continual measurement by the instruments in the ventilation stacks (noble gases), by laboratory evaluation (aerosols and iodine ^{131}I – gamma spectrometric method, tritium ^{3}H – by liquid scintillation spectrometer, transuranium – alpha spectrometric method, strontium and carbon ^{14}C - radiochemical analysis). The gamma spectrometric and alpha spectrometric measurements are performed on a multi-channel amplitude analyser.

All types of discharges from GovCo (JAVYS) and SE EBO to the atmosphere were significantly below the determined authorised limits in a followed year. The highest value of annual limit was reached in the case of discharges of noble gases – 0.453 %.

II.4.4 Pollution of surface and ground water

The affected municipalities are connected to the group water distribution line, however with the exception of Jaslovské Bohunice, none of the villages has got the sewage system and they are not connected to the sewage treatment plant. The Jaslovské Bohunice village has built the sewage system and two sewage treatment plants (sewage treatment plant belonging to the village and the sewage treatment plant at the site of former military base). The recipient for both sewage treatment plants is the Blava creek. At the present time, sewage treatment plants are nearly completed in Žlkovce, Ratkovce, Pečeňady and Veľké Kostoľany. The sewage treatment plant for Žlkovce and Ratkovce is the joint one. With regard to gradients and high levels of ground water, vacuum sewage system will be built in the villages.

In all the villages except Jaslovské Bohunice, sewage from the households, municipal facilities, and state and private organisations is accumulated in cesspools and septic tanks, which are emptied at irregular intervals. Sedimented sludge is usually transferred to the fields and gardens, often in cooperation with the farms. Drains are often used for leading water away from the cesspools and septic tanks. Cases of direct transfer of sewage to close sewage treatment plants are sporadic, e.g. in the case of apartment houses and state organisations. Wells are used as the source of irrigation water for gardens and private plots.

The problem of the sewage system in the affected municipalities in the district of Trnava is resolved by joint sewage collectors and by leading the sewage to the municipal Trnava sewage treatment plant in Zeleneč. Sewage water from Malženice, Jaslovské Bohunice and Radošovce will be carried away here (currently in the phase of project development). Sewage systems are planned to be built in Žlkovce, Ratkovce, Pečeňady and Veľké Kostoľany successively.

II.4.4.1 Pollution of surface streams by radioactive substances

Surface water and water streams in the affected area are contaminated namely by humus flushing, soil, fertilizers, and pesticides including sewage transferred from the fields and gardens. A rare form of Chtelnička creek pollution, which flows at the margin of Pečeňady and Ratkovce villages, is the sludge from cleaning the filters at the pumping station in Pečeňady, which provides the cooling and service water for NEC Bohunice.

Another big polluter of surface water in the affected area are the nuclear installations in Jaslovské Bohunice. The recipient for precipitation water from the whole site is the open Manivier canal, which empties into the unregulated stream of the Dudváh River, which is a source of irrigation water (3 pumping stations for irrigation), behind the village of Žlkovce. The stream of the Dudváh River is regulated from the village of Bučany to the mouth of Váh River near the village of Siladice.

The recipient for all technological and sewage waste water produced at the site is a piping collector called SOCOMAN. The water from the site is carried away in two branches: from A1 and V1 NPPs (together with the interim spent fuel storage facility) and from V2 NPP. The SOCOMAN runs water away in a gravitational way to the draining canal of hydro power plant Madunice. The SOCOMAN collector is 10.8 km long; it runs on the right bank of Manivier canal to the margin of Žlkovce, where it crosses to its left bank, crosses the Dudváh River, road communications and proceeds to the right bank outlet with a back-water gate in the village of Červeník.

More detailed information on the waste water treatment, limit amounts for the pollution of waste water discharged from the common site of GovCo (JAVYS) and SE EBO in Jaslovské Bohunice to the Váh recipient and Dudváh recipient as well as for the water quality parameters in the Váh recipient are presented in Part B, chapter II.3.

II.4.4.2 Pollution of ground water by non-radioactive substances

The contamination level of ground water of the affected area can be expressed by the degree of contamination C_d. This parameter is calculated for each sample, where the A value of the recommendation of the Slovak Commission of Environment for implementation of parameters and standards for the treatment of polluted soil and ground water, as a sum of the factors of contamination of individual analysed components for the given standard value, was exceeded. In general, there is a very low level of contamination of ground water in the affected area, The C_d value is up to 0.25% (majority of values equals to 0). To illustrate the significance of these values we can mention that the highest contamination levels in Slovakia range to about 20 for the discharges from adits, i.e. areas with former or current mining work.

Non-aggressive ground water occurs in the affected area. Other parameters of ground water, mentioned in Geochemical atlas, correspond with this fact. From the comparison of the values of parameters for aggressive effects of ground water according to STN 73 1214, STN 73 1215 and Geochemical atlas, it can be concluded that aggressiveness of ground water in the vicinity of NEC Bohunice is mild.

Table C-35: Ground water in the affected area and comparison with STN 73 1214 and 73 1215

Mild aggressiveness	*pH values*	*Aggressive CO_2 [mg.dm^{-3}]*	*Mg^{2+} [mg.dm^{-3}]*	*NH_4^+ [mg.dm^{-3}]*	*SO_4^{2-} [mg.dm^{-3}]*
STN 73 1214 and STN 73 1215	> 5.0 – 6.5	> 10 – 40	> 1000 – 2000	> 100 – 500	> 250 – 500
Geochemical atlas, R = 5 km from NPP	6.4 – 6.6	1.00 – 3.00	25 – 30	< 0.25	50.0 – 75.0

According to STN 75 7111 "Drinking water", the indication value for ^{222}Rn is the mass activity of 50.0 $Bq.dm^{-3}$, the radon concentration in ground water of the affected area ranges from 20 to 25 $Bq.dm^{-3}$, i.e. half values indicated by the standard.

The following critical acidity loads were calculated for the ground and surface water of the affected area:

- ground water: critical load (5-percentile) of 9-12 $keqv.ha^{-1}.r^{-1}$,
- surface water: critical load (5-percentile) of 6-9 $keqv.ha^{-1}.r^{-1}$.

The calculated values of critical load exceeding indicated that there are reserves for further dumping of acid deposition. From this point of view, the ground water is less endangered with regard to the damping capacity of soil cover.

II.4.4.3 Radioactive discharges from NEC Bohunice to the hydrosphere

The Public Health Authority of the Slovak Republic, Department of Health Protection against Radiation authorises the discharges of radioactive substances to the hydrosphere on the basis of demonstrably remaining within the limit.

The limits for liquid discharges from the site of nuclear installations in Jaslovské Bohunice are presented in table B-20 and B-21. Discharges to the surface water are determined as common ones for all nuclear installations at the site and at two discharge points: the piping collector SOCOMAN empties into the Váh River and discharges to the Manivier canal empty into the Dudváh River.

Corrosion, fission products, tritium, strontium and transuranium are measured in the samples of liquid discharges by gamma-spectrometric method. The summary activity of beta radionuclides is also measured.

In 2005, all waste water from SE EBO and GovCo (JAVYS) was transported via the piping collector SOCOMAN and the Drahovský canal to the Váh recipient. No discharge of low radioactive waste water via the Manivier canal to the Dudváh recipient took place in this period due to the reconstruction of the rain sewage system.

In the course of 2005, the standard operation of the rescue pumping of ground water from the N-3 (SO 106) borehole took place in GovCo (JAVYS) in cooperation with the EKOSUR company.

According to SKŽP recommendations, rescue pumping is performed as of the following contamination levels of ground water:

- Tritium ^{3}H 5000 Bq/l,
- Caesium ^{137}Cs 2.0 Bq/l,
- Strontium ^{90}Sr 1.0 Bq/l.

In the above mentioned period, 189 379 m^3 of ground water with a summary radioactivity 1.61x10^{11} Bq of tritium and summary radioactivity 2.27x10^7 Bq of corrosion and fission products were pumped from the N-3 borehole in the framework of rescue pumping.

The radioactivity measurement of discharged water is performed by the measuring of mass activity of tritium, corrosion and fission products and the amount of water in collection tanks of A1, V1 and V2 NPPs.

In the followed year, the values of tritium discharges to the Váh recipient reached 35.81% of the authorised limit (43 700 GBq). Discharges of corrosion and fission products in corrosive water were significantly below the determined values of the authorised limits.

II.4.4.4 Water radioactivity

The monitoring of ground water at the NPP Bohunice site and in its surroundings is carried out in the sense of amended regulations: *0-PKN-001 Laboratories for radiation monitoring of the surroundings* in the part concerning of ground and drinking water, *U-33 Stable systems for radiation monitoring of A1 NPP main production building* and *0PLN-10 Plan of emergency measures against surface and ground water pollution from SE EBO and SE VYZ* in the part concerning of ground water and of approved monitoring programme.

The monitoring of ground water and of ground percolation water has been carried out by the EKOSUR company since 1997 (part of the monitoring is simultaneously carried out by the SE EBO department 13221 – group of SE EBO radiation monitoring).

The purpose of ground water monitoring at the site of NEC Bohunice and its surroundings is to:

- Provide a check-up of the impact of the NEC Bohunice operation on ground water as one of the environmental components,
- provide bases for the regular informing of inspection and regulatory authorities about the radiation situation of ground water at the site of NEC Bohunice and in their surroundings,
- permanently obtain data on radioactivity and the hydrogeological situation of ground water at the site of NEC Bohunice and their surroundings in order to create data files for a historical analysis and more precise determination of reference levels,
- purposefully utilise the monitoring system, technical equipment and expert workers who are in a permanent stand-by in case of accident.

The subject of monitoring is preferentially the ground water in the 1st water-bearing layer of the site and at some places also the ground water of the 2nd water-bearing layer and ground water of the non-saturated overlying geological layer (due to differentiation from the ground water of the saturated zone) identified as percolation ground water. To evaluate communication between ground and surface water (bank infiltration), surface water is also monitored at some places.

The ground water under the site of NEC Bohunice and its close surroundings creates a unified indivisible unit, which has to be assessed in a comprehensive way. However, from the point of view of assessment of the impacts of the main subjects performing industrial activities at the site as well as from the organisational point of view, ground water monitoring is divided into the following sites:

- GovCo (JAVYS) (A1 NPP, V1 NPP and ISFSF),
- SE EBO (V2 NPP).

The assessment of ground water in the surroundings of NEC Bohunice represents a special issue, because except the impact of individual sites, ground water in this area can also be affected by technological equipment and systems located outside the site of NEC Bohunice (especially the waste water let-down systems from the nuclear installations). This is the reason why the monitoring of the surroundings of NEC Bohunice is divided into the following territorial parts in the sense of the monitoring programme:

- the area of the surroundings of NEC Bohunice to Dudváh River,
- the Dudváh River area, SOCOMAN, Drahovský canal, Váh River, Leopoldov,
- the area of the confluence of the Dudváh and Váh River.

Samples of ground water are taken according to the analyses required (monitored parameters) as follows:

Samples for detection of tritium ^{3}H mass activity

Samples of ground water with 1 dm^3 volume are taken from surface the level by a collecting vessel. Samples of ground percolation water with 1 dm^3 volume (or the volume that could be taken) are taken from the surface level by a collecting vessel.

Samples for gamma spectrometric analyses and detection of ^{90}Sr

Samples of ground water with 10 dm^3 volume are taken from the water column by a special pump Grundfos MP 1. Samples of ground percolation water with 10 dm^3 volume (or the volume that could be taken) are taken from surface level by a collecting vessel.

Samples for detection of total beta mass activity

Samples of ground water with 5 dm^3 volume are taken from the water column by a special pump Grundfos MP 1.

Samples for alpha spectrometric analyses and ^{90}Sr detection

Samples of ground water with 10 dm^3 volume for these analyses are taken from water column by a special pump Grundfos MP 1. In the case of rescue pumping, the samples with 0.5 dm^3 volume are taken from the sampling valve of the technological facility of GovCo (JAVYS) building no.106 and they are decanted to a composite sample for the whole month. Samples of ground percolation and drainage water with 10 dm^3 volume are taken from the surface level by a collecting vessel.

Samples for detection of ^{14}C

Samples of ground water with 20 dm^3 volume are taken from the water column by a special pump Grundfos MP 1. Samples of ground percolation and drainage water with 15 dm^3 volume are taken from surface level by a collecting vessel.

Conservation of the samples is carried out in accordance with *STN ISO 5667-3 "Water quality. Sampling. Part 3: Instructions for the conservation of samples and handling with them",* or in accordance with the special requirements of a laboratory performing the analysis.

Radiation situation in ground water

These are the main issues resulting from summarised assessment of radiation situation in 2005:

- The GovCo (JAVYS) site still remains the principal large-scale source of contamination of geological environment at the site of NEC Bohunice. Among several point, line and small-scale sources, the dominant position belongs to building no.41. However, the radiation situation in the ground water of the site is improved by the implementation of corrective measures (rescue pumping), by which the contaminated ground water is removed from the geological environment and movement of residual contamination outside the site is slowed down. The efficiency of the rescue pumping is about 80-90% with regard to the demarcated complex source at A1 NPP site; the average intensity of tritium pumping is approximately 5 $kBq.s^{-1}$ and in the case of ^{60}Co it is approximately 0.8 $Bq.s^{-1}$.
- The main contaminant of the geological environment is tritium. Its mass activity under the GovCo (JAVYS) site reaches up to 10^5 $Bq.dm^{-3}$. According to the results from the last year, the further direction of contamination spreading to the surroundings of NEC Bohunice is basically identical with the flow direction of the ground water and outside the site of NEC Bohunice, tritium mass activities in the ground water can be detected up to the line of the JB-16, JBP-6 and JBP-7 boreholes with maximum values up to 1000 $Bq.dm^{-3}$. The tritium contamination transported to the vicinity of the municipalities is low (Malženice up to 120 $Bq.dm^{-3}$, Žlkovce up to 100 $Bq.dm^{-3}$, margin of Jaslovské Bohunice ~ 600 $Bq.dm^{-3}$).
- Ground water in the remaining part of the followed area is not contaminated by radioactivity (< 10 $Bq.dm^{-3}$) except the boreholes in the Dudváh River vicinity (a consequence of the later infiltration of water discharged from the Dudváh River to the ground water with radioactivities up to 100 $Bq.dm^{-3}$ and of the adjacent area of SOCOMAN on the territory of the Červeník village – activities up to 30 $Bq.dm^{-3}$ in the boreholes of HŽ line in the 1st quarter, on MDA level in the 2nd to IVth quarter).
- The radiation situation in the area of Hlohovec and the water sources (wells) utilised in the area of Leopoldov is favourable. Tritium mass activities in this area reached up to 18 $Bq.dm^{-3}$, which is an insignificant level. It is possible to expect its variability, this being dependent on radioactivity of discharged water from SOCOMAN, its dilution in the Drahovský canal and subsequent infiltration to the ground water of the adjacent area.
- The significant improvement of the radiation situation in comparison with previous years can be observed in the area around the JB-6 borehole in front of Žlkovce as well as directly in the

Žlkovce village. This stems from a restriction of the discharge of waste water to the Manivier recipient and from the sealing of the SOCOMAN canal in this section.

- The radioactivity of other artificial radionuclides except tritium has not been found out in ground water outside the site of NEC Bohunice.

The *radioactivity of drinking water* is followed in 10 l samples taken quarterly. The samples were taken from the sources in Hlohovec, Kátlovce, Veľké Kostoľany, Malženice (cooperative farm), Siladice, Trakovice (I and II), Zelenice, Žlkovce (I and II). The content of the total beta radioactivity, radioactivities of ^{3}H and ^{90}Sr are measured after their radiochemical processing.

The results of the measurements in 2002 – 2005 period are presented in table C-36. ^{90}Sr radionuclide was under the detection limit of the detection method used in 2002 and 2003 and similarly as other radionuclides it was not detected in the remaining years.

Table C-36: Radionuclides in drinking water (taking of samples and analyses quarterly)

Year	*2002*	*2003*	*2004*	*2005*
Total beta radioactivity [mBq.dm^{-3}]	14.6 − 955.75	13.2 − 803.45	41.5 − 878	20.3 − 709
^{3}H radioactivity [Bq.dm^{-3}]	5.60 − 116.0	6.0 − 114.30	5.5 − 113.8	5.7 − 116.8
^{90}Sr radioactivity [mBq.dm^{-3}]	< DL	< DL	2.9 − 25.7	1.67 − 8.17

DL − detection limit

The *samples of surface water* were taken monthly from the following places: Bučany – Dudváh River, Várov Šúr – Váh River, Veľké Kostoľany – Dudváh River, Žlkovce – the canal, Madunice – Váh River. In the samples of surface water taken monthly (50 l volume), the content of ^{3}H, ^{90}Sr, ^{134}Cs, ^{137}Cs and ^{40}K is measured after radiochemical processing. Comparison of the radioactivity of surface water in 2002 – 2005 period is presented in table C-37.

Table C-37: Radionuclides in surface water (taking of samples and analyses monthly)

Year	*2002*	*2003*	*2004*	*2005*
^{3}H radioactivity [Bq.dm^{-3}]	5.4 − 18.6	5.3 − 17.2	5.4 − 10.9	6.0 − 55.3
^{90}Sr radioactivity [mBq.dm^{-3}]	< DL	2.28 − 7.00	2.60 − 25.40	1.9 − 17.0
^{134}Cs radioactivity [mBq.dm^{-3}]	2.00 − 7.19	1.7 − 8.15	2.54 − 9.73	0.91 − 290.0
^{137}Cs radioactivity [mBq.dm^{-3}]	1.60 − 8.00	1.70− 8.15	2.53 − 8.71	0.85 − 318.0
^{40}K radioactivity [mBq.dm^{-3}]	32.00 − 139.65	31.0 −160.0	62.7 − 205.47	65.0 − 6 500

DL − detection limit

Radioactivity of ground water. Monitoring is aimed at the check-up and analysis of the samples on a local as well as regional scale and it is divided into 4 parts. Mass radioactivity of tritium, total beta radioactivity and radioactivity of ^{90}Sr are measured in samples of ground water taken and gamma spectrometric analysis is carried out. The monitoring programme determines, in which of the monitoring places the sample is taken and in which intervals (monthly, quarterly or annually). The monitoring of ground water is divided as follows:

- Monitoring of ground water in the vicinity of actual or potential pollution sources at the site of NEC Bohunice. The monitoring places are boreholes and probes at the former SE VYZ site (21 monitoring places), at V1 NPP site (11 monitoring places) and at V2 NPP site (18 monitoring places).
- Monitoring of ground water in the vicinity of nuclear installations in Jaslovské Bohunice carried out at 97 monitoring places (boreholes, probes and wells), including:
- monitoring of ground water in the area of potential utilisation by the population in the municipalities, where the water can be used for individual irrigation, sporadically for drinking (the monitoring places are boreholes in the municipalities),
- monitoring of ground water in the surroundings of the nuclear installations in Jaslovské Bohunice used for drinking (the monitoring places are waterworks boreholes).

Maps of the monitoring points on the NEC Bohunice site and its surroundings with the marked isolines of tritium radioactivity are given in figures C-7 and C-8. Data on the monitoring of ground water according to the above-mentioned division is summarised in the table C-38.

Table C-38: Radionuclides in radiation monitoring boreholes

Year	*2002*	*2003*	*2004*	*2005*
Total beta radioactivity [mBq.dm^{-3}]	21.05 – 122.11	26.84 – 115.93	34.7 – 110.0	28.1 – 121.0
^{3}H radioactivity [Bq.dm^{-3}]	5.8 – 1944.0	5.60 – 61.8	5.6 – 46.1	6.0 – 33.6

Radiation risk assessment for the population

On the basis of the data obtained from the monitoring and simulating the prognosis of the radiation situation development, it can be stated that:

- Contamination of the ground water by tritium (coming from the sources at GovCo (JAVYS) and SE EBO sites) in the first water-bearing layer in the area of adjacent municipalities of NEC Bohunice cannot exceed 200 Bq.dm^{-3} even in the future. In the area of the cloud axis of main contamination (A1 NPP as a source), the value of 1000 Bq.dm^{-3} cannot be exceeded. For the illustration, the highest mass radioactivity of tritium in the precipitations was in 1963 as a consequence of the nuclear weapon tests, reaching the value of 270 Bq.dm^{-3}.
- Long-term rescue pumping of ground water by the SO 106 system has been provided at the A1 NPP site (the main source of spreading tritium contamination) since 1999. This will result in the reduction of ground water contamination spreading outside the source area. The construction of the rescue pumping system represents the significant active element of ground water quality protection at the site.
- The low contamination of ground water by other artificial radionuclides cannot spread to more distant places from the site of nuclear installations and thus it cannot endanger its quality in the municipality area.

- Contamination of the ground water by tritium as a consequence of leakages of low level radioactive water from the SOCOMAN waste water collector exceeds the investigation level of 100 Bq.dm^{-3} locally in the area between Žlkovce and Červeník. Exceeding of the 1000 Bq.dm^{-3} level in SOCOMAN area is not assumed.
- Mass radioactivities (assumed as well as measured) of tritium in ground water under the municipalities and in their surroundings are low and negligible from the radiological point of view. Possible individual dose equivalents will not exceed negligible value of 10 μSv.year^{-1}.

We can conclude that the existing radioactive pollution of the ground water at the site NEC Bohunice and in its surroundings, even under the most conservative assumptions, cannot cause health damage to any individual from the population on that level, which exceeds the negligibility level of individual risk (10 μSv.year^{-1}). All limit parameters of valid legislative regulations and international recommendations are higher than the actual values. This means that ground water contamination is low and if such water is pumped and used, it will not be defective from the radiation point of view.

No regulatory protective measures are needed for the population in the surroundings of NPPs in Jaslovské Bohunice. In spite of this fact, a water supply from the central water distribution line sources is provided to them.

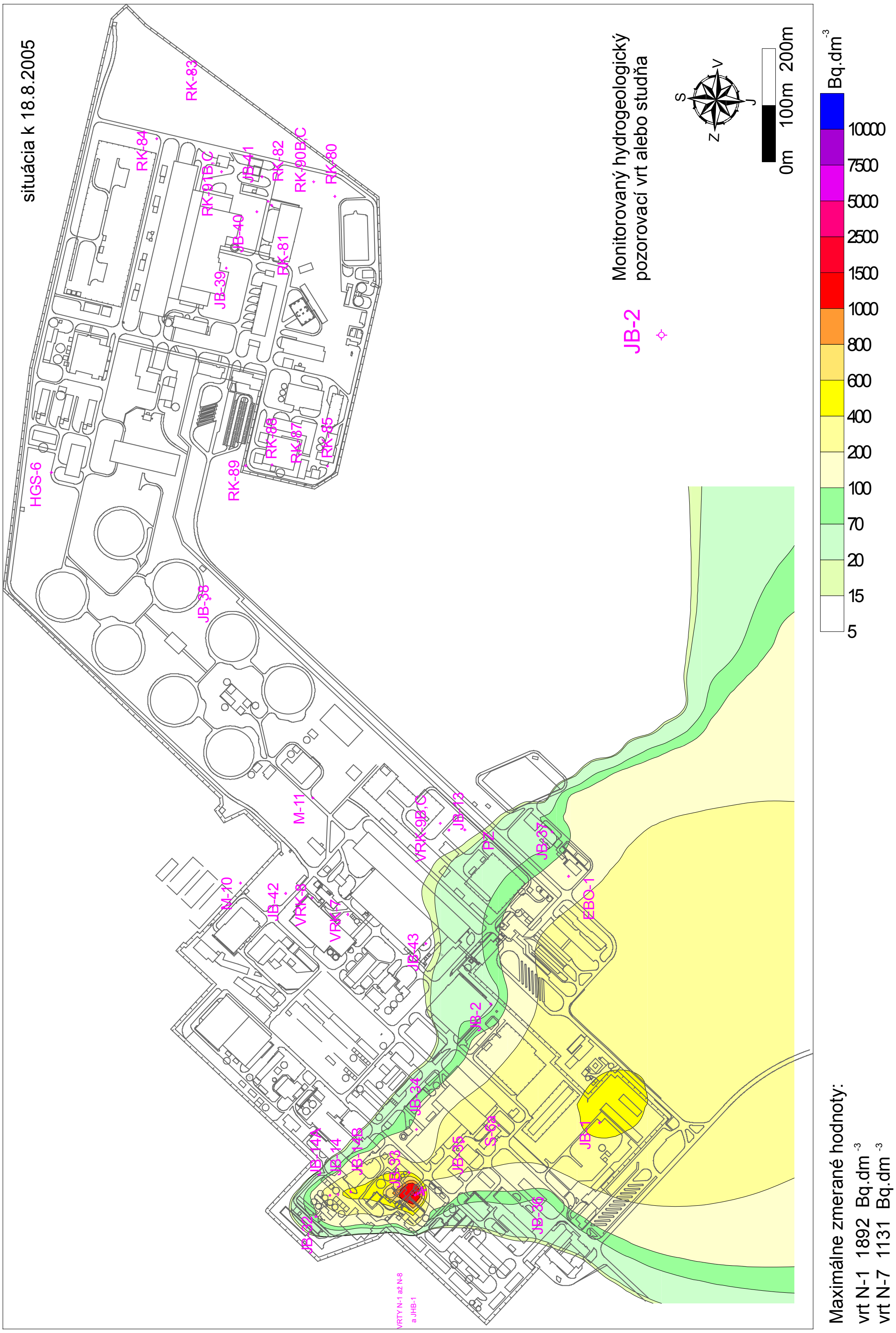


Figure C-7: NEC Bohunice site – Monitoring places layout (status on August 18, 2005)

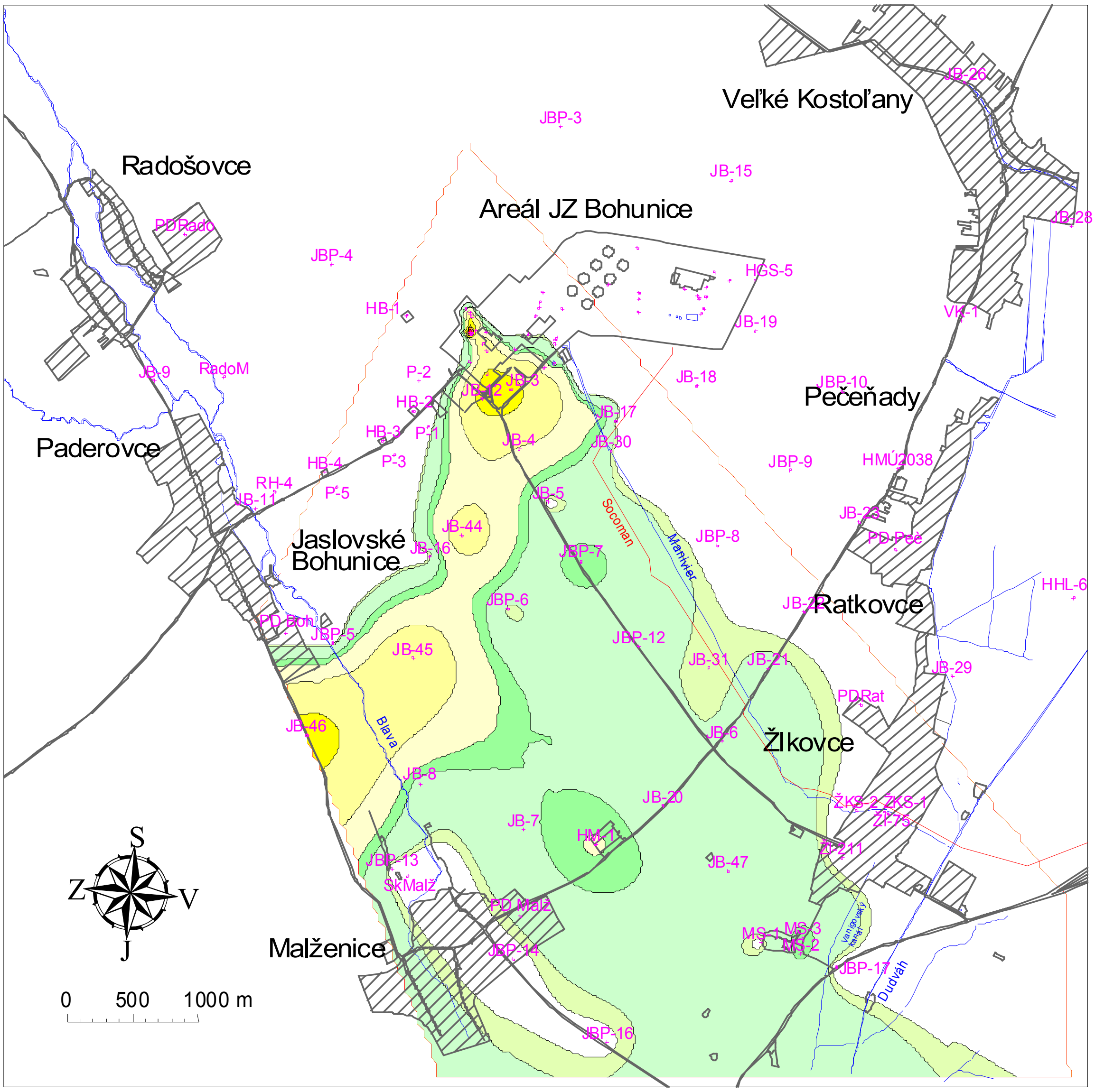


Figure C-8: Site of NEC Bohunice and its surroundings – isolines of tritium volume activities in the ground water, status on August 18, 2005.

II.4.5 Soil contamination and soils endangered by erosion

Soils in the affected area are contaminated by imission fall-outs, incorrect application of fertilizers and pesticides and frequently also by the release of septic tanks contents on agricultural soil. In the municipalities and their vicinity, the soils can be contaminated by pollutants coming from sewage system leakages and from septic tanks. Point (small-scale) pollution is caused by solid waste being transferred to illegal dump sites.

II.4.5.1 Solid waste from households and municipal infrastructure

All affected municipalities are connected to the group water distribution line with water sources in Orvište and Dobrá Voda, but they do not have the sewage system completed, except Jaslovské Bohunice. Sewage from the municipal buildings is accumulated in cesspools and septic tanks; it is transferred to fields and only sporadically to some of the close sewage treatment plants (in case of larger organisations). This leads to the above mentioned soil contamination by pollutants from the sewage system.

Solid waste from households and the municipal infrastructure is shipped to the controlled dump sites. Two dump sites for solid industrial and conventional waste are operated in the affected area:

- The controlled dump site for industrial waste and solid conventional waste in Žlkovce, which is operated by SE EBO and to which the solid waste from the affected municipalities of Jaslovské Bohunice, Radošovce, Malženice, Žlkovce and Ratkovce is shipped.
- The fenced temporary site in Nižná (only for the village), which is supposed to be removed after the completion of the dump site in Ratkovce.

The municipalities of Nižná, Pečeňady and Veľké Kostoľany are shipping the waste to a controlled dump site in Pastuchov. The dump site is also operated and used by SE EBO, which dispose of part of the industrial waste (sludge) to this dump site. Sporadically occurring illegal dump sites are removed by the affected municipalities.

II.4.5.2 Impact of agricultural production

Solid waste in the cooperative farms is processed according to its character and origin similarly as solid waste in the municipalities. Organic waste from agricultural production and from animal breeding (manure, dung water) is shipped to the fields as natural fertilizer. Scrap is sold to the salvage organisations; used oil products and lead accumulators are sold to the organisations certified for their processing. Ash from coal, waste similar to domestic waste, residues of used agents for plant protection, and old tyres are shipped to the dump sites. The utilisation of industrial fertilizers and pesticides has been restricted to the unavoidable extent in recent years.

II.4.5.3 Impact of the operation of nuclear installations in Jaslovské Bohunice

Nuclear installations in Jaslovské Bohunice produce all kinds of waste, i.e. both hazardous and other waste. In concrete terms, it is the waste of organic and inorganic character, metallic waste, waste containing heavy metals (lead, mercury), waste similar to domestic waste, etc.

SE EBO produced 12 617 tons of waste in 2005, of which 12 512.4 tons of other waste and 104.6 tons of hazardous waste.

Table C-39: Amount of produced waste in tons in 2005

Classification number	*Name of the waste*	*Category*	*Amount*	*Code*
10 12 08	Waste ceramics, bricks, tiles and paving bricks	O	561.18	D1
15 01 01	Packages made of paper and cardboard	O	12.94	R5
15 01 03	Packages made of wood	O	13.74	D1
16 01 03	Used tyres	O	1.36	R1
17 01 01	Concrete	O	471.89	D1
17 02 03	Plastic	O	3.55	R4
17 04 01	Copper, bronze, brass	O	1.68	R4
17 04 02	Aluminium	O	1.57	R4
17 04 05	Iron and steel	O	384.68	R4
17 04 11	Cables other than given in 17 04 10	O	4.66	R4
17 05 06	Excavation soil other than given in 17 05 05	O	436.94	D1
17 09 04	Mixed waste from constructions and demolition	O	1 461.33	D1
19 08 09	Mixture of fats and oils from oil separators	O	49.70	D2
19 09 03	Sludge from decarbonisation	O	7 640.22	D1
19 09 03	Sludge from decarbonisation	O	860.20	R10
19 12 04	Plastic and rubber	O	5.97	D1
20 03 01	Mixed conventional waste	O	600.71	D1
08 01 11	Waste colours and varnishes containing organic solvents or other hazardous substances – Y 12	N	0.31	D1
08 03 17	Waste printer toners containing hazardous substances – Y 12	N	0.222	D1
09 01 01	Solutions of water-soluble developers and activators – Y 16	N	0.09	D9
09 01 04	Solutions of fixatives – Y 16	N	0.20	D9
12 01 18	Metallic sludge from grinding, honing and lapping, containing oil - Y 8	N	6.05	D1
13 02 06	Synthetic engine, gear and lubricating oils – Y 9	N	15.26	R1
13 03 10	Other insulation and heat-bearing oils – Y 8	N	35.28	R1
13 05 08	Oil from oil separators from water – Y 9	N	35.72	R1
15 01 10	Packages containing residues of hazardous substances or contaminated hazardous substances	N	0.02	D1
15 02 02	Absorbents, filtration materials, cleaning rags, clothes contaminated by hazardous substances – Y 15	N	5.93	D1
16 01 07	Oil filters – Y 8	N	0.04	D1
16 05 07	Discarded inorganic chemicals consisting of hazardous substances – Y 14	N	0.04	D9
16 06 01	Lead batteries – Y 31	N	4.055	R4
20 01 21	Fluorescent lamps and other waste containing mercury – Y 29	N	1.40	R4

Note: D1 – Disposal into the earth or on the earth surface
D2 – Conditioning by soil processes
D9 – Physical and chemical conditioning (e.g. evaporation, drying, etc.)
R1 – Utilisation mostly as fuel or for energy generation by some other method
R4 – Recycling or regenerative recovery of metals and metallic compounds
R5 – Recycling or regenerative recovery of other inorganic materials
R10 – Soil modification for agricultural benefits or environment improvement

Mainly due to the storage of radioactive liquids in a way that was used at the time of the design and construction of A1 NPP, contamination of the soil and geological environment under this power plant occurred as well as contamination of the ground water (see the chapter on water). Alternatives of the final solution for handling these soils are being elaborated currently.

II.4.6 Radiation monitoring of the other components of environment and of agricultural production

When limiting the discharges from nuclear installations, the basic values of exposure of individuals from the critical population group determined by the legislation are considered. According to § 37, section (3), letter c) of the Decree of Ministry of Health no. 12/2001 Coll., it is allowed to discharge gaseous and liquid discharges from the nuclear installations on condition that the effective dose of an individual from the critical population group does not exceed 0.25 mSv in any calendar year, while this value relates to the total exposure from discharges of all nuclear installations of the given site.

The activity of aerosols from continual sampling and the activity of fall-outs of selected radionuclides are monitored in the atmosphere in a long-term manner. According to the summary report "Radiation safety of SE EBO and SE VYZ and the impact of SE EBO and SE VYZ sites on the surroundings" (2005), the present air pollution by radionuclides in the surroundings of nuclear installations in Jaslovské Bohunice is monitored as follows:

Radioactivity of aerosols from continual sampling is followed on the samples taken at 24 stations located at the site and in the surroundings of NEC Bohunice by means of large-volume suction sampling equipment with an air flow rate of approximately 220 $m^3.h^{-1}$. The filters are pressed to a tablet shape after 14 days of exposure and they are gamma-spectrometrically analysed by a semiconductor HPGe detector, especially ^{137}Cs radioactivity is detected. The content of ^{90}Sr and $^{239/240}Pu$ from composite samples is also analysed from aerosol filters at the stations EBO II, EBO III and Trnava.

The measured values of ^{137}Cs ranged from 0.4 to 5 $\mu Bq.m^{-3}$, of ^{90}Sr from 0.11 to 0.72 $\mu Bq.m^{-3}$ and the values for isotopes $^{239/240}Pu$ ranged from 3.0 to 24.5 $nBq.m^{-3}$. Except it, radionuclides of ^{110m}Ag (max. 5.93 $\mu Bq.m^{-3}$), ^{54}Mn (1.16 $\mu Bq.m^{-3}$), ^{58}Co (1.70 $\mu Bq.m^{-3}$), ^{60}Co (2.02 $\mu Bq.m^{-3}$) and ^{131}I (3.80 $\mu Bq.m^{-3}$) were detected in aerosols during the gamma spectrometric analysis.

Radioactivity of fall-outs is detected by means of large-scale sampling equipment with water levels at the selected stations in parallel with aerosol sampling. Fall-out samples are processed by the method of large-volume condensation with a subsequent gamma spectrometric analysis. Radioactivity of ^{90}Sr and $^{239/240}Pu$ from decanted samples is detected in the fall-outs from EBO III and Trnava stations.

Radioactivity of ^{137}Cs ranged from 0.05 to 0.30 Bq/m^2, radioactivity of ^{90}Sr ranged from 13.3 to 90.6 Bq/m^2 and radioactivity of $^{239/240}Pu$ ranged from immeasurable values to 49.90 Bq/m^2. Other artificial radionuclides were not identified in the fall-out samples in 2005.

In 2005, 12 exceedings of the investigation levels of aerosol mass activity were recorded. The intervention level was not exceeded. The causes of exceedings were investigated and filed by the Department of radiation monitoring.

Soil samples are taken once a year from grass growths (from 0-2 cm and 2-5 cm depths, the sample is taken in spring) and from arable land (from 0-5 cm depth, the sample is taken in autumn).

The samples taken are dried, homogenised and subsequently the radioactivity of ^{134}Cs, ^{137}Cs, ^{7}Be and ^{40}K is measured by the gamma spectrometric method. A composite sample is prepared from samples taken, in which the content of ^{90}Sr and $^{239/240}Pu$ radionuclides is detected.

The highest measured value of ^{137}Cs radioactivity was 19.75 $Bq.kg^{-1}$ (Žlkovce) in 2005, ^{90}Sr – 4.28 $Bq.kg^{-1}$ (LRKO) and $^{239/240}Pu$ – 119 $mBq.kg^{-1}$ (Žlkovce).

Sediments are taken once a year in summer. The samples are dried, homogenised and subsequently analysed by gamma the spectrometric method. Radioactivity of ^{90}Sr and $^{239/240}Pu$ in the samples is also analysed.

The detected specific radioactivities of ^{7}Be ranged from immeasurable values to 13.92 $Bq.kg^{-1}$, ^{40}K ranged from 226 to 338.9 $Bq.kg^{-1}$, ^{137}Cs ranged from 1.86 to 117.97 $Bq.kg^{-1}$, ^{134}Cs – less than the detection limit, ^{90}Sr ranged from 0.41 to 11.40 $Bq.kg^{-1}$ and ^{60}Co was detected in one sample - 1.02 $Bq.kg^{-1}$.

Measurement of gamma radiation dose equivalent rate is carried out at 8 dosimetric stations in monthly intervals. TLD dosimeters after 1-month exposure are evaluated in the laboratory. Values of the gamma radiation dose equivalent ranged from 28.02 to 63.64 μSv.

Measurement of dose rates is carried out continually at 24 stations of EBO teledosimetric system. Values of the dose rate ranged from 70.73 to 115.93 $nGy.h^{-1}$.

Contamination of selected agricultural products and river biotopes by radioactive substances is monitored in the vicinity of the NEC Bohunice site in a long-term manner. With regard to the fact that the majority of the land registry of affected municipalities consists of soil used for agricultural production, radiation monitoring of the surroundings of nuclear installations in Jaslovské Bohunice aims at the monitoring of agricultural production. From the products of animal production, milk radioactivity is followed. Samples of grasses, clover, wheat, barley, peas, sugar-beet and corn are analysed from plant production. The samples of potamogeton are analysed from natural biotopes.

Milk samples (2 l volume) are taken from the dairy (Hlohovec) and from the cooperative farms (Dolné Dubové, Nižná, Drahovce and Pečeňady) in weekly intervals. A gamma spectrometric analysis for the presence of artificial radionuclides is carried out. A monthly sample is prepared from weekly samples, then it is radiochemically processed, gamma spectrometric analysis is carried out to measure ^{90}Sr content. The specific activities of ^{137}Cs measured ranged from 0.020 to 0.071 $Bq.l^{-1}$, ^{40}K ranged from 46.94 to 54.04 $Bq.l^{-1}$ and ^{90}Sr ranged from 4.79 to 36.4 $Bq.l^{-1}$ (one value was significantly higher – 63.50).

Grass samples are taken twice a year (in spring and autumn) in the vicinity of the dosimetric stations, the gamma spectrometric analysis is carried out after drying and pressing. A composite sample is prepared from the samples for identifying the content of ^{90}Sr and $^{239/240}Pu$ by radiochemical analysis. Specific activities of ^{137}Cs measured ranged from 0.57 to 2.99 $Bq.kg^{-1}$, ^{7}Be ranged from 48.52 to 237.20 $Bq.kg^{-1}$, ^{40}K ranged from 233.74 to 1244.95 $Bq.kg^{-1}$. The presence of ^{90}Sr (max. 0.57 $Bq.kg^{-1}$) and of $^{239/240}Pu$ (max. 4.85 $mBq.kg^{-1}$) was found out in two grass samples.

Samples of clover were also taken for measurement twice a year. Specific activities of ^{137}Cs measured ranged from 0.41 to 1.05 Bq.kg^{-1}, ^{7}Be ranged from 51.14 to 88.56 Bq.kg^{-1}, ^{40}K ranged from 547.09 to 1125.90 Bq.kg^{-1}. The presence of ^{90}Sr (max. 2.32 Bq.kg^{-1}) and of $^{239/240}$Pu (max. 36.1 mBq.kg^{-1}) was found out in two clover samples.

Samples of agricultural products are taken once a year (at the time of picking): wheat, barley, peas, rape, sugar-beet and corn. A gamma spectrometric analysis is carried out from the samples and a composite sample is prepared for the measurement of ^{90}Sr and $^{239/240}$Pu content. The specific activity of ^{137}Cs was lower than the detection limit (0.6 – 0.95 Bq.kg-1) in the samples of barley, wheat, corn, sugar-beet, peas and rape. The content of ^{7}Be in the samples ranged from immeasurable values to 11 Bq.kg-1 (barley) and of ^{40}K from 87.92 to 308.92 Bq.kg-1.

The lowest measured content of ^{90}Sr in the samples was 13.1 mBq.kg-1 (corn), the highest one was 513.0 mBq.kg-1 (sugar-beet), but the content of ^{90}Sr was lower than detection limit in majority of cases. Content of $^{239/240}$Pu ranged from immeasurable values to 7.33 mBq.kg-1.

Samples of potamogeton (pondweed) are taken once a year in the summer period (Bučany and Veľké Kostoľany – Dudváh River and Žlkovce – the canal). After drying and homogenisation, the samples are analysed by gamma spectrometry and content of ^{90}Sr and $^{239/240}$Pu is also determined. Specific radioactivities of ^{40}K ranged from 434.95 to 734.77 Bq.kg^{-1}, ^{137}Cs ranged from 1.81 to 22.23 Bq.kg^{-1}, ^{90}Sr ranged from 0.34 to 2.25 Bq.kg^{-1} and $^{239/240}$Pu ranged from 36.0 to 65.7 mBq.kg^{-1}. The content of ^{134}Cs was lower than the detection limit of the method used (0.48 – 0.77 Bq.kg^{-1}). Other artificial radionuclides were not detected.

II.4.7 Radiation load of the population in the surroundings of GovCo (JAVYS) and SE EBO

To assess the impact of the GovCo (JAVYS) and SE EBO sites on the population of the affected municipalities, an analysis of the population dose load on the basis of actual meteorological measurements and actual data on discharges of radioactive substances to the atmosphere and hydrosphere in 2005, was carried out.

Waste water is discharged into the hydrosphere after purification. No radioactivity from the GovCo (JAVYS) and SE EBO sites was discharged to the Dudváh recipient via the Manivier canal in 2005. In 2005, the waste water from GovCo (JAVYS) and SE EBO sites was carried away via the piping collector SOCOMAN to the Drahovský canal, which is emptied into the Váh River. This canal is used for recreational purposes and irrigation. The biggest irrigation assembly in the affected area is the Kráľová water reservoir.

Data on meteorological situation in Jaslovské Bohunice in 2005 was obtained from the meteorological ground station of the SE EBO teledosimetric system.

Radioactive substances are discharged to the atmosphere through the V1, V2 and GovCo (JAVYS) ventilation stacks (ventilation stack of A1 NPP, ISFSF, BSC, building 44/10 – water treatment station).

Calculations performed by the programme for calculation of the population dose load RDEBO from discharges of radioactive substances from the SE EBO and GovCo (JAVYS) sites in 2005 indicate that the areas with the highest levels of effective doses are situated in the south-eastern direction from the site in accordance with prevailing wind directions. The zone in the east-south-eastern direction within a 2-3 km distance, where the village of Pečeňady is situated, was assessed as the permanent residential zone with the highest values of effective doses. The report graphically presents calculated values of individual effective doses (E) and collective effective doses (S) for the Pečeňady zone as well as for the zone of Kráľová water reservoir, where the maximum values of E from hydrosphere were calculated. The results indicate that the critical age group with the highest values of individual effective dose E are children from 7 to 12 years.

To each of the above mentioned two zones, contributions of individual sources (GovCo (JAVYS), V1 NPP and V2 NPP) to the radiation load of the population in 2005 are assigned for three age groups: sucklings from 0 to 1 year, children from 7 to 12 years and adults older than 17 years.

The highest E values in the populated zone were calculated in the east-south-eastern sector in the Pečeňady locality and the following values were reached:

- sucklings 1.188×10^{-7} Sv,
- children 7-12 years 1.605×10^{-7} Sv,
- adults 1.514×10^{-7} Sv.

The highest E values in the surroundings (including unpopulated zones) were calculated in south-eastern sector within a 0-1 km distance (unpopulated zone no.73) and the following values were reached:

- sucklings 3.775×10^{-7} Sv,
- children 7-12 years 3.778×10^{-7} Sv,
- adults 3.780×10^{-7} Sv.

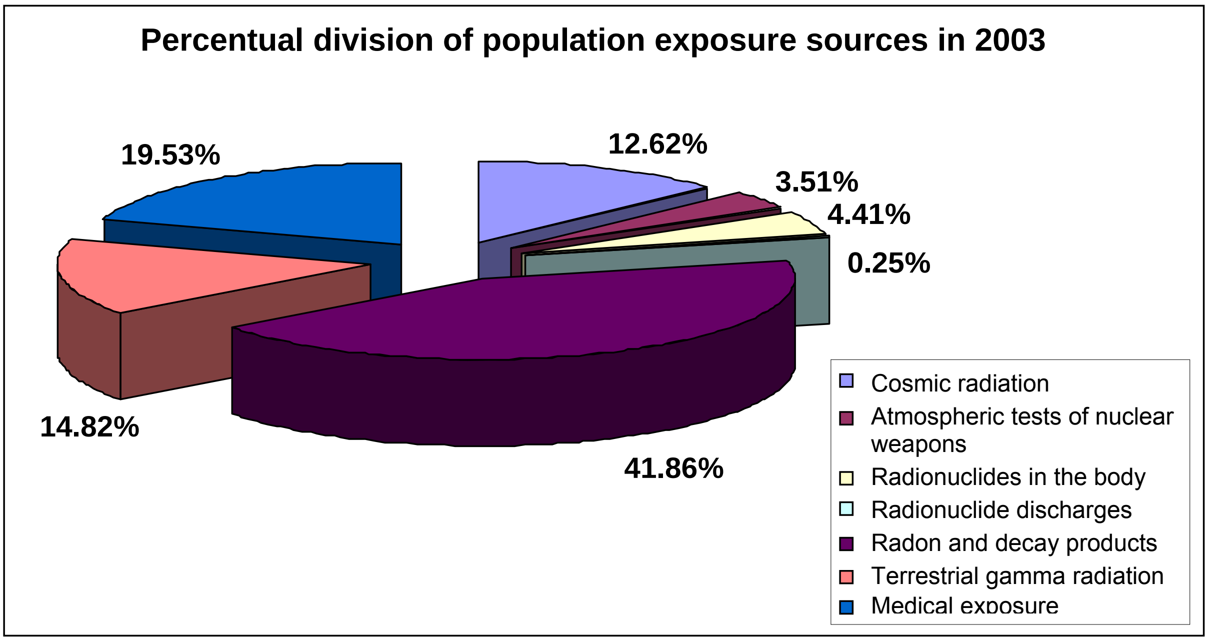
For the radiation load from the atmosphere, the critical path is the exposure from clouds and the deposition and ingestion of food contaminated by fall-outs from the atmosphere. For the radiation load from the hydrosphere, the critical path is ingestion of contaminated drinking water.

For the illustration and assessment of the population dose load in the surroundings of the SE EBO and GovCo (JAVYS) sites, it is necessary to mention that an individual obtains annually approximately 2.5×10^{-3} Sv of total dose from the natural radiation background. The population radiation load from various sources of natural radionuclides in 2003 is presented in table C-40.

Table C-40: Population radiation load from various sources of natural radionuclides in 2003

Exposure source	*Radiation load*	
	Individual (mSv)	*Population (10^5 man Sv)*
Natural background, total	**2.38**	**650**
cosmic radiation	0.39	
terrestrial gamma radiation	0.46	
radionuclides in the body	0.23	
radon and decay products	1.3	
Medicinal exposure, total	-	**165**
diagnostics	0.59	90
radiotherapy	-	75
Atmospheric tests of nuclear weapons	**-**	**30**
Radionuclide discharges	**-**	**2**

Source: ÚPKM



Source: ÚPKM

Figure C-9: Percentual division of population exposure sources in 2003

Besides the standard monitoring programmes of SE EBO and GovCo (JAVYS), the company VÚJE, a.s. performs measurements of the radiation situation in the close surroundings of nuclear installations in the frame of research programmes. The subject of measurement is the level of external radiation (continual method with automatic recording of measured data and using the TLD dosimeters) and the radioactivities of aerosols and fall-outs in the ground layer of atmosphere. These measurements have been continually performed since 1992, thus enabling to consider the trends. When keeping the suggested trend of radioactivity decrease of ^{137}Cs in 2010 at the Bohunice site and on the other territory of the Slovak Republic, radioactivities of ^{137}Cs in aerosols should reach the values in table C-41.

Table C-41: Current trend and expected decrease of ^{137}Cs radioactivity in the period 2005 to 2010

^{137}Cs radioactivity	*[μBq/m^3]*	*1992*	*1995*	*2000*	*2005*	*2010*
Jaslovské Bohunice		22.7	12.5	4.64	1.72	0.64

II.4.8 Synthesis of evaluation of current environmental problems

The impacts of three principal groups of human activities are currently significant in the affected area:

- the housing and functions of urban infrastructure,
- agriculture – plant and animal production,
- the industrial production associated with NEC Bohunice operation.

The impacts and problems of the first group of activities – the housing and associated functions of the urban infrastructure, i.e. civil infrastructure facilities, services and local economy enterprises mainly affect the environment in the built-up area of the municipalities.

The high dustiness from the fields striking the built-up area of the municipalities is the environmental problem in all municipalities of the assessed area. The dustiness is perceived by the municipality inhabitants more negatively than sporadic odours from the large-scale breeding farms for cattle and swine or from the emission sources outside the assessed area.

The key environmental problem in the affected municipalities associated with the housing and operation of the urban infrastructure is the absence of sewage systems in the municipalities of the assessed area (except Jaslovské Bohunice) and treatment of sewage. The most critical situation is in the village of Nižná.

From the point of view of the impacts of the second group of activities on the environment, we can appreciate the lower application of pesticides and industrial fertilizers in plant production as a result of economic recession. A more serious environmental load is represented by the large-scale cattle and swine breeding farms. There is at least one such breeding farm in each of the municipalities. Odours from the excrements and feeding mixtures affecting the vicinity of these sites are the factors of devastation.

Another element of devastation is represented by the farmyards of the cooperative farms, especially dung heaps and dung-water cesspools, where it is not possible to prevent soil devastation and the penetration of contaminants to the rock basement and the ground water when handling this waste, in spite of the fact that the condition of these objects is considered as good or very good. The mentioned increased dustiness from the fields in the dry non-vegetation period is one of the manifestations of the ecological instability of the area. The low ecological stability can be mentioned as another and probably the most serious problem of the assessed area. It is the consequence of intensified agricultural production in the Trnava region.

The consequences of the third group of impacts are represented by the radiation load of the population and environment in the surroundings of SE EBO and GovCo (JAVYS) as the consequence of the operation of nuclear installations. They are described in a detailed manner in the previous chapters of this report (chapters II.4.3 – II.4.7). The effective doses presented for the individuals from the critical population group (i.e. the highest doses among all inhabitants) due to existence of nuclear facilities in the area represent approximately a ten-thousandth of the radiation level from the natural radiation background.

II.5 ECOLOGICAL TOLERABILITY

II.5.1 Vulnerability of geological environment

The vulnerability of the geological environment is associated with its hydrogeological properties, i.e. it increases with the presence of ground water, therefore it is necessary to monitor its levels continually. The closer is the ground water level to the relief surface, the easier it can be contaminated, thus the possibility of geological environment pollution is higher.

The permeability of the geological environment is the basic feature of the contaminant mobility in the natural environment. From the point of view of permeability, the loess and loess loam of the Trnavská pahorkatina Upland have a weak permeability and due to its thickness they enable a lower infiltration of water to the water-bearing bed. Therefore they are less vulnerable than the Quaternary sediments of the Dolnovážska flood plain (the eastern margin of the affected area), which are highly permeable. A great vulnerability can be assumed in the layer of well permeable and water-bearing sandy gravel, which is a collector of the first water-bearing bed in the affected area. The second water-bearing bed is situated in the formation of badly permeable or impermeable Neogene loams.

In the direction of ground water flowing, the movement of contamination from the wells, illegal dump sites, and flushes from agricultural activities, etc. can be anticipated.

From the point of view of tectonic evolution, the affected area is relatively stable, i.e. less vulnerable. The plain relief does not enable sliding processes, with respect to seismicity. The affected area belongs to the areas with regional seismic intensity from 6° to 7° MSK.

II.5.2 Vulnerability of the relief

Relief, as the land property, is the result of endogenous and exogenous processes, which formed individual morpho-sculptures and morpho-structures into the present appearance. This process is continual and it is necessary to assign anthropogenic influences to the recent geomorphologic processes. Relief vulnerability can be defined as the fragility of auto-regulation processes, the disturbance of which led to an unfavourable change of dynamics of geomorphologic processes, such as slope movements, landslides, areal flushing, mud hole erosion etc. Relief vulnerability is closely associated with geological relations, relief inclination and vegetation cover.

II.5.3 Vulnerability of surface and ground water

Surface and ground water can be considered as one of the most vulnerable components of natural environment of the affected area. The ground and surface water is in continual connection, especially in the area of highly permeable Quaternary sediments of the Dolnovážska flood plain forming the collector of ground water with a confined ground water surface, which is in direct connection with the water level of surface streams. Ground water in the Neogene environment, where water-bearing layers are situated, can also be considered as vulnerable.

The important factor for the evaluation of ground water is the fact that it can cause contamination of other components of the natural environment as well as the contamination of loess over the water-bearing layers or soil in the Dudváh and Blava flood plains by capillary elevation.

The illegal dump sites and their leaches can be the sources of water contamination in the affected area. The absence of a sewage system in the affected municipalities (except Jaslovské Bohunice) or the damaged sewage system at EBO site can be the danger of contaminant leakage to the surface and ground water in affected area. Flushes from the unconsolidated areas, economic facilities and households can be sources of contamination.

The vulnerability of the ground water was manifested during the contamination of the ground water with tritium under the EBO site and further in the flow direction in the first water-bearing bed to the closest municipalities of Žlkovce and Malženice. Its contamination was also reflected in the surface streams of Manivier, Dudváh and the Váh River, which drain ground water in the affected area, especially at low water levels.

II.5.4 Vulnerability of soil

The vulnerability of soil by mechanical and biological degradation mainly depends on the agrotechnical procedures, terrain inclination and intensity of precipitations in the affected area. With regard to the plain terrain of the affected area and its functional utilisation (the majority of area is covered by arable land), the affected area has a high vulnerability of the soil against wind erosion. Wind erosion manifests especially in the non-vegetation period, when the soil is not protected by a vegetation cover. Soils with permanent grass growths are less vulnerable and the land with small islands of afforested soil seems to be the least vulnerable within the affected area. Vulnerability caused by water erosion, floods and subsoil irrigation was registered in the vicinity of water streams, namely in the area of the Dolnovážska flood plain and the Blava water stream flood plain.

II.5.5 Air vulnerability

Air is a significant transfer medium of radionuclide exposure of humans in the form of discharges to the atmosphere. Its vulnerability from the radioactivity point of view is given by the limitation of discharges and it must not be exceeded during the normal operation. The air pollution of the affected area is lower in comparison with other industrial areas in the Slovak Republic.

II.5.6 Vulnerability of vegetation and animals and their biotopes

One- and two-year plant cultures are situated on agricultural soil in the vegetation period. Their vulnerability is dependent on agrotechnical procedures. These plant monocultures represent the most vulnerable vegetation. Meadows with permanent grass growths are less vulnerable. Bushy and forest growths on the water stream banks are little vulnerable. The least vulnerable are the forest growths, which marginally occupy the affected area in its eastern and north-western margin.

The least vulnerable vegetation in the built-up area of affected municipalities is well maintained high public verdure, whose vulnerability increases with the negligence of maintenance. The vulnerability of the gardens of family houses maintained by their owners, is also low.

In contrast with vegetation, the vulnerability of fauna is decreased by the migration ability of individual animal species, the natural enlargement of the locations of progressive species or the artificial introduction, mainly of some fish species. Zoocenoses of fields or meadows, which are characteristic for the affected area, are considered as very vulnerable, zoocenoses of growths in the vicinity of water streams and forest growths are less vulnerable.

From the point of view of biotopes, the evaluation of their vulnerability is similar to the evaluation of phytocenosis and zoocenosis. It can be stated that the least vulnerable biotopes in the affected area are small forest areas, the most vulnerable are biotopes of monocultures on arable land.

II.5.7 Vulnerability of amenities and quality of life

The amenity of the housing environment in the affected municipalities is influenced by the condition of houses and apartments, which are obsolete and only partially modernised (water distribution line, sewage system, gas connection). The efforts of the inhabitants at an improvement of their living by good maintenance and modernisation of family houses, gardens and street areas reflect positively on the municipalities.

The civil infrastructure and services are proportional to the size of the municipalities, while the infrastructure of the smaller municipalities is considerably worse. This worsens the amenities and the quality of life of the inhabitants in these municipalities to a considerable extent. In comparison with other Slovak regions, the assessed municipalities have a little higher standard of environment reflecting the better social situation of their inhabitants.

The impact of nuclear installations on the amenities and quality of life of the inhabitants in the affected area is positive, but also negative. The positive impact appreciated is mainly in the social and economic sphere with respect to the employment rate. A directly perceived negative impact is the transport associated with the operation of the nuclear installations. This can be strongly felt especially in Malženice, Jaslovské Bohunice and Žlkovce. The negative impact of the vicinity of NPPs has only a semantic character and its impact on the psychical condition of inhabitants of the assessed area is suppressed by long-term habits. A contingent contamination of the environment with radioactive substances cannot be perceived by the senses and it does not evoke environmental changes perceivable by senses.

II.5.8 Synthesis of ecological tolerability of the area and its classification according to vulnerability

The affected area is a part of the region characterised by a high productivity of economic activities and an intensive functional utilisation of the area. The achieved condition is the result of long-term development, when the production elements of the country were modified, especially soils and vegetation. The modifications of these two elements were massive and they struck 98.7% of the land registry area of the assessed municipalities. Agriculture had a predominant share of these changes. The geological environment, surface and ground water were modified to a lesser extent. The quality of the air changed even less.

All changes in the country evoked by human activity interfere with the system of natural ecological balance. Reaching the limit threshold, when irreversible changes in the environment occur, is considered as the threshold of ecological tolerability.

From the point of view of ecological stability, the most stable element in the assessed area is the loess Quaternary cover of the Trnavská tabula Plain, which was one of the reasons why the first NPP on the territory of former Czechoslovak Republic was situated here. In the course of the erection of the other units of NPP in the affected area as well as construction in the surrounding municipalities, this layer was impaired by ground work and boreholes, thus enabling the penetration of contaminants into the vulnerable water-bearing layers of Neogene. However, the rate of ecological tolerability of the rock base was not exceeded.

Similarly, the changes of quality in the surface and ground water, from the point of view of natural ecosystems, did not reach the threshold of ecological tolerability. The problem is with health tolerance and utilisation by humans (e.g. the brook on the southern margin of the Nižná village contaminated by sewage) as well as with the capacity.

With regard to the low ratio of built-up areas on this territory, the character of built-up areas and good ventilation capability of built-up areas, critical concentrations of imissions do not occur and the atmosphere of the assessed area cannot be considered as the limiting factor of human activities and ecological tolerability.

The critical situation is in the soil utilisation and vegetation cover. Agriculture in the assessed area reached the technological maximum in a given time period with regard to the size and exploitation intensity and it practically exceeded the threshold of ecological tolerability of an original land. The changes evoked are irreversible.

The built-up areas of the affected municipalities decrease the ecological tolerability in a real way and only negligibly in qualitative way. A more pronounced complex is the site of NPPs, which creates mostly development barriers with its protection zone, needed distribution lines and networks in the assessed area. The outputs from NPP to the natural components of the environment are strictly limited so that they would not endanger the health and safety of workers inside the site and health of the population living in the closer and more distant surroundings. The values of these limits are considerably below the thresholds of ecological irreversible changes.

II.6 EVALUATION OF THE CONFORMANCE OF ACTIVITIES WITH TERRITORIAL PLANNING DOCUMENTATION

The proposed activity is in accordance with the still valid territorial planning documentation *Territorial Plan of Trnava region* dated 1998, respectively with its part approved by the Resolution of the Slovak Government no. 183/1998, which requires "to ensure safe decommissioning of the nuclear power installations at Jaslovské Bohunice site" in the part *Obligatory Regulatives of the functional and areal arrangement.*

Figure C-10: Cooling tower of the V1 NPP during winter time.

III. ASSESSMENT OF POTENTIAL IMPACTS OF THE ACTIVITY ON ENVIRONMENT

III.1 IMPACTS ON POPULATION

III.1.1 Number of inhabitants affected by the activity in affected municipalities

See Part A, chapter I.1.1.1.

III.1.2 Health risks

The current health status of the population of the assessed area is described in chapter II, Part C of this assessment report.

With regard to the character of the proposed activity of V1 NPP decommissioning, the radiation load of the population in the surroundings of the NEC Bohunice, in relation to the radiation load of the area and sources situated at the NEC Bohunice site, is analysed in a greater detail in this part of assessment report.

The predominant harmful factor that can affect the health of the individuals in the surroundings of a nuclear power plant is ionising radiation, i.e. α, β and γ radiation. All types of radiation mentioned can affect the human body externally (external exposure acting on the skin or internal organs and textures when crossing the skin) or internally (radioactive particles are inhaled or ingested to the gastrointestinal tract with contaminated water, food).

Higher doses of ionising radiation negatively act on texture cells and this results in changes of physiological functions of the cells, especially genetic information of the cells. In some cases, this can lead to disorders of the reproduction or initiation of malignant multiplication of cells or the death of individual cells. The most sensitive cells are the cells with rapid multiplication, i.e. skin, blood, gastrointestinal wall cells, etc. The damage of highly specialised cells with low reparation capability like neurons can also have serious consequences.

According to the time of exposure to ionising radiation, we divide its effects on health to acute and chronic ones. Acute effects are manifested with so called irradiation disease (disorders of blood production, of gastrointestinal and nervous system and immunity disorders) that occurs at high irradiation doses (Hiroshima, Nagasaki) or during the accidents at nuclear installations (Chernobyl, Tokai Mura – personnel irradiation).

The long-term effects of low radiation doses are scientifically divided into two groups – effects with and without a threshold:

- In the case of threshold effects, it is assumed that a certain radiation level is not capable of damaging some textures, as existing immunity and reparation mechanisms are capable of eliminating the damage without modifying the functionality of the texture. The damage of eye lens, benign skin injury, blood production suppression and damage of generative cells are included in this group.

- Effects without a threshold are those that cannot evoke damage even at the lowest exposures and the probability of such a damage increases with the dose. These effects have a statistical character, i.e. they do not have to be manifested in every irradiated individual. The number of individuals who will be hit by the effects is stochastically dependent on the dose magnitude. Mainly genetic damage and development of malignant multiplication are included. The development of malignant multiplication, i.e. carcinogenic effect, has also been demonstrated in humans.

It is possible to determine a safe limit for threshold effects that excludes body damage. In the case of effects without a threshold, limits are determined on the basis of so called socially acceptable risk, i.e. admissible increased number of deaths over the natural background of mortality per million or 100 000 inhabitants (usually $1x10^{-6}$ to $1x10^{-5}$).

It is necessary to realize that assumed damage of human organism issues from the experience with relatively high doses during accidents, from working exposure and experiments. Carcinogenic and genotoxic effects of low doses occurring in the environment cannot be practically demonstrated, as they overlap with the natural background of the occurrence of these damages in the population.

The assessment of health risks stems from the above-mentioned analysis of impacts of the proposed activities on operation personnel, employees and population. There is a risk of external and internal exposure for the operation personnel when handling the radioactive materials in the course of these activities. This risk can be effectively decreased by the qualified approach of the personnel and work organisation in the controlled area of NEC Bohunice, while using all technical and organisational measures. The doses of workers in the controlled area are followed individually. The magnitude of such individual doses (individual effective dose) shows the risk for the development of stochastic effects without a threshold (risk and probability). Threshold effects are excluded by identifying the limits.

Other risks like the risk of developing an allergy to chemical substances used or to the working environment, risk of ear damage in noisy operation, risk of joint damage during the work with vibrating mechanisms, rheumatic damage of the joints in humid working environment, claustrophobia, occupational injuries, etc. are either general risks of work performance or they are typical for a certain type of work and environment, where this work is carried out. Implemented as well as proposed technical and organisational measures associated with designed activities, will minimise the above mentioned risks to an acceptable extent, which corresponds with the appropriate legal regulations and conditions in other operations of a similar character.

For the inhabitants of the affected municipalities, other (non-radiation) risks resulting from the implementation of the proposed activities do not practically arise. The impacts of the proposed activities, which will manifest outside the GovCo (JAVYS) site or will be carried out outside this site are suppressed by a distance of at least 3 km, which is a sufficient distance to dampen such impacts as noise, dustiness, etc.

III.1.3 Loss of amenities and quality of life

The proposed activities of each proposed alternative will affect the population of the affected municipalities, employees and visitors of NEC Bohunice site and the workers carrying out the decommissioning work according to the selected alternative. The preparation of auxiliary operations in association with the implementation of the necessary construction work will result in loss of environment amenity and subsequently of working conditions directly at the site of the nuclear installations in Jaslovské Bohunice.

The amenity of the environment at the site of nuclear installations in Jaslovské Bohunice will be negatively influenced mainly by the building demolition (noise, vibrations, shakes, air pollutants from working mechanisms, dustiness depending on type of demolition). The demolition work is divided into two periods in the case of alternatives 2 and 3, i.e. the preparation period for safe enclosure under surveillance (reactor safe enclosure) and the period of removal of safe enclosure under surveillance (reactor safe enclosure), i.e. to the period of completion of V1 NPP decommissioning. This will shorten the time of loss of amenity of environment and worsened working conditions at the site of NEC Bohunice. Alternative 3 is the most even from the time point of view. The ground work associated with the final landscaping of the released areas will have a similar effect. The blasts of explosives used during the demolition work can be heard in the affected municipalities. The transfer of materials from the building demolition to the existing waste dump sites in the surroundings will have a more significant impact on the environment amenity in the affected area, especially on the housing amenity in the marginal parts of the villages Malženice, Jaslovské Bohunice, Spačince, Pečeňady and Žlkovce. The impact of the transfer of packaged forms of RAW to NSR in Mochovce (later also to the deep geological repository) on the housing amenity of the affected municipalities in all three alternatives will be eliminated by railway shipment.

The population will, in practical terms, not be affected by the radiation from the decommissioned nuclear power plant. Psychogenic factors like strong fears of the population induced by less serious or purpose-made information exaggerating the risks of decommissioning could be more significant than very low doses of ionising radiation. As a consequence, sensitive individuals can suffer from stress and psychic imbalance or from neurotic conditions.

A certain negative impact on the amenity of the inhabitants in the municipalities with access communications to V1 NPP will be induced by the truck shipment associated with the proposed activities, especially the infringement of acoustic comfort and of environmental amenity by vibrations from shipment means. This higher number of trucks passing through the living area can be considerably reduced by using the cheaper railway shipment for large bulks of materials. This loss of environmental amenity along the access communications has only a temporary character in the period of performance of the proposed activities. It can be assumed that during the intensified shipment on the access communications (during normal working hours), the impacts of the proposed activities on the amenity and quality of life will be overlapped by a generally higher level of noise and vibrations.

On the other hand, from the psychological point of view, a benefit of the proposed activities for the amenity and quality of life of inhabitants of the affected municipalities can be a feeling of increased radiation safety.

III.1.4 Acceptability of the proposed activity for the affected municipalities

The affected municipalities did not declare any standpoint to the assessment scope in a given time. An information meeting devoted to environmental impact assessment (EIA) of V1 NPP decommissioning was held in Jaslovské Bohunice on February 16th, 2006. Comments on the progress of environmental impact assessment of V1 NPP decommissioning according to Act No. 127/1994 Coll. on EIA in the wording of Act No. 391/2000 Coll. were provided as well as the information on the Proponent's approach to the development of EIA report on V1 NPP decommissioning with the participation of public and representatives of the affected municipalities and authorities.

The mayor of Jaslovské Bohunice Mr. Ryška also presented opinions on behalf of nearby municipalities. He particularly appreciated the concern of the European Bank for Reconstruction and Development in the process of the assessment and public consultation of the proposed activity. He presented several observations regarding the public involvement generally as well as other opinions not directly linked to the proposed project as follows:

- The process of environmental impact assessment is often formal and conclusions are not always implemented.
- The prepared (at the moment approved) Nuclear Act is not suitable.
- The nearby municipalities are negatively influenced by NEC Bohunice and legislation does not give them sufficient support to compensate these negative effects.
- The value of real estates is decreased due to negative perceptions of the locality.

According to the answers presented, it is not possible to accept all requirements of the affected municipalities for compensation only in the frame of this proposed activity. Besides it, the proposed activity will result in an improvement of environmental quality and a decrease of the potential risks within the affected area. Representatives of the operator (proponent) of the nuclear installations declared that they had always tried to help the affected municipalities in solving of their problems. Nevertheless, progress is possible only on the basis of mutual communication and co-operation.

Impact assessment process is not a formal act at all, appropriate legislation is fully in accordance with the legislation of European Union and international treaties and agreements and particular bodies and authorities take it very seriously.

The operation of the nuclear installations in Jaslovské Bohunice significantly improves the employment situation within the affected area (working opportunities, social guarantees, perspective for local people). It is also worth mentioning the increase in the standard of living and the building of local infrastructure in the municipalities of the area of interest. V1 NPP shutdown will partially eliminate these impacts; nevertheless, the proposed activity within all three decommissioning alternatives will ensure continuity of the positive impacts including environmental improvement.

The most significant positive impacts of the proposed activities on the population of affected municipalities are as follows:

- The removal of potential environmental contaminants represented by RAW stored in V1 NPP buildings and technological facilities and thus the reduction of health risks for the population of the affected area.
- The provision of social and economic guarantees for the workers participating in the implementation of proposed activities (i.e. part of the population of the affected area).

III.1.5 Public attitudes of the population in the surroundings of Jaslovské Bohunice

The public attitudes towards nuclear energy are relatively precisely described by various sociological opinion polls. One of the most recent surveys was carried out on behalf of SE EBO by the Department of Sociology, Trnava University in 2002, its name was "Opinions of the inhabitants of Jaslovské Bohunice region on nuclear energy". It was carried out in the municipalities within a 30 km radius of SE EBO and it was based on a representative sample of respondents from various groups of the region's population.

As much as 90.7% of respondents were the people living in this area for more than 10 years. Thus, they represent the group with detailed knowledge about the region, strong ties to this region and their responses are based on the personal experience. It is also worth noting that asked respondents judge the nuclear energy quite positively. No less than two thirds of them appreciate the fact, that it is a suitable source of energy, which is also environmentally friendly. Negative responses were presented by approximately 35 % of respondents, which consider nuclear energy as "inevitable evil" we have to live with. They propose to reduce the nuclear energy production and to replace it by some other, more convenient source of energy. Radical positions occurred very rarely, only approximately 3.5% of respondents claimed immediate termination of the NPP operation. The opinion that nuclear energy is relatively cheap and thus it supports the wasting of electrical energy was very rare (1.4%). It is generally recognised that connections between energy and the economy are very tight and the efficiency is a frequently used argument for the peaceful utilisation of nuclear energy. With regard to economic effectiveness of NPPs, the respondents mostly state that it is a cheaper source of electrical energy production. At the same time they are aware of the fact, that some of the activities, especially radioactive waste management, are very expensive. A relatively positive attitude towards nuclear power was presented by nearly half of the respondents (49.6 %). Just 6.6% of respondents agree that economic demands on nuclear power production are comparable with other forms of power production. On the other hand, 12.4% of the respondents agree that nuclear power production is expensive. Nearly 1/3 of the people were not able to judge this aspect, which is understandable taking into account complexity of the problem.

Public awareness

The importance of public awareness in the field of nuclear power production in this area is generally well recognised. Opinion surveys about attitudes to nuclear power invariably indicate that people feel a lack of information. However, they realize the importance of such information and they make efforts at obtaining new information.

Nearly one half of the people (47.5%) consider their own level of information as low, 23.1 % as insufficient and only 29.4% as extensive or sufficient. The survey confirmed the commonly expressed view that the information level of the people reflects their education. For example, 51.5% of the people with university degrees considered themselves as well informed; a similar opinion was expressed by 29.7% of the people with secondary education and by only 19.7 % of the people with the basic education.

Also the age of the people is one of the factors that influences the level of public awareness. Older people are significantly less informed and interested in new information compared with younger ones. The level of public awareness is also connected to the work in SE EBO. Respondents who have been working or are working in the NPP consider their level of information as extensive (up to 60%). Preferred information sources were followed as well. Television, press and radio were considered as the most important ones. As much as 32% of respondents receive significant amount of information from the people working in the NPP.

III.1.6 Social and economic impacts

In general, the decommissioning of V1 NPP will not induce new demands for manpower. From this point of view, the proposed activity will affect the sustainment of employment and living standards within the region. This concerns especially of the stage of preparatory decommissioning activities and for the first decommissioning stages of all proposed alternatives. The proposed activities will be carried out by employees of GovCo (JAVYS) and contractors; this will probably not require new manpower. On the other hand, these activities will ensure social guarantees and financial income for workers involved during their duration.

The Ministry of Labour, Social Affairs and Family of the Slovak Republic has elaborated „The proposal of the regional and economic development of Trnava region after 2005 with regard to V1 NPP shutdown and its impacts on the social situation within the region“. This document was elaborated on the basis of the task C.5 of Governmental resolution No. 974 dated November 29th, 2000. This study assessed the considerably modified decommissioning alternatives from the present point of view and it has only an illustrative character.

If we take into consideration the natural decrease of employees in the followed period of time (172 persons), the number of employees successively dismissed will be about 972.

According to the estimation of ÚPSVAR Trnava (Office of Labour, Social Affairs and Family), the distribution of employees dismissed according to the districts will be as follows: 35 % from Trnava district, 40 % from Piešťany district and 20 % from Hlohovec district and 5 % from other districts (in particular Nové Mesto n/Váhom, Galanta and Senica districts).

The V1 NPP shutdown will also affect contractors and suppliers. According to the information received, as many as 1 866 persons potentially endangered by the shutdown, are working at the most important contractors. On the basis of the monitoring of these organisations, 627 employees will be directly dismissed as a consequence of V1 NPP shutdown, most of them will be dismissed at the beginning of the shutdowns in 2007 and 2009, respectively (when regarding the Resolution of the Slovak Government No. 801/1999 on final premature shutdown of V1 NPP units).

Concerning the dismissed employees, we suppose that 2/3 of them will be registered at the particular Departments of Labour, which represent 418 persons in absolute numbers (189 from Trnava district, 147 from Pieštany district and 81 from Hlohovec district).

Along with the V1 NPP shutdown we can expect that some new working positions will be created in relation to decommissioning. The maximum need for employees (206-327 persons) for new activities will be in the 2009-2019 period. Redundant workers can perform these new activities after re-training.

The aforementioned study of the Ministry also concerns the proposals for the elimination of negative social effects. They are based on the opinions obtained from the appropriate district authorities (Hlohovec, Galanta, Trnava, and Piešťany) of Trnava region.

In spite of the fact that the considerations in these documents concern of considerably modified decommissioning alternatives at the present time, we can state that the need for new employees will not be a problem. The need for new employees will be just at the beginning of shutdown of both reactors and immediately after this period.

The requirements for manpower for individual alternatives and their activities are given Table B-4 in Part B of this EIA report.

III.1.7 Other impacts

During the process of decommissioning we can consider non-quantified infringement on the comfort of living for the inhabitants of nearby the municipalities. For instance, truck shipment may have negative influences on the quality of the housing environment of the municipalities and it can affect marginal parts of the municipalities situated along the road Veľké Kostoľany – Malženice. Nevertheless, it will be overlaid by the overall frequency and intensity of the transport on the mentioned route. The influence of the road shipment can be considerably reduced by precautionary technical and organisational measures (optimisation of routes, time of shipment, maximum usage of railway siding at NPP site, etc.)

On a single occasion, the comfort of living can be infringed by the demolition of bigger buildings or by the groundwork associated with the final landscaping of the released areas. Within the affected municipalities, blasts of explosives used in the process of demolition, can be heard.

Radioactive waste arising during decommissioning have to be conditioned into the appropriate waste package forms and have to be disposed in an adequate type of repository. Thus, there is a possibility of indirect impacts regarding the shipment of waste packaged forms for a disposal and the long-term existence of repositories. If it is verified, that the most convenient solution for the disposal of low-level RAW arising from the decommissioning is the disposal in the enlarged NSR Mochovce, the impacts of road shipment will be eliminated by using the railway shipment.

III.2 IMPACTS ON NATURAL ENVIRONMENT

Natural components and anthropogenic factors of the environment of the affected area were contaminated mostly in the period of V1 NPP operation.

The proposed and assessed activities basically remove the consequences of V1 NPP operation. Therefore all these activities are positive also in relation to the natural components of the environment. After the completion of the V1 NPP decommissioning, emissions and radionuclide discharges from the NEC Bohunice site will be decreased.

With regard to the relevance of the V1 NPP decommissioning impacts, the decisive risk factors are those associated with the release of radioactive substances into the environment. From this point of view, the proposed alternatives can be assessed as follows:

In the course of work performance for individual alternatives of V1 NPP decommissioning, radioactive materials will be released into the environment in an organised manner by the following routes:

- ventilation stack (aerosol gaseous discharges),
- technological waste water (liquid discharges)
- disposal of the RAW packaged forms in the near-surface repository at Mochovce.

Air exhausted by the HVAC systems (in all three alternatives) is cleaned in highly efficient aerosol filters before the inlet to the ventilation stack and it is continually monitored in the stack.

Water from the technological processes of the V1 NPP decommissioning project can after cleaning, be used in the technological process in BSC or, after checking of the pollution parameters, discharged in an organised manner to the piping collector SOCOMAN and via the Madunický canal to the Váh River recipient after monitoring.

Gaseous and liquid discharges into the environment, as a consequence of the V1 NPP decommissioning activities, are low and the annual limits for these discharges will not be exceeded with a sufficient safety reserve.

The total assumed gaseous discharges of aerosols for IDO and RSE alternatives (alternative 1 and 3) will be on the same level. The total amount of liquid discharges assumed will be on the same level for all individual decommissioning alternatives (IDO, RSE and SES).

From the point of view of the source of radioactive gaseous discharges, the most significant activity for all three alternatives is the dismantling of the radioactive technological equipment, whereby the gaseous discharges arising from this activity represent more than a half of the total amount of gaseous discharges for a given alternative.

Liquid discharges consist of cleaned technological water, especially from the processes of pre-dismantling and post-dismantling decontamination and of water from the hatches and laboratories whereby the predominant part of water from the hatches and laboratories fulfils the conditions for direct release into environment after the measurement.

For the IDO alternative, the liquid and gaseous discharges in the II. stage of decommissioning are the predominant ones with regard to the total amounts of discharges for the whole alternative.

In the RSE alternative, the predominant part of gaseous and liquid discharges with regard to the total amount for the whole alternative accrues to the I. stage of decommoňissioning, while in the SES alternative it is in the III. stage of decommissioning.

With regard to the facts mentioned in chapter 2, taking into account the present status of the environment and possible impacts in the affected area, we can state the following facts when comparing the individual alternatives:

- From the point of view of air protection, discharges to the atmosphere are governed by determined emission limits (generally) and an approved limit of radioactive substance discharges for all alternatives. If keeping in the limits, the performance of the proposed activities will not change the imission and radiation situation in the affected area.
- For the protection of the surface and ground water, discharges of technological waste water to the hydrosphere in all three alternatives have to comply with the determined purity limits with respect to the content of non-radioactive and radioactive pollutants. If keeping the quality of discharged water, the implementation of proposed activities will successively improve the quality of surface and ground water. At the time of completion of the activities of the individual alternatives, an improvement in the purity of surface and ground water in the affected area will be observed.
- With respect to gaseous and liquid discharges, the proposed alternatives mainly differ in the period of activity performance and duration of the activities.

The proposed activities in all three alternatives will not affect the soil quality in the affected area (indirectly by air, surface and ground water).

The impacts on the geological environment could be the lowest in the case of Zero alternative, but only on condition that a long-term continual inspection, water tightness of the civil structures and hermetic tightness of the technological equipment is ensured.

III.2.1 Impacts on geological environment, raw materials, geodynamic phenomena and geomorphologic relations

Leakages of liquid RAW from storage tanks and the sewage system can lead to the contamination of the rock base. The contamination routes, formation and distribution of leakages (leakage places of liquid RAW to ground water) are continually investigated by the monitoring and modelling of the process of contamination of rock basement by the EKOSUR company.

In the case of the alternatives considered, the proposed activities will have a positive impact on the rock base, due to the removal of the sources of ground water pollutants, by which the rock base can be contaminated.

III.2.1.1 Impacts of treatment and conditioning of radioactive waste to a form suitable for disposal

Treatment and conditioning of RAW to a solid form suitable for its final disposal will be carried out in technological facilities modified in such a way so that a leakage of contaminants from these facilities to the rock base does not occur. An indirect impact on the rock base can be assumed only in the case of fall-out of radionuclides or of the other non-radioactive pollutants and dust, which will be present in the whole course of performance of proposed technological processes. Nevertheless, this will be dampened by the vegetation cover and soil and it will probably be below the detection limit in the rock base, if keeping the approved limits of emission discharges.

III.2.1.2 Impacts of decontamination and dismantling of technological equipment and buildings

To prevent leakages of decontamination solutions to the geological environment through leaky civil structures, the activities associated with dismantling and decontamination will be carried out in the following way:

- decontamination of leaky building areas by grinding with intensive exhaust,
- decontamination of leaky linings by gels,
- circuit decontamination will be carried out in such a way so that the decontamination solution from the decontamination loop will be directly discharged to a collection vessel or via the special sewage to a collection vessel,
- there will be a portable trapping vessel under the place of cutting the penetrations and gullies,
- it is not assumed that liquid (e.g. cooling) solutions will be used during dismantling (cutting),
- the demolition of the buildings will be carried out when the building is clean and all material from the demolition can be released into environment.

III.2.1.3 Impacts of storage of unconditioned radioactive waste before its conditioning and subsequent storage before shipment to a disposal facility

In the course of the storage of unconditioned radioactive waste before its final conditioning or in the case of the storage of conditioned radioactive waste before its shipment to a disposal facility, it is assumed that technical modifications (isolation) of storage areas will be carried out against the leakage of the stored media to external (rock) environment, modifications for trapping the leaked liquids in collection canals and shafts, permanent monitoring and automatic signalling of base humidity increase or of a liquid in a trapping shaft reaching the critical level. These principles also apply to the proposed dump site of low-level contaminated soil. If keeping the technical and organisational measures issuing from the valid legal regulations, no recordable impacts on the rock base due to the storage of radioactive waste are assumed.

In practical terms, RAW shipment to the sites of their final disposal cannot affect the rock base on the shipment route with regard to RAW phase, resistance and tightness of the containers. There is a certain risk of environmental contamination in the case of accidents in the frame of on-site shipment. This is the reason why the shipment means for on-site RAW shipment are approved according to the internal operational regulations.

III.2.2 Impacts on air, local climate and noise situation

From the point of view of air protection, gaseous discharges to the atmosphere are governed by determined emission limits (generally) and by the approved limit of radioactive discharges for all alternatives. If keeping the technological procedures during the implementation of the individual activities, the determined limits for discharges will be kept.

From the point of view of the assessment of gaseous and liquid discharges, the proposed decommissioning alternatives differ in the time period of the performance of proposed activities or in their duration.

The HVAC systems in V1 NPP buildings work in such a way so that air exhausted from the rooms of V1 NPP buildings proceeds from the areas with lower possible surface contamination (corridors and staircases) to the areas with higher possible surface contamination (compartments) to prevent spreading of contamination by air. The exhausted air is led to a ventilation stack through high efficiency particulate air filters and it is continually monitored (radioactivity of alpha, beta and gamma aerosols). The measurement instrumentation is regularly calibrated in accordance with the quality assurance plan.

For air pollution, GovCo (JAVYS) enterprise has the authorised limits for emissions and for radionuclide discharges to the atmosphere. From the identification of the above mentioned limits, the result is that the impacts of individual operations or of individual groups of proposed activities can only be partial. Measures taken for their decrease or organisational matters of work have to be adapted in such a way so that these impacts do not exceed the determined limits for GovCo (JAVYS) in total.

After the completion of the V1 NPP decommissioning, the decrease of emissions and radionuclide discharges from NEC Bohunice site will take place.

III.2.2.1 Impacts of handling with the radioactive materials

The areas of the original formation and storage of RAW are permanently ventilated to HVAC systems. Trapped substances (released radionuclides) are cleaned in filter assemblies. They are discharged into the atmosphere through the ventilation systems in values lower than the approved emission limits. It can be assumed that there can be increased leakage of these substances in the first stage of handling radioactive waste during its retrieval from the places of original storage as well as during its shipment to the new storage sites. The capacity of HVAC systems is sufficient for retrieval processes and for further handling these materials. This is only a partial impact in the frame of GovCo (JAVYS) overall activities, where the approved limits of radionuclide discharges into the atmosphere must not be exceeded.

Figure C-11: Fuel reloading machine.

III.2.2.2 Impacts of treatment and conditioning of radioactive waste to the form Suitable for disposal in Near-Surface Repository in Mochovce

In the course of the treatment and conditioning of RAW to the solidified form suitable for disposal, the trapping of radionuclides and of other emissions will be a part of the technologies used.

Waste vapour, which will be condensed, will arise in wet processes (liquid RAW thickening and bituminisation). The condensate will be cleaned, monitored from radiation point of view and it will be either used in technological processes or it will be discharged to the piping collector SOCOMAN after achieving the purity required by the determined limit values. Other gases and vapours arising in the process of bituminisation or cementation will be trapped in ventilation systems.

Dust, aerosols arising, gases arising in the dry processes of fragmentation of materials and low-pressure compaction of solid RAW will be exhausted and cleaned by the existing ventilation systems of V1 NPP. The cleaned air from the processes of decontamination, dismantling, fragmentation, compaction, etc. will be discharged by the appropriate ventilation stacks into the atmosphere. The cleaned combustion products from incineration will be discharged by the BSC stack to the atmosphere and it is guaranteed that the approved limits will not be exceeded during normal operation.

III.2.2.3 Impacts of decontamination and dismantling of technological equipment and buildings

Activities associated with the decontamination and dismantling of technological equipment and buildings will increase the humidity or dustiness of the environment (according to the decontamination method) and the content of radioactive aerosols in the air of working areas. It is also possible to assume an increased level of noise and vibrations inside as well as outside of V1 NPP site and in its close surroundings during these activities.

The exhaustion of aerosols during wet decontamination, and of dust and aerosols during dry decontamination and dismantling of technological equipment and buildings, will be ensured by venting and by local exhaustion to the ventilation systems. The impact of decontamination and dismantling of the technological equipment and buildings on the air is only partial and it is included in the summary of impacts of GovCo (JAVYS) and SE EBO enterprises on environment. During this activity, it is not possible to exceed approved limits of radionuclides content in the atmosphere as well as the determined or permitted limits for dustiness at working places.

The maximum permitted values of noise exposition level will not exceed thevalues given by the Decree of the Slovak Government No. 339/2006 Coll. which gives the details on permitted values of noise, infranoise and vibrations and on the requirements on objectivisation of noise, infranoise and vibrations.

According to the EWN experience of the demolition of buildings the main acoustic sources are the activities given in table C-42.

Table C-42: Sound power levels of demolition activities

Activity	*Sound power level [dB]*	*Peak sound power level [dB]*
Ramming of spile walls	**126**	**140**
Operation of hydraulic chisels	**105**	**125**
Operation of excavator	**100.5**	**125**

III.2.2.4 Impacts of RAW storage before treatment and conditioning and impacts of the storage of conditioned RAW before the shipment to a disposal site

Venting of the areas for the storage of unconditioned radioactive waste before its conditioning or the storage of conditioned radioactive waste before its shipment to a disposal site and venting of the facilities for common V1 NPP operation is provided by HVAC systems.

The impacts of RAW storage on the air are just the partial in the frame of GovCo (JAVYS) overall activities, similarly to the impacts of previous activities.

III.2.3 Impacts on surface and ground water

For the protection of the surface and ground water, the values of discharges of technological waste water to the hydrosphere in all three alternatives have to keep admissible limits for the content of non-radioactive and radioactive pollutants.

If keeping the technological procedures, the amount of waste water discharged will be lower and water will be cleaner during the decommissioning than during the power operation. After the completion of the decommissioning and landscaping, no more waste water will arise.

The contamination of surface and mainly of ground water by radioactive substances is one of the key problems of the environment of the affected area. The removal of the contamination sources is one of the principal intentions of the Proponent. As in the case of impacts on air, the impacts of the proposed activities on the ground water have to be considered as partial and they cannot exceed the permitted limits for waste water discharges to the recipients. Negative impacts on surface water due to proposed activities, with regard to required and implemented measures as well as thick layers of loess above the ground water collector , can only theoretically be assumed.

III.2.3.1 Impacts of handling radioactive materials

The first group of the proposed activities – handling radioactive materials, which is aimed at the retrieval of liquid and solid RAW from the places of their original storage in the operation termination period, will significantly contribute to the solution of this problem. The subsequent activities – shipment, temporary storage in modified storage areas and facilities and their shipment to the facilities for their treatment and final conditioning will be performed with the equipment, which will have the tightness and resistance against RAW leakage verified in advance. So long as the damage of a storage site caused by the retrieval mechanisms does not occur during the retrieval of RAW from their original storage places, the handling radioactive materials can be considered as positive from the point of view of the impacts on the surface and ground water.

III.2.3.2 Impacts of treatment and conditioning of radioactive waste to the form suitable for disposal

During the treatment and conditioning of radioactive waste to the solidified form suitable for its disposal, the condensate of waste vapours which arises during liquid RAW thickening and bituminisation and waste water from other technological processes, will be used in another technological process (e.g. cementation and decontamination) or they will be led away by the piping collector SOCOMAN to the Váh River recipient after purification, chemical and radiation control. If keeping all determined limits, the impacts of RAW treatment and conditioning on the surface and ground water will not endanger the ecosystems and health of the population of the affected area.

The impacts of treatment and conditioning of radioactive waste to a solidified form on the hydrosphere are the same as the impacts of previous activities limited in the frame of GovCo (JAVYS) overall activities.

III.2.3.3 Technological equipment and buildings

The decontamination solutions and rinsing water used during the decontamination of buildings and equipment will be considered as liquid RAW, which will be concentrated and processed by means of bituminisation and cementation.

III.2.3.4 Impacts of storage of unconditioned RAW before the treatment and conditioning and impacts of the storage of conditioned RAW before their shipment to a disposal site

There is a lining under each liquid RAW storage tank, which will trap the whole content of the tank in case of leakage. Trapped liquid RAW will be pumped to a reserve tank and the leaky tank will be repaired.

The areas for the storage of RAW before their treatment and conditioning and for the storage of conditioned RAW before their shipment to a disposal site will be conditioned in such a way so that they correspond with the principles of safe storage not affecting the environment.

III.2.4 Impacts on soil

The proposed activities in all three alternatives will not directly affect the soil quality in the affected area (indirectly by air, surface and ground water). The establishment of operative buffer gathering places for solid non-radioactive waste is anticipated, mainly for the reasons of economical separation and the gathering of construction waste arising from demolition and its subsequent recycling and re-use. The buffer gathering places will be removed after the sale of recycled material.

While establishing the buffer gathering places , soil cover will be removed from its place and it will be restored after the closing. From the point of view of the final effect, the impact of the proposed activities on soils at V1 NPP site is positive.

Other proposed activities like handling with other radioactive materials (except the soils), treatment and conditioning of radioactive waste to a solidified form suitable for disposal, decontamination and dismantling of technological equipment and buildings, storage of unconditioned radioactive waste before its shipment to a disposal site as well as common operation of V1 NPP facilities will all have an indirect impact on soils of the affected area due to emission fall-outs produced by the proposed technologies. This impact will be negligible while keeping the determined emission limits.

III.2.5 Impacts on biodiversity

The impacts of the assessed activities on the biodiversity described in this report are not direct, but they are mediated by the abiotic components of natural environment. No impact of changed radiation situation on the biodiversity has been registered in the surveys of ecosystems and organisms in the affected area up to now. These ecosystems and organisms in the affected area are determined namely by intensified agricultural production.

The proposed activity is especially aimed at the removal of existing and potential sources of contamination of natural components of the environment by radioactive substances and at the improvement of the overall radiation situation in the surroundings of V1 NPP. In this way, the prerequisites of genetic (mutational) changes of organisms caused by radiation decrease. From this point of view, the impact of proposed activities on the biodiversity is positive.

The alternative solutions for the proposed activity will not affect features of the existing biotopes and their relevance, natural biotopes of the fauna and flora, protected areas and natural monuments or endangered animal biotopes, which are described in Part C, Chapter II.

III.3 LAND IMPACTS

III.3.1 Impacts on structure and exploitation of land

The implementation of the assessed alternatives will predominantly take place in the existing buildings and facilities of V1 NPP and in external areas inside the site of nuclear installations. Thus the proposed activities will not cause neither *changes of land structure nor changes of land scenery.*

The proposed activities will positively influence the rock base, surface and ground water, soil, air and biota from the natural land elements. The land relief or the proportion of individual natural components in the affected area will not change due to the proposed activities. The implementation of the proposed activities will not considerably change the proportions between natural components and anthropogenic components of the environment. The functional utilisation of the affected area will remain unchanged. A disbalance among the afforested area, the agricultural land utilised intensively and the built-up area will persist. The proposed activities will not affect other features and elements of the land.

The implementation of the proposed activities will partially affect the overall character of the SE EBO built-up area and the character of the infrastructure networks. The activities will affect part of V1 NPP site from the structural point of view by the erection of necessary technological facilities and buildings, by the function modification of released and decontaminated buildings as well as by the dismantling and demolition of unnecessary and non-utilisable technological facilities and buildings. The implementation of the Intention alternatives can result in partial positive impacts on the stability of the site verdure.

The permanent removal of existing and potential sources of contamination of the natural components of the environment of the affected area and removal of non-utilisable and non-functional buildings of the decommissioned power plant will be the positive impacts of the alternatives of V1 NPP decommissioning activities on the natural environment and land.

The implementation of the proposed activities will basically not change the way of land utilisation, but it will provide the prerequisites for further utilisation by the release of the V1 NPP site.

III.3.2 Impacts on land scenery

The V1 NPP decommissioning will terminate the current functional utilisation of V1 NPP site as an industrial production area identified for electrical power production from nuclear fuel. This function of V1 NPP site will persist until the completion of one of selected decommissioning alternatives, except Zero alternative, which does not have any time limitations for the persistence of the current activities.

Alternative 1 will release V1 NPP site for a new functional utilisation after 2025, in case of alternative 2 as well as for alternative 3 after 2063. The period of 51 years represents a double period of life-time of industrial technological equipment, therefore even temporary utilisation of the released areas for the activities corresponding to the industrial character of the environment will be significant for the proponent from the point of view of area economics. Depending on this utilisation, the percentage of area which is built on will change.

III.3.3 Impacts on protected areas and protective zones

The alternative solutions for the proposed activity will not affect the characteristics of existing biotopes and their significance, natural biotopes of fauna and flora, protected areas and natural monuments with regard to the distance from the GovCo (JAVYS) site, where the proposed activity will take place and where the most significant impacts will be located.

The protected areas of the significant ground water sources – the hygienic protection zones of 2^{nd} degree and the natural thermal spring located in Váh River flood plain around the town of Piešťany – a protection zone of 2^{nd} degree, will not be affected by the proposed activity.

III.3.4 Impacts on territorial system of ecological stability

The territorial system of ecological stability of the affected area will not be impaired by any of the alternatives of the proposed activity.

III.4 IMPACTS ON URBAN COMPLEX AND LAND UTILISATION

The urban complex consists of the existing structure of the settlement of the affected area, of seats characterised by built-up area, civil and technical infrastructure and communications, which create an indivisible land complex used by its inhabitants together with the functional utilisation of the area. The connection of the historical structure of the settlement with a novel power production complex and its power distribution lines, which exceed the borders of the affected area by their territorial and economic influence, is typical for the affected area.

The implementation of the proposed activities will result in the reduction of the ecological and radiation load of the affected area. The positive impact of removal of actual and potential sources of contamination of the ground and surface water, rock base and soil will result especially in better agricultural use of the soil and in a quality improvement for water from local sources in the municipalities of the affected area. These activities can indirectly contribute to a mitigation of the psychological barriers for the erection of housing estates in the affected municipalities and thus to their social and economic development.

The implementation of the assessed alternatives will not induce changes of the structure of individual settlements and changes of infrastructure of the affected area.

The positive influence of the Intention's implementation outside the urban complex of the affected area is namely the support of industrial production. Supplies of technological equipment and materials for treatment and the conditioning of RAW will represent a part of the planned costs. It can also be positively evaluated the design of several unique devices with great know-how value, gaining experience and qualification of the workers participating in decommissioning that can be used for the development of nuclear power industry.

Long-term negative impacts, which would be even more pronounced after accepting the Zero alternative, are the most unfavourable from the time point of view. Time limited negative impacts, where we can include basically all impacts of the proposed activities, are less unfavourable. The most favourable positive impacts are the long-term ones and time limited positive impacts are less favourable. An assessed impact can act in a full extent or only partially, if it is dampened e.g. by a barrier or distance or if it partially solves a given problem in a positive way.

It is apparent from the assessment that the Zero alternative, which prolongs the contamination of the natural environment components as a consequence of the retained contamination sources, is disadvantageous from an ecological point of view. On the other hand, certain extensions of negative impacts of GovCo (JAVYS) due to the performance of proposed activities is compensated by the positive influences of the removal of possible sources of contamination of the natural environment components by radioactive substances. According to the comprehensive assessment of the proposed activities from the aspects of their civil and ecological significance and from the time aspect, alternative 1 of the proposed activity is the most suitable one.

III.4.1 Impacts on cultural and historical sights, palaeontological and archaeological sites, settlement structure, architecture and buildings

The assessed activities associated with V1 NPP decommissioning in Jaslovské Bohunice will not have any direct impact on cultural and historical sights, on infrastructure and services and on the composition and character of the built-up area of the affected municipalities. An indirect positive impact (better care for sights or for the territorial development of the municipalities) can result from the persisting social and economic guarantees associated with employment in SE EBO and GovCo (JAVYS) enterprises in Jaslovské Bohunice.

The impact of V1 NPP decommissioning on the built-up area of affected municipalities can be restricted to the impacts of truck shipment. Buildings built in post-war period are usually resistant against such impacts. Damage could occur in older, poorly maintained houses with wooden ceilings and roof trusses without joining beams on masonry foundations. Their protection is important if they belong to the sights. Due to this problem, shipment routes for materials and waste removal from the site of nuclear installations in Jaslovské Bohunice will be designed in such a way that they do not pass nearby the protected sights or some other necessary measures will be suggested.

The implementation of V1 NPP decommissioning will not incur investments that would affect the built-up area of the affected municipalities, residential houses, buildings of services and civil infrastructure. It will also not incur investments for the construction of communications and technical infrastructure of the area. The impacts of V1 NPP decommissioning activities can be reflected in the construction work in the affected municipalities and in the maintenance of residential buildings, indirectly as a consequence of the good financial situation of their inhabitants (GovCo (JAVYS) employees or employees of supplying organisations) and their investments.

III.4.2 Impacts on agricultural production

The proposed activities will be carried out within the sites of GovCo (JAVYS) enterprise in its buildings and on its external areas. With regard to the character of activities, they are associated with the operation of GovCo (JAVYS) enterprise and with other supplying organisations from the machine and civil engineering industry. They do not create direct supplier-client relations or any other relations with local agricultural organisations. When keeping the proposed measures, no impacts of the proposed activities on agricultural production will arise.

III.4.3 Impacts on industrial production

The V1 NPP decommissioning will require financially demanding supplies of materials, machinery and other equipment and constructions, the manufacturing of which will be provided by several fields of the machinery, chemical and electrotechnical industry, power industry, industry of building materials, etc. in the course of proposed activities. A significant part of the financial costs will be spent by the supplies from the above-mentioned industrial fields as well as the work directly at

GovCo (JAVYS) site. Besides the direct economic impacts, the impact on employment in these industries will also be significant.

The positive impact of the proposed activities on industrial production does not consist only in the amount of financial means, but also in the gaining of precious knowledge and experience that can be used in nuclear power or in other areas of industry.

III.4.4 Impacts on shipment

The shipment situation at the site will be influenced by the shipment of RAW from the places of their origination or storage to the place of conditioning and treatment, shipment of RAW packaged forms to the RAW interim storage facility and subsequently to NSR in Mochovce. 500 shipments are expected per a period of 14 years, i.e. one truck every 9 days.

The RAW shipment at GovCo (JAVYS) site and outside the sites will be carried out in technical facilities with the required barriers and shielding elements, which will minimise the impact of RAW shipment on the required health, hygienic and environmental minimum together with safety measures during this work.

The treatment and conditioning of RAW to solidified form suitable for their final disposal, except RAW shipment, will require a supply of raw materials and materials for bituminisation and cementation in an amount lower than 500 trucks during 14 years.

For the decontamination and dismantling of technological equipment and buildings, it will be required to ensure the supply of raw materials for the decontamination by foam spraying, chemical solutions and dry methods. Besides this, the dismantling of technological equipment and buildings will require the supply and removal of uncontaminated technological equipment and parts of civil structures, construction debris, etc.

The storage of unconditioned radioactive waste before its conditioning or the storage of conditioned radioactive waste before its shipment to a disposal site does not mean any special requirements for the shipment.

It is apparent that the proposed activities will result in a higher intensity of mainly personal transport due to the higher frequency of truck passages on the access roads to GovCo (JAVYS) site. This will temporarily affect the shipment situation in Jaslovské Bohunice and Malženice as well as the situation at the railway station in Veľké Kostoľany (which will also be better than during V1 NPP power operation).

III.4.5 Impacts of associated civil structures, activities and infrastructure (construction of new communications, engineering networks, construction of housing estates, etc.)

Associated civil structures, activities and supplementary infrastructure are not considered directly in the affected area. The associated civil structures and activities are the enlargement of NSR in Mochovce, the anticipated construction of VLLW repository, the anticipated construction of RAW interim storage facility in Jaslovské Bohunice (at the site of nuclear installations) and the programme for development of a deep geological repository for spent fuel and high-level radioactive waste, the preparation of which is in the stage of survey of the study sites.

III.5 SPACE SYNTHESIS OF THE ACTIVITY IMPACTS ON THE AREA

The most significant impact of V1 NPP decommissioning will be the removal of the existing ecological burden, non-functional buildings and facilities from the area and the removal of the costs for their non-productive maintenance and inevitable operation. The benefit is the site release for a new utilisation, e.g. industrial zone with new activities in buildings and facilities, new working opportunities, etc.

The land relief or the proportion of individual natural components in the affected area will not change due to the proposed activities. The implementation of the proposed activities will not considerably change the proportion between natural components and anthropogenic components of the environment. The functional utilisation of the affected area will remain unchanged. The disbalance among the afforested area, intensively utilised agricultural land and built-up area will persist. The proposed activities will not affect other features and elements of the land.

III.5.1 Assumed anthropogenic load of the area, its relation to ecological tolerability of the area

The proposed activities will take place inside the existing site of V1 NPP. Part of them will be carried out by GovCo (JAVYS) employees and the other part by suppliers. The basic technological inputs, i.e. RAW are located inside the site. External material inputs (machines, machinery products and raw materials) will be transported by railway and truck transport. The actual outputs from the technological processes in the affected area are the limited discharges to the atmosphere and surface water. The main material outputs – recyclable building and metallic material, non-utilisable non-radioactive waste, containers with conditioned RAW will be shipped away by railway and truck shipment.

In the course of V1 NPP decommissioning, the anthropogenic load of the affected area will increase only slightly, mainly due to the more intensive shipment associated with the supply of necessary materials and depending on the shipment of conditioned RAW and other waste (e.g. construction debris) to a place of their final disposal. This increased anthropogenic load will basically not have any impact on the ecological tolerability of the area, which is in this case determined namely by the low proportion of the forests and permanent grass growths. The anthropogenic load of the area will be decreased immediately after the shutdown of V1 NPP units and then after the completion of V1 NPP decommissioning to the "green field". In the case of a new functional utilisation of the site (more probable alternative), the anthropogenic load of the area as well as its economic productivity will depend on the character of new activities in this area. No overloaded sites will arise due to the proposed activity.

III.6 COMPREHENSIVE ASSESSMENT OF EXPECTED IMPACTS FROM THE POINT OF VIEW OF THEIR SIGNIFICANCE

The comprehensive assessment of the expected impacts of the activities proposed after completion of 1st decommissioning stage stems from the character of the assessed impact, its social and ecological significance as well as the expected time interval during which the impact acts. Each assessed impact becomes significant when the intensity or consequences of its negative influence exceed the limits of system or legislative tolerability (limit).

The purpose of the proposed activities is mainly the treatment and conditioning of RAW located in the buildings and areas of V1 NPP to a solidified form suitable for their final disposal. In this part of the assessment report, impacts of proposed activities on the population, natural components of the environment, land and the urban complex of the affected area are assessed.

In the factual assessment of the impacts, the authors of the assessment report issue from the information provided by the proponent – GovCo (JAVYS), from its experience acquired during V1 NPP power operation, experience from the decommissioning procedures of A1 NPP up to now. They also issue from the description of the proposed activities of V1 NPP decommissioning.

Except the Zero alternative, which means preservation of the original status, three alternatives of V1 NPP decommissioning are considered in the assessed Intention:

- alternative 1: V1 NPP immediate decommissioning alternative (IDO),
- alternative 2: V1 NPP deferred decommissioning with the safe enclosure under surveillance for 30 years (SES),
- alternative 3: V1 NPP deferred decommissioning with the reactor safe enclosure for 30 years (RSE)

In all decommissioning alternatives (except the Zero alternative), the final stage is the release of the V1 NPP site for a new, functionally unrestricted use. The subject of decommissioning (reactor, technological equipment, buildings, networks and distribution lines), decontamination, dismantling and demolition procedures as well as the procedures for treatment of RAW and non-radioactive waste, which will arise in the course of main decommissioning activities, are described in chapter II. Thus, the population can be affected only by mediated impacts, e.g. by contamination of the environmental components by discharges from the nuclear installations.

Besides the assessment of environmental contamination by radioactive substances in the overall assessment of alternatives described in the Intention, the following facts are important for the assessment of the impacts of the proposed activities: the course of time and the preparedness of the necessary investments, the different risk rate and its distribution over time as well as the amount and time distribution of the costs. When taking into account the above mentioned aspects, the comprehensive assessment of the alternatives is as follows.

III.6.1 Impacts on personnel

The principal negative impacts of all the assessed alternatives of the proposed activity including the Zero alternative (namely on personnel carrying out decommissioning work and marginally on the population) are as follows:

External and internal radiation is the accompanying phenomenon of handling radioactive materials and it is specific for the activities in nuclear installations. Radiation intensity to safe acceptable values is modified by technical measures (e.g. engineering barriers, shieldings, protective means, exhausting, remotely controlled manipulators) and by other organisational measures (duration of stay in controlled area, measurement and evaluation of the radiation doses).

Noise and vibrations are typical for mechanically moving machinery and for moving mechanisms. The mechanisms for ground work, heavy trucks and compressors are among to the noisiest sources that usually exceed the values determined by a standard. Their performance can lead to deterioration of the amenity of the external environment of GovCo (JAVYS) and SE EBO sites.

Waste heat is typical for industrial technologies with thermal processing. Especially evaporation and thickening of liquid radioactive waste, its bituminisation and cementation are typical such activities. This impact is reduced to an acceptable extent by its removal with cooling water, air exhausting and conditioning at the working places.

Environment humidity manifests in the course of all wet technologies, where we can include bituminisation, cementation and wet decontamination of the surfaces. At the stable working places, humidity is also removed by exhausting and air exchange. Individual protective means will be used during wet decontamination of the surfaces.

Odours can arise especially in the course of RAW bituminisation and the incineration of combustible RAW. With regard to the fact that these are the stable working places ventilated to HVAC systems, odours do not manifest in the working environment of the nuclear installations. Air exhausted by ventilation systems is filtered and it is discharged into the atmosphere only after cleaning. According to the evaluation of EBO LRKO information, odours from incineration and bituminisation do not manifest in the external environment of GovCo (JAVYS) site.

Dustiness is typical for all dry processes, where handling loose materials (e.g. cementation) takes place or where the surface of solid materials is machined (surface grinding, fragmentation of solid RAW and dry decontamination), during the ground work and shipment. Solid pollutants also arise during the waste incineration. Dustiness from the incineration is reduced by ventilation systems and by efficient filtration of exhausted combustion products. Individual protective means will be used during dry decontamination. Dustiness during the ground work and material shipment will be maintained at an adequately low level by terrain sprinkling and road maintenance in dry weather.

The action of the above mentioned impacts on the population of the affected municipalities is different. The full scale of these impacts with the intensity dampened only by construction and technical barriers, measures, HVAC systems or personal protective means will act only on operating personnel. The most serious impact is handling radioactive materials with the direct risk of external and internal contamination.

In the external environment of the site of nuclear installations and at the adjacent working places, the risk of external and internal radiation, heat, humidity as well as noise and vibrations from technological equipment, will be dampened by the civil structures or they will be overlapped by the impacts from other sources in the surroundings. Only the impacts of those proposed activities that will be carried out on external areas of V1 NPP, i.e. impacts of shipment, ground work and demolition associated with the proposed activities, will be manifested to their full extent. The authorised dose rate on the surface of containers with conditioned RAW, noise, vibrations, dustiness and odours from the activities of working mechanisms and shipment means are included here.

III.6.2 Alternative 1: V1 NPP immediate decommissioning alternative (IDO)

The characterisation of this alternative is presented in Part A, chapter II.7.2.

The basic features of alternative 1 are as follows:

- It represents a basic decommissioning alternative for comparison with the other ones from the point of view of all decommissioning parameters.
- High availability and reliability of information on design and operational history of V1 NPP.
- Experience of EWN GmbH with Greifswald NPP can be used for the dismantling in a safe and cost effective way.
- High potential for using the existing structures, systems and components in the decommissioning process such as ventilation, dosimetric system, cranes, barriers, etc.
- It enables an effective use of existing facilities for the treatment and conditioning of RAW.
- Use of the Mochovce near-surface repository for disposal of low and intermediate level radioactive waste.
- Continuity of employment in the region because a higher number of trained, skilled and experienced staff can be engaged in decommissioning immediately after the final shutdown of V1 NPP.
- The V1 NPP site owner can sell the site to other investors or use it for his own investments to create new working places.
- Higher potential for reusing the released site for other purposes, because all buildings, technological structures and infrastructure will be decommissioned in a reasonable time.
- The lowest time load of the site by radioactivity inventory.
- Higher radiation impact of gaseous and liquid discharges on the environment than in alternative 2, but lower than in alternative 3.

- High levels and amounts of radionuclides present.
- It represents the total cost distribution in the shortest time period whereby these financial sources are available from the BIDSF (EBRD) in the supposed time period.

When assessing the impacts of the proposed activities on the health status of the population of the affected municipalities and of the population of the broader area around the NEC Bohunice in general, it is necessary to aim at:

- the possibilities of population health impairment due to the change of radiation situation in the area, which result from handling radioactive materials,
- non-radioactive negative impacts of the proposed activities,
- positive impacts from the implementation of the proposed activities that can also influence health status of the population.

When assessing the impacts of the activities of alternative 1 (IDO) on the population of the affected municipalities and of broader area around the NEC Bohunice, the following impacts can be assumed:

Operation termination of V1 NPP

Impacts on the modification of the radiation situation of the affected area and broader area around the NEC Bohunice are not anticipated in this group of activities.

The positive influence of the V1 NPP operation termination period activities will be the utilisation of operating and maintenance personnel and the temporary extension of job positions for a bigger number of professions from auxiliary work, crafts to professions with high school and university education.

Monitoring of radiation situation in the buildings before the commencement of decommissioning activities

These activities do not modify the radiation situation in the area. They do not induce negative impacts that would affect the health status of the population and they do not require special measures for their elimination in the area. They will be carried out by GovCo (JAVYS) workers in the frame of their ordinary work.

Pre-dismantling decontamination of internal surfaces of technological equipment

The pre-dismantling decontamination of internal surfaces of the technological equipment will take place in the closed areas of V1 NPP facilities and buildings. The performance of these activities will not affect the radiation situation in the affected area and in the broader area around the NEC Bohunice. Taking into account all facilities operated at Jaslovské Bohunice site and discharge limits, the radiation situation will be more favourable. On the other hand, the existing monitoring programme, i.e. the monitoring of discharges and environmental components of the surroundings will continue in operation.

Treatment and conditioning of RAW arising from decontamination

The final product of RAW treatment and conditioning will be the solid RAW modified to a packaged form suitable for the disposal at a disposal site. Limits for the dose rates on the surface of containers are determined in such a way so that they do not jeopardise the health of the workers when handling with them. FCC containers are also the shipment containers for a considered shipment. Strict international rules included in the appropriate regulations of the Slovak Republic are valid for the shipment of radioactive materials and waste. The essence of the rules is to prevent such an exposure that could affect the health status of the inhabitants who come into contact with the containers (even under extraordinary circumstances).

Discharges of non-radioactive substances from RAW treatment into the atmosphere and hydrosphere are limited and approved for the whole site of NEC Bohunice, similarly to discharges of radioactive substances. Keeping these limits is the guarantee that even non-radioactive materials from the treatment and conditioning of radioactive waste will not induce negative impacts on the health status of the population in the area. Reduction of the risk of radiation contamination of environment with the positive influence on population psychics and existing working opportunities, the effect of which is described above, can be included among the positive impacts.

Dismantling of radioactive equipment

In the course of these activities, partial modifications to the radiation situation in the area can occur, especially indirectly by exhausted air from the working areas where dismantling takes place. This air has to be cleaned and continually monitored before discharge and the authorised limits for discharges from the nuclear installations in Jaslovské Bohunice into the atmosphere have to be kept. If this condition is kept, the dismantling of the V1 NPP radioactive equipment will not have any impact on the health status of the population in the affected area and the broader area around the nuclear installations.

Of the non-radiation impacts, noise and vibrations can be manifested in the closest surroundings of the working places. They cannot negatively affect comfort and health status of the inhabitants with regard to the distance from the affected municipalities.

Permanent monitoring of the discharges and radiation monitoring of the surroundings of nuclear installations are the measures to prevent negative impacts.

Reactor dismantling

The principal measure to prevent negative impacts of reactor dismantling on health status is the radiation protection of the workers who will carry out this dismantling. Reactor dismantling will take place in the closed area, by means of remotely controlled manipulators with sufficient shielding. Dose rates in the working areas, from which the workers will carry out the dismantling, must not be higher than the limits authorised during the work in controlled area. External areas of V1 NPP site are minimally shielded from the controlled area by the civil structure of the external peripheral casing of building no.800 in alternatives IDO and SES. Permanent monitoring of discharges and radiation monitoring of the surroundings of nuclear installations will be the measures for the preservation of an acceptable radiation situation.

With regard to the closed working places, reactor dismantling does not induce negative non-radioactive impacts that could affect the health status of the population of the affected area and the broader area around the nuclear installations.

Reactor dismantling itself represents the removal of a significant source of radioactivity and thus the impact of the reactor removal will also be positive on awareness and psychics of the population.

Post-dismantling decontamination of dismantled radioactive equipment

Modifications of the radiation situation are determined by the authorised limits of radionuclide discharges also in this case. Permanent monitoring of the discharges of radioactive substances to the atmosphere and hydrosphere, radiation monitoring of the surroundings of the nuclear installations, decontamination interruption, technological instructions for emergency situations, etc. belong to the measures that have to ensure for required radiation safety. Post-dismantling decontamination will take place in closed areas of V1 NPP buildings.

Decontamination of contaminated building surfaces

Induced modifications of the radiation situation are limited in a similar way to the previous case. Besides occasional noise and vibrations that will be manifested in the adjacent area of the working place, this activity will not result in any negative impacts in the affected area.

Building demolition

Only non-radiation impacts will be manifested. Noise, vibrations, dustiness, waste gases from working mechanisms and trucks will act negatively in the adjacent area to the demolition. Suitable work organisation, use of suitable demolition methods, and the sprinkling of communications will be used as the measures for reducing these negative impacts.

Treatment and conditioning of radioactive waste

For the treatment and conditioning of radioactive waste arising from the dismantling and decontamination, the same is valid as mentioned in the section "Treatment and conditioning of radioactive waste arising from decontamination".

Impacts of alternative 1 on environment and population

The impacts of alternative 1 on the environment and population in the affected area are summarised in the tables B-41 and C-43. The implementation of alternative 1 represents the shortest duration of V1 NPP decommissioning.

The alternative reckons with the erection of an interim RAW storage facility for high-level RAW (necessity to store the equivalent of 44 pieces of FCC containers, representing 216 m^3 of storage volume) and disposal of low and intermediate level RAW at the near-surface repository in Mochovce (necessity to dispose 1038 pieces of FCC containers, representing 5100 m^3 of storage volume; considerations for the existing storage areas of NSR reckon with such amounts).

Regarding non-radioactive negative impacts in relation to the surrounding country, it is necessary to mention that the processing or disposal of non-utilisable waste on the dump sites (3331 tons) and shipment of 55 996 tons of metallic waste to the salvage have to be solved in a relatively short time in the case of this alternative.

With regard to the influence of the V2 NPP, ISFSF and TSÚ RAW operations, effective individual dose equivalents and collective dose equivalents for the critical groups of the population of the affected area and of the broader area around the nuclear installations in Jaslovské Bohunice will not significantly change. From this point of view, the complete V1 NPP decommissioning according to alternative 1 will not significantly influence radiation situation in the area (see table C-43). The implementation of alternative 1 will result in successive removal of the risks of possible environmental contamination and the risks of health impairment of the population of the affected area and of the broader area associated with the potential leakages of radioactive substances to the environment as a consequence of the damage of barriers consisting of the civil and technological structures of V1 NPP.

Table C-43: Impacts of alternative 1 on the environment and population in the affected area

Activity (duration)	*Impacts on radiation situation modification*	*Negative non-radioactive impacts*	*Positive impacts of the activity implementation*	*Measures*
Preparatory decommissioning activities	activities do not modify radiation situation	shipment impacts overlapped by overall shipment situation	possibility of extension of working opportunities, reduction of discharges into the atmosphere and hydrosphere	shipment is carried out from 6 a.m. to 4 p.m., the route passes along the margins of the municipalities
Monitoring of radiation situation in the buildings before the commencement of decommissioning work (short-term)	activities do not modify radiation situation	does not induce negative impacts affecting health status of the population	existing working opportunities	without measures
Pre-dismantling decontamination of technological equipment (limited)	discharges of radionuclides into the atmosphere and hydrosphere within the authorised limits	does not induce negative impacts affecting health status of the population	existing or extended working opportunities	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations
Successive dismantling of radioactive equipment (limited)	discharges of radionuclides into the atmosphere and hydrosphere within the authorised limits	does not induce negative impacts affecting health status of the population	existing or extended working opportunities, working opportunities for other business companies	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations
Reactor dismantling (limited)	discharges of radionuclides into the atmosphere and hydrosphere within the authorised limits	does not induce negative impacts affecting health status of the population	existing or extended working opportunities, working opportunities for other business companies	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations
Post-dismantling decontamination of dismantled equipment	discharges of radionuclides into the atmosphere and hydrosphere within the authorised limits	does not induce negative impacts affecting health status of the population	existing or extended working opportunities	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations
Post-dismantling decontamination of building surfaces (limited)	discharges of radionuclides into the atmosphere and hydrosphere within the authorised limits	does not induce negative impacts affecting health status of the population	existing or extended working opportunities	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations

Activity (duration)	*Impacts on radiation situation modification*	*Negative non-radioactive impacts*	*Positive impacts of the activity implementation*	*Measures*
Demolition of radioactive buildings (limited)	activities do not modify radiation situation	noise, vibrations, dustiness in the adjacent area of the working place, shipment impacts overlapped by overall shipment situation	existing or extended working opportunities, working opportunities for other business companies	organisation of work and shipment, use of suitable demolition methods
Treatment and conditioning of radioactive waste (running activity)	discharges of radionuc-lides into the atmosphere and hydrosphere within the authorised limits	shipment impacts overlapped by overall shipment situation	existing or extended working opportunities, reduction of the risk of environment radiation contamination	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations, shipment is carried out from 6 a.m. to 4 p.m.
Treatment and conditioning of non-radioactive waste (running activity)	activities do not modify radiation situation	shipment impacts overlapped by overall shipment situation	existing or extended working opportunities, working opportunities for other business companies	shipment is carried out from 6 a.m. to 4 p.m.

III.6.3 Alternative 2: V1 NPP deferred decommissioning with the Safe Enclosure under Surveillance for 30 years (SES)

The characterisation of this alternative is presented in Part A, chapter II.7.3.

The basic features of alternative 2 are as follows:

- Availability and reliability of the data on design and operational history of V1 NPP is lower after elapsing of the safe enclosure period.
- Lower potential for using the existing structures, systems and components in decommissioning process such as ventilation, dosimetric system, cranes, barriers, etc.
- It leads to an ineffective use of existing facilities for treatment and conditioning of RAW.
- Lower levels of radionuclides present in comparison with the first alternative.
- It leads to the interruption of employment continuity in the region.
- It results in the recruitment of untrained and inexperienced personnel after elapsing of safe enclosure period.
- Distribution of total costs over time is less convenient than in alternatives 1 and 3.
- It represents the most convenient alternative from a safety point of view (CED, amount of RAW to be disposed).
- The lowest radiation load of the environment resulting from gaseous and liquid discharges.
- Higher time load of the site by radioactivity inventory.
- It increases the time period of site release for other purposes.

From the point of view of impacts on operational personnel, we can state that preparatory activities, monitoring of the radiation situation in the buildings before the commencement of decommissioning work, pre-dismantling decontamination of contaminated equipment, dismantling of radioactive equipment of contaminated buildings, reactor dismantling, post-dismantling decontamination of dismantled equipment, decontamination of building surfaces, dismantling of non-radioactive technological equipment, demolition of non-radioactive buildings, treatment and conditioning of radioactive waste will be carried out at lower dose rates than for alternatives 1 and 3.

The anticipated impacts of the activities different from the previous alternatives, i.e. construction of SES, provision of maintenance and inspection of the barriers, provision of energy sources and operating media and operation of the safe enclosure under surveillance will be as follows:

- Construction of SES, maintenance and inspection of the barriers – the implementation of these activities will not affect the radiation situation in the affected area and in the broader area around the NEC Bohunice.
- Provision of energy sources and operating media – the implementation of these activities will not affect the radiation situation in the affected area and in the broader area around the NEC Bohunice.

Impacts of alternative 2 on environment and population

From the point of view of impacts of both groups of activities on health status of the population, it is possible to anticipate insignificant impacts of increased shipment frequency (waste gases, increased dustiness, noise and vibrations) to the same extent as in alternative 1.

The safe enclosure under surveillance will be characterised by lower amounts of radioactive discharges from the nuclear installations in Jaslovské Bohunice into the atmosphere and hydrosphere. Subsequently the radiation load for the population of the affected area will decrease. The survey of other impacts of activity groups of alternative 2 (besides the activities described for alternative 1) on the environment and population of the affected area and measures for their elimination are presented in the following table.

Table C-44: Impacts of other activities of alternative 2 except the activities described for alternative 1 on the environment and population of the affected area.

Activity (duration)	*Impacts on radiation situation modification*	*Negative non-radioactive impacts*	*Positive impacts of the activity implementation*	*Measures*
Provision, maintenance and inspection of the barriers (limited) Construction of SES	activities do not modify radiation situation	impacts of construction activity in the close surroundings of the working area, shipment impacts overlapped by overall shipment situation	possibility of extension of working opportunities	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations, organisation of work and shipment
Provision of energy sources and operating media (limited)	activities do not modify radiation situation	shipment impacts overlapped by overall shipment situation	possibility of extension of working opportunities	organisation of work and shipment

Safe enclosure under surveillance (30 years)	improvement of radiation situation in the area	insignificant shipment impacts overlapped by overall shipment situation	long-term working opportunities, reduced risk of the environment radiation contamination	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations

The conception of alternative 2 is similar to alternative 3 from the point of view of time distribution of V1 NPP decommissioning. These alternatives represent a sufficient time period for the solution of the final disposal of that radioactive waste not disposable in NSR Mochovce, concretely for the disposal of RAW from the reactor dismantling.

The essence of this alternative is the creation of a so called "nuclear island" with ensured maintenance and inspection of the tightness of buildings and equipment. If keeping the designed parameters of the SES operation, the radiation situation in the vicinity of the nuclear installations in Jaslovské Bohunice will not be modified and it will not have a negative impact on the health status of the population.

III.6.4 Alternative 3: V1 NPP deferred decommissioning with the Reactor Safe Enclosure for 30 years (RSE)

The characterisation of this alternative is presented in Part A, chapter II.7.4.

The basic features of alternative 3 are as follows:

- It represents a medium alternative in comparison with the alternatives 1 and 2 from the point of view of all decommissioning parameters.
- It leads to less effective use of existing facilities for treatment and conditioning of RAW.
- It partially results in a higher unemployment rate in the region.
- It results in the recruitment of untrained and inexperienced personnel after the elapsing of the reactor safe enclosure period.
- It represents a more convenient distribution of costs over time in comparison with alternative 2, but less convenient than in alternative 1.
- It represents a medium convenient alternative from the safety point of view (CED, amount of RAW to be disposed).
- The highest radiation load of environment by gaseous and liquid discharges.
- Higher time load of the site by radioactivity inventory.
- It increases the time period for site release for other purposes.

The activities in the first stage of implementation of this alternative starting from the preparatory decommissioning activities and ending with the treatment and conditioning of non-radioactive waste basically do not differ from alternative 1 (IDO) in the features and principles for performance of the activities and description of their impacts on personnel carrying out the activities is the same as in alternative 1 (IDO). The following groups of activities in the stage of RSE decommissioning – reactor dismantling, post-dismantling decontamination of auxiliary equipment and building surfaces, demolition of RSE structure, treatment and conditioning of RAW and treatment and conditioning of non-radioactive waste, are also identical in their features and principles for performance of the activities. The description of the impacts of activities on personnel carrying out the activities is also the same as in alternative 1.

The construction of reactor safe enclosure and the maintenance of the RSE itself are different activities in comparison with alternative 1.

Construction of the reactor safe enclosure

The performance of these activities will not influence the radiation situation in the affected area.

From the impacts on the health status of the population in this group of activities, it is possible mainly to assume the common – non-radioactive impacts like shipment impacts to the extent and with the measures described in alternative 1.

Reactor safe enclosure

It will be characterised by the reduction of radioactive discharges from the nuclear installations in Jaslovské Bohunice into the atmosphere and hydrosphere. As a consequence, the radiation load of the population in the affected area will decrease.

Impacts of alternative 3 on environment and population

Survey of the impacts of basic groups of activities in alternative 3 differ from alternative 1 on the environment and population of the affected area and measures for their elimination are presented in the following table (decommissioning of RSE is also included for completeness).

Table C-45: Other impacts of activity groups in alternative 3 (except the impacts described for alternative 1) on environment and population in the affected area

Activity (duration)	*Impacts on radiation situation modification*	*Negative non-radioactive impacts*	*Positive impacts of the activity implementation*	*Measures*
Construction of reactor safe enclosure (limited)	activities do not modify radiation situation	shipment impacts overlapped by overall shipment situation	possibility of extension of working opportunities	organisation of work and shipment
Operation of reactor safe enclosure (30 years)	improvement of radiation situation in the area	insignificant shipment impacts overlapped by overall shipment situation	reduced risk of the environment radiation contamination	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations
Decommissioning of reactor safe enclosure (limited)	improvement of radiation situation in the area	noise, vibrations in the surroundings of the working area, shipment impacts overlapped by overall shipment situation	extension of working opportunities, successive reduction of risk of the environment radiation contamination	monitoring of discharges and radiation monitoring of the surroundings of nuclear installations, organisation of work and shipment

The alternative 3 reckons with the reactor dismantling at the time of the lowered induced radioactivity of the reactor and surface contamination of its internal surfaces by radionuclides. It anticipates the construction of the protective casing, which requires the interruption of piping connections and lines between the reactor and surroundings. In spite of the reactor dismantling in a later period and decrease of the reactor radioactivity in time, RAW whose radioactivity does not enable their disposal in NSR Mochovce will arise, thus it will be necessary to dispose them in a deep geological repository, similarly to alternative 1. It is assumed that 1050 FCC containers will be disposed in NSR Mochovce (5158 m^3 of storage volume) and 30 FCC containers in a deep geological repository (147 m^3 of storage volume). It is assumed that 7883 tons of non-utilisable waste to be dumped will arise and 59 867 tons of metallic scrap will be shipped to the salvage.

With regard to the influence of the V2 NPP, ISFSF and TSÚ RAW operations, effective individual dose equivalents and collective dose equivalents for the critical groups of the population of the affected area and of the broader area around the nuclear installations in Jaslovské Bohunice will not significantly change, similarly to alternative 1.

The need for financial means is not accumulated in time, part of the financial means (associated with RSE decommissioning) will be needed in a later period.

III.6.5 Assessment of anticipated development of the area, if the activity was not performed – Zeroalternative

The Zero alternative generally represents the status that would arise if a proposed activity (in this case V1 NPP decommissioning) was not performed. According to the Act No. 127/1994 Coll. and to Act No. 541/2004 Coll. nuclear power plants, following the final reactor shutdown, should be operated in such a way that their radiation safety is continuously ensured and monitored. The Zero alternative thus means continuation of the shutdown status of V1 NPP without time limitation. This alternative does not require an investments availability for decommissioning, however it is not time limited and will put off the horizon of a new site utilisation to a very far future. In addition, it will extend the hazards of possible leakage of radioactive substances into the environment. It is also not advantageous with respect to the costs needed for an indefinite duration.

It can be seen from the above mentioned facts that the Zero alternative is unrealistic and unacceptable for the NPP decommissioning generally and for V1 NPP decommissioning due to the increased radiological risks as well as cost-related reasons.

The assumed development of the area, if the activity was not performed, is closely associated with the definition of Zero alternative. Zero alternative defines the state that would have to be ensured if the V1 NPP decommissioning did not take place. In this case, according to the legislative regulations concerning the nuclear installations, nuclear safety would have to be ensured to a full extent after the V1 NPP decommissioning without any time limitation. Therefore, the Zero alternative would mean the continuing operation of the buildings without time limitation, in which the radioactive technological equipment is located, inevitable and continual monitoring of the radiation situation, maintenance and inspection of the barrier tightness and provision of energy sources and operational media. In the case of the Zero alternative, it is also necessary to operate some non-radioactive buildings that serve as technical support for the operation of given radioactive buildings or these non-radioactive buildings serve for social purposes of the employees (administrative areas, workshops, etc.). In the case of the Zero alternative it would mean a permanent operational state after the removal of spent fuel from the units to ISFSF in 2011.

Permanently operated systems are as follows:

- Ventilation systems constituting the appropriate hygienic and radiological conditions for the personnel during the inspection of the radioactive premises and technological equipment, while enabling to maintain temperature of rooms and areas in order to establish the conditions for minimisation of the corrosive conditions of the technological equipment.
- Special sewage (collection and monitoring of possible leaks) with waste water removal system.
- Radiation monitoring of equipment and areas by a stationary system and portable instruments.
- Automated information system (AIS - equipment status control system, building barrier tightness monitoring system, indication of leaks into the controlled area, etc.).
- Electronic fire protection system (EPS).
- Electrical distribution systems for area lighting as well as for providing the power supply to the operated systems (continual power supply system operation).
- Media piping (fire fighting water, drinking water for access to controlled area, etc.).
- Ground water monitoring system in the vicinity of buildings.
- Hatches and shower rooms.
- Operator rooms, from which the continual operation and monitoring of the equipment in service will be carried out (in addition, walk downs to check the premises and equipment shall be ensured).

Concurrently, maintenance and restoration (including investment one) of the above mentioned systems should be provided as well as the maintenance of the construction part with emphasis on the inspection and maintenance of the barriers. The method of the Zero alternative operation is similar to the activities during the enclosure under surveillance, the difference is that it is basically permanent (see below).

The duration of the Zero alternative is determined by the character of radioactivity inventory of the decommissioned nuclear power plant, which is especially important for V1 NPP with regard to the radioactivity inventory in it. The Zero alternative means the persistence of the status, which will be reached after the shutdown without time limitation in practical terms, where the radioactivity of radioactive substances present will decrease only due to the natural decay of radionuclides. It should last for so long until the possibility of releasing the equipment to environment due to natural radioactive decay is reached. With respect to the current values of the radioactivity inventory in V1 NPP and its character (presence of radionuclides with a long half-time, especially of alpha radionuclides), the time horizon of the Zero alternative can be estimated to $10^4 – 10^5$ years.

The performance of necessary activities for such a period would require high levels of permanent material as well as investment costs and costs for personnel to ensure the required condition of the equipment and civil structures. Legislation would also have to ensure the given status by corresponding legislative regulations for a given time period. From the present point of view, such conditions can be guaranteed only for a considerably shorter time (some hundreds of years). A new functional utilisation of the area is postponed to a very far future and the risks of possible leakages of radioactive substances into environment are prolonged for an indefinite time period.

From the above-mentioned reasons, it is not possible to accept the situation, which would be a continuation of V1 NPP status after the shutdown and removal of spent fuel in 2011, as an ultimate solution.

III.6.6 Accordance with the valid legislative regulations

Negative impacts of the proposed activity on the population and environment of the affected area are limited by technical and organisational measures, which are determined by the appropriate legislative regulations and technical standards for the proposed activity. It can be stated that keeping the appropriate legislative and technical standards and thus accordance with the valid legislative regulations is already declared in the Intention.

Within the design preparation, technical measures are reflected in material, construction and technical execution of designed equipment and adherence to them is required for issuing the positive standpoint for building authorisation, its approval and authorisation for building operation or the operation of particular technological equipment by the state administration authorities and NRA SR. The operation authorisation is also associated with the implementation of organisational safety measures.

Technical and organisational measures also include completion and extension of the monitoring system, the purpose of which is the checking of the effectiveness of the above mentioned measures and signalling of the situations that could lead to the exceeding of limits of individual impacts. Authors of the assessment report got acquainted with the existing system of environment monitoring at SE EBO and GovCo (JAVYS) sites and with the operation of the laboratory for the radiation monitoring of SE EBO surroundings in Trnava (LRKO), which monitor operational safety of the NPP and its surroundings from a long-term point of view. The connection of the monitoring of the proposed activity with this system is also desirable from the aspect of the parallel operations of two V2 NPP units, ISFSF, technological plants for RAW treatment and V1 NPP decommissioning.

III.7 OPERATIONAL RISKS AND THEIR POSSIBLE IMPACT ON THE AREA

III.7.1 Basic principles for the management of emergency situations

During the whole decommissioning process, abnormal situations can occur due to malfunction of systems and equipment or mistakes of personnel. Emergency situations must be detected as soon as possible and measures must be initiated for the resolution of such situations and mitigation of their consequences. To comply with the respective requirements during the decommissioning, the existing public warning and notification system will be reconstructed and the emergency response centre relocated in the course of the decommissioning preparatory activities. In addition, emergency arrangements (emergency plan and emergency procedures) are necessary.

The objective of implementing the emergency arrangements is to prepare means for the resolution of emergency situations and the mitigation of the consequences of such situations in order to comply with the following aims (from the radiation safety point of view):

- Enclosure of radioactive materials,
- Limitation of exposure.

The basic principles of emergency arrangements during the decommissioning are as follows:

- As long as radioactive materials or other hazards remain on site and a potential exists for accidents to occur, emergency procedures to cope with emergencies will be required.
- Emergency situations that could occur during decommissioning will be analysed and taken into account for planning and implementation of decommissioning activities.
- Necessary emergency procedures to cope with abnormal situations will be developed, implemented and maintained for the whole decommissioning period.
- Emergency planning during the V1 NPP decommissioning will be based on the existing emergency plan for the whole site of NEC Bohunice. Such planning will be reviewed and updated regularly during the decommissioning progress to adapt the planning and procedures to the modified situation (successive reduction of requirements and respective procedures).
- Emergency procedures will be agreed with the regulatory body and other competent authorities for the management, assessment and reporting of incidents and accidents.
- Site personnel will be trained in emergency procedures.

In general, the requirements for emergency planning during the decommissioning are reduced in comparison with the requirements for emergency planning during the power operation of V1 NPP (due to absence of nuclear fuel at the plant, protection aims like fuel cooling and sub-criticality are no longer valid). With the progress of decommissioning, the amount of radioactivity contained in the facilities and areas of V1 NPP and subsequently, radioactive releases into the environment will be reduced to a level acceptable for the unrestricted usage of the buildings or site for other purposes at the end of decommissioning.

The following activities are supposed to be sources for radioactivity discharges in liquid or gaseous form in the course of the operation termination period and during V1 NPP decommissioning activities:

- Handling fuel after the reactor final shutdown,
- Equipment decontamination,
- Decontamination of building surfaces,
- Dismantling and fragmentation of contaminated equipment,
- Treatment and conditioning of radioactive waste arising in the course of decommissioning to a form suitable for disposal in a repository.

During all these activities the appropriate HVAC systems equipped with the necessary filtration devices will be in operation in order to considerably reduce the radioactivity of liquid and gaseous discharges into the environment. The rules of emergency planning will be valid in the case of failure of these systems.

The above described principles are applicable for radiation safety. Similar principles will also be applied to ensure the fire and industrial safety during decommissioning.

III.7.2 Assessment of potential emergency situations

In the assessment of accidents during decommissioning the same principle can be applied as during the V1 NPP operation. In this case, a “standard” situation means a situation when all activities are performed in the planned way with a defined (expected) impact on the radiation safety and on the vicinity of the decommissioned V1 NPP. In compliance with this principle, emergency situations are all events, which exceed such expected impact.

With the progress in V1 NPP decommissioning work, the inventory of radioactive materials in the decommissioned power plant decreases but the risk of their leakage into the environment remains. Such risk cannot be neglected. It is necessary to identify and assess the most probable emergency situations just in the period of documentation preparation for V1 NPP decommissioning in order to prepare and introduce respective preventive measures.

In general, for safety improvement, only equipment and facilities with sufficient passive safety features are being used in the nuclear field. Thus secondary failures caused by the occurrence of a primary failure will be excluded.

For the emergency situations that cannot be excluded by preventive measures, it is necessary to assess the radiological impact on the population and environment in order to demonstrate that even in such cases radiation safety will be sufficiently guaranteed.

In the Conceptual Decommissioning Plan, it has been conservatively assumed that the considered emergency situations will occur at the most unfavourable places and times (e.g. in systems with the highest activity of radioactive materials or the highest contamination, close to the end of lifetime of filters, etc.).

III.7.3 Potential emergency situations in various stages of decommissioning

A part of the emergency situations that may occur depends on the work being performed in the different decommissioning stages and the (radioactive) materials being stored or handled. In general, the work is the same for all decommissioning alternatives considered, but the timing is different and thus the probability of occurrence of individual emergency situations and their consequences depend on the selected decommissioning alternative.

Other emergency situations may occur independently from the work being performed. Such events could be caused by failure of the support and supply systems (e.g. black out) or fire. Impacts of such events depend on the place and time of their occurrence.

In all considered events radionuclides in gaseous or liquid form can leak into the environment or may cause an unexpected exposure of personnel. In the case of accidents in the systems considered below, only those that have the greatest radiological impact will be assessed.

III.7.3.1 Potential emergency situations in Alternative 1

The work in the period of decommissioning preparation and during decommissioning stage I, related to handling radioactive materials, mainly includes:

- Subsequent liquid RAW treatment in the purification plants for operational media,
- Removal of concentrates from the evaporators and of spent sorbents for conditioning,
- Sorting and low pressure compacting of compactable solid RAW,
- Shipment of solid RAW for incineration or high pressure compacting,
- Decontamination of the primary circuit as a whole.

The identified emergency situations connected with a radiation risk are therefore derived from the above mentioned work. They include:

- Leakage or failure of the gas purification plants and air exhaustion systems,
- Leakage or failure of liquid RAW purification plants,
- Leakage of liquid RAW storage tanks,
- Leakage of the system of concentrate re-pumping from storage tanks into shipment containers,
- Leakage of spent decontamination solutions.

During the decommissioning stage II the remaining total inventory of radioactive materials in V1 NPP will be decreased by the dismantling of contaminated and activated equipment and systems and by the decontamination of contaminated buildings and by a spontaneous decay of radionuclides. Simultaneously, the operational RAW from the remaining V1 NPP systems will be treated. Thus, on the other side, the number of activities during which an accident with radiological consequences can occur, will expand significantly. These activities include:

- Pre-dismantling decontamination of inner surfaces of technological equipment,
- Post-dismantling decontamination of dismantled equipment parts,
- Decontamination of building surfaces,
- Dismantling of contaminated/ activated technological equipment,
- Treatment and conditioning of radioactive waste,
- Remote dismantling of activated equipment.

In addition to the emergency situations identified for the decommissioning preparation and decommissioning stage I that also apply to decommissioning stage II, additional potential emergency situations resulting from the above mentioned activities are:

- Loss of the organised air flow during the decontamination and dismantling of contaminated/ activated equipment,
- Drop of a dismantled or fragmented part of a reactor,
- Failures during remote dismantling of a reactor.

The above indicated emergency situations and their impacts are thoroughly discussed in the Chapters III.7.4 – III.7.11 (taken over from *V1 NPP Conceptual Decommissioning Plan).*

III.7.3.2 Potential emergency situations in Alternative 2

From the radiation point of view, the work in the period of decommissioning preparation and during decommissioning stage I is the same as for the decommissioning alternative 1 (IDO). Thus the emergency situations to be considered are identical with those identified for alternative 1 during the decommissioning preparation and during decommissioning stage I.

The centre of activities in decommissioning stage II consists in the control and maintenance of the barriers against leakages of radioactive materials to the surroundings and penetrations of surface water and precipitations into the rooms of radioactive structures.

In this stage, the radioactive structures with technological equipment remain in place without changes. No handling radioactive materials or contaminated equipment will be carried out. Non-operated technological equipment and systems in the radioactive structures contain radioactive materials in the form of inner surface contamination. The reactor contains radioactive materials in the form of activated constructional reactor parts and in the form of surface contamination of the internal reactor parts. The reactor and the radioactive technological equipment are hermetically closed and there is no presumption of corrosive failure of this hermetic closure.

The building part of radioactive structures is weather- and water-proof. There is no presumption of water penetration into these structures. If it occurs, the penetration will be signalled by an automatic information system. The personnel will detect the reason of water penetration into the structure and remove the water into collecting tanks. A failure of the ventilation systems will not result in releases of radioactivity into the environment.

From the radiation point of view, the work during decommissioning stage III is the same as for decommissioning alternative 1 (IDO) stage II. Thus the emergency situations to be considered here are generally the same as those identified for alternative 1 during decommissioning stage II. The difference here is that the emergency situations would occur later than in alternative 1 (after the safe enclosure period) and therefore the level of contamination and radioactivity to be considered would be lower than in alternative 1. In terms of the consequences, this means that these emergency situations would be covered by those for alternative 1.

III.7.3.3 Potential emergency situations in Alternative 3

The potential emergency situations during decommissioning stage I are identical as those for alternative 1. Emergency situations and their impacts are discussed in the Chapters III.7.4 – III.7.9 (taken over from *V1 NPP Conceptual Decommissioning Plan).*

The centre of activities in decommissioning stage II consists in the monitoring and maintenance of barriers against leakages of radioactive materials to the surroundings and penetrations of surface water and precipitations into the rooms of the RSE.

In this stage the non-decommissioned radioactive components and structures remain in place without changes. In this stage no handling radioactive materials or contaminated equipment will be carried out. The reactor contains radioactive materials in the form of activated constructional reactor parts and in the form of surface contamination of internal reactor parts. The reactor is hermetically closed and there is no presumption of corrosive failure of this hermetic closure.

The RSE is weather- and water-proof. There is no presumption of water penetration into the safe enclosure. If it occurs, the inner arrangement is such that all penetrated water will flow into the lowest part at the level of –14.0 m, where it will be collected in the collecting tank with signalisation of even minimal volume.

In the decommissioning stage III the dismantling of reactors and demolition of reactor shafts will be carried out. Emergency situations with a radiation risk depend on the activities being performed:

- Drop of a dismantled or fragmented part of a reactor,
- Failures during remote dismantling of a reactor.

As these activities will be performed 30 years later than the respective activities in alternative 1 (IDO), the impacts on the environment of V1 NPP vicinity will be negligible. The given emergency situations are covered by the analysis presented in chapters III.7.10 and III.7.11.

III.7.3.4 Other potential emergency situations in all Alternatives

Other emergency situations that may occur independently from the work being performed are the failures of support and supply systems and fires. Failures in the support and supply systems are:

- Loss of power supply for certain equipment (e.g. waste treatment facilities, shipment systems),
- Interruption of media supply (e.g. water, compressed air).

A loss of the power supply leads in the worst case to a failure of ventilation systems. By stopping the work in the affected area, creation of radioactive aerosols will be stopped too. Work will be continued only after the recovery of the ventilation system. Radioactive releases into the V1 NPP surroundings would be immeasurable in this case.

A loss of the power supply or interruption of the media supply for working tools, waste treatment facilities or pipe systems (pumps) leads to the interruption of a certain technological process, but not to unexpected releases of radioactivity from the affected systems.

Figure C-12: V1 NPP main control room

Other emergency situations may occur due to fire. During the fires in radioactive CBs, hot smoke gases could inflame aerosol filters of the air exhaust system thoughthere is a low probability. In such cases radioactive dust retained by the affected filters could be released into the environment. A fire in the containment system is considered as the emergency situation with the greatest radiological impact (see chapter III.7.12).

Other fires (e.g. in electrical cables) not affecting ventilation systems may cause a black out in the power supply system (due to a short cut) in the worst case. It is assumed that local fires, caused e.g. by the thermal cutting of contaminated or activated materials, will be detected and extinguished immediately. Releases of radioactivity into the environment are not expected in such cases.

III.7.4 Leakage or failure of the gas purification plants and air exhaustion systems

The following situation is considered as the emergency situation with the greatest radiological impact:

- One gas admission line in the system of the gas purification plant and the technological air exhaustion system is broken just in front of the adsorption column and this admission line is not closed for more than one hour.
- During this emergency situation the air will be released directly into the environment.

Under real conditions this accident would cause a significant slowdown of gas flow through the affected pipeline because air compressors are located behind the angular adsorption columns, i.e. in the air flow direction after the leakage. It is assumed that one hour is a sufficiently long time for the closing of the relevant valves situated before the leakage place. The closing of such valves stops the leakage of radioactive materials into the V1 NPP surroundings.

The radiological consequences of such a situation were analysed in the *Safety analysis report of V1 NPP after successive reconstruction (1999)*. The result of the calculation and evaluation of population radiation doses in the V1 NPP surroundings caused by such an event was 2.64×10^{-2} mSv.

III.7.5 Leakage or failure of liquid RAW purification plants

Leakages of the liquid RAW purification plants include all possible situations, in which a release of radioactive liquid media could occur due to a failure of some equipment in the liquid radioactive waste system (e.g. valves, pipelines, tanks). This also includes components where concentrated liquid media are stored. From all such accidents that can occur in the system, a rupture of a completely filled tank has the most serious consequences. The accident with the most serious radiological consequences, i.e. a rupture of the tank with radioactive concentrates is described in the following chapter.

Radiological consequences of other leakages in the liquid discharge systems have a lower extent in respect of the violation of radiation safety and they can be eliminated by technical and technological measures. This statement is also valid for the drops of drums with radioactive sludge or failure during the filling of the drums with sludge.

III.7.6 Leakage of liquid RAW storage tanks

All storage tanks for liquid RAW are made of stainless steel and are situated in CB 801 (auxiliary production building) in the specific compartments lined by stainless steel up to the maximum height, which can be reached by the emptying of a full tank.

For the concentrate storage, five tanks with a volume of 460 m^3 and five tanks with a volume of 445 m^3 are reserved. The storage of medium level spent sorbents is provided for three tanks with the same volume of 460 m^3 and one of them is assigned as a reserve. Low level spent sorbents are stored in two tanks with the volume of 180 m^3.

The following situation is considered as the emergency situation with the greatest radiological impact:

- Rupture of the tank with the maximum volume and highest concentration of radionuclides in the concentrate.
- Complete leakage of the working volume (428 m^3) of liquid radioactive waste into the room where the tank is placed.
- Further leakage of the radioactive concentrate into the sewage and its diversion into the Váh River.

This scenario assumes a violation of several barriers which is basically very improbable:

- Tightness failure of a stainless steel storage tank,
- Tightness failure of stainless steel lining in the room where the tank is placed,
- Leakage of the full volume of liquid RAW from the room to the rain sewerage, which is outside the building.

The leakage of liquid RAW out of the building structure is technically impossible, because all leakages in the building are collected into the special sewage and they are repumped into storage tanks.

The radiological consequences of such a situation were analysed in the *Safety analysis report of V1 NPP after successive reconstruction (1999).* The result of the calculation and evaluation of population radiation doses in the V1 NPP surroundings caused by such an event was 7.25×10^{-2} mSv.

III.7.7 Leakage of the system of concentrate repumping from storage tanks into shipment containers

The leakages considered here include all possible situations, in which a release of radioactive liquid media occurs due to a failure of some equipment during repumping from storage tanks into shipment containers, during liquid RAW shipment in the shipment containers to the treatment plants and during the emptying of the shipment containers (e.g. untightness).

From all such accidents that can occur in the system, a rupture of a completely filled tank during repumping has the most serious consequences. This accident is described in the previous chapter. With regard to very conservative assumptions, including the large volume of the leakage, the consequences of this accident cover all possible consequences from leakages during the repumping and shipment of liquid RAW considered here.

III.7.8 Leakage of spent decontamination solutions

The impact of this radiation accident on the environment during pre-dismantling or post-dismantling decontamination is assumed to be one to three orders of magnitude lower than the impact of the accident described in chapter III.7.6, because the radioactivity inventory of spent decontamination solutions is lower by at least one to three orders of magnitude than in RA concentrate.

A leakage during decontamination was analysed in the EWN documentation *(Explanatory report 4: Assessment of emergency situations, 1995)* for Greifswald NPP, namely a leakage during decontamination of the primary circuit loop through a nominal diameter of 15 mm (equivalent to a the rupture of a drain pipe). Here the following situation was considered:

- The leakage occurs just before finishing the decontamination.
- The decontamination solution contains the maximum possible radioactivity inventory (based on the maximum DF and SG internal surface contamination).
- The whole liquid content of the contaminated loop leaks into the SG compartment before the accident is detected.
- The leakage runs into the special sewage system (waste water collection).
- 0.0004 % of the decontamination solution radioactivity escapes into the atmosphere due to evaporation (0.75 % of the decontamination solution volume).
- The aerosol radioactivity is discharged into the environment through the air exhaust system and the stack.

The radiological consequences of such a situation were analysed in the EWN documentation *(Explanatory report 4: Assessment of emergency situations, 1995)*. The result of the calculation and evaluation of the population radiation doses in the Greifswald NPP surroundings caused by such an event was 7.0 x 10^{-4} mSv. A similar emergency situation with comparable consequences is assumed for V1 NPP in the CDP.

III.7.9 Loss of the organised air flow during the decontamination and dismantling of contaminated/ activated equipment

The following situation is considered as the emergency situation with the greatest radiological impact:

- The loss of function of all ventilation systems and thus the loss of the organised air flow and air purification before the release into the atmosphere.
- The air leaks partially into the environment through untightness of the building.

The initiating event of this accident is a blackout. During the breakdown of the ventilation system an interruption of organised air flow from clean rooms into rooms with expected higher contamination occurs. The discharge of the contaminated air through cleaning filters into the ventilation stack is also interrupted.

Upon detection of the emergency situation (change of pressure in the affected rooms) the work of personnel in the controlled area is stopped until recovery of the function of the ventilation system. The accident will be terminated by recovering the power supply and thereby the function of ventilation systems. The radiation impact of the loss of ventilation systems on the V1 NPP surroundings is assumed to be not measurable.

III.7.10 Drop of a dismantled or fragmented part of a reactor

The following situation is considered as the emergency situation with the greatest radiological impact:

- The dismantled (fragmented) part of a reactor will get loose from the handhold (gripper) of a manipulating mean (manipulator, crane, etc.) and falls down.
- While falling down the part will bump into other reactor parts and finally it falls on the bottom of the reactor pit.
- Repeated gripping of the dropped reactor part and its safe relocation to a defined place will finish the accident.

The initiating event can be a mistake of the personnel (violation of the defined technological procedure) in handling the dismantled or fragmented radioactive part of a reactor or a failure in the handling equipment.

Drop of the reactor radioactive part will generate radioactive aerosols, which will leak into the reactor hall. In the mitigation of the accident a negligible increase of radiation load for personnel will occur. This accident will not have any impact on the environment in the V1 NPP surroundings.

III.7.11 Failures during remote dismantling of a reactor

The following situation is considered as the emergency situation with the greatest radiological impact in the EWN documentation *(Safety report, 1994)* for Greifswald NPP:

- Failure of the power supply during shipment of the reactor vessel.
- The reactor vessel is located outside the reactor cavity.

The initiating event can be any failure of the shipment mean (crane) or its power supply during the reactor vessel relocation. In the worst case, the failure of the power supply leads to long-term stoppage of the shipment mean. Taking into account the shielding properties of the main reactor building, the expected dose rate in the vicinity is estimated to 0.009 μSv/h (EWN documentation – *Safety report, 1994*).

Assuming the duration of shipment mean stoppage at one year, such an event results in 8.0×10^{-2} mSv. A similar emergency situation with comparable consequences can also be assumed for V1 NPP while handling the reactor pressure vessel before its fragmentation.

III.7.12 Fire in the containment system

The following situation is considered as the emergency situation with the greatest radiological impact in the EWN documentation *(Explanatory report 4: Assessment of emergency situations)* for Greifswald NPP:

- Fire in the cables in the containment system.
- Even the properly working ventilation system is not sufficient to cool down the smoke gas to below the ignition temperature of the aerosol filters of the air exhaust system.
- Hot smoke gases inflame the aerosol filters of the air exhaust system.
- The decomposition of the filters results in the release of radioactive dust retained by the affected filters.

Radiological consequences of such a situation were analysed in the EWN documentation *(Explanatory report 4: Assessment of emergency situations)*. The result of the calculation and evaluation of the population radiation doses in NPP surroundings caused by such an event was 0.19 mSv.

IV. MEASURES PROPOSED FOR THE PREVENTION, ELIMINATION, MINIMISATION AND COMPENSATION OF IMPACTS ON THE ENVIRONMENT

IV.1 TERRITORIAL PLANNING MEASURES

Territorial planning measures at the site of NEC Bohunice are in accordance with the territorial plan of the affected area as well as with the current development activities at the site. V1 NPP decommissioning as well as the anticipated continuation of A1 NPP decommissioning in the frame of stage II, the operation of RAW treatment and conditioning facilities (TSÚ RAO) and of the interim spent fuel storage facility (ISFSF) do not require any additional territorial planning measures or modification of the existing measures.

IV.2 TECHNICAL MEASURES

IV.2.1 Ventilation systems

HVAC systems in the buildings of V1 NPP respectively GovCo (JAVYS) are identified for the creation of suitable hygienic conditions for the work of service personnel and equipment operation, prevention of contamination spreading, provision of air filtration, check-up and organised discharge of air, which could be contaminated by radioactive aerosols. The HVAC systems are divided into inlets (supply of fresh air and heating of areas by warm air) and outlets (room ventilation and forced discharge of air that could be contaminated by radioactive aerosols through the filtration stations to the ventilation stack).

The HVAC systems used during the decommissioning have the same character as the systems used during the operation. Other local ventilation systems increasing the overall system efficiency are added in the course of decommissioning according to the character of the activities carried out (e.g. during dismantling or mechanical decontamination). These supplementary HVAC systems have their own filtration and they are emptied into the stable HVAC system, which remains in operation. The reduction of the stable HVAC system is successive in the course of decommissioning and the terminal HVAC systems are among the last to be decommissioned.

IV.2.2 Systems for purification and discharge of waste water

The discharge of waste water from the individual buildings at V1 NPP site is ensured by three separate sewage systems – rain sewerage, sewage drainage and low-level radioactive drainage. The purification of individual types of waste water also takes place separately according to the drainage systems.

In the course of V1 NPP decommissioning, the systems for waste water purification and discharge built at V1 NPP site will be used. Additional new systems are not necessary.

IV.2.3 Safety features in the technical and technological equipment used

The technological equipment for the nuclear power industry is designed in such a way so that a leakage of radioactive substances outside the equipment does not take place during a normal operation. Technical measures for the prevention of leakages of radioactive substances into the environment are represented by technological barriers (design of the equipment itself) that prevent the leakage of radioactive substances into environment and by the monitoring systems. Construction barriers represent another element, from the point of view of the protection against leakage of radioactive substances into environment. The organisational safety measures are represented namely by the limits and conditions and operational regulations.

Technological barriers consist of the construction parts of the equipment for treatment, storage and shipment of radioactive waste. From the construction and material point of view, they are designed in such a way that they could offer resistance against all operational strains. They form the first barrier, which prevents leakage of radioactive substances outside the working areas. The barriers are either single or double (for liquid radioactive waste) according to the type of radioactive substances.

According to the purpose or type of radioactive substances, the technological equipment is equipped with the monitoring systems used for the follow-up of the operational status of the part of equipment, equipment as a whole or the status of the equipment vicinity.

Building structures are designed in such a way so that waste liquid radioactive substances arising in the course of the planned operation of equipment or leakages of liquid radioactive substances arising during non-standard situations, are safely trapped in the working areas by the system of special drainage. Liquids trapped by special drainage are classified as liquid radioactive waste and they are transported to the facilities for treatment of such waste.

IV.2.4 Selected equipment

The equipment or its parts used for the handling with and treatment of radioactive materials and equipment used for the handling, conditioning and shipment of spent fuel, is the selected equipment. Special requirements for ensuring the quality of this equipment, its parts and materials, means for automatic control of technological processes including hardware and software, systems of power supply important from the point of nuclear safety apply to the selected equipment.

The selected equipment is approved by NRA SR. The selected equipment is subject to a special check-up in the stage of its design, production and operation. The means of operation of the selected equipment and every modification on the selected equipment has to be approved by NRA SR. Thus, a high degree of safety for equipment used in nuclear power industry is provided.

IV.2.5 Limits and conditions for decommissioning and operation of technological facilities

Limits and conditions determine and adjust the operation of technological and storage facilities so that their safety is ensured. These are the organisational measures that prevent the exceeding of identified discharge limits and determined operational values in technological facilities, thus preventing the rise and development of abnormal, accidental and emergency situations in the facilities. All activities of V1 NPP decommissioning including the operation of technological facilities are carried out in accordance with the valid operational regulations, while the limits and conditions are an inseparable part of the operational regulations.

Limits and conditions belong to organisational measures during the operation to prevent unfavourable development of situations leading to the jeopardy of personnel or population or resulting in facility damage. Limits and conditions contain the summary of organisational, technical and technological conditions that have to be kept to ensure safety. Limits and conditions are approved and their fulfilment is followed by NRA SR.

IV.2.6 Operational regulations

Technological procedures also comprise operational regulations, which contain such planned procedures and activities, the fulfilment of which ensures achieving of the required operational safety. The facilities are operated exclusively according to the appropriate approved operational regulations.

IV.3 COMPENSATION MEASURES

The implementation of any of the submitted alternatives of the proposed activity will not result in any proprietary or other detriment of physical or legal entities as the activity will be performed within the current boundaries of GovCo (JAVYS) site. The individual alternatives do not raise any requirements for the extension of shipment and other infrastructures outside the site. The impacts of the installation on the environment are very small and basically restricted to GovCo (JAVYS) site and thus they will not significantly affect the environment and health status of the population living in the municipalities of the affected area.

Due to the reasons mentioned, no compensation measures are assumed. The final result of decommissioning is the permanent reduction of risk in V1 NPP surroundings and thus the permanent improvement of current status of environment.

IV.4 STATEMENT ON THE TECHNICAL AND ECONOMIC FEASIBILITY OF THE GIVEN MEASURES

All measures mentioned in the previous chapters are fully feasible using the available technical and economic means. Technical and economic feasibility of the measures is assessed namely from the point of view of the following domains:

- *Territorial planning measures:* new measures are not necessary, because V1 NPP decommissioning activities will be performed within the GovCo (JAVYS) site and their impacts on the environment will not exceed the current valid limits, which were used for the territorial planning measures valid at the present time.
- *Technical measures:* they are an inseparable part of the proposed activity. Financial covering of the planned activity also includes the necessary technical measures for the minimisation of impacts on environment.
- *Limits and conditions:* they are comprised in current valid operational regulations. Limits and conditions for new activities will be a part of new operational regulations and they will be elaborated by the authorisation holder and approved by NRA SR before the commencement of these activities.

All assumed measures for prevention, elimination and minimisation of the impacts of the proposed activity on the environment, loss of amenities of the population and employees are technically feasible.

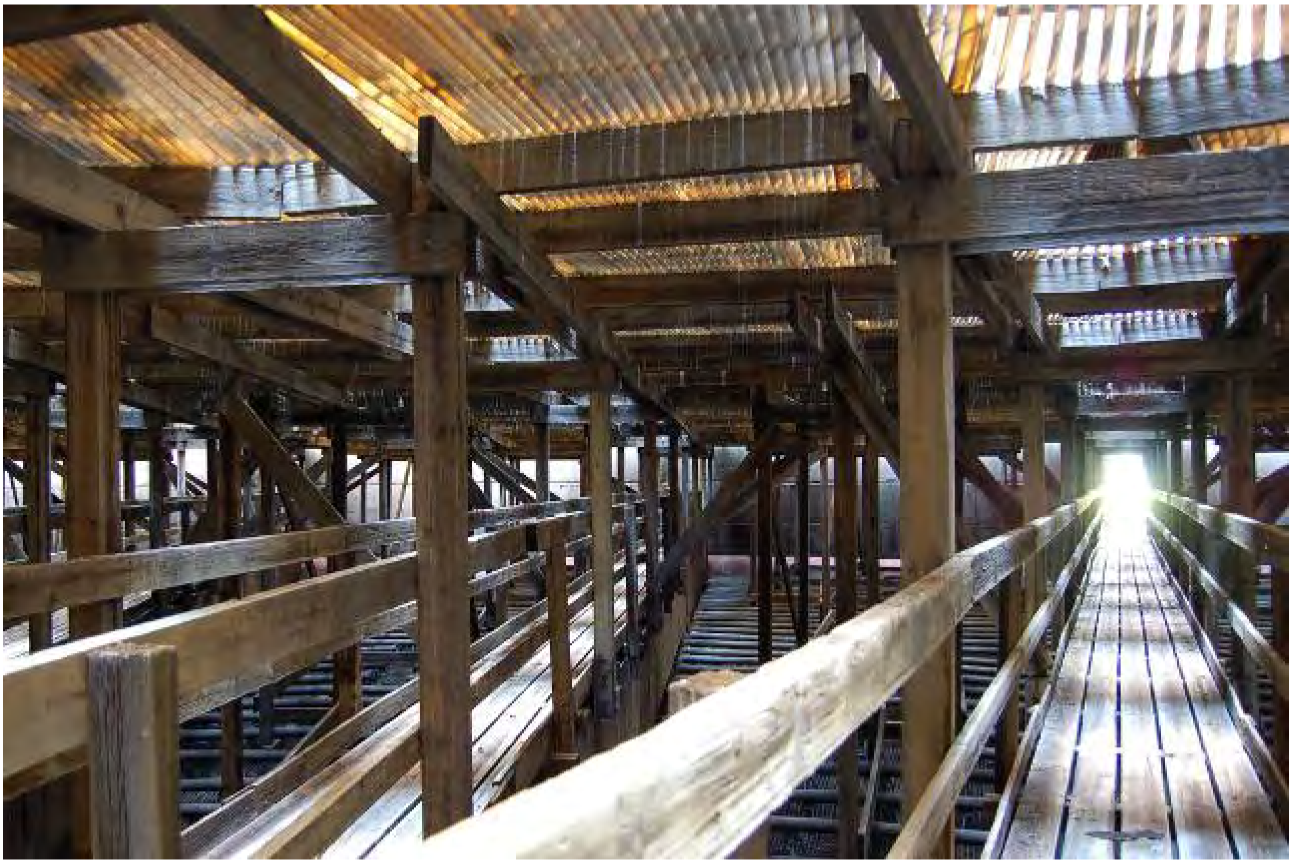


Figure. C-13: View into inside the cooling tower.

V. COMPARISON OF ACTIVITY ALTERNATIVES AND SELECTION OF THE MOST SUITABLE ALTERNATIVE

The method of the NPP decommissioning alternative selection using only one criterion comparison (e.g. total decommissioning costs, total collective effective dose) leads to a one-sided assessment of the most suitable alternative. This method does not consider other criteria, which can be also important from the point of view of selection and does not evaluate the rate of their influence on the final decision. That is why it is proposed to use the multicriterial analysis for comparison of decommissioning alternatives and selection of the most suitable alternative based on the results of this comparison and assessment. MCA is a powerful tool, which is able to compare particular alternatives by means of considering a larger number of parameters and also to take into account their mutual links and rate of their importance.

V.1 DEVELOPMENT OF THE ASSEMBLY OF CRITERIA AND ASSIGNMENT OF THEIR IMPORTANCE FOR THE SELECTION OF THE MOST SUITABLE ALTERNATIVE

For the selection of the most suitable V1 NPP decommissioning alternative, based on the analysis (calculation) performed in chapters 4 and 5 of the CDP, 13 criteria were defined and divided into the following 5 groups as shown in Table C-46:

- safety criteria,
- environmental criteria,
- economic criteria,
- implementation criteria,
- demands for repositories of RAW.

It is necessary to define groups of criteria, to be sure that all important areas in the process of the most suitable alternative selection are covered. In addition, the criteria were divided into the following classes:

- Objective classes, for which the criterion value for the alternative is calculated in the previous analysis.
- Subjective classes, for which the criterion value for the alternative is not calculated and it is assigned by a team of experts.

Further, to be able to take into account the relative importance of the individual evaluation criteria, it is necessary to assign a criterion weight to each criterion. By weighting the criteria it shall be assured that the influence of less important criteria on the evaluation result is lower than the influence of more important criteria. The criterion weight is common to all decommissioning alternatives considered. The general range of criterion weight is proposed to be from 1 up to 10. To the criteria of higher importance a higher criterion weight shall be assigned and vice versa.

The experience of a group of experts is used in the process of criterion weight determination. At first, all criteria have to be arranged in descending sequence according to their importance. After this arrangement, each criterion has its own position and a criterion weight can be assigned to each position. The criterion weight of value 10 can be assigned to the most significant criterion. Consequently, the criteria on the next positions are weighted by values lower than 10 according to the predominant opinion of the experts. Some of the criteria may be evaluated equally, if the experts agree that there is no principal difference among their significance. This approach allows flexible assessment, so that the second position can be evaluated by weight factor 10 or 9 or lower, and so on.

The method described is used for all positions in the criteria list, so that correct comparison of the considered criteria importance is ensured. Finally, the appropriate criterion weights from the given range of values are assigned to all considered criteria. The results are presented in the table C-46.

In the MCA process it is necessary to pay attention to the objectivity of the criterion weight determination. This can be achieved by means of team work.

Table C-46: Set of evaluation criteria, their division into groups and classes and determination of criterion weight

No.	***Description***	***Criterion weight***	***Criterion class***
	Safety criteria		
1	Total CED	10	Objective
	Environmental criteria		
2	Radiation consequences of gaseous discharges to environment	5	Objective
3	Radiation consequences of liquid discharges to environment	5	Objective
4	Time load of site by radioactivity	6	Objective
5	Amount of non-utilisable waste	2	Objective
	Economic criteria		
6	Total costs	8	Objective
7	Time distribution of costs	8	Subjective
8	Labour hours needed	5	Objective
	Implementation criteria		
9	Continuity of manpower and RAW processing facilities utilisation	8	Subjective
10	Time of final site release	7	Objective
11	Preparedness of site for further utilisation	3	Subjective
	Criteria of demands for RAW repositories		
12	Total number of FCC into NSR	8	Objective
13	Total number of FCC into ISRAW	8	Objective

Source: CDP

V.2 TECHNICAL AND ECONOMIC ASSESSMENT OF THE ALTERNATIVES

Alternative 1: V1 NPP immediate decommissioning alternative (IDO)

Technical assessment of the alternative:

This alternative assumes the immediate fluent and adequate distribution of the decommissioning activities. The advantage of this procedure is the possibility to start with simpler cases of dismantling and decontamination activities where the practical experience will be gained, which will be used in the course of dismantling of the most complicated parts like reactor and the most contaminated equipment. The advantage is the continuity of experience and of knowledge of the buildings and equipment, which are the most favourable in this alternative.

Economic assessment of the alternative:

The costs for this alternative represent 17 624.48 million SKK and they are the highest ones from all evaluated alternatives.

Alternative 2: V1 NPP deferred decommissioning with safe enclosure under surveillance for the period of 30 years (SES)

Technical assessment of the alternative:

The alternative assumes the postponement of the main decommissioning activities for 30 years. Deferred decommissioning will principally not affect the technical feasibility of this alternative. However, deferred decommissioning can have an unfavourable effect on concrete partial solutions caused by loss of the continuity of the concrete knowledge of areas and equipment by present V1 NPP workers or their direct successors. Not all the details on areas and equipment are recorded in the decommissioning database and some of them can have relevant consequences for the proposal of partial solutions.

The operation of the safe enclosure under surveillance represented by the inspection of building barriers and inspection of the barriers of technological equipment which is not operated is also viable in connection with the operation of TSÚ RAO technological facilities.

Economic assessment of the alternative:

The costs for this alternative represent 15 809.93 million SKK and this is the middle value from evaluated alternatives.

Alternative 3: V1 NPP deferred decommissioning with the reactor safe enclosure for the period of 30 years (RSE)

Technical assessment of the alternative:

This alternative assumes postponed decommissioning of the reactor by means of its safe enclosure.

Economic assessment of the alternative:

Costs for this alternative represent 15 435.07 million SKK and they are the lowest from evaluated alternatives.

List of main characteristic parameters for evaluating the analysed three alternatives of V1 NPP decommissioning is given in Table B-42.

V.3 SELECTION OF THE MOST SUITABLE ALTERNATIVE

The result of the assessment of the alternatives of the proposed activity is the recommendation of this assessment report that the most suitable alternative is **alternative 1 – V1 NPP immediate decommissioning.** Alternative 2 – V1 PP deferred decommissioning with the safe enclosure under surveillance for the period of 30 years is the second most favourable followed by alternative 3 – V1 NPP deferred decommissioning with the reactor safe enclosure for the period of 30 years and finally the Zero alternative. More detailed results of the assessment of individual alternatives are presented in table C-47.

Table C-47: Final results of multicriterial analysis

No.	*Description*	*Contribution of criterion to the alternative value*		
		IDO	*SES*	*RSE*
	Safety criteria			
1	**Total CED**	11.799	6.949	11.251
	Environmental criteria			
2	**Radiation consequences of gaseous discharges to environment**	5.662	3.587	5.750
3	**Radiation consequences of liquid discharges to environment**	5.655	3.590	5.755
4	**Time load of site by radioactivity**	2.131	7.934	7.934
5	**Amount of non-utilisable waste**	1.048	2.472	2.480
	Economic criteria			
6	**Total costs**	8.655	7.764	7.580
7	**Time distribution of costs**	4.000	10.667	9.333
8	**Labour hours needed**	5.442	4.889	4.669
	Implementation criteria			
9	**Continuity of manpower and RAW processing facilities utilisation**	4.235	11.294	8.471
10	**Time of final site release**	2.492	9.254	9.254
11	**Preparedness of site for further utilisation**	1.000	4.000	4.000
	Criteria of demands for RAW repositories			
12	**Total number of FCC into NSR**	8.377	7.150	8.473
13	**Total number of FCC into ISRAW**	10.154	6.923	6.923
	Alternative value - S_j	70.651	86.473	91.875

Source: CDP

The alternative of V1 NPP immediate decommissioning has more advantages in comparison with the other assessed alternatives:

- It takes into account the anticipated development at the site from the point of view of creating the conditions for decommissioning of the other NPPs at the site and the utilisation of V1 NPP buildings for these purposes.
- The time schedule for the performance of the decommissioning activities is distributed uniformly with regard to the utilisation of the qualified work force. The complexity of the tasks is successively increasing, thus gaining the experience for the decommissioning of the most complicated parts of NPP from the radiation point of view.
- This alternative is the most unfavourable with regard to the costs, because the buildings are decommissioned back the level of the foundations.
- This alternative is optimal from the technical point of view, because it is linked up with the current status of the technical provisions for decommissioning and the conditions for a fluent transition to V2 NPP decommissioning will be created in the course of decommissioning according to this alternative.
- The important aspect to regard nowadays, on the basis of decommissioning experience, is the preservation of the experience and knowledge of the current personnel, which can be effectively used for the development of concrete working procedures during the partial decommissioning tasks (continuity in knowledge of equipment and areas).

The recommendation stems mainly from the following reasons and associations:

- The Zero alternative does not comprise decommissioning and therefore it does not reduce potential leakages of radioactive substances or the risk of accidents associated with the presence of radioactive materials in the facility (at the site) to the full extent. It consists of maintaining the situation after the NPP operation termination without any decommissioning activities for an indefinite time period. It does not finish with landscaping the site and its release for further use. Due to this reason, a reasonable comparison of the costs and requirements for maintaining the Zero alternative and of other alternatives is not possible, because the Zero alternative is not equivalent with them. However, the overall impact of the Zero alternative is positive, if we consider only the immediate environmental impacts due to NPP shutdown. As the Zero alternative does not represent an ultimate solution, rejection of other alternatives of the proposed activity would with a very high probability, sooner or later, result in re-assessment of the decision.
- Alternatives 2 and 3 achieve the above-mentioned parameters, because they end up with the demolition of non-utilisable buildings and the elimination of all impacts and risks resulting from their presence and they include site landscaping and release of the site for further use. However, their time period is less convenient with the risk of loss of technical information on the equipment and with the loss of continuity with the operation and the resulting social and economic impacts on the population of the affected area.
- Alternative 1 achieves all of the above-mentioned positive impacts in the shortest possible time, but on the other hand this leads to slightly more negative impact resulting from the

immediate implementation of the decommissioning (higher radiation doses for the personnel and costs).

- The assessment states that alternative 1 is to be preferred in spite of the fact that there is a slightly more negative impact resulting from the immediate decommissioning, because it is well compensated by the positive impacts of removal of NPP non-utilisable buildings, site landscaping and its release for further use. Savings of financial costs and radiation doses (not very significant and applying after 30 years) anticipated due to the radioactive decay of radionuclides in some contaminated and activated facilities and buildings of NPP are disputable or at least burdened by a higher indefiniteness.
- The recommendation of alternative 1 also adheres to the concept of sustainable development and to the basic principles for the safety of radioactive waste management. It represents the most acceptable solution for the population of the affected municipalities and for the affected area from the social, economic and environmental point of view, when considering all submitted alternatives. It is also in accordance with public opinions and standpoints and recommendations of non-governmental organisations, which entered the assessment process at the stage of scoping.

The differences between the Zero alternative and the proposed alternatives concerning of the impacts on the population stem from the fact that it will be necessary to continue to preserve the safety of non-operated V1 NPP facilities (reactor, equipment of the primary circuit, etc.) in the case of Zero alternative. It is also necessary to provide the other above-mentioned activities forming the part of the common operation of this decommissioned NPP. Finally, it can be stated that:

- The collective equivalent dose for the critical population groups of the affected area and the broader surroundings of the nuclear installations in Jaslovské Bohunice, with regard to the further operation of V2 NPP, ISFSF and TSÚ RAO during V1 NPP decommissioning implementation according to the above described alternatives, will basically not change in comparison with the present time.
- The Zero alternative is not acceptable due to the extend of time and preparedness of the investments. Alternatives 1 and 3 provide an adequate time period for the construction of incurred investments, while alternative 1 is characterised by a fluent course of decommissioning.
- The necessary financial means for the implementation of the proposed alternatives of V1 NPP decommissioning are comparable for alternatives 2 and 3, while they are higher for alternative 1 (buildings are also removed with the foundations in this alternative).

V.4 MITIGATION OF NEGATIVE IMPACTS

Minimisation of ionising radiation exposure of personnel and population (ALARA principle) – by thorough implementation of efficient programmes and working plans issuing from the valid legislation on health protection against ionising radiation and on work in the environment with ionising radiation as well as by using the equipment with remote control, manipulators, etc.

Minimisation of contaminant emissions into the atmosphere – by using highly efficient filtration systems to trap emissions and dust, by local suction cleaning of dust, dust fixation (e.g. by sprinkling) and by the thorough planning of activities with increased formation of dust.

Minimisation of surface water pollution – by minimising the water consumption, treatment of waste water and by using the waste water in further process of RAW treatment and conditioning, efficient filtration, etc.

Noise reduction – by using noise barriers and routing and timing of the shipment.

Minimisation of requirements for land occupation (at V1 NPP site) needed for operative buffer collection/storage places for decommissioning waste. Technologies minimising the formation of secondary waste and preventing the contamination of surroundings are used.

Utilisation of operating personnel, preferentially from the V1 NPP operation and recruitment of the work force preferentially among the inhabitants of affected municipalities.

Adequate training and re-training of the personnel at all levels and working places of the organisation.

Site landscaping and further use of the site.

Land scenery – if new buildings are required, they are to be built in such a way that the landscape is not affected.

VI. PROPOSED MONITORING PROGRAMME AND POST-PROJECT ANALYSIS PROGRAMME

VI.1 MONITORING PROGRAMME DURING DECOMMISSIONING ACTIVITIES

The basis for the assessment of the impacts of nuclear installations on the population is the balance monitoring of the radioactivity of waste gases in the ventilation stack. All nuclear installations at the site have their own ventilation stacks, where the monitoring systems capable of balancing the following specific types of radioactive emissions are installed:

- radioactive noble gases (Ar, Kr and Xe) that are considered as the sources of external irradiation,
- radioactive aerosols with a longer decay time (> 24 h), which are considered as the sources of internal contamination that takes place during the inhalation,
- radioactive ^{131}I, due to its specific radiochemical properties (it can occur in gaseous form as well as aerosol form), is monitored independently by trapping on the selective sorbents and it is considered as a source of organ dose (dose equivalent in thyroid gland).

Besides this, other radionuclides in waste gases are also monitored, especially those that have a specific position in the assessment of impacts on the population. We can mention e.g. 3H, 14C, 90Sr, 239Pu, as these radionuclides are significant from the point of view of assessment of global impacts of NI operation on the environment. This measurement is provided by a separate taking of samples (water steam, aerosols, forms of carbon oxides and carbohydrates) and subsequent radiochemical detection of the aforementioned radionuclides, while using the selective detection methods (liquid scintillation spectrometer, semiconductor alpha spectrometry, etc.) (see Part A, chapter II.8.5.3 and Annex 1, chapters 2.1.5, 2.3.4, 2.3.6.4, 2.3.6.6.1).

Besides the monitoring of waste gases, liquid discharges also undergo the balance monitoring on the basis of samples from water reservoirs, where the over-balance of service water is accumulated. Water reservoirs are emptied into the water recipient (by means of the ground piping collector SOCOMAN directly to Váh River) only after the evaluation of samples taken on condition that radioactivity of this water is below the authorised limit determined for this kind of waste water (see Part A, chapter II.8.5.3 and Annex 1, chapters 2.1.5, 2.3.4, 2.3.6.4, 2.3.6.6.1).

The monitoring of gaseous and liquid discharges (monitoring at the source of pollution) is supplemented by the systematic monitoring of individual environmental components based on the monitoring programme of the NEC Bohunice surroundings approved by the hygienic regulatory authorities (see Part A, chapter II.8.5.3; Part C, chapter II.4.6 and Annex 1, chapters 2.1.5, 2.3.4, 2.3.6.6.2).

With regard to the fact that the monitoring of liquid discharges and the monitoring of the V1 NPP surroundings is performed for the NI site in Jaslovské Bohunice as a whole (i.e. for A1 NPP, V1 NPP, V2 NPP, BSC RAO, ISFSF), it is possible to assume that in the course of V1 NPP decommissioning and thereafter , the extent of the monitoring of liquid discharges and monitoring of the surroundings will be comparable with the present extent of monitoring, when taking into account the condition of the other nuclear installations located at the site. At a later time, the frequency of some types of measurement or limit values of the discharges from the site into the atmosphere and hydrosphere can be changed.

This means that the collection and evaluation of the data on the monitoring of individual point sources of air pollution (ventilation stacks of existing NI) and of liquid discharges and on the monitoring of the surroundings are also fully sufficient for the monitoring of the activity impacts in the course of V1 NPP decommissioning.

VI.2 PROPOSED CONTROL TO ENSURE COMPLIANCE WITH THE CONDITIONS LAID DOWN IN MONITORING PROGRAMME

It is suggested to perform the control of keeping the determined conditions for the activity implementation according to the project of V1 NPP decommissioning in the form of submitting the quarter reports *Analysis of discharges of radioactive substances from the site SE EBO and GovCo (JAVYS) and of radiation situation in their surroundings* and annual summary reports *Radiation protection of SE EBO and GovCo (JAVYS) and impact of SE EBO and GovCo (JAVYS) on the surroundings* to the appropriate approving and affected authorities. The report will stem from the standard report that is comprehensively elaborated for the whole site of NI in Jaslovské Bohunice.

VII. METHODS USED IN THE IMPACT ASSESSMENT PROCESS AND OBTAINING THE DATA ON CURRENT STATUS OF ENVIRONMENT IN THE AFFECTED AREA

VII.1 OBTAINING THE DATA ON CURRENT STATUS OF ENVIRONMENT IN THE AFFECTED AREA

Data necessary for the assessment of the impacts of NEC Bohunice on the environment are mostly collected by the SE EBO and GovCo (JAVYS) enterprises – operators of the individual NI. General issues of the assessment of radiation impacts of NEC Bohunice on the environment are provided by the Laboratory of radiation monitoring of the surroundings in Trnava.

The following organisations also systematically deal with the monitoring of radionuclide occurrence in the surroundings of NI from the point of view of environmental impact assessment:

- Public Health Authority Bratislava – it independently monitors ambient dose equivalent rate and volume concentration of the aerosols, it performs state health surveillance (in case of accidents),
- Slovak Hydrometeorological Institute Bratislava, observatory in Jaslovské Bohunice – it systematically monitors climatic and meteorological parameters at the site necessary for the prognosis of impacts of a potential NPP accident,
- VÚJE Trnava a.s., Division of the radiation safety, NPP decommissioning and RAW treatment – a laboratory certified in this field performs special measurements out of the scope of the monitoring programme in the frame of tasks aimed at more detailed and accurate description of the radiation situation in GovCo (JAVYS) surroundings (measurement of external radiation, mass concentration of aerosols and fall-outs),
- Institute of Preventive and Clinical Medicine – it collects and evaluates the data from environment monitoring from the above mentioned sources and it becomes the Centre of radiation monitoring network in case of radiation accidents.

Some other organisations and companies also work in this field, but to a lesser extent. They usually solve concrete tasks for the operator of NI (e.g. EKOSUR and Environment, a.s. companies).

Data on the current status of the environment in the broader surroundings of the Bohunice site necessary for the assessment of impacts of NEC Bohunice operation on the environment is obtained from the monitoring of radioactive and non-radioactive pollution in gaseous and liquid discharges, which are released into the environment as well as in individual components of the environment in the broader surroundings of NEC Bohunice. Results of the monitoring of discharges and of radiation situation in the surroundings of NEC Bohunice together with the operation assessment in the form of the population radiation load are presented in the annual reports of SE EBO and GovCo (JAVYS) on the radioactivity of discharges and radiation situation in the surroundings of NEC Bohunice. These reports and research reports of VÚJE or of other organisations served as the basis for obtaining the data in this report. The radiation impacts resulting from the power operation and emergency situations were calculated specially for this report and for the *V1 NPP Conceptual Decommissioning Plan* respectively, while using the experience from Greifswald NPP decommissioning with the reactors of the same type as in V1 NPP.

The method of obtaining the data was closely coordinated between the authors and the proponent. Basic data on the current status of V1 NPP, on proposed activities, the monitoring of technological outputs and monitoring of the environmental components within the site of NEC Bohunice and in its surroundings were provided by the proponent. The proponent also ensured provision of the data from the other organisations participating in the monitoring of environmental components (EKOSUR, SE EBO, GovCo (JAVYS), LRKO EBO, VÚJE, a.s. and Environment, a.s.).

Data on the discharges of radioactive substances into the hydrosphere and atmosphere was taken over from annual reports on the impact of nuclear installations in Jaslovské Bohunice on the environment (period between 2001-2005).

Data on the contamination of ground water and soils coming from the old tanks of A1 NPP was taken over from the documents regularly elaborated by the EKOSUR company, which deals with their rescue.

Other data on the status of the environment and population of the affected and broader area stemmed from the bases of other national authorities and institutions, which are responsible for the follow-up of particular components of the environment and health status of the population (MŽP SR, SAŽP, ŠÚ SR and ÚZIŠ).

The authorship of the assessment report stemmed from the bases provided by VÚC Trnava region, MPSVR SR and ÚPSVaR in the parts concerning of the description of the affected area, affected municipalities, development and territorial plan of the region and decision about V1 NPP shutdown.

Other data have been taken from the previous EIA reports of proposed activities on the NEC Bohunice site and from conceptual documents associated mainly with A1 NPP decommissioning and with the intended V1 NPP decommissioning.

Expert literature in particular fields, published statistical surveys and analyses of the data concerning the affected area, consultations with other experts and naturally own work and long-term experience in particular fields were used by the authors of this report as information sources.

A detailed list of the documentation, from which the information was obtained is given in chapter XI. A list of supplementary analytic reports and studies is available at the proponent and in the list of references.

VII.2 METHODS USED IN THE IMPACT ASSESSMENT PROCESS

After detailed mapping of the current status of all components and factors of the environment and their analysis, the expected changes evoked by the implementation of the proposed activities were reflected in this status. These changes were compared namely with the limits of the appropriate legislative regulations and standards from the point of view of their possible exceeding. The expected positive impacts were also assessed. Space and time aspects of the changes evoked by implementation of the assessed activity were followed.

The proposed activities and their impacts on the environment were assessed in the frame of all safety, technical, technological, organisational and hygienic standards and regulations, which will have to be kept during the implementation. They were also assessed from the point of view of the system to check adherence to them. Unambiguousity of safety standards and the checking of adherence to them, the manifest character of the impacts on natural components of the environment of affected area and on health status of the population of the affected area as well as the economic advantageousness and social impacts were assessed in a semi-quantitative and descriptive way.

For the estimation of costs and other output parameters of the selected decommissioning alternatives, a calculation model based on Microsoft Excel was used.

This model is based on the Microsoft Excel spreadsheets and implements the breakdown to the items on the basis of the Proposed Standardised List of Items for Costing Purposes (PSL) as proposed by OECD [55]. This list:

- enables a systematic approach to the evaluation of decommissioning alternatives,
- guarantees that no important item can be omitted,
- gives the possibility of international comparison of the analysis results.

It enables a sufficient level of detail for the conceptual planning. The computing algorithms are designed so that the cell formulae are standard for each decommissioning alternative and the changes between individual alternatives are implemented by changing the inputs or including/ excluding the computing rows into the alternative.

Various decision scenarios and optimisations can be achieved by changing the input values. In order to avoid any confusion, a philosophy of single input is adopted throughout the model. It means that every variable or specific unit factor is put into the spreadsheet only once and all other instances of that same variable or specific unit factor are copied from there.

The development and use of the model can be divided into three steps:

- Step 1 - development of the template procedures. Every template procedure forms a computing row of cells unique for the type of activity described. There are template procedures for activity-dependent cost items like dismantling, decontamination, radiation survey, demolition, waste treatment and conditioning, packaging, storage, shipment, disposal, assets recovery and for time-dependent activities. A more detailed description of these template procedures is provided in the CDP.
- Step 2 - assignment of the template procedures. The template procedures are assigned to the individual items from the PSL and the input data (including fixed costs) is filled in for each item (row).

- Step 3 - the starting dates for individual items (rows) are set so that the logical sequence of activities is maintained.

After these steps the model shows the total costs of each item, its duration and cost components and other decommissioning parameters broken down by the number of years of the activity duration.

It was assumed in the CDP that the V1 NPP decommissioning will be performed after the operation termination period. It was assumed that no operational event will occur in the time of further operation up to the Units final shutdown which would, in principle, influence the assumed initial state of the plant and the course of decommissioning after the final shutdown and that such an operational event will not cause the operation to be ceased.

On the conceptual level the scope of the CDP includes:

- Summary of preparatory decommissioning activities,
- Description of initial status of V1 NPP and of input assumptions and data,
- Analysis of decommissioning alternatives including all decommissioning activities such as decontamination, dismantling, demolition, RAW management, management of non-contaminated material, radiological monitoring landscaping, management of the decommissioning process,
- Complex comparison of decommissioning alternatives and the recommendation of the most suitable decommissioning alternative,
- Summary conclusions.

The preparatory decommissioning activities needed for V1 NPP decommissioning are summarised in the CDP including those covered by BIDSF projects, those identified by other organisations as well as those identified by the Consultant for the CDP preparation. The projects mentioned are necessary to ensure the appropriate external boundary conditions for V1 NPP decommissioning such as:

- Separation of V1 NPP from the other SE EBO facilities remaining in operation,
- Preparation and implementation of V1 NPP final shutdown and termination of operation,
- Assessment of V1 NPP status at the beginning of decommissioning,
- Ensurance of availability of qualified personnel for decommissioning,
- Development of V1 NPP decommissioning documentation,
- Provision of new and/or modified infrastructure for V1 NPP decommissioning (including RAW and non-radioactive material management),
- Other issues, such as assessment of legal, technical and other preconditions and requirements for hand over of the V1 NPP for decommissioning.

It will be necessary to ensure the implementation of these projects so that their results will be available in time for the V1 NPP decommissioning purposes.

The basic calculation was carried out in accordance with the PSL structure separately for each particular PSL item for each V1 NPP decommissioning alternative considered. As a result of the analysis/calculation the following output parameters for every considered PSL item as well as for PSL item groups were determined:

- Time demands of main activities and their mutual links,
- Demands on manpower,
- Demands on technological media, consumables and energy,
- Amount and type of generated radioactive waste,
- Amount and type of non-contaminated waste,
- Requirements of final disposal of radioactive waste,
- Collective effective dose,
- Impact of the decommissioning process on the environment (radioactivity of gaseous and liquid discharges),
- Total costs and their components according to the PSL (labour costs, expenses, investment costs and contingency).

The PSL structure item results were transformed into their time dependence. Each output parameter was distributed over the time, in which the item activity is carried out and summarised for individual years. In such a way the time dependence of the output decommissioning parameters was obtained.

The method of NPP decommissioning alternative selection using only one criterion comparison (e.g. total decommissioning costs, total collective effective dose) leads to one-sided assessment of the most suitable alternative. This method does not consider other criteria, which can be also important from the point of view of selection and does not evaluate the rate of their influence on the final decision. That is why it is proposed to use the multicriterial analysis for comparison of decommissioning alternatives and selection of the most suitable alternative based on the results of this comparison and assessment. MCA is a powerful tool, which is able to compare particular alternatives by means of considering a large scale of criteria and also to take into account the rate of their importance. Multicriterial analysis of NPP decommissioning alternatives and selection of the most suitable alternative is a generally used method world-wide. The final quality of multicriterial analysis is given by the two following conditions:

- The first condition is the correct definition of a particular set of criteria to be taken into account during the assessment. Consequently, it is necessary adequately to describe all important properties, which have to be taken into account during the assessment process.

- The second condition is a reasonable scaling of particular criteria importance from the most suitable alternative selection point of view. The importance of each criterion has to be defined by the assignment of a criterion weight. Due to this, the influence of more significant criteria on the final results of mathematical processing will be emphasized. Logically, the impact of less important criteria will then be appropriately reduced.

Basic steps at work with the MCA can be summarised as follows:

- Definition of a particular set of criteria,
- Division of criteria into objective and subjective class and determination of criterion weight,
- Calculation/assignment of criterion value for the alternative,
- Mathematical evaluation of alternatives according to the methodology - calculation of alternative values,
- Recommendation of the most suitable V1 NPP decommissioning alternative on the basis of gained results of the comparison of the analysed alternatives.

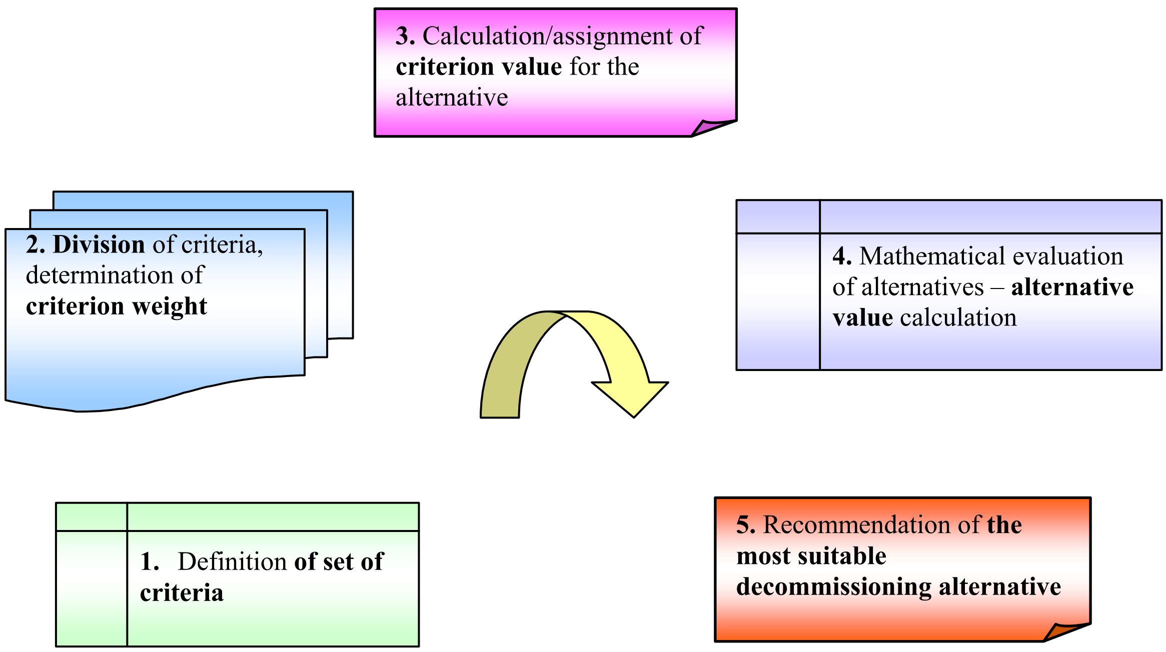


Figure C-14: Scheme of multicriterial analysis

VIII. LACK AND UNCERTAINTY IN KNOWLEDGE, WHICH OCCURRED DURING THE ELABORATION OF ASSESSMENT REPORT

The V1 NPP decommissioning will include many activities which may be influenced by factual, temporal and financial considerations during the decommissioning process. The most significant factor influencing the feasibility and quality of currently proposed activities is the time point of view, because the implementation of V1 NPP decommissioning represents a long time horizon – in case of alternatives 2 and 3 it means tens of years and in case of the Zero alternative without time restriction (if the decision that V1 NPP is not going to be decommissioned, was not re-evaluated). This fact is the biggest source of uncertainty in the assessed activity: in spite of the relatively accurately formulated ideas about concrete activities during the decommissioning and removal of individual facilities of the power plant, it is not possible to analyse all associations in a greater detail. From the time point of view, uncertainty is the smallest in case of alternative 1.

V1 NPP is the part of the site of nuclear installations in Jaslovské Bohunice, where V2 NPP is currently operated as well as the facilities for RAW and spent fuel management and the decommissioned A1 NPP. RAW interim storage facility is also in the stage of design preparation. The nuclear installations at the site are mutually connected – from the technological point of view and by the civil structures. Therefore it is not simple to assess the impact of an individual nuclear installation on the environment when taking into account impacts of other nuclear installations (e.g. common discharge for GovCo (JAVYS) nuclear installations).

In the course of elaboration of the assessment report, significant changes in the relevant legislation took place – new Act No. 24/2006 on Environmental Impact Assessment and on the Amendment and Supplementation of Some Acts of the Coll., series of the new Decrees of NRA SR (Decrees no. 46/2006 – 58/2006) as well as the new Act No. 126/2006 on Public Health and on the Amendment and Supplementation of Some Acts of the Coll., which supersedes some Decrees of MZ SR on June 30th, 2006 and the new decrees are in the phase of preparation, which can also be a source of uncertainty.

Some problems, especially those of organisational character, resulted from the change of ownership relations in SE, a.s., the transformation of SE VYZ to the state stock company GovCo, a.s. (JAVYS, a.s.), the transfer of V1 NPP under the administration of GovCo (JAVYS) and the transfer of PMU administration from SE to GovCo (JAVYS).

The last source of uncertainty results from the infrastructure of RAW and the spent fuel management, which represents a part of the decommissioning of nuclear installations.

Several studies indicate that the current capacity of NSR will not be sufficient for all disposable radioactive waste. The enlargement of NSR and subsequent creation of further disposal capacities is a natural solution, but not the only one (e.g. the construction of the disposal repository for very low level waste is considered).

Even greater uncertainty is represented by the disposal of that radioactive waste not disposable in NSR Mochovce and of the spent fuel. In the case of V1 NPP decommissioning, namely the reactor internals can be taken into account. The conceptual decommissioning plan as well as this report anticipate their storage in the Interim RAW storage facility followed by the disposal in a deep geological repository. It is nearly certain nowadays that the planned term of operation commencement of the deep geological repository in about 2037 is very optimistic. The reason is the suppression and even stoppage of the research and development work on the programme of development of deep geological repository and sporadic considerations about some other strategic solutions for the final stage of waste management for that waste not disposable in NSR and especially of spent fuel management, but still not justified by realistic technical and economic analyses.

On the other hand, actual results and experience from the Greifswald NPP decommissioning with WWER type reactors, which were also used, can significantly reduce the uncertainty, namely in the technical, technological, safety and environmental fields.

IX. LIST OF THE EIA REPORT ANNEXES

Two text annexes form the part of this EIA report:

- Annex No.1 – Information on fulfilment of conceptual requirements and answers to the comments and proposals of the non-governmental organisations Energia 2000 (Energy 2000) and Energia tretieho tisícročia (Energy of the third millennium) presented in the Scope of assessment of the Intention of this proposed activity.
- Annex No.2 – Experience from Greifswald NPP decommissioning in the Federal Republic of Germany (*EWN environmental impact register*).

X. EXECUTIVE SUMMARY

Through the adoption of Resolution No. 801/99 of the Slovak Government of 14th September 1999, as a condition for fulfilling the Accession Agreement of the Slovak Republic to the European Union, *Protocol No.9 on unit 1 and 2 of V1 NPP Jaslovské Bohunice in Slovakia,* the Slovak Republic undertook a commitment to shut down units 1 and 2 of Jaslovské Bohunice V1 NPP in 2006 and 2008 respectively.

According to the Act of NR SR No.127/1994 Coll. on *Environmental Impact Assessment*, Slovenské elektrárne, a.s. (proponent)[4], submitted the document *"Complex Study of the V1 NPP Decommissioning"* to the Ministry of Environment of the Slovak Republic on 26th June 2002. MŽP SR accepted this Complex Study as a Preliminary Environmental Study (Intention), i.e. as the first step of standard EIA process, and consequently opened up the process of scoping specified by §12 of Act No. 127/1994 Coll. on the Assessment of Environmental Impacts as amended by Act No. 391/2000 Coll., for the assessment of impacts caused by the proposed activities[5].

The Scope of Assessment issued by MŽP SR on 8th October 2002 covers the environmental impact assessment of all three alternatives of V1 NPP decommissioning which were considered in the *Complex Study of the V1 NPP Decommissioning* and also the so called Zero alternative (whereby no action will take place).

In July 2004, a Grant Agreement (*GA 005*) for the development of documentation on the decommissioning of Bohunice V1 NPP was established between the EBRD -as the administrator of Grant Funds provided by the Bohunice International Decommissioning Support Fund (BIDSF)- and SE, a.s., as the recipient. The subject of this Grant Agreement comprises the following projects:

- B6.1: "The V1 NPP Conceptual Decommissioning Plan";
- B6.2: "The Environmental Impact Assessment (EIA) Report of V1 NPP Decommissioning".

The proponent shall perform an environmental impact assessment in accordance with Act No. 127/1994 Coll. and under the framework of BIDSF, also in accordance with EU EIA Directives, including preparation of the Environmental Impact Assessment Report and public consultation process. The above mentioned projects are included in the BIDSF B6 project, which also covers the project B6.3. *"The V1 NPP Decommissioning Stage Plan and other Documentation"* and the project B6.4 *"Decommissioning Database".*

"The V1 NPP Conceptual Decommissioning Plan" and this *"V1 NPP Environmental Impact Assessment Report"* (after issuing the final statement of MŽP SR) will be the basis for issuing the decision on authorisation for the activity according to special regulations and for the documentation

[4] At the present time the function of the proponent has been taken over by the GovCo, a.s. (Jadrová vyraďovacia spoločnosť, a.s.), Jaslovské Bohunice, which is besides other also the V1 NPP operator.

[5] The new EIA Act No. 24/2006 Coll. came into force on 1st February 2006 and it revokes the previous Act No. 127/1994 Coll. and Act No. 391/2000 Coll. According to §65, item 3 of Act No. 24/2006 Coll., environmental impact assessment commenced before February 1st, 2006 will be completed in accordance with previous regulations.

which should be developed in the framework of the B6.3 project and be attached to the written application for authorisation for the decommissioning stage (the Act No. 541/2004 Coll.).

X.1 PROPOSED ACTIVITY

V1 nuclear power plant decommissioning.

X.2 PURPOSE OF PROPOSED ACTIVITY

The purpose of the proposed activity "*V1 NPP Decommissioning*" is to achieve the status fulfilling the criteria (in accordance with appropriate legal regulations) for site release for unrestricted use. V1 NPP decommissioning will thus be completed by removal of all unnecessary and non-utilisable buildings and equipment and the release of the site for further use.

The goal of the assessment report is to assess and compare the impacts of the proposed V1 NPP decommissioning alternatives on the environment in accordance with Act No. 127/1994 Coll. and to recommend the most suitable alternative.

X.3 LOCATION OF THE IMPLEMENTATION OF PROPOSED ACTIVITY

The activities will be carried out on the V1 NPP site (Fig. A-2), which is a part of the common site of SE EBO (operator of V2 NPP) and GovCo (JAVYS) in the Bohunice nuclear-energy complex.

Possible impacts arising from the proposed activities on the natural and anthropogenic components of the environment and the population will be evaluated in the affected area, which represents the first threatened zone, i.e. circle around the power plant of 5 km radius (Fig. A-10). In case of social and economic impacts, a broader area will be assessed. The affected area comprises of 8 villages:

- Jaslovské Bohunice, Malženice and Radošovce belonging to the district of Trnava;
- Žlkovce and Ratkovce belonging to the district of Hlohovec;
- Veľké Kostoľany, Nižná and Pečeňady belonging to the district of Piešťany.

X.4 SIMULTANEOUSLY SUBMITTED ALTERNATIVES OF THE INTENTION

Simultaneously submitted alternatives of the proposed activity in the Intention are as follows:

- Alternative 1 - Immediate decommissioning alternative (IDO);
- Alternative 2 - Deferred decommissioning alternative with safe enclosure under surveillance for 30 years (SES);
- Alternative 3 - Deferred decommissioning alternative with reactor safe enclosure for 30 years (RSE).

These alternatives have been compared to the Zero alternative, which represents the situation and its consequences, should the proposed activity - V1 NPP decommissioning -, not take place.

X.5 COMMENCEMENT AND DURATION OF THE PROPOSED ACTIVITY

In compliance with the proponent's instructions alternative solutions for the decommissioning were addressed in all studies, strategic and planning documents. The initial and final status were in each case the same:

- The V1 NPP decommissioning begins with the issuing of the authorisation for decommissioning after the removal of the fuel from V1 NPP and its placement into the GovCo (JAVYS) ISFSF in Jaslovské Bohunice. This means that the period between Unit 1 final shutdown and the start of the decommissioning itself (pursuant to the Government Resolution No. 801/1999, between years 2007 and 2011) does not generally fall within decommissioning activities, rather is a part of the operation termination and a period during which preparatory decommissioning activities take place.
- The V1 NPP decommissioning is completed when all building structures and equipment identified for decommissioning have been removed and the plant site has been released for further use.

Assumed dates for proposed activity or alternatives of proposed activity are given in the following table.

Table C-48: Terms of commencement and termination of activities.

Alternative of proposed activity	*Commencement*	*Termination*
Alternative 1 (IDO)	2012	2025
Alternative 2 (SES)	2012	2063
Alternative 3 (RSE)	2012	2063
Zero alternative	2012	Without time limitation

X.6 ZERO ALTERNATIVE

The Zero alternative is characterised as the situation and its consequences which would arise if the proposed activity, i.e. V1 NPP decommissioning did not take place. In the case of V1 NPP decommissioning, the Zero alternative is the status that would arise after the NPP shutdown without commencement of decommissioning activities and its retention with no time limitation. This means that Zero alternative does not represent further operation of the power plant.

In accordance with the Atomic Act, nuclear power plants must be operated in such way, that their radiation safety would be ensured and continuously monitored after the reactor final shutdown to the extent identified by Decree of NRA SR No. 50/2006. During the operation termination period, spent fuel will be removed from each unit and operational radioactive waste will be treated.

In the case of the Zero alternative, namely the following specific systems must be permanently operated:

- HVAC systems creating suitable hygienic and radiological conditions for personnel during inspections of radioactive rooms and technological equipment and enabling at the same time moderate heating of rooms to minimise corrosion of technological equipment;
- special drainage water system (collection and check for potential leakages) with waste water let down system;
- monitoring of equipment and rooms for radiation using a stationary radiation monitoring system and portable devices;
- automated technological information system – (monitoring system for equipment, monitoring system for civil barrier tightness, signalling of leaks in the controlled area, etc.);
- electronic fire protection system;
- electrical distribution systems for lighting of rooms and power supply to operating systems (permanent operation of power supply systems);
- piping distribution systems for media (water for fire-fighting, drinking water for changing rooms and contamination checkpoints, etc.);
- groundwater monitoring system in the vicinity of individual buildings;
- main changing rooms and showers;
- rooms for operating personnel, from which permanent attendance and monitoring of operating systems will be ensured (in addition to walk-downs).

The maintenance and reconstruction of the aforementioned systems must be concurrently ensured. In addition, civil part maintenance with emphasis on the check-ups and maintenance of barriers will be necessary.

X.7 ALTERNATIVE 1: V1 NPP IMMEDIATE DECOMMISSIONING

The main feature of this alternative is the immediate and continuous dismantling of the equipment and facilities, demolition of buildings back to the bottom of their foundations and the preparation of the site for further use.

Within the operation termination period the spent fuel is removed from the Units into the ISFSF, remaining operational RAW are processed and the decontamination of the PC as a whole is carried out. Subsequently, during the decommissioning stage I, the non-radioactive technological systems are dismantled and the non-contaminated buildings which are intended for no other purposes are demolished.

The principle sequence of further decommissioning activities is: system decontamination before continuous dismantling and if necessary decontamination after dismantling. The RAW generated are treated and stored immediately. This is followed by the decontamination of the building surfaces and the demolition of the buildings including the hermetic area. In this alternative the decommissioning is continuous. At the end the site is released for further use.

X.8 ALTERNATIVE 2: V1 NPP DEFERRED DECOMMISSIONIG WITH THE SAFE ENCLOSURE UNDER SURVEILLANCE (SES) FOR THE PERIOD OF 30 YEARS

A basic feature of this alternative is the safe enclosure of the equipment of the primary circuit. Before the authorisation for the operation is terminated, the spent fuel is removed from each Unit, the operational RAW are processed and the decontamination of the PC as a whole is carried out.

At the beginning of the decommissioning no additional internal decontamination is carried out and no contaminated items are dismantled. Corrective building maintenance is performed and the non-contaminated obsolete CBs are dismantled and demolished. The facilities are closed as scheduled. After the facilities are closed, the environmental impact is regularly monitored.

After the expiration of the term of SES, the facilities are dismantled, taking into account the radiation that has decreased because of the natural decay of isotopes. Thus this alternative could be characterised as an interrupted decommissioning process, where the contaminated/activated facilities are safely enclosed and monitored during the determined time and finally they are dismantled up to the point of unrestricted release of the site.

During the safe enclosure under surveillance, the equipment and systems which are important to safety are still operated. Maintenance of equipment and systems, electrical equipment, instrumentation and control equipment and radiation monitoring is ensured according to the programme determined in advance. In the course of the 30-year period of enclosure under surveillance, it is necessary to consider the reconstruction of equipment including the replacement of cable and distribution systems. With regard to the importance of civil barriers, maintenance (replacement) of civil engineering parts (roofs, peripheral panels, foundations, structures, etc.) is ensured in regular intervals in accordance with the results of inspections carried out. The appropriately assumed maintenance intervals will be given in operational regulations.

X.9 ALTERNATIVE 3: V1 NPP DEFERRED DECOMMISSIONING WITH THE REACTOR SAFE ENCLOSURE (RSE) FOR THE PERIOD OF 30 YEARS

A basic feature of this alternative is the safe enclosure of the reactor in the reactor shaft.

Before the authorisation for the operation is terminated, the spent fuel is removed from the units, the operational RAW are processed and decontamination of the primary circuit as a whole is carried out.

Further, during decommissioning stage I, the non-contaminated facilities are dismantled and buildings are demolished if they are not intended for any further use. Pre-dismantling decontamination, dismantling of the technological equipment (with the exception of that required for the RSE), decontamination after dismantling and processing of the resulting waste are performed consecutively. These activities are followed by the decontamination of the building surfaces and demolition of the controlled area except the part, required for the RSE. The safe enclosure of the reactor meets all the requirements of environment and radiation protection.

This alternative also includes an interruption of the decommissioning process. During the time of reactor safe enclosure, two independent groups of buildings remain in the site area: the reactor shafts with the reactors and some buildings necessary for service.

X.10 TOTAL COSTS

The total costs of the individual alternatives for the proposed activity are presented in the following table:

Table C-49: Total costs for individual V1 NPP decommissioning alternatives

Alternative of the proposed activity	*Costs* [SKK mill.]*
Alternative 1 (IDO)	17 624.48
Alternative 2 (SES)	15 809.93
Alternative 3 (RSE)	15 435.07
Zero alternative	90.00 per year

*In the case of Zero alternative the annual costs necessary for operation (energy and media), barrier integrity control, radiation protection, maintenance and work are given.

X.11 STANDPOINT ON TRANSBOUNDARY IMPACTS

The contribution of V1 NPP decommissioning to environmental impacts is negligible in comparison with usual environmental impacts of NPP units in operation, the TSU RAO or ISFSF installed at the NEC of the Bohunice site. No significant transboundary impacts (if they are relevant at all) are expected at any stages of any of the decommissioning alternatives because of the distance of the affected area from state boundaries (*Figure A-11*). All impacts of radiological character are restricted to the site of the decommissioned power plant, some non-radiological impacts will influence the affected municipalities of the first threatened zone and the socio-economic impacts will affect a broader area (districts of Trnava, Piešťany and Hlohovec).

In view of the proponent this project does not fall under the provisions of the ESPOO Convention.

X.12 SUMMARY OF MAIN PARAMETERS FOR THE INDIVIDUAL ALTERNATIVES OF THE PROPOSED ACTIVITY

A summary of characteristic parameters for individual decommissioning alternatives is presented in the following table.

Table C-50: Summary of main parameters for alternatives 1, 2 and 3

Parameter	*Alternative 1*	*Alternative 2*	*Alternative 3*
Total costs [SKK mill.]	17 624.48	15 809.93	15 435.07
Collective effective dose [manSv]	13.8778	8.1734	13.2333
Duration of the decommissioning process under	14	52	52

Parameter	Alternative 1	Alternative 2	Alternative 3
authorisation for decommissioning [year]			
Labour hours needed [10^3 hours]	15 026.5	13 498.4	12 891.1
Amount of liquid RAW (at 200 g/dm^3 salinity) [m^3]	1 930	1 774	1 931
Radioactivity of gaseous discharges [Bq]	$3.22{\cdot}10^6$	$2.04{\cdot}10^6$	$3.27{\cdot}10^6$
Radioactivity of liquid discharges [Bq]	$7.94{\cdot}10^7$	$5.04{\cdot}10^7$	$8.08{\cdot}10^7$
Amount of metals released into the environment [t]	55 996	61 004	59 867
Amount of recyclable construction waste [t]	418 125	318 734	318 599
Amount of non-utilisable waste [t]	3 331	7 855	7 883
Number of FCC for NSR [pcs]	1 038	886	1 050
Number of FCC for IRAWSF [pcs]	44	30	30
Duration of the site's radiation load [year]	13.7	51	51

Source: CDP.

The relatively small difference between the CED's for the alternatives 1 and 3 stems from the fact that the reactors together with their internal parts are in both cases decommissioned remotely (by a manipulator) and thus the resulting radiation load is low.

The average value of the radioactivity of discharges during the power operation of V1 NPP is about 160 MBq for aerosols and about 65 MBq for corrosion and fission products in liquid discharges. These values result from appropriate values published in the SE, a.s. Reports on Environment in 2001 to 2005 obtained from the former SE EBO. These discharges represent about 0.1% and 0.2% of the permitted annual limit values for the radioactivity of gaseous and liquid discharges for NEC Bohunice site as the whole.

The environmental impact of decommissioning results mainly from:

- The extent of operated equipment in controlled area and its mode of operation,
- The amounts of RA materials being dismantled,
- The management methods for RAW generated during decommissioning.

The principal sources of radioactive discharges are the treatment and conditioning of RAW, decontamination of RA material and dismantling. Gaseous and liquid discharges are generated, depending on the technologies used. However, the chronological distribution of the amounts of discharges generated also depends on the decommissioning alternative selected.

The distribution of radioactive discharges over a period of time is generally similar to the distribution of the radiation load of personnel over a period of time. The highest amounts are produced during the dismantling of contaminated and activated equipment, the decontamination work and RAW management, i.e. in Alternative 1 stage II, Alternative 2 stage III and Alternative 3 stage I.

For alternative 1, the estimated average annual radioactivity value of liquid discharges represents about 5.6% and the respective value for gaseous discharges represents 0.1% of the appropriate annual values measured for the V1 NPP power operation. The respective average annual radioactivity values for alternatives 2 and 3 are comparably lower than for alternative 1 due to the safe enclosure period with very low annual radioactivity values of liquid and gaseous discharges.

In general, the radioactivity of discharges from the V1 NPP decommissioning, independently of the chosen alternative, is much lower than during the power operation. The estimated maximum annual value of radioactivity of liquid discharges represents about 13.8% and the respective value of gaseous discharges represents 0.23% of the corresponding annual values measured for the V1 NPP power operation.

In comparison with the V1 NPP power operation, non-radiological impacts (for example ground water consumption, cooling water consumption and emission of water pollutants) are also significantly reduced after the shutdown.

These impacts remain at this low level during the decommissioning practically independently of the selected alternative.

During the performance of the proposed activities, particularly in the cases of dismantling and demolition of building structures, some additional impacts such as noise, dust and emissions from the transport of waste and material can occur. Such impacts are typical for each dismantling and demolition activity. These additional impacts are temporary and restricted to the site of the power plant and its nearest surrounding or the transport routes and therefore do not affect significantly the components of the environment such as flora, fauna, soil or surface and groundwater.

Therefore there are no significant additional non-radiological impacts in relation to the current situation of the environment. The proposed and assessed activities basically remove the consequences of the V1 NPP operation.

Thus the decommissioning activities are positive also in relation to the environment.

X.13 TECHNICAL AND ECONOMIC ASSESSMENT OF THE ALTERNATIVES

Alternative 1: V1 NPP immediate decommissioning (IDO)

Technical assessment of the alternative:

This alternative assumes the immediate continuous and adequate distribution of the decommissioning activities. The advantage of this procedure is the possibility of starting with simpler cases of dismantling and decontamination activities whereby the practical experience is gained. This will later be used in the course of dismantling the most complicated parts such as the reactors and the most contaminated equipment. The advantage is the continuity of experience and knowledge of the buildings and equipment, which are most favourably evident in this alternative.

Economic assessment of the alternative:

The costs of this alternative represent 17 624.48 million SKK and they are the highest of all evaluated alternatives.

Alternative 2: V1 NPP deferred decommissioning with safe enclosure under surveillance for the period of 30 years (SES)

Technical assessment of the alternative:

This alternative assumes the postponement of the main decommissioning activities by 30 years. Deferred decommissioning will not affect the technical viability of this alternative. However, deferred decommissioning can cause the unfavourable effect whereby the familiarity and specific knowledge relating to areas and equipment possessed by present V1 NPP workers or their direct successors is no longer available. Not all details of areas and equipment are recorded in the decommissioning database and this can have unfavourable consequences.

Operation of the safe enclosure under surveillance in the form of the inspection of building barriers and the barriers for technological equipment not in operation is also viable in connection with the operation of the TSÚ RAO facilities.

Economic assessment of the alternative:

The costs of this alternative represent 15 809.93million SKK and this is the second most expensive of the evaluated alternatives.

Alternative 3: V1 NPP deferred decommissioning with the reactor safe enclosure for the period of 30 years (RSE)

Technical assessment of the alternative:

This alternative assumes the postponement of the decommissioning of the reactor by means of its safe enclosure.

Economic assessment of the alternative:

The costs of this alternative represent 15 435.07 million SKK and they are the lowest of the evaluated alternatives.

X.14 SELECTION OF THE MOST SUITABLE ALTERNATIVE

The result of this assessment of the alternatives of the proposed activity is the recommendation of this assessment report that the most suitable alternative is **alternative 1 – V1 NPP immediate decommissioning.** Alternative 2 – V1 NPP deferred decommissioning with the safe enclosure under surveillance for the period of 30 years is the second most suitable followed by alternative 3 – V1 NPP deferred decommissioning with the reactor safe enclosure for the period of 30 years and finally the Zero alternative. The alternative of V1 NPP immediate decommissioning has more advantages in comparison with the other assessed alternatives:

- It takes into account the anticipated development of the site from the point of view of creating the conditions for decommissioning of the other NPPs at the site and the utilisation of V1 NPP buildings for these purposes.

- The time schedule for the performance of decommissioning activities is distributed uniformly with regard to the utilisation of the qualified work force. The complexity of the tasks increases with the passing of time, thus providing the experience for the decommissioning of the most complicated parts of the NPP (from the point of view of radiation).
- This alternative is the most suitable from the technical point of view, because it is linked to the current status of technical provisions for decommissioning and furthermore the conditions for a fluent transition to the V2 NPP decommissioning are created in the course of decommissioning according to this alternative.
- An important aspect from the current perspective, based on existing experience of decommissioning, is the preservation of experience and knowledge of current personnel. This can be effectively used for the development of specific working procedures during the partial decommissioning tasks (continuity of knowledge of equipment and areas).
- This alternative is the most unfavourable in terms of the costs, because the buildings are decommissioned right back to the foundations.

The recommendation is mainly based on the following reasons and related facts:

- The Zero alternative does not comprise decommissioning and therefore it does not reduce potential leakages of radioactive substances or the risk of accidents associated with the presence of radioactive materials in the facility (at the site) to the full extent. It consists of maintaining the situation after NPP operation termination without any decommissioning activities for an indefinite time period. It does not end up with the landscaping of the site and its release for further use. Due to these reasons, an objective comparison of costs and requirements for maintaining the Zero alternative with other alternatives is not possible. The Zero alternative is in no way equivalent to the others. However, the overall impact of the Zero alternative is positive, if we consider only the immediate environmental impacts of the NPP shutdown. As the Zero alternative does not represent an ultimate solution, the rejection of the other alternatives of the proposed activity would, sooner or later, very probably result in the re-assessment of the decision.
- The alternatives 2 and 3 fulfill the above mentioned parameters, because they end up with the demolition of the non-utilisable buildings and the elimination of all impacts and risks resulting from their presence and they also include site landscaping and the release of the site for further use. However, the time scale is less convenient with the risk of loss of technical information on the equipment and with the loss of continuity of the operation and the resulting social and economic impacts on the population of the affected area.
- In the case of carrying out alternative 2 or 3, the loss of experience during the time period of safe enclosure (30 years) requires expensive education and training of the personnel before the beginning of the decommissioning continuation after the 30 year's interruption.
- The alternative 1 achieves all of the above mentioned positive impacts in the shortest possible time, but on the other hand this leads to the slightly more negative impact resulting from the

immediate implementation of the decommissioning (higher costs and radiation doses for the personnel).

- The assessment states that alternative 1 is to be preferred in spite of the aforementioned slightly negative impact resulting from immediate decommissioning, because this is well compensated by the positive impacts of removal of the NPP non-utilisable buildings, landscaping of the site and its release for further use. In addition, the anticipated financial saving and lower radiation doses (not very significant and only relevant after 30 years) due to the radioactive decay of radionuclides in some contaminated and activated facilities and buildings of NPP are questionable or at the very least burdened by a high level of uncertainty.
- The recommendation of alternative 1 also adheres to the concept of sustainable development and to the basic principles for the safety of radioactive waste management. When considering all submitted alternatives it represents the most acceptable solution for the populations of the affected municipalities and for the affected area from the social, economic and environmental point of view. It is also in accordance with public opinions and recommendations of non-governmental organisations, which have taken part in the assessment process since the stage of scoping.

X.15 MITIGATION OF NEGATIVE IMPACTS

The minimisation of ionising radiation exposure of personnel and population (ALARA principle) – by thorough implementation of efficient programmes and working plans based on the relevant legislation on health protection against ionising radiation and on work in the environment with ionising radiation as well as by using the equipment with remote control, manipulators, etc.

Minimisation of contaminant emissions into the atmosphere – by using highly efficient filtration systems to trap emissions and dust, by local suction cleaning of dust, dust fixation (e.g. by sprinkling) and by the thorough planning of activities involving an increased formation of dust.

Minimisation of surface water pollution – by minimising the water consumption, treatment of waste water and by using the waste water in further process of RAW treatment and conditioning, efficient filtration, etc.

Noise reduction – by using noise barriers and optimising the routing and timing of the transportation.

Minimisation of requirements for land occupation (at the V1 NPP site) needed for operative buffer collection/storage places for decommissioning waste. Technologies minimising the formation of secondary waste and preventing the contamination of surroundings are used.

Utilisation of operating personnel, preferably from the V1 NPP operation and recruitment of the work force preferably from the inhabitants of affected municipalities.

Adequate training and re-training of the personnel at all levels and working places of the organisation.

Site landscaping and further use of the site.

Land scenery – if new buildings are required, they are to be built in such a way that the landscape is not affected.

X.16 MONITORING PROGRAMME FOR DECOMMISSIONING ACTIVITIES

The monitoring programme for decommissioning activities is the continuation of the present monitoring programme for the nuclear energy complex of the Bohunice site which has been approved by the relevant authorities . It fulfils all applicable legal requirements. The monitoring programme includes the determination of gaseous and liquid discharges of radionuclides and other pollutants into the environment and the monitoring of environmental components (e.g. groundwater, surface water and soil) and a number of agricultural products.

The main point of the monitoring programme is the balance monitoring of the waste gases radioactivity in the ventilation stack of V1 NPP.

Besides these measurements of waste gases, liquid discharges also undergo the balance monitoring on the basis of samples from water reservoirs, where the over-balance service water is accumulated.

Monitoring of gaseous and liquid discharges is supplemented by systematic monitoring of individual environmental components, such as groundwater, surface water and soil and a number of agricultural products based on the monitoring programme of the Bohunice nuclear energy complex surroundings approved by hygienic regulatory authorities.

The collection and evaluation of data from the monitoring of individual point sources of air pollution (ventilation stack) and of liquid discharges and from the monitoring of the surroundings are fully sufficient also for the monitoring of the activity impacts in the course of the V1 NPP decommissioning.

It is suggested to perform the control of keeping the determined conditions of the V1 NPP decommissioning project in the form of submitting the quarter reports *Analysis of discharges of radioactive substances from the site SE EBO and GovCo (JAVYS) and of radiation situation in their surroundings* and the annual summary report *Radiation protection of SE EBO and GovCo (JAVYS) and impact of SE EBO and GovCo (JAVYS) on the surroundings* to the appropriate approving and the affected authorities.

XI. SUMMARY OF PART C

The EIA report provides in this Part C the comprehensive characterisation of the impacts of the individual alternatives of the proposed activity (the V1 NPP decommissioning) on the environment respective its components. It characterises the affected area and describes the current environmental status in the affected area, assesses the potential impacts of the proposed activity on the environment, enumerates and assesses the measures proposed for the prevention, elimination and minimisation of the impacts on the environment. It compares the alternatives of the proposed activity and recommends the most suitable alternative of the V1 NPP decommissioning (alternative 1: immediate decommissioning of the V1 NPP). The comparison is made on the basis of the multicriterial analysis, which takes into account different technical, safety, economic, environmental and social aspects. The methods used in the impact assessment process as well as the lack and the uncertainty in the knowledge which occurred during the elaboration of this EIA report are also described.

XII. LIST OF THE AUTHORS AND ORGANISATIONS PARTICIPATING IN THE ASSESSMENT REPORT ELABORATION

On the basis of the international tender, this environmental impact assessment report on V1 NPP decommissioning has been elaborated by EWN GmbH – STM POWER, a.s. consortium for the proponent SE, a.s. Bratislava (GovCo, a.s. (JAVYS, a.s.), Jaslovské Bohunice at the present time).

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Axel Bäcker, Prof. Dr. Wolfram Thiele, Brigitte Lenk and Thomas Reinke (Annex No.2 – Experience from Greifswald NPP decommissioning in the Federal Republic of Germany – *EWN Environmental Impact Register*).

XIII. LIST OF SUPPLEMENTARY ANALYTIC REPORTS AND STUDIES AVAILABLE AT THE PROPONENT

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XIV. DATE AND CONFIRMATION OF THE CORRECTNESS AND COMPLETENESS OF THE DATA BY SIGNATURE (STAMP) OF THE DELEGATED REPRESENTATIVE OF THE PROPONENT

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ANNEX 1

INFORMATION ON FULFILMENT OF CONCEPTUAL REQUIREMENTS AND ANSWERS TO THE COMMENTS AND PROPOSALS OF THE NON-GOVERNMENTAL ORGANISATIONS ENERGIA 2000 (ENERGY 2000) AND ENERGIA TRETIEHO TISÍCROČIA (ENERGY OF THE THIRD MILLENNIUM) PRESENTED IN THE SCOPE OF ASSESSMENT OF THE INTENTION OF THIS PROPOSED ACTIVITY.

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I.1 REQUIREMENTS OF CONCEPTUAL CHARACTER FROM ITEM 2.1 OF THE SCOPE OF ASSESSMENT

2.1.1. *A conceptual document for nuclear installation sites shall be elaborated summing up the developments in these sites, taking into account all the relations and time schedules for individual stages and steps with regard to the principles of the national approach to radioactive waste and spent fuel management.*

Answer:

This requirement has been primarily solved for the SE EBO site in the document *V1 NPP redevelopment* **[3], more precisely in chapter 7 (subchapters 7.1 to 7.4),** elaborated by DECOM Slovakia in 2004.

Analysis of time and space relations at the site was performed for the following activities:

- A1 NPP decommissioning,
- V1 NPP and V2 NPP operation,
- V1 NPP decommissioning,
- V2 NPP decommissioning,
- ISFSF operation and decommissioning,
- BSC RAW operation and decommissioning,
- operation and decommissioning of other RAW treatment plants located outside BSC RAW.

During the analysis of the relations of operation and decommissioning of individual nuclear installations, it was assumed that NPP decommissioning would be performed in the fastest possible way:

1. Continuous alternative of A1 NPP decommissioning (2008 – 2033), in which active dismantling was anticipated in 2008 – 2029 period.
2. So called accelerated V1 NPP immediate decommissioning alternative (2012 – 2025), in which the beginning of active dismantling was anticipated in 2017.
3. So called accelerated V2 NPP immediate decommissioning alternative (2030 – 2043) in case of 40-year NPP operation, in which the beginning of active dismantling was anticipated in 2035.

With respect to the requirements for further RAW management, proposed alternatives are the most conservative ones, because they put the heaviest demands on RAW management in the considered time horizon of the implementation.

BSC RAW and other RAW treatment plants should be continuously operated till 2043 in the considered cases. Their operation would depend on the decision about the commencement of ISFSF decommissioning or on the decision about contingent continuation of the power production in a nuclear power plant at the site, what cannot be definitely excluded. In case of currently valid decision about the termination of nuclear power industry development and successive construction of substitute power sources, it would not make any sense to conserve BSC RAW for approximately 30 years for the treatment of radioactive waste arising from ISFSF decommissioning (the considerations also reflect possible prolongation of its operational lifetime by 25 years), but the treatment would be performed in mobile treatment plants. Thus, BSC RAW could be shut down and subsequently decommissioned in 2043, after treatment of all radioactive waste arising from V2 NPP decommissioning.

With regard to the optimisation of further waste management, one of the input assumptions was the cessation of bituminisation of operational (historical) liquid RAW from V1 and V2 NPP, i.e. they will be used as a radioactive cement grouting of the waste in FCC.

The conclusion of mentioned conceptual approaches in the document [3] is that if the construction of a new nuclear source at the site does not take place, nuclear installations at the site will be *exempt from Act No.541/2004 Coll.* in about 2080. The final activities of peaceful use of nuclear energy at the site will be the decommissioning of ISFSF and management of RAW arising from this decommissioning (on condition that its operational lifetime will be prolonged from 2050 to 2075). Otherwise, ISFSF will be decommissioned after 2050 and interim RAW storage facility decommissioning (amount of RAW arising from operation and decommissioning of this facility is negligible in the frame of these considerations) will take place approximately in 2080.

Analysis results from the document [3] had been successively developed in documents [4 - 6]. With regard to the fact that erection of a re-melting facility at GovCo (JAVYS) site is not recommended in the document [4, Annex E] from technical, environmental and mainly economic reasons, the conceptual study in the document [4] proposes, in the frame of PMU BIDSF Project No. C7- A (Treatment of metallic waste) [5], to prepare and erect large-capacity fragmentation and decontamination facilities for metallic RAW with the aim to release an equivalent amount of metallic RAW into environment after their decontamination, what has been supposed in the case of their re-melting. In addition, the document [4] also analysed further aspects of RAW management that had not been thoroughly analysed in the document [3] as follows:

- treatment of historical waste, sludge and sorbents [17],
- additional transportation means for liquid historical RAW from the V1 NPP to the existing treatment facilities,
- refurbishment of the radiation protection monitoring equipment,
- provision of suitable decontamination facilities,
- equipment for safe clearance of decommissioning materials [20],
- interim storage of RAW at the Bohunice site [18],

- enlargement of the national repository at Mochovce [19] in connection with planned the very low-level waste repository.

Above mentioned projects are supposed to be financed completely or partially from the BIDSF and their time schedule of preparation and implementation is planned in such a way so that it would be convenient for V1 NPP decommissioning schedule.

Document [6, in chapter 3] had identified and proposed further projects in the field of RAW management, decision on financing of which remains still open:

- technologies for historical solid waste retrieval,
- deep geological repository planning and implementation,
- provision of sufficient buffer storage places for decommissioning materials.

Similar analyses have not been elaborated for the Mochovce site, except the considerations about further operation and subsequent shutdown of NSR (2 km distant from the nuclear power plant). However, they have been elaborated for different reasons connected with the enlargement considerations [21].

2.1.2. *Systemic issues related to the erection of radioactive waste interim storage facilities and a final repository for high-level radioactive waste (including spent fuel) shall be resolved pursuant to the Resolution No. 5/2001 of the Government of the Slovak Republic. With respect to undesirable loads on future generations, postponement is unacceptable.*

Answer:

RAW storage at Jaslovské Bohunice site will be systemically resolved by interim RAW storage facility erection. Government of the Slovak Republic adopted Resolution No. 5/2001, in which it took cognisance of the "Proposal for economic, factual and time solution of spent fuel management and the procedure for decommissioning of nuclear power installations" and set, by the end of September 2001, to submit to the Government for discussion a "Concept of decommissioning of nuclear power installations and spent fuel management assessed in the sense of Act No. 127/1994 Coll. in the wording of later regulations". Subsequently, the Government of the Slovak Republic during its 159th meeting on 23rd May 2001 had postponed the date of fulfilment of this task until 31st December 2007. The document is being currently elaborated.

It is necessary to mention that the development of disposal into a deep geological repository lasts for several tens of years in an ideal case. Functional national programme for the development of disposal into a deep geological repository had been implemented in the Slovak republic in 1996 – 2001 period. This programme was interrupted by the decision of the management of Slovenské elektrárne, a.s. in 2001; financing of its continuation was not also recommended by the Council of State Fund for the Decommissioning of Nuclear Power Installations and Spent Fuel and RAW Management. At the present time, basically all states with nuclear power industry perform the activities either resulting in the implementation of the disposal into a deep geological repository (Finland, Sweden and USA) or in the expert support of a qualified decision (e.g. France, Switzerland, Japan, etc.). Solution of selected expert problems associated with the disposal into a deep geological repository is financed also in the cases of interruption of activities resulting in the implementation of the disposal into a deep geological repository due to public pressures (UK and Spain). However, new possibilities of regional or global disposal facilities or trans-mutational technologies do not mean cessation of the development of disposal into a deep geological repository on the national level in any case. In addition, trans-mutational technologies do not eliminate need for the disposal into a deep geological repository, but they affect inventory of radionuclides in disposed waste, safety features and costs for the disposal into a deep geological repository. The costs can be ultimately higher, because major part of the costs for research, development and implementation work concerning of a deep geological repository is fixed and independent on the amount of disposed waste. Approach to the long-term storage of all RAW and spent fuel (up to 100 years) is the part of waste management strategy in the only European state – the Netherlands. Details about these issues can be found in the document [22].

Raised requirement of a systemic character exceeds the possibilities on the side of proponent. It has to be solved on a governmental level and, of course, with the adequately financed expert support. The new Act No. 238/2006 Coll. on the National Nuclear Fund, which will come into force on July 1st 2006, may bring change of the approaches in this field.

Efforts of the proponent to solve this problem are also documented by arguments given in the previous item 2.1.1, explicitly by planning the construction of ISRAW at GovCo (JAVYS) site (EIA process successfully took place and the design preparation is being performed at the present time).

2.1.3. *Within the national system, an entity beyond the structures of the NPP operator and owner shall be established that would be responsible for radioactive waste and spent fuel management.*

Answer:

The raised conceptual requirement was included in the wording of Act No. 541/2004 Coll. (Atomic Act), where § 3, section (9) states: "Disposal of the radioactive waste or spent fuel can be performed, on the basis of authority permission, only by a legal entity independent from the producer of radioactive waste, established or founded by the Ministry of Economy of the Slovak Republic". The other paragraph says that this should take place till 2007. The fact is that the Ministry of Economy has not established or founded such an organisation yet. To support the implementation of this paragraph, the project financed by EC in the frame of PHARE programme: "Technical aid for the Ministry of Economy of the Slovak Republic for the establishment of national institution - Agency for the radioactive waste and spent fuel management", has been adopted and currently implemented. The new Act No. 238/2006 Coll. on the National Nuclear Fund for the Decommissioning of Nuclear Installations and Spent Fuel and RAW Management (Act on the Nuclear Fund) and on the amendment and supplementation of some acts will come into force on July 1st 2006. This act amended quoted statement of the Atomic Act by changing the term of establishment of this organisation to 2012.

The company **GovCo, a.s., Bratislava** was established and enrolled in the business register of the District Court Bratislava I on July 16th 2005 (at the present time, after a change in the business register as GovCo, a.s. **(JAVYS, a.s.)**, Jaslovské Bohunice). As a consequence of the privatisation of Slovenské elektrárne, a.s., this company has to perform these activities:

- A1 NPP decommissioning,
- V1 NPP operation and later decommissioning,
- storage of radioactive waste and spent fuel,
- operation of the facilities for RAW treatment and conditioning,
- provision of the centralised collection and further management with institutional RAW including used closed radiators,
- operation and later closure of the near-surface repository.

2.1.4. *The responsibility for the processing quality of packed radioactive waste shall be ensured by its separation from the responsibilities for radioactive waste final disposal in order to preserve a continuous pressure and supervision of the radioactive waste repository operator over the organisation treating the radioactive waste (see article 21 of MZV SR Official Notice No. 125/2002 Coll.).*

Answer:

In the future, this field will be solved similarly as nowadays, i.e. by the enterprise guidelines and quality management system in GovCo (JAVYS). Its solution in the future will depend on the organisational arrangement of the radioactive waste management, i.e. on a way of establishing the agency mentioned in the previous item.

2.1.5. *The issue of the necessity and duration of radioactivity monitoring in individual environmental components, after the last nuclear facility on the site is decommissioned, shall be resolved.*

Answer:

After finishing the decommissioning process of each NPP, a document (the final site report) will be elaborated in the sense of the Act of the Slovak National Council No. 541/2004 Coll., §20, item 6 and in the sense of § 35 – 38 of the NRA SR Decree No. 58/2006 Coll. containing the extent and duration of radioactivity monitoring in individual environmental components after completing the respective NPP decommissioning. The V1 NPP Conceptual decommissioning plan [6] contains an outline of the final site report in chapter 7. After completing the decommissioning of the last nuclear installation at the site, monitoring of environmental components will be still performed for a certain time period, which will have to be determined in the decision about *"removal from the coverage of Atomic Act"* (see below). To the mentioned, it is possible to consider now whether the *"removal from the coverage of Atomic Act"* is a synonym of the frequently used term *"release for the unrestricted use"*, or whether it will be preceded by the site monitoring phase or by activity limitation at the original site. In general, it is possible to expect the substantially lower frequency of measurement of substantially lower number of samples. It is possible that it will be analogy to the activity called *"active institutional inspection of the surface disposal repositories after their closure"*. If we take into account that the last nuclear facility decommissioning completion cannot be, at the present development, performed sooner than in the second half of this century, these general conceptual considerations are sufficient now. Appropriate decisions of involved regulatory authorities will be made on the basis of actual situation in that time and they will contain the exact factual, time and space definition of monitoring.

I.2 REQUIREMENTS OF A SPECIFIC CHARACTER FROM ITEM 2.3 OF THE SCOPE OF ASSESSMENT

2.3.1. *When selecting an optimal alternative for the V1 NPP decommissioning, technological and financial potentials as well as needs in relation to the other nuclear facilities at Jaslovské Bohunice and Mochovce sites shall be taken into account. The capacity and the technological potential of radioactive waste management shall be analysed, availability of technologies and funds needed for all the activities shall be assessed in time relation to the activities being performed at the other nuclear facilities at the given site.*

Answer:

Management of V1 NPP historical and decommissioning RAW (in the broadest sense of the word) and its relations to all other nuclear installations at JEK Bohunice site as well as its financing are commented in item 2.1.1 and partly in item 2.1.2.

The selection of the most suitable decommissioning alternative of V1 NPP is in accordance with assumptions accepted for the analysis, which is commented in item 2.1.1. From this point of view, substantial problems in the field of V1 NPP decommissioning RAW management and its relations to A1 NPP and V2 NPP decommissioning RAW management will not occur.

Financial arrangements of V1 NPP decommissioning in relation to the decommissioning of the other nuclear installations at JEK Bohunice site had been analysed in detail in document [3, subchapter 7.5] for IDO and SES decommissioning alternatives. Conclusion resulting from the analysis is that in view of financial arrangements, the V1 NPP IDO decommissioning alternative can be performed in parallel with the A1 NPP continuous decommissioning and with the deep geological repository development. Newly adopted Act on National Nuclear Fund should, besides other issues, ensure availability of sufficient amount of financial means at the time when the individual activities of the final part of nuclear power industry should be implemented on the basis of particular strategies.

2.3.2. *In individual decommissioning alternatives, requirements imposed upon the existence and capacity of radioactive waste management facilities shall be stated, without which meeting the time schedules for V1 NPP decommissioning could be considered unrealistic*

Answer:

See item 2.1.1. Overview of the amount and type of radioactive waste arising during decommissioning is presented in the Conceptual decommissioning plan [6]. Accordance of decommissioning time schedules on one hand and the existence of facilities for the waste management and their “permeability” in time on the other hand, is the condition for implementation [21]. All conceptual considerations in the Conceptual Plan and in this document issue from this accordance, i.e. it is assumed that all identified preparatory activities/projects for V1 NPP decommissioning including the projects associated with RAW management will be implemented in a timely manner.

2.3.3. *The solutions for occupational safety and health protection issues shall be described in accordance with NR SR Act No. 330/1996 Coll. on occupational safety and health protection as amended by Acts No. 95/2000 and 158/2001 Coll.*

Answer:

During V1 NPP decommissioning the aspects of occupational safety and health protection will be solved in a standard manner in all stages of decommissioning process: during designing, technical preparation and implementation in the field of general, technical/industrial and radiation safety of the employees. Safety documentation, which will be attached to the written application for authorisation for a particular stage of decommissioning, will thoroughly deal with these aspects. Issue of occupational safety and health protection of the employees is generally not the subject of EIA process. But, this aspect can represent one of criteria when selecting the most suitable alternative of given activity.

2.3.4. *Reliable monitoring of potential non-radioactive and radioactive pollution of the affected area shall be continued with stress being placed on thorough monitoring of ground water and surface water; this monitoring will be used as a basis for a more precise specification of potential environmental impacts of the V1 NPP decommissioning enabling to adopt relevant measures.*

Answer:

Reliable monitoring of potential non-radioactive and radioactive pollution of the affected area in V1 NPP surroundings with stress being placed on thorough monitoring of ground water and surface water is performed now and will be also performed during the decommissioning process itself. It can be anticipated that there will be no substantial changes in the current monitoring system of environmental components, if even only one nuclear reactor is operated at the site. It has to be noted again that the monitoring of environmental components under normal circumstances will not provide information, which could define more precisely anticipated development of V1 NPP decommissioning possible impacts, especially set against the background impacts of operated units. Such information will always be, first of all, the information obtained by measurements at the sources, i.e. monitoring of discharges.

There can be a different situation if the exceeding of investigation values (i.e. mostly higher than natural background) , respectively of intervention values of appropriate quantities will be detected by monitoring measurements (regulation of the Slovak Republic government No. 345/2006 Coll.). In such a case, this standard procedure is used:

- finding the origin of increased values and association with the operation or events at a source respectively,

- determination of the necessity of intervention is a part of investigation. When the investigation shows, in the sense of legislative provisions (§43 of the Slovak Government regulation No. 345/2006 Coll.), the necessity of intervention, the appropriate measures are performed:
  - first of all the measures at a source leading, in the sense of ALARA optimisation approaches, to the cessation/decrease of unplanned leakage of radioactive substances
  - determination of the necessity of intervention in the environment, i.e. performing the corrective measures in the environment also in the sense of ALARA optimisation approaches.

If, in the case of necessity, the corrective measures are performed, the continual re-evaluation of a particular monitoring system is made so that its results could confirm the correctness of decisions on corrective measures or correct these decisions. The example of such an approach is the ground water monitoring at the site and in its surroundings. After finding the contamination occurrence, its origin was found first of all. After it, such corrective measures were taken so that the leakage of radioactive substances was stopped/significantly reduced. Subsequently, the corrective measure in the environment (rescue pumping) was taken. More details are given in chapter 2.3.6.6.2.

2.3.5. *A thorough analysis of all the other comments issuing from the standpoints of individual participants of the review process shall be performed and the reasonable ones shall be taken into account in the assessment report.*

During the review process, **nine control and administration authorities** provided their standpoint in a written form to the Complex study of V1 NPP decommissioning, which was determined as the Intention in the sense of Act of NR SR No. 127/1994 Coll. on environmental impact assessment:

- Ministry of Economy of the Slovak Republic, department of power industry,
- Ministry of Health of the Slovak Republic, chief hygienist,
- Ministry of Environment, department of environmental risks, department of water protection, department of geology and environmental geo-factors and department of geological law and contractual relations,
- Nuclear Regulatory Authority, main inspector,
- National Labour Inspectorate, Bratislava,
- Regional Office, Trnava, department of environment, department of state building administration, state administration of water protection, air protection, waste industry and state administration of nature and country protection,
- Regional Directorate of Fire and Rescue Service, Trnava,
- District Mining Office, Bratislava,

- District Office Trnava, department of civil protection and defence, department of agriculture and forestry and department of transportation, ground communications and of other branch relations.

Common standpoint of **2 non-governmental organisations:** Energia 2000 (Energy 2000) and Energia 3.tisícročia (Energy of 3rd millennium) and **1 civil standpoint** of Ing.Ľ.Kupke-Šipošová were also delivered.

The standpoints of District Mining Office, Regional Directorate of Fire and Rescue Service and department of civil protection and defence and department of agriculture and forestry of the District Office Trnava did not contain any comments. The standpoints of state building administration and protection of nature and country of the Regional Office Trnava also did not contain any comments.

Department of transportation, ground communications and of other branch relations of the District Office in Trnava recommended to transport the radioactive waste preferentially by railway. This recommendation is accepted, but it will not be possible to avoid road transportation completely with regard to the character of waste and its destination. Transportation of waste packaged forms between TSÚ RAW Jaslovské Bohunice and NSR Mochovce was recently re-evaluated in order to optimise it. The result is the decision to use so called combined transportation, i.e. transportation from Jaslovské Bohunice site to Mochovce by railway with the subsequent local transportation by trucks (about 2 km). The proceedings leading to the issue of appropriate permission take place at NRA SR at the present time.

The standpoint of Ministry of Health of SR and Nuclear Regulatory Authority of SR emphasises the selection of decommissioning alternative; its optimisation has to be carried out on the basis of the consideration of technical, financial, ethical and social aspects and needs in relation to the other nuclear installations, consideration of technology availability, etc. NRA SR characterises submitted alternatives only as orientation ones. Defining the individual alternatives and environmental impact assessment as required by EIA Act together with the selection of the most suitable alternative is the principal goal of V1 NPP Conceptual Decommissioning Plan and of the submitted Assessment Report, which is based on the principles of Conceptual Plan. On the basis of information currently available, the process of estimation of the whole decommissioning impacts has to be burdened by a certain indefiniteness. These and similar objections can be omitted, because environmental impact assessment does not result in the decision, but in the recommendations that are taken into account during the decision-making process. From the point of view of decommissioning duration, it is not possible to exclude partial changes in approaches and used technologies in the course of decommissioning. Anyway, it can be stated that impact of NPP decommissioning on environment will be lower by orders than its operation (see Annex 2) and therefore it is not reasonable and environmentally justified to insist on uselessly detailed analyses of an impact, if this results in process delay without an adequate effect on the assessment process quality.

Ministry of Health of SR confirms the justification of V1 NPP decommissioning. On the other hand, it considers the assessment of individual alternatives and selection of the most suitable alternative as premature and impossible while having the conceptual matters open. Submitted Assessment Report represents another, more precise level of the systemic solution of the decommissioning of nuclear installations, in accordance with the requirements of MZ SR.

For the development of the Assessment Report in the environmental impact assessment process, comments of the National Labour Inspectorate are accepted, asking to mention legislative references to the occupational safety and health protection of the employees during a work in the particular parts of Assessment Report. In the stage of project and detailed organisational solutions of the processes of V1 NPP decommissioning, duties to elaborate dismantling and demolition procedures will be respected and new operational regulations of the facilities and buildings will be elaborated in a necessary extent in accordance with the regulations for occupational safety and health protection. On the other hand, it has to be stated that these issues are the subjects of other legislative regulations, which are not directly associated with the environmental impact assessment pursuant to the Act of NR SR No. 127/1994 Coll. in the wording of later amendments. See item 2.3.3 as well.

Method of continual evaluation of the filter condition in the sense of requirement of the Department of environmental risks of MŽP SR is the subject of operational documentation. The method used in nuclear installations cannot result in unplanned leakage of radioactive substances. Some other documents needed for the proceedings of regulatory authorities will have to be in accordance with the operational documentation;, they will be prepared for the first time in the frame of permission process of the first decommissioning stage.

According to the comments of Regional Office in Trnava, data on dump sites in JEK Bohunice surroundings (Žlkovce) and data on air pollution by non-radioactive pollutants in affected areas, including their correct classification are more precisely specified in the report. Also see the following report chapters: B II.1.1, B II.5.5 and C.II.4.5.3.

Assessment report as well as all current and future activities at the site respect the comments of the Department of water protection of MŽP SR and of the state administration of water protection of the Regional Office in Trnava concerning of the strict monitoring of surface and ground water quality and adherence to the decisions about waste water discharging from JEK Bohunice. More details are given in items 2.3.4, 2.3.6.6.2 and C II.4.4.

In the standpoints of MH SR and Department of environmental risks of MŽP SR, opinion is expressed that zero alternative is unacceptable and thus its analysis is useless. Non-governmental organisations and Department of geology and geo-factors of MŽP SR similarly recommend to restrict assessment to the alternative of continual decommissioning. The same opinion is expressed by the Department of environmental risks of MŽP SR. Comments of this type cannot be accepted. Recommendations in the standpoints are not supported by any factual argumentation. Scope of assessment requiring the analysis of all alternatives considered in the Intention is obligatory for the report elaboration. In addition, approach required in the standpoints would not comply with the items of the Decree of NRA SR No. 58/2006 Coll. Also see the initial consideration in item 2.3.6.

MH SR, department of power industry also requires organisational division of the treatment and disposal of radioactive waste and solution of the systemic issues of extremely long state supervision over the disposal facilities for radioactive waste and contaminated materials in its standpoint. This justified systemic requirement issuing from the practice of the countries with developed programme of nuclear power plants can however not be solved in the frame of environmental impact assessment. In this connection PHARE project has already been mentioned (see item 2.1.4), which is currently being implemented and which has to recommend the most suitable arrangements for radioactive waste management for the Slovak Republic (MH SR). As far as the institutional control of disposal facilities is concerned, Atomic Act provided the principal legislative frame for this problem.

Departments of geology and geological law of MŽP SR recommend not to postpone development of the conception of the decommissioning of nuclear installations and spent fuel management till 2007 and they point out a disputable step represented by the dampened programme of searching the suitable geological structures for a permanent disposal facility for high-level radioactive materials. These facts are also pointed out in the standpoint of the Department of environmental risks of MŽP SR. Development programme for the disposal into a deep geological repository is a systemic issue, which has got a relatively strong political dimension except the expert one. Also see the item 2.1.2.

Approval of the new Act No. 238/2006 Coll. on National Nuclear Fund makes it necessary to elaborate the given conception as soon as possible. It will represent one of the principal documents serving as the basis for a long-term release of the financial means from the fund.

Department of geology and geo-factors of MŽP SR required soil decontamination under V1 NPP in its standpoint. In this connection it is necessary to mention that in the sense of ALARA principle [23], corrective measures concerning the contamination of environmental components, where the required decontamination indisputably belongs, are subject to the optimisation. As far as soil is concerned, decontamination is not the only alternative at all.

When optimising the corrective measure in the sense of ALARA, it is issued from the maximum pure benefit of a given corrective measure (§43 of the Slovak Government regulation No. 345/2006 Coll.), i.e. decrease of the commitment of effective equivalent dose for an individual from a critical population group (respectively of collective dose), as a consequence of a given corrective measure, has to exceed the costs for a given corrective measure in the maximum possible extent. Soil decontamination itself is a relatively cost-demanding activity, therefore it is performed only in the cases when soil contamination is much higher by orders than in our case or its consequences could be higher by orders. Analysis of a convenient solution for the contaminated soil management is comprised in the document [24], which was elaborated in a time, when operators of the nuclear installations considered the construction of a dump site for contaminated soil at Bohunice site. The analyses demonstrated that only a small amount of soils had to be treated as radioactive waste. Separation of a small amount of more contaminated soils and their further treatment, conditioning and disposal identical with the radioactive waste management is currently being performed. As a consequence of the current experience and optimisation considerations, construction of a dump site for large amounts of low- level contaminated soils as a contingent corrective measure has been abandoned now.

Comments to the requirements presented in the standpoints of non-governmental organisations and citizens are given in a part devoted to fulfilment of the task 2.3.6 of the Scope of assessment.

2.3.6. Standpoints of Non-Governmental Organisations

Standpoints of non-governmental organisations represent approximately 3/5 of the overall scope of assessment. Presented standpoints are not argued in the document, they are presented as the requirements. They have some common features, which will be firstly dealt.

The first requirement is to deal only with an alternative of continual decommissioning. Disregard the fact that this requirement is at variance with the identification of the alternatives for further assessment (item 1 of the Scope of assessment), this requirement is not justified nowadays without giving the arguments. In contrast with some states, decommissioning method is not determined by legislation in the Slovak Republic. With the placement of a nuclear installation, Atomic Act requires to elaborate “application reports on the decommissioning method”, then the “preliminary conceptual decommissioning plans” and “conceptual decommissioning plans”, the last document is elaborated before the “planned shutdown of a nuclear installation for operation termination”. The main purpose of conceptual plans [6] is to assess the decommissioning alternatives for a given installation in an objective way, mostly by means of multi-criterial analysis and to select the most suitable alternative. Parameters for decision-making, which are analysed in the conceptual plans, have an internal character, i.e. the parameters issuing from anticipated decontamination and dismantling technologies, but there are also the parameters indicating the external impacts on decommissioning course, e.g. connection with the system of radioactive waste management in time, including RAW disposal, connections with the other nuclear installations at a given site, possibilities of financing from a particular account of the National Nuclear Fund. From the point of view of currently valid wording of the Atomic Act [8], Conceptual decommissioning plan is the part of Assessment report in the sense of EIA Act (see below). In the sense of approaches described in Atomic Act and EIA Act, decision about the alternative, which will be implemented, fully depends on the permission holder/proponent. It depends on this entity how the standpoints of the participants of the Report review process will be taken into account during this decision, including the standpoint of the Nuclear Regulatory Authority. Thus, required information is presented for all decommissioning alternatives.

Another substantial problem concerning of the standpoints of non-governmental organisations, is the detail rate of required information. A majority of existing information and information derived from it, is nothing else than an expert estimate. Information level of the data available nowadays is fully convenient for the purpose it should be currently used: preparation of a Conceptual decommissioning plan and the estimate assessing the environmental impact of decommissioning. For example, it is premature to deal with the radioactivity atlas in the nuclear power plant, which should inconsistently contain “total radioactivity inventory after removal of the fuel from the reactors” (it is required to present inventory nowadays, the last fuel will be removed in 2011) during the conceptual planning and environmental impact assessment. Another example is the requirement to present discharged amount of radioactive substances during the whole period of decommissioning already now. Required information will be presented below as it is considered at the present time.

2.3.6.1. Time Schedule, Status of the Buildings, Decommissioning Costs, Waste Balance

The first group of comments concerned of:

- Presentation of the time schedule of the activities concerning of the decommissioning, description of the activities and technological procedures.
- Status of individual buildings and facilities from the point of view of potential leakage of radioactive substances into the environment with presenting the corrective measures in a case that the barriers against leakage of radioactive substances are damaged.
- Financial costs for individual decommissioning activities, while it was requested to compare these costs with the costs for decommissioning of the nuclear power plants of the same type, mainly Greifswald NPP, then the comparison with the costs for zero alternative, inclusion of the inflation to the cost considerations and their risk analysis[1]
- Balance of materials and radioactive waste with the specification of further management.

Conceptual decommissioning plan deals with the mentioned issues in a relatively detailed way. It uses the existing information or expert estimates according to the current know-how. This document is elaborated in the frame of a separate project, because it was planned before coming the Act No. 541/2004 Coll. (Atomic Act) into force, similarly as the Environmental impact assessment report. Paragraph 20, section (2) of this Act states that the operation permission holder is obliged, before the planned shutdown of a nuclear installation for the operation termination purpose, to submit the documentation in accordance with EIA Act and to supplement it in such a way so that it complies with the requirements for Conceptual decommissioning plan. From the present point of view, V1 NPP Conceptual decommissioning plan becomes the part of V1 NPP Environmental impact assessment report. The above mentioned as well as further requirements will be solved by a referral to the particular parts of the Conceptual plan, if it is reasonable.

Answer to the above mentioned requirements can be firstly found in chapter 2 of the Conceptual plan called "Initial status of V1 NPP and input assumptions and data". In part 2.1 and annex to this part, all systems of the nuclear power plant are described in a detailed way, i.e.:

- systems of unit 1 and systems of unit 2 – primary part,
- systems of unit 1 and systems of unit 2 – secondary part,
- systems of unit 1 and systems of unit 2 – electrical part,

[1] As the term "risk analysis of the costs" was not specified in the requirements, we understand it as a consideration about the risk of insufficient amount of financial means for covering the decommissioning costs at a given time.

- common systems – primary part,
- common systems – secondary part,
- common systems – chemical part,
- common systems – electrical part,
- other common systems.

The status, to which the system has to get in the period between the reactor shutdown and the beginning of the first decommissioning stage was defined for each system, while three principal statuses are determined:

- the system is disabled,
- the system is modified,
- the system is operated as during power operation.

What concretely this category means for the individual systems is presented in Annex A to the chapter 2 of the Conceptual plan. The list of buildings that will not be decommissioned (or will be decommissioned only partially) is presented in the document for all decommissioning alternatives; these buildings serve for the whole site. In case of alternative 1 (so called accelerated continual alternative), buildings that can potentially serve for the construction of a new nuclear power source at the site, if such a decision is made in the course of decommissioning, still belong here. The buildings, which will not be removed, remain at the site and their future will depend on later conceptual decisions about the development of the whole site of nuclear installations in Jaslovské Bohunice.

Another part of chapter 2 is a detailed estimate of the balance of technological materials from the decommissioning of individual buildings with the following break-up: stainless steel, carbon steel, non-ferrous metals, other materials and balances of construction materials. Balances of radioactive materials are estimated in subchapter 2.4.

Chapter 3 of the Conceptual plan deals with the activities called as preparatory ones from the point of view of V1 NPP decommissioning in a detailed way.

It is important to note that the radioactive waste already arising during the operation was included in the calculation of radioactive materials located at the power plant at the beginning of decommissioning. However, these will be transported from the power plant for treatment and conditioning till the commencement of decommissioning (their management is not included in the decommissioning costs).

The document [6] contains description of all types of activities, which can be taken into account in the course of decommissioning. For the individual balanced materials it is estimated what part will be released into the environment[2], what part will be considered as radioactive waste or in which form a given waste will end up: either in the frame of standard disposal at NSR or if it is a very low-level radioactive waste[3].

It has to be underlined again that it is a conceptual plan, not a detailed activity plan. The purpose of estimate of balances and other parameters in the Conceptual plan is exclusively the support for making a decision about a decommissioning alternative.

Given parts of the Conceptual plan do not divide facilities of the radioactive part of the power plant from the point of view of "leakage of radioactive substances into the environment". From the philosophical point of view, it can be stated that the aspect of prevention of radioactivity leakages into the environment was decisive during the design, construction, operation and refurbishment of all systems of the radioactive part of the power plant. In a simplified way, the main barriers against the leakage during the normal operation are:

- fuel cladding,
- primary circuit,
- hermetic areas and ventilation system with filters,
- system for trapping of radioactive water to the special sewage and the system for its further management.

Other safety systems and equipment, primary task of which was to prevent leakage of radioactive substances into the environment (their improvement was one of the goals of refurbishment work at the power plant) serve for the adequate technological and technical – organisational reaction to an abnormal situation that could occur during the operation and which is represented by "designed maximum operational accident".

V1 NPP decommissioning can be commenced after granting the permission for decommissioning and, in a simplified way, it is characterised by the condition when all spent fuel is removed from the power plant and primary circuit is contingently decontaminated and shut down (i.e. empty). Therefore it is irrelevant to deal with fuel cladding, primary circuit and the systems for coping with the maximum design operational accident, when assessing the barriers against leakage during the decommissioning. Hermetic areas with the ventilation system and the system for trapping and subsequent treatment of waste water will be operated during the decommissioning like during the operation, but they will be adjusted to concrete work conditions. For example, it is anticipated that for some kinds of work, local exhaust connected to the central ventilation system will be installed.

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[2] The term "release into the environment" is used as the equivalent for English "clearance from regulatory control" in the Slovak legislative regulations, what means release of (radioactive materials) from the control of a regulatory authority. In our case, release into the environment means not only disposal of non-radioactive materials to a dump site, but also e.g. recycling at the salvage or recycling of construction materials.

[3] This type of radioactive waste is defined as a waste, radioactivity of which enables to dispose of it under economically more advantageous conditions (e.g. without currently used containers, to the "trench" type disposal facilities, etc.). Its radioactivity range will depend on concretely selected site and method of disposal. Worldwide, such a waste is disposed in separate disposal facilities of "trench" type (France, Spain) or at dump sites for non-radioactive waste of higher engineering classes (England) or directly at the site of a nuclear installation, where it was generated (Sweden, Japan). For the preliminary considerations in our country, maximum radioactivity of very low-level waste was determined as a hundred-fold of release levels for the release into the environment.

Detailed description of loss of hermetic tightness (when and which method) and the subsequent demolition of hermetic areas, of ventilation system dismantling and removal of special sewage will be the subject of documentation for granting the permission for the subsequent stage of decommissioning. This documentation will be elaborated in such a way so that the permission for the first stage of decommissioning will be granted before its intended commencement, i.e. before 2012.

Estimate of financial costs for the individual activities associated with decommissioning is one of the key problems solved in the Conceptual plan. In order to clarify and unify the procedures for calculation of decommissioning costs, the Proposed standardised list of items for costing purposes [11] was published in the late nineties of the last century. Estimates in the Conceptual plan are based on the items of this list. Four cost components are defined for each cost item: labour costs, investment costs, expenses and contingency. Chapters 2 and 3 of the Conceptual plan and mainly the whole chapter 5 deal with the estimation of decommissioning costs.

Chapter 5 contains the considerations in its conclusion, if the calculated decommissioning costs can be covered from the particular state fund on the basis of Act No. 254/1994 Coll. on the State Fund for Decommissioning of Nuclear Power Installations and Spent Fuel and Radioactive Waste Management and its two amendments (No. 78/2000 Coll. and No. 560/2001 Coll.) valid at the time of its elaboration. Considerations about the generation and spending of financial means in the Fund at that time dealt with the problem of financial coverage of the final part of nuclear power industry globally, i.e. not from the point of view of a partial decommissioning of the only power plant. Their common conclusion was the fact that in case of existing system of generation and spending of financial means, the Fund will not be able to cover everything necessary as expressed in the wording of the act ("use of the Fund financial means"). The main reason was a long-term ignorance of the problem of so called historical debt concerning of the contributions to the Fund from the state, i.e. the fact that generation of the Fund financial means does not compensate period of the operation of nuclear power plants in the Slovak Republic before 1994, when the owner of the power plants was not forced to accumulate financial means for the "costs of future periods" and he actually did not do it. Balance of the Fund is even worse due to the political decision about the premature V1 NPP shutdown, because the contributions to the Fund are derived from generated and sold electrical energy. Even relatively high contributions from BIDSF, which has been established by the European Bank for Reconstruction and Development on the basis of political decision, do not represent a systemic solution: these are not the financial contributions to the State Fund for the "costs of future periods", but only reimbursement of the concrete projects in the stage of decommissioning preparation (see chapter 3 of the Conceptual plan). Considerations about the generation and spending of the Fund financial means brought several suggestions, how to cope with the historical debt. Way of resolving the historical debt is just one of the key parts of a new Act No. 238/2006 Coll. on the National Nuclear Fund.

As far as the aspect of inflation is concerned, it is a part of considerations in the strategic documents dealing with the generation and spending of financial means from the State Fund. We note once again that the financial considerations in the Conceptual plan are also based on the aspect of selection of the most suitable decommissioning alternative. This is the reason why these considerations do not deal with inflation.

2.3.6.2. *Comparison of the Costs with the Decommissioning Costs for Similar Power Plants Worldwide*

In another group of requirements, it is emphasised to compare the decommissioning costs with the costs for Greifswald NPP decommissioning and of other "similar nuclear power plants with pressure water reactors". However, it is necessary to take the assessments, examples of which are quoted below, critically and carefully, because:

- these are always the estimates, which gradually change with the increasing amount of information on a given NPP or with the modification of strategic intentions of a state;
- in spite of the fact that the first significant step resulting in a clearer and unified estimation method (publishing of the mentioned PSL) was taken, method of the calculations is still not unified and in addition, values of individual PSL parameters considerably differ in this initial stage in different states;
- various aspects are included in the calculations, which are even not considered in other cases, e.g. the costs for transfer of spent fuel from the existing ISFSF to the Castor storage containers in a newly built storage facility in Greifswald NPP;
- a period of several years elapses between the preparation of quoted documents and their publishing.

The last of the documents, which makes efforts to find unified approaches to the calculations for generation and spending of the financial means in the funds is the IAEA document [25]. A part devoted to the cost estimation issues from PSL and it summarises the methods of cost estimation currently used. It distinguishes among order estimates, budget estimates and definitive estimates according to the purpose of cost estimation and time, when the estimation was elaborated. In an ideal case, the estimation usually differs from the correct values in the range from –30% to +50% in the first case and –5% to +15% in case of definitive estimation.

Another document, which deals with the comparison of costs is the NEA/OECD document [26]. On the basis of the data gained from the questionnaires, this document compares costs for the decommissioning of PWR type power plants as well as the cost estimations for the decommissioning of WWER type power plants – see the following tables.

Table 1: Cost estimation for the decommissioning of PWR type power plants.

State	*Name of the power plant*	*Installed power [MW_e]*	*Total costs*	
			USD mill.	*USD/kW_e*
Immediate decommissioning				
Belgium	Doel 1,2	412 x 2	280	340

State	*Name of the power plant*	*Installed power [MW_e]*	*Total costs*	
			USD mill.	*USD/kW_e*
	Tihange 1	1009	213	212
Germany	Ref. PWR	1200	315	262
Italy	Trino	270	245	909
Slovenia	Krško	707	332	479
South Africa	Koeberg	944 x 2	317	168
Spain	Ref. PWR	1000	166	166
Sweden	Ringhals 2	917	85	93
Switzerland	Beznau	370 x 2	259	341
	Gösgen	1020	238	234
USA	Haddam Neck	587	452	769
	Maine Yankee	900	379	421
	Trojan	1155	296	256
	Zion	1085 x 2	904	417
Deferred decommissioning				
Brazil	Angra 1	657	198	301
	Angra 2	1350	240	178
France	Ref. PWR	1070 x 58	13973	225
Germany	Ref. PWR	1200	331	276
Japan	Tsuruga 2	1160	470	405
Netherlands	Borssele	481	168	348
Slovenia	Krško	707	152	216

Table 2: Cost estimation for the decommissioning of WWER type power plants.

State	*Name of the power plant*	*Installed power [MW_e]*	*Total costs*	
			USD mill.	*USD/kW_e*
Immediate decommissioning				
Finland	Loviisa	510 x 2	166	162
Slovakia	EBO	430 x 2	273	317
Deferred decommissioning				
Armenia	Metsamor	408 x 2	225	276
Bulgaria	Kozloduj	440 x 2	377	429
Czech Republic	Dukovany	404 x 4	383	218
Hungary	Paks	467 x 4	740	396
Russia	Novovoronez	288 x 2	291	506
Ukraine	Ref. VVER	1000	319	319

The third document, which was available in the time of preparation of this report, was the comparative study of the costs for the decommissioning of WWER type power plants [27]. The document summarises the knowledge gained from all states operating this type of power plants in 1998 – 2002 period. The conclusion in this study brings the comparison of costs based on PSL method for 11 main groups of items and for 2 principal types of decommissioning approaches: immediate decommissioning, decommissioning with the enclosure under surveillance.

Table 3: Costs for the decommissioning of WWER type power plants – immediate decommissioning

Main item number	Name of PSL group	Costs in USD mill./1998					
		Armenia 440/270	Germany 440/230	Slovakia 440/230	Finland 440/213	Hungary 440/213	Slovakia 440/213
01	Decommissioning preparation	a)	29.4	7.4	7.4	9.2	7,4
02	Operation termination	4.1	490.8	3.1	31.4	58.3	3,1
03	Provision of general equipment and materials	4.0	10.9	7.2	8.2	9.4	7,2
04	Dismantling	28.0	197.0	53.4	93.0	100.1	59,1
05	Waste management	53.3	498.1	106.9	42.7	262.1	113,3
06	Physical protection, surveillance and maintenance of the site	14.7	53.7	22.5	8.0	15.8	22,5
07	Demolition of the buildings, restoration, cleaning and landscaping of the site	25.0	14.5	75.1	n.r.	94.1	97.7
08	Project management	19.2	17.5	34.0	6.0	26.4	34.0
09	Research and development	a)	0.0	6.2	n.r.	2.6	6,2
10	Fuel and nuclear materials	34.0	58.0	n.r.	11.0	26.9	n.r.
11	Other	0.2	n.a.	11.2	11.5	27.2	11,2
Total		212,5	1369.9	327.0	219.2	632.1	361.7

a) in 08.0200 item
n.a., n.r. – not estimated, not solved

Higher costs by order for the decommissioning of the German power plant are explained by:

- post-operational activities and activities associated with the operation of the site till the project completion, starting with the unplanned final shutdown of the power plant,
- construction and operation of the above mentioned interim storage facility, treatment of operational waste and costs for waste disposal,
- costs for fuel removal from NPP units and its storage in CASTOR containers,
- higher labour costs in comparison with the other states in the study.

Table 4: Costs for the decommissioning of WWER type power plants – decommissioning with the enclosure under surveillance

Main item number	Name of PSL group	Costs in USD mill./1998									
		Armenia	Bulgaria	Russia	Slovakia	Czech R.	Finland	Hungary	Russia	Slovakia	Ukraine
		440/270	440/230	440/230	440/230	440/213	440/213	440/213	440/213	440/213	440/213
01	**Decommissioning preparation**	a)	18.7	20.6	7.4	1.5	7.4	9.2	20.6	7.4	3.4
02	**Operation termination**	4.1	27.1	b)	3.1	2.7	24.8	53.6	b)	3.1	6.9
03	**Provision of general equipment and materials**	4.0	5.0	n.a.	7.8	3.4	8.2	10.0	n.a.	7.8	6.8
04	**Dismantling**	28.1	151.9	165.2	55.4	14.9	83.0	83.0	148.7	61.3	27.9
05	**Waste management**	47.6	10.7	13.6	86.0	17.3	40.0	84.1	13.6	92.6	136.5
06	**Physical protection, surveillance and maintenance of the site**	24.1	47.3	b)	24.4	70.3	69.0	45.5	b)	24.4	13.0
07	**Demolition of the buildings, restoration, cleaning and landscaping of the site**	25.0	72.0	38.5	75.1	95.4	n.r.	94.1	34.6	97.7	6.8
08	**Project management**	90.8	10.5	b)	34.0	b)	7.0	28.3	b)	34.0	5.6
09	**Research and development**	a)	n.a.	9.5	6.2	4.2	n.r.	2.1	9.5	6.2	2.0
10	**Fuel and nuclear materials**	34.0	10.8	c)	0.0	0.0	11.0	26.9	c)	0.0	n.a.
11	**Other**	0.8	5.1	25.6	11.2	0.2	17.1	32.2	23.0	11.2	65.9
Total		258,4	359.1	273.0	310.6	209.9	267.5	469.0	250.0	345.6	274.8

a) included in 08.0200 item
b) included in total sum, but not specified here
c) included in item 01
d) in case of Bulgaria, items 03, 05, 08 and 11 formally continue for the final shutdown, preparation for the enclosure under surveillance and partially for the enclosure under surveillance
e) in case of Russia, waste treatment is also included in item 04

2.3.6.3. Radioactivity Inventory in V1 NPP After its Shutdown

The standpoint of non-governmental organisations also comprises the requirement to elaborate radioactivity atlas, which should contain total radioactivity inventory of the power plant as well as inventory of individual buildings, groups of equipment and of individual equipment with the specified radionuclides. Finding out the actual condition of contamination at the power plant within this report or within the Conceptual decommissioning plan has not been considered. Knowledge of this condition has to enable correct planning of the first decommissioning stage. Therefore the separate project financially covered by BIDSF was formulated in order to create database of all relevant quantities, including the required ones. The project should be implemented in autumn 2006 and completed in January 2008. Detailed data on V1 NPP contamination will be available after this term. Creating of the inventory will have a substantial influence on detailed planning of decommissioning of individual buildings and equipment, i.e. on the exposure of personnel, who will perform appropriate activities. Thus, it will provide input information for the elaboration of appropriate parts of the safety documentation before the permission of the first decommissioning stage. More detailed knowledge of radioactivity inventory at the power plant will basically not influence environmental impact assessment in the surroundings; it is given by discharges, method of their determination and subsequent check-up.

Current status of the knowledge about internal contamination of the buildings and equipment of V1 NPP is presented in the Conceptual decommissioning plan, concretely in its chapter 2 called "Initial status of V1 NPP and input assumptions and data". The second chapter of this part, respectively its subchapter 2.4 presents tabular information on contaminated equipment and on the equipment with induced activity respectively, which are the input data for considerations about further activities: need and method of pre-dismantling decontamination, estimation of dose commitments during individual decommissioning activities. Another part deals with the estimation of material flows from decommissioning, i.e. it is estimated for various materials, which part should be disposed as radioactive waste and in which concrete form, which part should be released into the environment, etc.

2.3.6.4. Discharges and Assessment of Discharge Impact on Environment and on the Population

Another group of objections and comments in the standpoints of non-governmental organisations concerns of the discharges from nuclear installations at the site as well as their prognosis for the decommissioned power plant separately. It is also required to explain the method of calculation of effective dose equivalents for the population in the surroundings of the nuclear installations at the site, including the presentation of calculation parameters and development of effective dose for the population in time. It is required to present effective dose equivalents from V1 NPP decommissioning separately. The given quantities represent own impact of operated or decommissioned nuclear installations on the environment, therefore we will deal with the problem of discharges and their consequences in a greater detail at this place.

Radioactive discharges resulting from operation and decommissioning will be the most important ones for environmental impact assessment. Except them, nuclear installations also discharge non-radioactive components, especially in liquid form. These discharges are subject to the same regulations and mechanisms as in the case of discharges from non-nuclear industrial technologies. For the stack of BSC RAW, the following substances are limited and monitored in gaseous discharges:

- nitrogen oxides,
- sulphur dioxide,
- carbon monoxide

and other pollutants like HCl, HF, heavy metals, etc.

For gas boiler plants currently belonging to GovCo (JAVYS), the following substances are limited and monitored in gaseous discharges:

- solid pollutants,
- total organic carbon (the limit is not established, but it is subject to a charge),
- carbon dioxide, sulphur dioxide and nitrogen oxides.

Problem of radioactive discharges is legislatively covered firstly by the regulations on health protection currently derived from recently approved Act No. 126/2006 Coll. on Public Health and on the amendment and supplementation of some acts. This act will come into force on June 1st 2006 and it also supersedes Decree of MZ SR No. 12/2001 Coll. on requirements for radiation protection to this date. In the sense of above mentioned act, Public Health Authority of the Slovak Republic issues the "permissions for release of radioactive substances into the environment" (§5, section (7), letter b) and §25, section (4)). This act also adopted the guideline of the Council of Europe No. 96/29/EURATOM dated May 13th 1996, which establishes the basic safety standards for health protection of the workers and population against the dangers arising from ionising radiation (ES L 159, June 29th 1996), articles 1 to 5, article 24, 41 and 51. It also anticipates issue of the whole series of governmental resolutions including the field of protection against undesirable effects of ionising radiation – the regulation has been recently adopted as the governmental resolution No. 345/2006 Coll.

Another group of regulations concerning of the issues of discharge limiting is represented by the regulations on nuclear safety. Atomic Act defines "limits and conditions for safe operation or decommissioning" as a "document, which contains admissible values of the parameters of equipment of a nuclear installation, defines its operational modes or decommissioning modes". Every note about the aspects of radiation protection in Atomic Act and its execution decrees (namely No. 50/2006 Coll., which establishes the details of requirements for nuclear safety of nuclear installations in the course of their placement, design, construction, commissioning, operation, decommissioning and disposal facility closure as well as the criteria for classification of selected equipment to safety classes and No. 58/2006 Coll., which establishes details of the extent, content and method of development of the documentation for the nuclear installations necessary for individual decisions) is solved by referral to the radiation protection regulations. In practice, the operator sends application for permission and the Public Health Authority will issue particular permission decision in case of positive standpoint. This decision is one of the bases for the proposal of a particular limit and condition for its approval by NRA SR.

The third group of regulations indirectly concerning of discharges is represented by the statements of the Governmental Resolution No. 296/2005 Coll., which establish the requirements for quality and qualitative goals of surface water and limit values of the parameters of waste water and special water pollution are still valid. This resolution brings "admissible degree of pollution" of surface water also for the following quantities in its Annex No. 1:

- total alpha mass activity – 0.5 Bq/l,
- total beta mass activity – 1 Bq/l,
- tritium mass activity – 1000 Bq/l.

Governmental resolution No. 345/2006 Coll. in item I.2 of its Annex No. 3 (Criteria for release of radioactive substances into environment) states:

"It is possible to discharge radioactive substances from the nuclear installations into the atmosphere and ground water, if it is ensured that effective doses in a particular critical population group do not exceed 250 μSv per one calendar year as a consequence of these discharges. This value is considered as a limiting dose for the design and construction of nuclear installations. If there are more nuclear installations at one site affecting doses of individuals in the same critical population group, this value relates to total exposure from all nuclear installations at a site or region. "

The value of 250 μSv is divided into 200 μSv of gaseous discharges and 50 μSv of liquid discharges, what is generally consistent with the approaches in other states operating the nuclear power plants. This value represents ¼ of annual limit for an individual from the population. It was originally the result of optimisation analysis on condition that total installed power of NPPs at a given site does not exceed 6000 MW (i.e. it was originally not a value for the site, but for individual nuclear power plants at the site). For example, the highest design values of normalised discharges from a stack per year per 1000 MW of nominal power corresponded to the determined limit of effective dose equivalent under conservative (i.e. not site-specific) assumptions in a previous time [28]:

- mixture of noble gases 6700 TBq,
- ^{131}I (gaseous and aerosol phase together) 0.13 TBq,
- mixture of short-term radionuclides 2.7 TBq,
- mixture of long-term radionuclides 0.2 TBq.

At the present time, the same approach principally applies to the limitation of discharges from nuclear installations as the one used during their designing. If needed, the discharge limits are re-evaluated or modified in an expert way, also using newer approaches, which issue from a limiting dose for an individual from the critical population group and which have also been recently established in a legislation (see above). This happens if the number of discharge places at the site changes or if the entity of owner or operator of the individual nuclear installations at the site changes. This is just the case of Jaslovské Bohunice site.

<u>Gaseous discharges</u>

All formulations of limits and conditions of nuclear installations have as the goal to achieve annual commitment of effective dose equivalent for an individual from a critical population group not higher than 200 µSv. Own limits distinguish between the following two types:

- Balance values, which are determined in the quantities of annual discharges. These quantities are monitored by so called balance monitoring, the main task of which is to provide actual data for annually repeated calculations of actual commitment of effective equivalent dose for an individual from critical population group.
- Reference values, which do not have direct relation to the above mentioned dose limit. They serve as the bases for identification, investigation and contingent intervention at a source, from which the discharge comes. Quantities of the radioactivity of radionuclides per time unit (day or week in case of gaseous effluents) or mass activities are used. They have three levels: registration, investigation and intervention ones. The values of quantities themselves were created by expert assessment of appropriate fractions of balance values taking into account type of nuclear installations as well as possibilities of the devices used for so called signal monitoring in this case.

The above mentioned facts can be illustrated on the example of nuclear installations in Jaslovské Bohunice. Public Health Authority established the following annual limits of gaseous discharges for the whole site in its appropriate permission:

a)	noble gases	4000 TBq
b)	^{131}I (gaseous and aerosol form together)	0.13 TBq
c)	mixture of radionuclides with a long half-time in aerosols	0.16 TBq
d)	^{89}Sr and ^{90}Sr in aerosols	0.3 GBq
e)	mixture of selected transuranic elements emitting α-radiation	0.05 GBq.

In principle, it is apparent that the first two limits can only concern of operated nuclear units, the other three ones should be common for all nuclear installations at the site. The share of other nuclear installations is in fact reflected by balance values established additionally for the facilities of GovCo (JAVYS), specifically to the considered composition of the discharges:

I. for the ventilation stacks “at A1 NPP site”:
   a) mixture of radionuclides with a long half-time emitting βγ-radiation, in aerosols: 0.94 GBq
   b) mixture of radionuclides emitting α-radiation, in aerosols: 0.0088 GBq

c) ^{89}Sr and ^{90}Sr in aerosols: 0.027 GBq

II. for ISFSF stack:

a) mixture of radionuclides with a long half-time emitting βγ-radiation, in aerosols: 0.3 GBq

It is necessary to mention that the particular limits will have to be changed in a similar way at the commencement of decommissioning of currently operated power plants, therefore in the case of V1 NPP as well. Stricter limits for A1 NPP and ISFSF could be represented by the values optimised at the source in an expert way.

The last event in the development is the decision of the Department of radiation protection of the Public Health Authority, which reacts to the fact that the operated V1 NPP is transferred to GovCo (JAVYS) company as the consequence of privatisation decisions. While there were the common limits of discharges for both nuclear power plants (V1 and V2 NPPs – see the data above), after V1 NPP takeover by the joint stock company GovCo (JAVYS), there will be, in the sense of appropriate decision, the separate balance annual limits of gaseous discharges for this NPP till the end of 2008:

a)	noble gases	2000 TBq
b)	^{131}I (gaseous and aerosol form)	0.065 TBq
c)	mixture of radionuclides with a long half-time in aerosols	0.08 TBq
d)	^{89}Sr and ^{90}Sr in aerosols	0.14 GBq
e)	mixture of selected transuranic elements emitting α-radiation	0.02 GBq.

These values do not concern of the limit values mentioned above. They are the final result of the division of nuclear installations of the site between two entities – operators. If we compare above mentioned values, we can basically say that V1 NPP balance values are, in a considerable extent, the balance values for GovCo (JAVYS) entity: this is completely true for noble gases and ^{131}I (as it was mentioned sooner, these nuclides are generated only during the operation of nuclear power plants) and partially true for the other items: the limits of other GovCo (JAVYS) facilities represent 1.25% of the V1 NPP limit for βγ-aerosols (isotopic composition will probably be different), 19% for ^{89}Sr and ^{90}Sr in aerosols and 44% for the mixture of selected transuranic elements (concretely: ^{238}Pu, $^{239+240}Pu$, ^{241}Am) emitting α-radiation.

It has to be realised that GovCo (JAVYS) currently leads away its gaseous radioactive discharges by five stacks (A1 NPP main production building + bituminisation plants, BSC RAW, ISFSF, building 44/10 – water treatment station, V1 NPP). Out of them, only V1 NPP and ISFSF stacks have the own limits of gaseous discharges established and the other ones are identified for “the ventilation stacks at A1 NPP site”. Due to the initiative of NRA SR, the following division of limits was suggested: for A1 NPP stack (+ bituminisation plants) – 90% of the limit for the stacks at A1 NPP site and for the stacks of other technologies for treatment and conditioning of waste – 10% of the limit for the stacks at A1 NPP site.

Reference levels of gaseous discharges for the whole site are determined as follows:

	Registration level	*Investigation level*	*Intervention level*
Noble gases [Bq/day]	$1.1 \cdot 10^{12}$	$3.3 \cdot 10^{12}$	$5.5 \cdot 10^{13}$
^{131}I (gaseous form) [Bq/day]	$3.6 \cdot 10^{7}$	$1.07 \cdot 10^{8}$	$1.8 \cdot 10^{9}$
Mixture of radionuclides with a long half-time in aerosols [Bq/day]	$4.4 \cdot 10^{7}$	$1.32 \cdot 10^{8}$	$2.2 \cdot 10^{9}$

These values basically determine the method of monitoring of gaseous discharges in the stacks of operated power plants. Weekly discharge limits are determined for A1 NPP and ISFSF.

I. for A1 NPP ventilation stacks:

   a) mixture of radionuclides with a long half-time emitting βγ-radiation, in aerosols: 90 MBq

   b) mixture of radionuclides emitting α-radiation, in aerosols: 0.85 MBq

II. for ISFSF stack:

   a) mixture of radionuclides with a long half-time emitting βγ-radiation, in aerosols: 50 MBq

Investigation level of 10 Bq/m^3 for the summary βγ radioactivity in aerosols is also determined for these stacks.

The requirements for monitoring of gaseous discharges, i.e. for the provision of monitoring devices (see below) result from the established limits. For the needs of annual assessment of the impact of discharges on population dose load, the following quantities are measured except the above mentioned ones:

a) amount of discharged air,

b) for the discharges from operated nuclear power plants - radioactivity of radionuclides in aerosols detected by gamma spectrometric analysis, radioactivity of ^{238}Pu, $^{239+240}Pu$, ^{241}Am detected by alpha spectrometric analysis and radioactivity of tritium and ^{14}C,

c) for the discharges from other GovCo (JAVYS) facilities - radioactivity of radionuclides in aerosols detected by gamma spectrometric analysis, radioactivity of ^{238}Pu, $^{239+240}Pu$, ^{241}Am detected by alpha spectrometric analysis.

The measurements performed for balancing and assessment of population dose load are performed by means of certified measuring devices, which are verified by the state metrology authorities in the sense of metrological regulations. This fact can be understood as the response to the objections of namely the non-governmental organisations, which object to the incredibility of the measurements at a source. These measurements are used as the bases for the estimation of discharge impact on the environment.

Liquid effluents

Water management authority for Jaslovské Bohunice area - the Regional Office of Environment determined the maximum annual amount of discharged water and a series of limit values of waste water parameters, which must not be exceeded due to discharges, i.e. they have to be monitored. The following quantities are concerned:

- oxygen biochemical consumption – BSK_5,
- oxygen chemical consumption detected by chromate – $CHSK_{Cr}$,
- insoluble substances – NL,
- soluble substances – RL,
- ammonia – $N\text{-}NH_4$,
- nitrates – $N\text{-}NO_3$,
- sulphates – SO_4^{2-},
- chlorides – Cl^-,
- non-polar extractable substances – NEL,
- total phosphates – $P_{celk.}$,
- iron – Fe,
- hydrazine hydrate – N_2H_4,
- detergents – PAL,
- acidity/salinity – pH.

Approach to the liquid radioactive discharges is basically identical as to the gaseous discharges. However, there is a principal difference: the whole site has the only common discharge place for discharging into Váh River, i.e. into Drahovský canal as well as for discharging into Dudváh River. Amount of water coming from the purification of radioactive water discharged into Dudváh River is practically negligible in comparison with the amount of water discharged via SOCOMAN piping into Váh River (the piping is emptied into the drainage canal of Madunice power plant).

Specificity of the system in Jaslovské Bohunice is the contribution of water coming from rescue pumping of ground water at A1 NPP site. Ground water at the site is contaminated; underground storage tanks of radioactive water (building 41) and other underground storage areas (building 44/20) were identified as the sources. The principal reason of contamination is the construction and operation of the tanks and storage areas corresponding to the safety approaches used in the sixties and seventies of the last century (corrective measures directly at the contamination sources were or are being carried out). Decision about the implementation of the corrective measure in the environment –

ground water pumping as well as the permission of pumping from the side of water management authority was primarily substantiated by the comparison with the values of contamination intervention levels given in the document of Slovak Commission of Environment, where the standpoint/ recommendation for the assessment of the enterprise area/site for needs of privatisation was expressed (Methodical instruction of the Ministry for Administration and Privatisation of National Property of the Slovak republic and of MŽP SR dated December 18th 1997, no. 1617/min. explaining the procedure for evaluation of the enterprise commitments from the point of view of environment protection in a privatisation project submitted by the enterprise in the frame of privatisation). Intervention levels are 5000 Bq/l for tritium, 2.0 Bq/l for ^{137}Cs and 1.0 Bq/l for ^{90}Sr. Chapter C.II.4.4.4 of this report deals with the contamination of ground water at Jaslovské Bohunice site and in its surroundings and its consequences in a greater detail.

From the point of view of total balance, situation in water discharging can be illustrated e.g. with the data from 2005: total liquid discharges from the site into Váh River had approximately 10 million m^3 volume (about 60% of the limit of water management authorities). Out of this amount, only about 219 thousand m^3 were represented by water, which could principally contain radioactive substances coming from the operations of nuclear installations. About 86% (i.e. about 188 thousand m^3) of this amount was represented by water from the mentioned rescue pumping of ground water from the borehole at A1 NPP site. It has to be noted that the whole volume of low-level radioactive water was exclusively discharged via SOCOMAN piping to Váh River in the last years. Also see the chapter B.II.2 of this report.

In Jaslovské Bohunice, water from two branches is collected to a common collector with a common inspection and monitoring place (building 614): one branch represents water drainage from V2 NPP, the other one from V1 NPP and other GovCo (JAVYS) installations.

Water from the sewage system is carried away to GovCo (JAVYS) branch, which is divided again into V1 NPP branch and branch of other installations, where it is monitored. The whole discharge of low- level radioactive water takes place in a following way: “collection tank – taking of samples and their measurement – discharge permission”, while the water is measured continually or quasi-continually according to the appropriate limit values (see below) during the discharging.

Liquid discharges from GovCo (JAVYS) installations other than V1 NPP, which are finally emptied into SOCOMAN piping, come from the buildings 41, 28, 30, 44/10, 808 of original SE VYZ and they are emptied into a retention tank. Liquid discharges from the building 808 are continually monitored at the inlet to the retention tank. Continual monitoring of water is also ensured at the outlet from the retention tank. Liquid discharges are led away from building 809 directly via a continual monitor. All liquid discharges from the site of original SE VYZ (i.e. GovCo (JAVYS) except V1 NPP) are continually monitored by two monitors (VYZ 1, VYZ 2) ahead of the connection with V1 NPP water. Before the pumping of the content of collection tanks, sample is taken, in which the mass activity of beta/gamma corrosion and fission products and tritium mass activity are detected.

Another check-up of water mass activity follows at Jaslovské Bohunice site:

- in a measurement building common for GovCo (JAVYS).

The following annual balance values of radioactivity are established for discharging into Váh River:

- tritium: 43.7 TBq,
- "other fission and corrosion products": 38 GBq.

The values lower by two orders are valid for discharging into Dudváh River via Manivier canal. These values were obtained by a project method, in a similar way as in case of gaseous discharges. In the past, annual balance values of discharges were established separately also for original SE VYZ branch (i.e. GovCo (JAVYS) without V1 NPP nowadays). For discharging into Váh River (SOCOMAN), the values were as follows:

- tritium: 10 TBq,
- fission and corrosion products: 12 GBq;

For discharging into Dudváh River (via Manivier canal), the values were as follows:

- tritium: 37 GBq,
- fission and corrosion products: 0.12 GBq.

Separate annual balance values for liquid discharges from V1 NPP have been recently established by the decision of state regulatory authority for radiation protection for the transient period from 2006 to 2008:

- tritium: 20 TBq,
- fission and corrosion products: 13 GBq;

For discharging into Dudváh River (via Manivier canal), the values were as follows:

- tritium: 200 GBq,
- fission and corrosion products: 0.13 GBq.

In association with the mentioned values it has to be asked what effective doses for the population would be caused by the discharges of limit values. In the past, the whole-life commitment of effective dose (i.e. 50-year commitment for adults and 70-year one for the sucklings to one year of life) was calculated, while assuming zero mixing of a discharge with river water and assuming that a member of the critical group would drink water (whole annual consumption) directly at the discharge place [29]. The whole-life commitment for discharges into Váh River for a given radioactivity limit of tritium was 55 µSv and 19 µSv for the radioactivity limit of fission and corrosion products (on condition that they are represented exclusively by ^{137}Cs), i.e. also under significantly conservative circumstances, it was numerically roughly on the level of annual limit (50 µSv).

Concentration limits for continual measurements checking the concrete discharging are also established at all discharge points. They are established equally for all discharges. They do not have any connection with the mentioned balance values, but they are more the expression of measurement features (detection limit, determinability limit) of used gauges and methods:

- tritium: 1.95 x 10^8 Bq/m^3,
- fission and corrosion products: 3.7 x 10^4 Bq/m^3.

As it was mentioned before, as in the case of gaseous discharges, it is required to perform further measurements in representative samples of discharged water, so that it is possible to determine annual commitment of individual effective equivalent dose for a population.

As far as metrological aspects of balance monitoring and the monitoring for the assessment of population dose load are concerned, measurements at the place of liquid discharge from individual nuclear installations (V2 NPP, V1 NPP, other GovCo (JAVYS) installations) are performed by determined measuring instruments in the sense of metrological regulations.

<u>Assessment of the impacts of discharges on the environment</u>

Calculations for the determination of population dose load due to normal discharges of radioactive substances are performed once a year [30, 31]. Calculation inputs are annual balance values of discharges (see above). All possible scenarios – exposure routes are considered for assessment:

- for liquid discharges:
  - exposure during swimming and sailing,
  - exposure from contaminated fluvial deposits,
  - exposure during the stay on irrigated soil,
  - exposure from ingestion of drinking water,
  - exposure from fish ingestion,
  - exposure from ingestion of irrigated agricultural products – food.
- for gaseous discharges:
  - exposure from a cloud,
  - exposure from a deposit,
  - exposure from inhalation,
  - exposure of food contaminated by fall-outs from the atmosphere.

Estimation of effective doses is performed by means of mathematic modelling. The latest method of the estimation of population radiation load due to discharges is clearly and thoroughly analysed in the document [32], elaboration of which took about 14 years; method published in 1984 [33] is principally used in our country. Particular calculations for Jaslovské Bohunice site are performed by RDEBO programme. Extent of the annual reports does not cover information either on the site-specific parameters and parameters characterising way of life of the population or on the method of calculations or used calculation means. Data on annually averaged wind rose are included in the last reports. If we realise critical route and critical population group (see below) for Jaslovské Bohunice site, annual update of meteorological data is decisive for the assignment of activity/dose conversion factors, i.e. for the correctness of the calculation of effective dose for an individual from the critical population group.

For the calculation of effective doses, areas around the sites of nuclear installations (circle with 100 km radius in Jaslovské Bohunice and with 60 km radius in Mochovce) are divided into 192 zones. Annual individual effective doses and 50- resp. 70-year commitments of collective effective doses for adults and age categories of children respectively are calculated for each zone comprising permanent settlements of the population as well as unpopulated area. Collective doses are also summarised for the whole assessed area.

For the rationalisation of assessment and its interpretation, it is usual to determine critical radionuclides (i.e. those in the discharges, which contribute to the exposure of assessed age group of the population most of all) and the critical population group respectively. This group is defined in the document [32] as “the group of population that is adequately homogenous from the point of view of its exposure from a given radiation source and from the point of view of a given exposure route and which is characterised as the group of individuals obtaining the highest effective or equivalent dose from a given source”. In case of our assessments, it is the population group in a particular zone, for which the particular effective doses are the worst (the highest numerical values).

Overview of the impacts of discharges also includes identification of the critical exposure routes, i.e. those that contribute to the exposure of the critical population group most of all. The critical exposure routes in Jaslovské Bohunice are air routes, namely exposure from a cloud and ingestion of food contaminated by fall-outs from the atmosphere. Annual reports for this site also comprise a supplementary information, in which of the population groups (in which of 192 mentioned zones) comes the highest contribution to the effective dose from water exposure route (main contribution comes from ingestion of drinking water).

Annual reports on the impacts of discharges also provide comparison of obtained values for the last 8 – 10 years. It is interesting that several changes of the critical population group occurred in this period:

1994 – 1998 sucklings to 1 year of age in the village of Žlkovce

1999 – 2001 children from 7 to 12 years in the village of Malženice

2002	children from 2 to 7 years in the village of Malženice
2003, 2005	children from 7 to 12 years in the village of Pečeňady
2004	children from 2 to 7 years in the village of Pečeňady

The highest value of annual effective dose for an individual from the critical population group for Jaslovské Bohunice site in the last period was calculated in 1996: approximately 460 nSv. As far as the dependence of values of annual effective doses of an individual from the critical population group on time is concerned, no trends could be observed:

year	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
E [nSv]	154	463	371	164	87	205	231	225	93	149	161

It has to be noted that the contribution of water route to the exposure of an individual from the critical population group equals to zero since 1996. Even the highest contributions from water route, (e.g. for children from 7 to 12 years in zone no.92 – village of Kráľová in 2005) are approximately by one order lower in comparison with the values for an individual from the critical population group. Estimated values of population dose load due to discharges are usually interpreted by comparison with the exposure of an individual from the natural radiation background. The worldwide average value of this quantity is about 2.5×10^6 nSv at the present time.

As far as the changes in discharges and their impacts caused by the change of V1 NPP from operated to decommissioned power plant are concerned, it has to be noted that the impact of decommissioned power plant on the background of operated power plant is practically negligible – it is superimposed by indefiniteness of calculation parameters and the calculations themselves. Comparison of the estimations of effective dose of an individual from the critical population group due to discharges from original SE VYZ facilities (i.e. decommissioned A1 NPP, ISFSF, RAW treatment and conditioning facilities altogether) with the currently operated power plants can serve as an argument:

year		*2004*			*2005*	
Facility	SE VYZ	V1 NPP	V2 NPP	SE VYZ	V1 NPP	V2 NPP
E [nSv]	0.1	85	64	0.15	88	72

This table basically demonstrates the fact that the exposure of an individual from the critical population group due to discharges will decrease roughly by 60% in comparison with the current status after the commencement of V1 NPP decommissioning. It has to be noted at this place that for the future periods, if there was not any operated nuclear power plant at the site, critical nuclides, critical route and critical population group will probably have to be re-evaluated, i.e. limitation of discharges and method of estimation of their consequences will have to be completely re-evaluated.

Requirement for the presentation of annual discharges for the whole decommissioning period with the indication and graphic illustration of their sources and division of discharges into these individual sources is not feasible on the basis of up-to-date knowledge. The estimations will be performed during the preparation of documentation necessary for the permission of a particular decommissioning stage. It can be stated at the present time that:

- The main source of radioactive discharges will be the RAW management at the place of its generation, i.e. in the areas of decommissioned power plant, as well as decontamination and dismantling. Distribution of discharges in time will depend on the selected decommissioning alternative. The highest amount of discharges can be anticipated in IDO stage II, SES stage III and RSE stage I (see chapter 4.5.8.2 of the Conceptual decommissioning plan).
- Distribution of radioactive discharges in time will be generally similar to the distribution of personnel radiation load in time.
- Estimated average annual radioactivity of liquid discharges represents about 5.6% and estimated average annual radioactivity of gaseous discharges represents about 0.1% of the particular values measured for V1 NPP power operation in case of alternative 1 (IDO). Particular average annual values of radioactivity for alternatives 2 and 3 (SES and RSE) are comparably lower than for alternative 1 due to distribution of the same total values in a longer time period.
- Estimated maximum value of radioactivity of annual liquid discharges represents about 13.8% and the particular value of gaseous discharges represents 0.23% of the corresponding measured annual values for V1 NPP power operation.

2.3.6.5. *Population Health Status*

Non-governmental organisations in their standpoint require to elaborate an epidemiological study comprising the information on mortality of the population, mortality on malignant tumours and their incidence, on incidence of chronic lung diseases for each village in 30 km zone for the last 20 years. It has to be noted at this place that such designed studies are systematically elaborated and updated for both Slovak nuclear sites for many years and they are published in the reports of VÚJE, a.s. and Environment, a.s. Some of the outputs are presented in chapter C.II.3.2.1 of this report. List of the reports of Environment, a.s. is given on the web page: http://environment.sk/sk-nase-prace.php.

Last of the large studies on impact of nuclear installations on the environment at Jaslovské Bohunice site processed the data from 2000 and 2001 and they were published in 2001 and 2003 [34, 35] and they include the results of epidemiological studies. A relatively extensive statistical evaluation of the following parameters is presented in these studies:

- number of potentially lost years of life on 100 thousand inhabitants,
- number of potentially lost years of life on one death,
- number of deaths on all types of malignant tumours on 100 thousand inhabitants,

- number of deaths on malignant tumours of gastrointestinal tract on 100 thousand inhabitants,
- number of deaths on leukaemia on 100 thousand inhabitants,
- number of deaths on malignant lung tumours on 100 thousand inhabitants,
- number of deaths on cardiovascular diseases on 100 thousand inhabitants,
- gross mortality (number of deaths on 1000 inhabitants),
- gross mortality of males (number of deaths on 1000 males),
- gross mortality of females (number of deaths on 1000 females),
- percentage of premature (before 65 years of age) deaths of inhabitants,
- percentage of premature (before 65 years of age) deaths of males,
- percentage of premature (before 65 years of age) deaths of females,
- percentage of children with low birth weight (less than 2500 g),
- share of spontaneous abortions on all conceptions.

Attention was also paid to long-term incidence of tuberculosis, occurrence of which was found out just in this region. Demographic and epidemiological data from 30 km (2826 km^2; 212 villages) and from 10 km (314 km^2; 26 villages) circle around the site of nuclear installations respectively are compared with the data in the Slovak Republic as a whole and in the individual regions. Data from individual villages are also compared. It is not reasonable to show extensive statistic tables and their graphic presentation in this report; for those who are interested, they are available at the customer. We will only mention interpretations of the statistical evaluations here.

As far as the mortality parameters are concerned, mortality in the surroundings of JEK Bohunice is higher due to older age of the inhabitants, the status is expectable and natural in the sense of parameter construction. The inhabitants in the area of nuclear installations in Bohunice generally live to a great age – the particular parameter is 10-fold higher than for Slovakia as a whole. Higher mortality on malignant tumours without specification and on cardiovascular diseases is also given by an older age of the population. It is interesting that the malignant tumours that are associated with ionising radiation are all below the Slovak average (blood haemopoiesis organs, skin, thyroid gland). As far as the space statistics is concerned, occurrence of all mentioned parameters in space is accidental. The parameter of number of deaths on leukaemia reached a positive auto-correlation, i.e. just in the surroundings of nuclear installations Jaslovské Bohunice, there are space clusters without occurrence of deaths on leukaemia.

2.3.6.6. *Monitoring*

In spite of annual publishing of the reports on radiation impact of nuclear installations at the site on the environment, where a detailed calculation of the results of radioactivity measurements of environmental components forms a significant part of the reports, non-governmental organisations require once again to publish what is measured, how it is measured, with which instruments and how frequently.

2.3.6.6.1. Monitoring of the Discharges

Firstly, it has to be repeated what was already mentioned in the discussion about discharges: the only monitoring measurements capable to contribute to the knowledge of impact of <u>individual</u> nuclear installations at the site during the normal operation will be those that are performed directly at a source or in its close vicinity. In practical terms, it means monitoring of gaseous discharges in the stacks, measurement of liquid discharges at the discharge places of individual installations or the measurement of some of the quantities (see below) at the measuring places directly at the site in a close vicinity of a particular nuclear installation.

<u>Monitoring of gaseous discharges</u>

The difference in monitoring of gaseous discharges in operated nuclear power plants and decommissioned nuclear power plants or in the stacks of facilities for radioactive waste or spent fuel management is given by appropriate limits and conditions: it is necessary to measure also the content of noble gases and iodine in the stacks of operated power plants (besides it, particular facilities have to be capable of measuring the discharges during the accidents, i.e. they have to have an extensive measurement range); measurement of radioactive substances in aerosol component of gaseous discharges without the nuclides of noble gases and iodine will be required in the other stacks.

Compared to liquid discharges, monitoring of gaseous discharges is more complicated and less accurate and definite. The reasons are specific features of the measurement of gaseous media and for the measurement of a correct value of one quantity, in contrast with the liquid discharges, it is necessary to separate the components that would interfere with such a measurement (i.e. they would significantly influence its correctness).

This is the case of KALINA equipment, which has been used in the Slovak nuclear installations from the beginning and which is currently used exclusively as a supplementing operational measurement instrument. The equipment consists of three measurement channels:

- for the measurement of summary activity of long-living aerosols,
- for the measurement of summary activity of (noble) gases,

- for the measurement of ^{131}I summary activity.

Gaseous mixture for the measurement is taken off by a vacuum pump, which continually sucks an air sample via the whole measurement system. At the beginning, humidity of the air is removed by means of condensation and it proceeds to the branch for aerosol measurement. The branch works continually; aerosol activity is detected in two consequent 24-hour cycles: sample is taken to a suitable filter in the first cycle, decay of short-living aerosols takes place in the second cycle (about 21.5 hours) and the sample is measured. After passing the air sample through a filtration tape for aerosol measurement, the sample proceeds to radioactivity measurement of noble gases. Due to the correctness of this measurement, iodine filter is located before the above mentioned filter in this branch, contingent fouling of which is continually checked-up. After filtering the iodine isotopes, total beta radioactivity of (noble) gases is measured in a quasi-continual way. To measure ^{131}I in the branch, which is parallel with the branch for aerosols and noble gases, it is necessary to place the filter for aerosol trapping in its branch. Then, ^{131}I is detected similarly as the aerosols in its branch: by trapping on a filtration tape with specific properties in two 24-hour intervals (trapping, decay, measurement).

For checking the exceeding of limits of investigation and intervention levels and for measurement of balance values of gaseous discharges the independent equipment is installed in nuclear power plants. The equipment enables to take a representative sample as well as to determine actual flow rate of air in a particular stack: rose of isokinetic sample taking, anemometer, detector of temperature and humidity are located in a stack at 10.5 m height. Sensitivity of this equipment enables to perform hourly and daily balancing of three mentioned limited components of gaseous discharges and it also continually checks-up mentioned quantities and provides information on exceeding the set threshold levels. It consists of five branches in total:

- aerosol monitor,
- gas monitors (2 pcs),
- iodine monitor,
- sampling system with two iodine-aerosol samplers.

Aerosols are measured by means of ZnS + plastic scintillator; effective measurement time of one cycle is 150 minutes during 30-minute suction through aerosol filter. Gas monitors are installed in a parallel way due to full redundancy of this measurement. They have the aerosol filter placed before them. Gas monitors are equipped with two proportional detectors, signals of which are led to a two-channel amplifier. Measurement time of one cycle is usually 1800 s. Iodine monitor has an aerosol filter placed before it, gaseous ^{131}I is trapped on a filtration cartridge, which is measured by a scintillation NaI (Tl) detector. In this case, measurement cycle lasts for 120 minutes. Iodine-aerosol samplers, which have to provide data to the system for the compensation of gaseous iodine supplement (allowance) in the course of gas measurement as well as to ensure taking of the representative samples for other measurements, e.g. the spectrometric ones, are placed in parallel with the branches for the measurement of gas radioactivity.

A modular processor unit called as "concentrator" controls the whole system. The concentrator:

- takes over the data from individual monitors,
- calculates actual flow rate of air in a stack,
- regulates blowers of the monitoring system as a whole and flow rate in individual branches,
- converts concentration data from individual sensors to balance values (Bq/time unit),
- checks-up the functionality of sampling systems of individual branches.

It has to be mentioned that principally the facilities for monitoring of discharges from the operated nuclear power plants have to be equipped in this way. In other installations, this equipment is considerably simpler, because measurement of noble gases and iodine does not apply here. Requirements for the representative samples do not have to be so strict as in the operated power plants with regard to a possible contribution to the discharges also under non-standard circumstances. This is the consequence of the fact that newer facilities have a possibility of isokinetic sampling, the older ones do not have it. Thus, older facilities do not have the measurement of actual flow rate of air in the stacks ensured. With regard to the purposes of measurements it is not important, because the flow rate which is nominally established by the manufacturers of individual blowers of ventilation systems is conservatively considered as the actual one.

For the completeness, the third system installed in the stacks of operated power plants for the needs of emergency monitoring of mass activity of noble gases, aerosols and iodine has to be mentioned. The system is characterised by high measurement ranges: in the range of 9 orders of Bq/m^3 for noble gases (ionisation chamber is the detector) and 7 orders for iodine and aerosols (gamma radiation is measured by means of NaI (Tl) detector). The equipment is continuously in stand-by mode, switching over to the operational mode depends on the decision of personnel on the basis of a given situation or on the basis of information from the above mentioned system. Switching between its continual and periodic mode takes place automatically.

Monitoring of liquid discharges

Two types of water are discharged from the site:

- Continually discharged water. It is used cooling water and water from rescue pumping of ground water. Discharging is ensured by continual measurement of mass activity and procedures during the reaching of investigation value. In the case of rescue pumping the representative samples are taken and evaluated before and during the rescue pumping. The volume of pumped water is measured as well.

- Discontinually discharged water. These discharges work according to the system tank – discharge. A representative sample is taken before the discharge of this water, necessary analyses are performed and the protocols on water discharges are prepared in the computer network. Number of a particular tank and volume of water identified for discharging is entered into the protocol. The protocol is a basis for the approval of application of a particular facility for the discharge of a particular tank. The condition for discharging that has to be confirmed by the measurement is the mass activity of corrosion and fission products lower than 37 Bq/l. The applicant for the permission of discharging the particular tank will supplement the protocol with a required water flow rate during discharging and with a contingent necessary dilution if tritium value exceeds 1.95 x 10^5 Bq/l.

Water check-up takes place before discharging and in its course; values necessary for the balancing of individual radionuclides in the discharges are gained by radiochemical and gamma spectrometric measurements of decanted representative samples. Before discharging of individual tanks, laboratory detection of βγ mass activity (by measurement of evaporation residue on low background device) and detection of tritium mass activity by liquid scintillation spectrometry are performed. The principal device for the check-up of liquid discharges during discharging from individual tanks, branches or from the site is a quasi-continual βγ radioactivity measurement device MR-100. In fact, it is a 15 l vessel made of stainless steel equipped with a scintillation detector working in the continual mode. The device also enables continual taking of 24-hour decanted sample necessary for further measurements. Each exceeding the set value of 37 Bq/l is the reason for closing of a particular discharge valve, cause investigation and a contingent corrective measure. When going from the end, this device monitors terminal branch for discharging into SOCOMAN piping (the same device serves for the check-up of discharges into Manivier canal). A particular device is also on two independent discharging branches for A1 + V1 NPP (currently GovCo (JAVYS)) and for V2 NPP. The same device is installed on A1 NPP branch, to which the water from the following places is collected:

- main production building of A1 NPP (intermediate cooling circuit and condensate of heating steam from the vitrification plant),
- rescue pumping of ground water,
- building 809 – this building is also equipped with own measurement device MR-100 with the output enabling to close a particular valve,
- building 41, which is also equipped with MR-100 measurement device of the same properties and which collects water from other buildings and tanks (cooling water from the operation of building 41, cooling water from the operation of building 28, cleaned-up waste vapour condensate from the operation of building 41, condensates of heating steam from the buildings and facilities, retention tanks).

After it, the quantities, which declare compliance with the limit values are detected in the collected water by laboratory methods. Balance values of discharges are intended and needed for the calculation of annual effective dose equivalents due to liquid discharges.

2.3.6.6.2. Monitoring of the Environmental Components

Under the normal circumstances, either during the operation or decommissioning of nuclear installations, it is principally not possible to detect impact of individual nuclear installations at the site or of individual events on the environmental components by monitoring measurements. The exceptions could be some measurements in the atmosphere performed inside or in the close vicinity of the site. As it was mentioned before, under normal circumstances, it is not possible to detect impact of decommissioned nuclear installations or the facilities for radioactive waste or spent fuel management on the background of operated nuclear power plant by such measurements at all.

Monitoring of ground water

Monitoring of ground water at the site and in its surroundings is the example, when monitoring contributed to the identification of abnormal situation from the present point of view, to the proposal and implementation of corrective measures and assessment of their effectiveness. The programme of regular monitoring of ground water (especially of Ist water bearing bed and in some places of IInd water bearing bed as well as of non-saturated overlying layer – so called percolation water) has been elaborated and implemented. To assess the communication between ground and surface water – bank infiltration, surface water is also monitored at some places.

Except the boreholes, samples of water are also taken from water sources – wells, from drainage and excavated probes and from the surface at some places. Total number of sampling places at the site and its surroundings changes and it is the result of a concrete condition of contamination spreading, water presence, condition in the implementation of corrective measures and technical condition of sampling boreholes and probes. Sampling places – objects (status in 2005) can be divided as follows:

- A1 NPP site – 19 objects,
- ISFSF site – 2 objects,
- V1 NPP site – 11 objects,
- V2 NPP site – 17 objects.
- Area of the site surroundings to Dudváh River:
    - A1 NPP water sources (wells) – 5 objects,
    - A1 NPP water sources (boreholes) – 4 objects,
    - other water sources (wells) – 12 objects,
    - objects in the villages – 13 objects,
    - solid communal waste dump site in Žlkovce – 3 objects,

- other – 43 objects.

- The area among Dudváh River – SOCOMAN – Drahovský canal – Váh River – Leopoldov:
  - water sources in Hlohovec (wells) – 5 objects,
  - water sources in Hlohovec (boreholes) – 14 objects,
  - water sources in Leopoldov (wells) – 7 objects,
  - water sources in Leopoldov (boreholes) – 5 objects,
  - water sources in Slovlik (wells) – 5 objects,
  - water sources in Slovlik (boreholes) – 3 objects,
  - other – 4 objects,
  - area around SOCOMAN piping – 10 objects,
  - area between Drahovský canal and Váh River – 7 objects,
  - objects in the villages – 2 objects.
- Objects in the villages in the area of Dudváh and Váh River confluence – 2 objects.

Activity of tritium as a nuclide, migration of which is given by movement of ground water was detected in all these objects. In some of the objects samples were taken monthly, quarterly or in some objects only once a year. So called total beta radioactivity was detected in the samples from 9 objects, measurement of ^{137}Cs, contingently of ^{60}Co (and naturally of ^{40}K as well) was performed by gamma spectrometry from 32 objects, ^{90}Sr was detected from 20 objects, alpha-nuclides (^{238}Pu, $^{239+240}Pu$, ^{241}Am) were detected from 111 objects, three cases were reported about unsuccessful attempt (impossibility to take the volume sufficient for analysis) to detect ^{14}C radionuclide.

Besides it, tritium was detected in the samples of percolation and drainage water at the site, which were taken at 38 places; ^{137}Cs, ^{134}Cs, ^{90}Sr and mentioned alpha-nuclides were detected in some samples. The result is a vast amount of numerical data published in the documents [30, 36] for 2005. In case of tritium, the graphic presentations are quarterly maps of iso-lines illustrating the traces of ground water contamination in various scales [30, 36].

Measured values can be briefly interpreted as follows:

1. Tritium contamination from A1 NPP buildings has been distributed in Ist water bearing bed basically under the whole area of A1 NPP site. Maximum values were detected in N1 borehole in 2005 (also see the part C II.4.4.4) and they reached up to 2500 Bq/l.
2. Concentration maximum of the contamination at A1 NPP site is associated with the area of underground radioactive water storage tanks of 41/10 building. The current sources of contamination are contaminated surfaces and contaminated ground surroundings of the

building, including contaminated water in it (at the present time, it is possible to exclude leakages from the storage tanks of the building except 7/1 and 7/2 tanks, because all other tanks are cleaned-up and empty or operated in such a way that the leakages are excluded. The tanks 7/1 and 7/2 still contain the media that can be the sources of adverse effects of contamination to a surrounding geological environment). Another significant source of contamination in the past – building 44/20 is still less and less important, because the measures were also taken to prevent water penetration into the building and waste and contaminated liquids were removed from the building.

3. Ground water under ISFSF and its surroundings is not contaminated.

4. Gamma nuclides identified in some samples (^{137}Cs: max. 0.043 Bq/l, ^{60}Co – max. 1.3 Bq/l) come from the mentioned building or from the surroundings of building 44/20.

5. As a consequence of increased sensitivity of the detection of ^{90}Sr and alpha-nuclides, the occurrence was recorded in decanted monthly sample from rescue pumping (N-3 borehole).

6. Radiation situation in ground water of A1 NPP site is stabilised due to rescue pumping, i.e. contamination spreading in ground water was brought to a standstill.

7. Due to leakage of sewage systems or technological assemblies, tritium contamination at V1 NPP site (JB-43 – up to 380 Bq/l) still persists, however decreasing trend reflecting corrective measures taken before approximately 10 years is obvious in comparison with the previous years. Other slight exceedings of 10 Bq/l value are the residues of above mentioned leakages or they come from A1 NPP trace contamination.

8. Ground water of V2 NPP site can be considered as uncontaminated.

9. Tritium mass radioactivity of water sources to Dudváh River did not exceed 10 Bq/l value with the following exceptions:

   a) wells in the compressor station of Malženice gas pipeline – max. 120 Bq/l, the levels are stabilised and it is anticipated that they will decrease due to mentioned corrective measures,

   b) wells of Malženice agricultural farm – max. 26 Bq/l, the same situation is anticipated.

10. Tritium mass radioactivity in the objects in the villages to Dudváh River also did not exceed 10 Bq/l value with the exception of TKS 2 boreholes (92 Bq/l) and the boreholes of solid communal waste dump site in Žlkovce (86 Bq/l). The given radioactivity is interpreted as the relict of communication between Manivier canal and ground water at the time of discharging via this canal. Situation in the boreholes indicates that the contamination of ground water in the village of Žlkovce has a decreasing trend after cessation of the radioactive discharges into Manivier canal.

11. As far as other objects in the surroundings of Bohunice nuclear installations to Dudváh River are concerned, two sub-areas with increased tritium activity exist:

a) Trace of contamination spreading coming from A1 NPP. The values are up to 600 Bq/l in a close vicinity of the site in south-western direction. In other areas in southern to south-eastern direction, tritium activity decreases to 70 Bq/l values.

b) Another area is the line more to the east with detected values up to 100 Bq/l. This contamination is the relict of leakage from V1 NPP sewage system, which was resolved by corrective measures in 1996 – 1997 period. Due to them, this contamination has a decreasing trend.

12. Mass radioactivity of other radionuclides than tritium in the samples taken from measurement objects outside the site is on the level of natural background.

13. Mass radioactivity in water sources in broader area (Dudváh River, SOCOMAN, Drahovský canal, Váh River, Leopoldov) was detected in the wells and observation boreholes of Hlohovec water source. The highest detected value was 18 Bq/l. It is interpreted as a consequence of infiltration of water in Drahovský canal to the surrounding ground water – occurrence has been registered since 2002.

14. Higher values of tritium mass radioactivity from other objects in a broader area are interpreted in the same way (infiltration from Dudváh River or from Drahovský canal) – higher values than 10 Bq/l were detected in the samples from three boreholes; the highest one was 42 Bq/l.

15. Increased tritium radioactivity (24 Bq/l) was detected in one case in one of the boreholes, which are situated parallel with SOCOMAN piping between Žlkovce and Červeník. This occurrence is explained by a local leakage in SOCOMAN discharge piping.

For the illustration of mentioned values it has to be noted that the highest mass radioactivity in the precipitations on the Slovak territory was registered in 1963 as a consequence of nuclear weapon testing; the value was 270 Bq/l of tritium. In the mentioned Methodical instruction of the Ministry for Administration and Privatisation of National Property of the Slovak Republic and the Ministry of Environment dated December 15th, 1997, no. 1617/min., on the procedure for assessment of the company commitments from the environment protection point of view in a privatisation project submitted by the company in the frame of privatisation, the following intervention levels are presented: 5000 Bq/l for tritium, 2.0 Bq/l for ^{137}Cs and 1.0 Bq/l for ^{90}Sr.

<u>Air</u>

Stations of NEC Bohunice teledosimetric system are used for taking of samples for monitoring of aerosols and fall-outs. Their primary task is to continually record equivalent dose rate and monthly equivalent dose at a given place. Taking of aerosols is performed at 24 stations by means of suction equipment (220 m^3/h). The stations are situated as follows:

- 5 stations at the site of nuclear installations,
- (Jaslovské Bohunice) – 1 station in Bohunice, 1 station in Jaslovce
- 2 stations in Kátlovce,

- 3 stations in Veľké Kostoľany,
- 2 stations in Malženice,
- 2 stations in Nižná,
- 2 stations in Pečeňady,
- 1 station in Krakovany, Piešťany, Radošovce, Šulekovo, Trnava and Žlkovce, 6 stations altogether.

Graphic presentation of the location of monitoring stations is given in a figure in the document available to the public [30, 36].

The filters are evaluated by a semiconductor gamma spectrometric analysis after a 14-day exposure. Radiochemical analysis of ^{90}Sr and $^{239+240}Pu$ is performed in composite filter samples (2 filters, i.e. after 2x14 days) from three stations (two ones at the site and one in Trnava). Radioactivity of fall-outs is detected in six stations (Bohunice, EBO3, Nižná1, Pečeňady2, Trnava, Veľké Kostoľany2) by means of large-scale sampling facilities and subsequent gamma spectrometric analysis after a large-volume precipitation. Radiochemical analysis of ^{90}Sr and $^{239+240}Pu$ is performed again in monthly decanted samples from two sampling places (EBO3, Trnava).

Besides the contamination of ground water, anomalies were found out only in the course of air measurements. Every measured anomaly, which is out of range of usually measured values of ^{137}Cs in aerosols (tenths to ones of μBq/m^3, but these values are burdened by indefiniteness, because they are below the limit of determinability by an appropriate method and instrument, i.e. the investigation level is basically every positively measured result in the spectrum) is the reason for investigation. The investigation is usually carried out in the form of comparison with measured mass activities of gaseous discharges in individual stacks and with the activities, which could be potential sources, i.e. they were performed simultaneously in a given time and space. Identification of each other radionuclide in the spectrum of gamma samples of aerosol filters is also the reason for investigation. Detailed tables and diagrams of all measured values are annually published in the annual reports [30]. In 2005, 12 investigations of the causes of positive occurrence of ^{110}Ag, ^{54}Mn, ^{58}Co, ^{60}Co, ^{131}I and ^{137}Cs in the spectrums took place. The highest measured value was 19.8 μBq/m^3 for ^{137}Cs. The quoted annual report indicates the causes for mentioned occurrences detected namely in the samples from the site, but also from Jaslovce (Jaslovské Bohunice), Veľké Kostoľany and Pečeňady. General overhaul of V1 NPP units, sometimes also the activities associated with RAW management in SE VYZ, GovCo (JAVYS) respectively and with A1 NPP decommissioning procedures were mostly the causes. The given facts do not represent any increased risk for the population. Investigation results are filed at the operators of nuclear installations.

As far as the fall-outs are concerned, the only occurrence of ^{137}Cs over the determinability limit – 0.304 Bq/m^2 – was recorded in June sample from EBO3 station by a gamma spectrometric analysis in 2005. The highest recorded value for ^{90}Sr was 81 Bq/m^2 and 50 mBq/m^2 for $^{239+240}Pu$. The detailed tables with measurement results are presented again in the particular annual report [30].

Milk radioactivity

The samples are taken in weekly intervals from the diaries and agricultural farms at 5 sampling places (cowsheds in Dolné Dubové, Nižná, Drahovce and Pečeňady, dairy in Hlohovec). Presence of artificial radionuclides is detected in 2-litre samples by a gamma spectrometric method. Weekly samples are then decanted. Monthly sample, after a radiochemical processing, will undergo again gamma spectrometric measurement and subsequent radiochemical detection of ^{90}Sr. Measurements of ^{137}Cs ranged from 0.02 to 0.067 Bq/l in 2005, however all values were below the level of statistically acceptable measurability limit. The highest measured value for ^{90}Sr was 64 mBq/l in April sample from Hlohovec diary, the other values ranged from 6.4 to 36 mBq/l.

Water

Laboratory for radiation monitoring of the surroundings of nuclear installations in Bohunice takes 10-litre samples of drinking water at eleven sampling places in quarterly intervals. After radiochemical processing, so called total beta radioactivity and content of ^{90}Sr and ^{3}H by means of a liquid scintillation spectrometry are detected. In 2005, a higher total beta radioactivity was measured in the samples from Kátlovce and Veľké Kostoľany (maximum 709 mBq/l), a higher tritium radioactivity was detected in the samples from Malženice and Trakovice (maximum 117 Bq/l). The highest measured value for ^{90}Sr was 8.2 mBq/l in the sample from Žlkovce.

Radioactivity monitoring of surface water is also performed at five sampling places: Dudváh River in Bučany and Veľké Kostoľany, Váh River in Madunice and Várov Šúr and the canal in Žlkovce. Content of ^{90}Sr and ^{3}H is detected in 50-litre monthly samples after a radiochemical processing by the method of liquid scintillation spectrometry and content of gamma nuclides (^{137}Cs, ^{134}Cs) is detected by gamma spectrometry after a large-volume precipitation. All values gained by gamma spectrometry were below the determinability limit in 2005. The same situation applied to the majority of samples when detecting the tritium radioactivity, where only several values were over that limit – the highest one was 55 Bq/l. The highest values of ^{90}Sr ranged from 9 to 17 mBq/l.

Besides it, LRKO operates 16 own boreholes, where the samples are taken twice a year: in spring and in autumn. So called total beta radioactivity and tritium are detected in these samples by means of liquid scintillation spectrometry. Radioactivity of ^{3}H with the exception of two boreholes did not exceed the value of minimal detectable radioactivity, the maximum measured value was 34 Bq/l.

In summer period, samples of sediments are taken at four sampling places (Bučany-Dudváh River, Sereď – Kráľová dam, Veľké Kostoľany – Dudváh River, Žlkovce - the canal), samples of potamogetone are taken at three places as well. The samples are dried, homogenised and measured by gamma spectrometry at the laboratory and subsequently content of ^{90}Sr and $^{239+240}Pu$ is detected by a radiochemical method. The highest measured value for ^{137}Cs was 118 Bq/kg (Žlkovce canal); ^{60}Co

was also identified and the highest value for ^{90}Sr (11 Bq/kg) as well as for $^{239+240}Pu$ (520 mBq/kg) was measured in the same sample.

Agricultural products

Samples of grass (15 sampling places) and clover (8 sampling places) are taken in spring and autumn in the vicinity of dosimetric monitoring stations. Gamma spectrometric analysis is performed in pressed and dried samples. An average sample is prepared from all samples, where ^{90}Sr and $^{239+240}Pu$ are detected. The same procedure applies to the samples of agricultural products taken once a year in the time of picking (harvest). The highest measured value for ^{137}Cs was about 3 Bq/kg of a dry grass sample in 2005, in case of ^{90}Sr it was 2.3 Bq/kg of a dry sample and 36 mBq/kg of a dry sample for $^{239+240}Pu$.

Soil

Soil samples are taken at the sampling places for grass (9 sampling places) in spring in two horizons – 0-2 cm and 2-5 cm. Samples of topsoil (6 sampling places) are taken in 0-5 cm horizon in autumn. The samples are dried, homogenised and measured by gamma spectrometry at the laboratory. The highest value for ^{137}Cs was about 18 Bq/kg in 2005; presence of ^{60}Co was also identified in this sample. In five soil samples, ^{90}Sr (max. 4.3 Bq/kg) and $^{239+240}Pu$ (max. 119 mBq/kg) were detected by a radiochemical analysis.

Other measurements

In situ dose rate measurement by ionising chamber as well as supplementary information of in-situ gamma spectrometry is performed at the place of taking the soil samples. The measured value for ^{137}Cs was maximally 1900 Bq/m^2 for grass growths and 8 Bq/kg for the topsoil in 2005. Dose rate values ranged from 40 to 80 nGy/h.

2.3.6.5.1. Notes

It is useful to mention in this section, how the adequate accuracy and correctness of performed measurements during the radioactivity monitoring in the environmental components is ensured. These aspects are relatively significant, especially if we realise that we move in the ranges close to detection or determinability limits during the measurement of radioactive substances contained in the environmental samples. Big amount of numerical data in annual reports is marked with “<” sign, which means that a given value was gained by a measurement, determinability limit of which is numerically higher than a given value at selected statistic parameters characterising indefiniteness of a given measurement. This fact does not mean anything wrong, if we realise that the purpose of radioactivity measurement in the environmental samples from the surroundings of nuclear installations during their normal operation is not to determine an appropriate quantity with a statistic definiteness at all costs, but to check-up if nuclear installations do not affect appropriate components of environment. Annual reports on the environmental impacts of the site do not deal with the aspects of correctness of presented measurement results. Laboratories performing the mentioned measurements ensure accuracy and correctness of their measurements on an adequate level; correctness is ensured mainly by the participation in comparative measurements or round analyses, also in international scale.

Standpoint of non-governmental organisations required not to present only maximum and minimal measured values, but to present results in the **form of detailed measurement protocols** in case of measurements in environmental components. With regard to the fact that it means thousands of measurements annually, fulfilment of this requirement is not reasonably possible when taking into account extent of the assessment report. Only the presentation of measurement results in the last annual report in the form of tables or diagrams takes about 40 pages (without ground water monitoring, results of which take 30 pages more in the annual report). In the sense of regulations covering the access to the information on environment, it can be anticipated that besides the available annual reports on the site impact on the environment, other relevant information concerning of the monitoring of radionuclide content in the environmental components at Jaslovské Bohunice site and in its surroundings, will be available on request.

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Annex 2

EXPERIENCE FROM GREIFSWALD NPP DECOMMISSIONING IN GERMANY

(EWN ENVIRONMENTAL IMPACT REGISTER)

TABLE OF CONTENTS FOR ANNEX 2

LIST OF ABBREVIATIONS

AOX	Adsorbable Organic Halides
CASTOR	cask for dry storage of spent fuel elements
COD	Chemical Oxygen Demand
EDTA	Ethylene Diamine Tetra Acetic acid
FFH	Flora Fauna Habitat areas (EU definition)
ISN	Interim Storage North (storage for radioactive waste with conditioning plants and storage for filled CASTOR casks)
KTA	rules of the committee for nuclear technology
LUNG	Environmental Protection Agency of Mecklenburg – Western Pommerania
NTA	Nitrilo Tri Acetic acid
RPV	Reactor Pressure Vessel
TRGS	Technical Rules for handling of hazardous materials
UBA	Federal Environmental Agency
WWER 213	Water Water Energy Reactor type 213, Russian type with wet condensation (advanced type)
WWER 230	Water Water Energy Rreactor type 230, Russian type **w**ith hermetically sealed compartment system (first type)
ZAB	**W**et storage for spent fuel
ZAW	Central Warm Workshop, facilty for dismantling and decontamination of plant parts

1. INTRODUCTION

EWN GmbH Rubenow company has gained much experience with Environmental Impact Assessment (EIA) procedures in connection with the decommissioning of the units 1 to 5 of the Greifswald NPP. Environmental Impact Assessment (EIA) procedures related to the decommissioning of the units 1 to 5 of the Greifswald NPP were implemented in accordance with the German requirements but a large range of the issues (environmental impacts) for the EIAs at the Greifswald site are likely to be important also for the V1 NPP decommissioning. Therefore the most important results from the various EIA procedures applied at Greifswald NPP are summarised below. These results can be used as indicators for the environmental impacts that could be expected during V1 NPP decommissioning.

The summarised information provided below is, in general, based on very detailed data on environmental impacts of the Greifswald NPP decommissioning, collected in the so called „Environmental Impact Register“ of the Greifswald NPP, which is based on [1] – [9].

1.1 OVERVIEW ON THE GREIFSWALD NPP DECOMMISSIONING

The units 1 to 4 (WWER 230) on the Greifswald site were shut down in 1990, first unit 2 followed by unit 3, unit 4 and unit 1. The unit 5 (type WWER 213) started trial operation 1989 and was shut down at the end of 1989. The construction of units 6 to 8 was stopped in 1990.

The units 1 to 4 of the Greifswald NPP with regard to EIA have the same technical design as the Bohunice V1 NPP units. Differences to the EWN units 1 to 4 are only the turbine condenser cooling systems (V1 - cooling towers / Greifswald units - direct cooling system from Baltic sea).

Another important issue which has to be considered regarding EIA is the different approach for treatment and conditioning of operational radioactive waste.

1.1.1 EWN operation termination stage (1991 – 1995)

The main activities in this post operation phase were:

- defuelling, that means transport of all spent fuel elements from the units to the wet storage for spent fuel,
- treatment of operational waste,
- decontamination.

In 1992 the dismantling of buildings and plants outside the controlled and monitored area has started.

1.1.2 EWN decommissioning stage (1996 to now)

The EWN dismantling strategy comprises the removal of all components / equipment (e.g. steam generators and pressurizers) as large as possible for decay storage and their later treatment in the newly constructed Interim Storage North (ISN).

Contaminated plant parts can also be treated in the Warm Workshop (ZAW) by cutting and decontamination and other treatments.

At the end of 2005 about 60% of the plant parts of the controlled area and more than 60% of the monitored area have been dismantled.

In the frame of the remote dismantling of the activated components (reactors and internals), new technologies were developed and realized. In preparation a mock up phase (model dismantling) was realized in unit 5 with non-activated components of the reactors of unit 7/8.

The RPVs of the units 1 to 4 will be stored as complete components in the ISN. The high- activated RPV internals of the units 1 and 2 have been cut on the basis of the mentioned newly developed and tested technology (ongoing).

The RPV internals of the reactors 3, 4 and 5 will be stored in shielded casks in the ISN.

The low activated Reactor Pressure Vessel (RPV) of unit 5 was dismantled and also stored as one piece in the ISN.

The spent fuel elements stored in the Wet Storage (ZAB) have been reloaded into CASTOR casks in the following steps:

- transport from the wet storage to the reloading facility (unit 3),
- reloading into CASTOR cask,
- closing, emptying and drying of the CASTOR casks, and
- transport into the ISN (hall 8).

This process has started in 1999 and was be finished in May 2006.

The treatment of operational and post operational waste is ongoing. After reconstruction of the Special Building No. I, the conditioning of mixed operational waste, stored there in concrete pits, has been carried out from 1998 until 2002.

Up to the end of 2005 about 80% of all operational waste has been conditioned.

2. DIRECT IMPACTS FROM EWN DECOMMISSIONING IN COMPARISON TO IMPACTS FROM THE OPERATION AND POST OPERATION PHASES

The comparison of the direct impacts from EWN decommissioning with respective impacts from the operation and post operation phases results in the following:

- important reduction of all impacts, after shut down of the operating units, except conventional emissions into the air,
- all impacts are well below under limit values or other legally required values;
- the low level impacts by decommissioning are in the same range as impacts from other activities (e.g. post operation);
- the most relevant impacts are temporary and disappear or are essentially reduced at the end of the decommissioning process (e.g. waste);
- all activities in the controlled area take place in a closed system with effective control, exhaust air cleaning systems according to the best available techniques and a closed water system with waste water treatment plants and control of all outside releases.

2.1 RADIATION EXPOSURE OF PERSONNEL

During the operation stage the Collective Effective Dose (CED) was about 10 Sv/ year (average 1986 – 1989).

In the post operation stage (1991 – 1995) the CED decreased from 0.56 Sv/year (1991) to 0.23 Sv/year (1995).
In the ongoing dismantling stage the average annual CED (1996 – 2005) was between 0.12 Sv (2001) and 0.26 Sv/year (1998). For this stage the radiation exposure of the annual average CED can be splitted due to activities in the following approximate range:

1. dismantling incl. treatment of waste from dismantling between 30 to 50%
2. post operation and all other activities (outside 3. – 6.) between 20 to 30%
3. guarding about 10 to 20%
4. radiation protection less than 10%
5. fuel reloading (into CASTOR casks) about 5 to 10%
6. conditioning of operational waste about 5 to 10%

For the dismantling of all facilities and plant parts (without demolition of building structures) of one unit, the total CED is < 0,5 Sv.

For the remote dismantling of activated components (core components without reactor pressure vessel) of one unit, the total CED is < 0,1 Sv. The main part of the exposure is caused by preparation activities.

The annual CED from all activities in the Interim Storage North has been increased from 1.51 mSv in 1998 (start of operation) to 5.89 mSv/year until 2005.

2.2 RELEASE OF RADIOACTIVE NUCLIDES INTO AIR

- In comparison between operation and post operation the emission of aerosols is reduced in 1 order of magnitude at the beginning of the post operation (from 28155 MBq/year to 2744 MBq/year) to 2 orders of magnitude at the end of the post operation (422 MBq) .
- In comparison of post operation and dismantling stage the emission of aerosols is decreasing to 1 order of magnitude (average 29 MBq/year in the dismantling stage).
- The main emitters are the stacks 1-3, the quotas of ZAB, ZAW and ISN are all together in the range of some percents.
- The emissions of aerosols in the decommissioning stage are on a very low level (0.02 – 0.05 % of the limited values). ***The effects of dismantling activities regarding the emission of aerosols are existing but not explicitely detectable.*** The low level is caused by an effective system of measures for prevention and separation of aerosols (closed dismantling areas with additional exhaust air plants, use of filters with the best available rate of filtration for the exhaust air system).
- An influence of the remote dismantling was not detectable.
- At the stack of the conditioning area of the ISN aerosols are not detectable.
- The aerosol emissions from the ventilation systems of the ISN storage halls are calculated by model of emissions with the assumptions:
  - 100 % capacity utilization rate, and
  - the maximum of contamination of 4 Bq / cm^2 on all surfaces.

  These calculated emissions are 2 orders of magnitude below the total aerosol emissions and thus to be considered as negligible.

2.3 RELEASE OF RADIOACTIVE NUCLIDES INTO SURFACE WATER (BALTIC SEA)

- In comparison between operation and post operation + dismantling, the total emissions (without H-3) were reduced in 2 orders of magnitude (28 800 MBq / year by operation to 102 MBq / year since 1996) .
- The main source for these emissions is the treatment of operational and post operational waste. All emissions are caused exclusively by the waste water treatment process.
- ***An influence of the dismantling activities is not detectable*** as:
  - all dismantling activities are realized on empty and dry facilities;
  - in the case of dismantling activities with water use, band saw and remote dismantling, the waste water is contaminated with solid particles which have very small influence to the quality of evaporator condensate;
  - waste water from post dismantling decontamination has only a small influence to the quality of evaporator condensate as it is neutralized before evaporation.

2.4 WASTE

The whole mass of the site is about **1 800 000 t.**.
This mass is divided into 3 Categories. The Category 1 is defined as unrestricted material and the part of the whole mass is about 1 235 000 t. This material is conventional waste.
Material of the Category 2 is defined as suspected material, i.e. material with possible contamination. Material of the Category 3 is defined as contaminated material. The materials of Categories 2 and 3 are radioactive waste. Their part of the whole mass is about 565 000 t.
They can be exempted from the Atomic Law after free release measurement procedure (measurement and decision of the radiation protection authority when the values are below defined limited values) and possible previous decontamination.

Another type of Category 3 material is operational waste from operation and post operation.

2.4.1 Radioactive waste

The treatment or conditioning of operational- and dismantling waste according to the requirements for final disposal leads to an important decrease of the emergency potential.
On the other hand, the total amount of radioactive waste is reduced by treatment, and the release as conventional waste is possible.
These aspects are to be considered by the assessment of the low environmental impacts by treatment and conditioning of waste.

At the end of 2005, 40 015 t (appropriate 59%) of the plant parts Categories 2 and 3 material has been dismantled.
88.4% of this amount of plant parts were disposed off as conventional waste (unrestricted release and release with restrictions) after free release measurement and possible previous decontamination:

- Out of that 9% (8.3 % from it are large components) were stored for decay in the ISN.
- Out of that 0.6% was for reuse or utilization in nuclear facilities.
- Out of that 2% were disposed off as radioactive waste, with 0.6% in the final storage Morsleben (closed 1998) and 1.4% in the ISN.

At the end of 2005 the net inventory of stored material in the ISN was 19 364.7 t with a total activity of 5.518E+14 Bq.

2.4.2 Conventional waste

Besides the waste from the NPP dismantling: the Category 1 material and Categories 2 and 3 material after free release, important amounts of the disposed waste are generated by other dismantling activities on the EWN site.
In the years with the highest mass of conventional waste (2001, 2003 and 2004) in the range of annually 50.000 t, the main part (about 75%) were concrete and other mineral building materials.
More than 10% are scrap metals.
About 90% of this conventional waste was recovered (e.g. by recycling).
For the assessment of the impacts from waste recovering it has also to be taken into account that the use of natural resources is reduced and thus environmental impacts (e.g. by ore processing) are prevented.
The quota of about 10% not recoverable waste is disposed environmentally friendly by deposition in landfills (dumps) or burning in waste incineration plants.
All subcontractors for treatment, disposal and recovery of waste are regularly audited.
The transport emissions are an important impact of the conventional waste management (see 2.6) as secondary temporary impact.

2.5 THERMAL OUTPUT (COOLING WATER)

The thermal output with the cooling water was important during operation but insignificant after shut down.

2.6 CONVENTIONAL EMISSIONS INTO AIR

Conventional emissions were increased by operation of the thermal power station, but this station was a necessary prerequisite for shut down the NPP units. In the year 2000, 11 t N-oxides and 1.5 t CO were emitted. With the decreasing energy consumption during the progress of decommissioning, these emissions are reduced.
Steady emissions come from the emergency diesel engines. The annual emissions between 1988 and 2001 were about 3400 kg N-oxides, 130 kg SO_2, 115 kg VOC (Volatile Organic Compounds) and 230 kg PM10 (Particulate Matter < 10 µm). Since 2002 this emissions are stepwise reduced due to the replacement by smaller emergency diesel engines.
The emissions from decommissioning activities:

- dismantling and cutting of facilities and facility parts,
- removal of insulation,
- removal of asbestos materials,
- waste conditioning,
- cutting of concrete structures,
- demolition of buildings, and
- demolition of plants for utilization of concrete and other mineral building materials

are reduced also by mitigation measures (e.g. filtration plants, band saw facilities), and present significant emissions are only limited to the working area.
The emissions from the transport of waste are more important. The range of these emissions is (worstly estimated) about 300g NO_x and 10g PM10 per ton of waste.

2.7 EMISSIONS OF NUTRIENTS AND WATER POLLUTANTS INTO SURFACE WATER (BALTIC SEA)

In comparison to the operation stage the annual emissions of nutrients, particulary N-compounds, were reduced from 6930 t to 860 t at the end of the post operation stage. Since the dismantling stage, the annual emissions were reduced to 130 t in 2000 and are approximately constant since this year.

The emission of water pollutants, e.g. Chemical Oxygen Demand or heavy metals, was similar. ***Impacts from the decommissioning process are not detectable***. With the progress of decommissioning further decrease of the amount of waste water and the load of nutrients and water pollutants is expected.

2.8 GROUNDWATER CONSUMPTION

An approximately constant quantity of groundwater consumption is caused by groundwater lowering for keeping a constant groundwater level of the EWN site. This quantity is independent from the stages operation, post operation and dismantling and on a level of about 940 000 m^3 per year.

Another part of the groundwater consumption is the drinking water. This annual consumption depends on the number of personnel and was decreasing from 1996 to 2005 from 312 Tm^3 to 99 Tm^3 .

The annual technological groundwater demand, primarily for the production of demineralized water is decreasing (214 Tm^3 1996 to 46 Tm^3 2005). ***Significant impacts from the decommissioning process are not detectable.***

2.9 ENERGY CONSUMPTION

The annual **electrical** energy demand for the whole site decreased almost continuously after shut down, except the period of the ISN construction. The demand in 1991 was 80 606 MWh and in 2004 it was 62 062 MWh.

The most important consumers of electrical energy are the pumps of the cooling systems, the ventilation systems, lighting and the ISN.

The annual **thermal** energy demand for the whole site has been decreased from 403 000 MWh after shut down in 1990 until the year 2000 when reached the value 138 580 MWh and is approximately constant since this year.

There are no significant impacts from the decommissioning process.

With the progress of decommissioning, further decreasing of the energy consumption is to be expected.

Another part of energy demand is the energy demand of transport processes from decommissioning, primarily for the internal and external transport of waste from decommissioning. This amount of primary energy is worstly estimated in the range of about 150 kWh per ton of waste.

2.10 NOISE

According to our experience from demolition of buildings outside the controlled or monitoring area the acoustic sources with the highest noise level are the activities ram of spile walls and operation of hydraulic chisels. Noise levels above the limited values of the German Technical Instruction for Noise in the nearest residential areas were not measured or calculated for planning.

For the demolition of concrete structures of the hermetic compartments in the controlled area, band saw facilities with a low noise level will be used.

Thus, ***the temporary noise impacts of the whole decommissioning process are below the legally required limit values.***

2.11 LAND USE

The construction of the ISN was a necessary prerequisite for the decommissioning process.

Land consumption outside the EWN site was not necessary.

3. EVALUATION OF THE IMPACTS TO THE PROTECTED GOODS

3.1 CHARACTERISTICS OF EWN SITE

The EWN site is surrounded by the FFH areas “Greifswalder Bodden”and “Struck”, by a bird protection area, by the community Lubmin, a seaside resort, and large woodlands.

3.2 IMMISSION OF RADIOACTIVE NUCLIDES

Small amounts of nuclides were detected in sediments of a sewer which flowed into the cooling water outlet channel and in sediments of the closed part of the cooling water outlet channel inside the EWN territory.
In the environment outside the EWN territory were only found artificial radionuclides from the Chernobyl disaster. ***Impacts from decommissioning are not detectable.***

3.3 IMMISSION OF AIR POLLUTANTS (FFH AREAS)

The immission state was slightly deteriorated by the operation of the thermal power station. This deterioration was below a detectable level.
Impacts from decommissioning are not detectable.

3.4 SURFACE WATER (GREIFSWALDER BODDEN)

The important impacts from the operation phase (thermal, transport of dirty river water, nutrients and water pollutants) were reduced after shut down to a very low level.
Impacts from decommissioning are not detectable.

3.5 GROUNDWATER (HYDROGEOLOGY)

Impacts from decommissioning are not detectable.

3.6 SOCIO – ECONOMIC IMPACTS

The shut down caused an important reduction of the personnel to about 1/3 of the initial staff. The decision to use own personnel for decommissioning resulted in a personnel need of about 1000 for the decommissioning period.
The social impacts are essentially mitigated by decommissioning.

4. CLASSIFICATION OF IMPACTS

With the shut down of all units and the beginning of the post operation stage, the following impacts were reduced in comparison with the operation stage:

- important reduction of the thermal output,
- important reduction of personal radiation exposure (almost 2 orders of magnitude),
- important reduction of the release of radioactive nuclides into air (almost 1 order of magnitude),
- important reduction of the release of radioactive nuclides into water,
- important reduction of the release of nutrients and water pollutants into water,
- important reduction of the groundwater consumption for the production of demineralised water,
- reduction of the electrical energy consumption,
- reduction of the thermal energy consumption.

Additional impacts

- emissions of conventional air pollutants generated by the thermal heating station,
- social impacts (reduction of personnel).

1. Impacts caused by post operation, independent of NPP dismantling activities:
   - groundwater consumption for the production of demineralised water,
   - release of nutrients and water pollutants into water,
   - release of radioactive nuclides into water,
   - thermal energy consumption,
   - electrical energy consumption,
   - quota of release of radioactive nuclides into air (post operation, fuel reloading, treatment of operational- and post operational waste),
   - quota of radiation exposure of personnel (post operation, guarding, radiation protection),
   - quota of radioactive waste (operational and post operational waste),
   - quota of impacts from ISN operation,
   - quota of conventional waste (post operation waste, dismantling of facilities and buildings outside the controlled and monitored area).

2. Impacts caused by decommissioning

   a) low level impacts
   - quota of radiation exposure,
   - quota of release of radioactive nuclides into air,
   - quota of emission of conventional air pollutants by dismantling activities,
   - quota of impacts from ISN operation,
   - small quota of electrical energy demand,
   - small quota of thermal energy demand.

   b) important impacts
   - radioactive waste, but on the other hand reduction of the emergency potential,
   - mitigation/reduction of social impacts

   c) important impacts but independent from other decommissioning options
   - conventional waste,
   - emissions into air by transport of waste.

3. Impacts independent from operation, post operation and decommissioning
   - emissions from the emergency diesel engines,
   - groundwater demand from groundwater lowering of the site.

The experience of EWN shows that the impacts on the protected goods from decommissioning/dismantling are on a significant low level, independent from chosen options.

5 IMPACT MITIGATION MEASURES

5.1 ORGANISATIONAL MEASURES

Additional to the legal required documents as the operational manual, the industrial safety instructions and radiation protection instructions, an environmental manual according to the EMAS and ISO 14000 requirements has been issued. As an important tool for supervision and control of all

environmental impacts and environmental related activities, an Environmental Information System in the companies intranet was developed.
The EWN company is certified as “Company specialised for plants with water harmful substances”. The responsible department for conventional waste management is certified as “Specialised Waste Management Department”.

5.2 TECHNICAL MEASURES

5.2.1 Minimisation of conventional and radioactive emissions

In the exhaust air systems of the controlled area, the Petrjanow filters were changed in 1997/98 to filters with the best available technique.
For all activities with the potential of aerosol formation, additional mobile systems for capturing and filtering are used. In the case of thermal cutting, non-inflammable ceramic filters have been used.
On all cutting places in the turbine hall, capturing and filtration systems are installed.
The cutting of armoured concrete structures is realised by diamond wire saw systems.
Advantages of these systems are:

- high cutting performance (1 – 2 m^2 / h),
- low aerosol / dust release (water cooling),
- low noise level (73 dB(A)), and
- possible automatic operation.

The removal of insulation of piping and plant equipment in the turbine hall was done by implementing a mobile suction system with separation of the insulation material in big bags. Advantages of this system are:

- high performance of removal of insulation,
- low release of stone fibres,
- only one worker is needed for operation of the suction system, and
- no direct handling of the insulation material.

5.2.2 Waste water treatment

For the purification of waste water from pickling activities in the operation stage (pickling of steam generators secondary side); and pickling of turbine condensers cooling water side resulting in the water pollutants high concentrations of heavy metals, small contamination with radioactive nuclides and high concentrations of complexones (EDTA and NTA)), a treatment procedure with the steps UV radiation exposure, precipitation and filtration was developed and implemented.

5.2.3 Reduction of groundwater demand

The high capacity demineralisation plant (planned for 8 NPP units) was oversized for post operation and decommissioning purposes. Caused by the lower consumption of demineralised water, the internal water consumption rate of this plant was about 44%**.**
With the erection and operation of a smaller demineralisation plant according to the best available techniques the internal water consumption rate was reduced to 3.5%.

REFERENCES TO ANNEX 2

Additionally to the EWN internal data the following references were used:

[1] KTA 1503.1 (rule of the committee for nuclear technology number 1503.1, supervision release of radioactive substances by stack output air) February 1979.

[2] Kurzbericht zur Luftguete des Jahres 2004 (report about air quality 2004), publication Environmental Agency of Mecklenburg – Western Pommerania (LUNG), 2005.

[3] Personal notification Federal Environmental Agency (UBA), April 2006.

[4] European Commission, Directorate General Environment, Service Contract Ship Emissions; assignment, abatement and market –based instruments, Task 2-General Report, Final Report, August 2005.

[5] Future Diesel, publication Federal Environmental Agency, July 2005.

[6] KTA 1504 (rule of the committee for nuclear technology number 1504, supervision release of radioactive substances by water) June 1978.

[7] Emissionsinventar deutsches Ostsee- Einzugsgebiet (emission inventory of the German Baltic Sea catchment area) Federal Environmental Agency (UBA) report, September 2000.

[8] VASA Energy Grosskraftwerk Lubmin Vertraeglichkeitsuntersuchung nach 19 c BnatSchG des EU-Vogelschutzgebietes „Greifswalder Bodden und Strelasund“ / FFH-Vertraeglichkeitsuntersuchung (FFH and bird protection area Compatibility Examination for the Power Plant Lubmin), Froelich & Sporbeck, Bochum, 1999.

[9] Central Radiological Computer System, publication Framatome ANP, Strahlenschutzpraxis February 2000, pages 26-29.