VUJE, a.s.

The Assessment Report in accordance with the Act of National Council of the Slovak Republic no. 24/2006 on Environmental Impact Assessment

Enlargement of NRR in Mochovce for disposal of LILW and erection of repository for VLLW

Title of the task: Implementation of the phase 2 of A-1 NPP decommissioning

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ANNOTATION

In the report is developed environmental impact assessment for enlargement of National Radwaste Repository in Mochovce for disposal of low and intermediate level waste, within which should be erected also the spaces for disposal of very low level waste. Assessment Report was developed in accordance with the Act of National Council no. 24/2006 Coll. as amended “on Environmental Impact Assessment“ Appendix no. 11 based on the Scope of Assessment issued by the relevant authority in respect of Intent assessment for such action. The report was elaborated in VUJE, a.s. Trnava - for Jadrová a vyraďovacia spoločnosť, a.s. Bratislava (JAVYS).

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LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As low as reasonable achievable
ARSOZ	System for administration and maintenance of technological equipment
BIDSF	Bohunice International Decommissioning Support Fund
CEO	Chief Executive Officer
CHSK	chemical oxygen demand
DP	Dose rate of gamma radiation in air quantified in value Kerma in air (Ka) [Gy/hod] or spatial dose equivalent (H*(10)) [Sv/hod]
EBO	Bohunice Nuclear Power Plant
EIA	Environmental Impact Assessment
EMO	Mochovce Nuclear Power Plant
EMO12	Mochovce Nuclear Power Plant, Units 1 and 2 (in operation), individual plant within SE, a.s. Bratislava
E	Effective dose, Sv
FS KRAO	Final processing of RAW (is by operation connected with EMO12, but also operated by company JAVYS, a.s.)
FCC	Fibre-concrete container
FMFI UK	Comenius University in Bratislava, Faculty of Mathematics, Physics and Informatics
H	Equivalent dose, Sv
HDPE	High-Density Polyethylene
HWGCR	Heavy Water Gas Cooled Reactor
IAEA	International Atomic Energy Agency
IED	Individual Effective Dose
IR	Ionising radiation
IWN	Infiltration Water Network
JAVYS, a.s.	Jadrová vyraďovacia spoločnosť, a.s. Jaslovské Bohunice
NPP	Nuclear Power Plant
A-1 NPP	Nuclear power plant A1 – shutdown, currently in the phase 2 of decommissioning, owned by JAVYS, a.s.
V-1 NPP	Nuclear power plant SE-EBO, Unit 1 and 2 (Ist decommissioning phase)
V-2 NPP	Nuclear power plant SE-EBO, Unit 3 and 4 (in operation)
KNK	Acid neutralizing capacity
IRAW	Institutional RAW
L1	measurement weir L1
L2	measurement weir L2
LCN	Losses Control Network
LILW	Low and Intermediate Level Waste
LRKO SE-EMO	Laboratory of radiation control of EMO NPP surrounding in Levice
MH SR	Ministry of Economy of the Slovak Republic
MMA	Minimum Measured Activity
m a.s.l.	meters above sea level

MO34	Mochovce Nuclear Power Plant, Units 3 and 4 (erection in process), owned by SE, a.s. Bratislava
MPV	measurement weir V (output from reservoir Čifáre)
MSK-64	International seismicity scale
MWe	mega-watt electric
MZ SR	Ministry of Health Care of the Slovak Republic
NEIS	National Emission Information System
NRR (RÚ RAO)	National Radwaste Repository Mochovce (operated by company JAVYS, a.s.)
NC SR	National Council of the Slovak Republic
NRA SR	Nuclear Regulatory Authority of the Slovak Republic
PF UK	Comenius University in Bratislava, Faculty of Natural Sciences
PHA SR	Public Health Authority of the Slovak Republic
PpBS	Preoperational Safety Report
PP	Operational procedure
p.v.	After levelling, it refers to height above sea level (Balt after leveling)
RAL	radioactive substance
RAW	Radioactive waste
RAP	Identification of information system for archiving of data on disposed RAW
RN	radionuclide
RWTC	Bohunice Radwaste Treatment Centre
RVT	Development of science and technique
S	Collective effective dose, man Sv/r
SCK•CEN	Belgian Nuclear Research Centre
SE, a.s	Slovenské elektrárne, a.s. (Slovenské elektrárne, Inc.)
SE-EBO	Slovenské elektrárne a.s., Bohunice Nuclear Power Plant (represents V-2 NPP – EBO34)
SE-EMO	Slovenské elektrárne a.s., Mochovce Nuclear Power Plant
SHMÚ	Slovak hydrometeorological Institute in Bratislava
SR	Slovak Republic
STN	Slovak technical standard
STU	Slovak University of Technology in Bratislava
Sv	Sievert (Sv) – measure of equivalent dose or effective dose. 1 Sv = J/kg
ŠGÚDŚ	State Geological Institute of Dionýz Štúr in Bratislava
TOC	Total organic carbon
TZL	Total suspended particles
TMR	Technical and manipulation frame
VLLW	Very Low-Level Waste
VVTL	Very high-pressure (gas pipeline)
VÚJE, VUJE	VUJE, a.s.
WWER, VVER	Water Moderated - Water Cooled Energetic Reactor (Woronezh type of pressure water reactor)
ZRAM	Seized radioactive material

Coll.	Collection of acts in SR
ZNK	Base neutralizing capacity

TERMINOLOGY, DEFINITION OF TERMS

1.	**Activity leading to exposure** Is any human activity, which could lead to habitants exposure from the existing sources of ionising radiation (IR) except the process of exposure in case of radiation incident or radiation accident; shall be justified and the risk of exposure shall be balanced with the assumed contribution for the person or for population.
2.	**Ionising radiation** It is a radiation transferring energy in the form of particles or electromagnetic waves with wave length up to 100 nm or frequency over 3.10^{15} Hz, which has the capability of producing ions directly or indirectly.
3.	**Institutional RAW** It is radioactive waste produced by working with sources of ionising radiation with the exemption of nuclear spent fuel and radioactive waste from nuclear facilities.
4.	**Critical group of habitants** It is a group of persons, that is in relation to the certain source of ionising radiation to the significant extent homogenous and representative for habitants, being exposed the most from the mentioned sours of ionising radiation.
5.	**Monitoring** Is repeated measuring of values, by which or by means of which is controlled, monitored and assessed exposure of persons and measurement of radioactive contamination of employees or workplace with sources of ionising radiation.
6.	**RAW management** Represents collection, sorting, storing, processing, conditioning, handling, RAW disposal from nuclear facilities, conditioning and disposal of institutional RAW.
7.	**Submitter** Is the legal entity or natural person intending to perform activity, which should be assessed under the Act on impact assessment (EIA).
8.	**Low and intermediate level waste** Is RAW, of which activity is higher than the limit value for its release into environment and produced remaining heat is lower than 2 kW/m^3. For RAW, which after conditioning meet limits and conditions for surface repository of RAW is the average mass activity of alpha nuclides lower than 400 Bq/g (locally is acceptable mass activity of alpha nuclides up to 4000 Bq/g).
9.	**Personal dose** It is a common term for quantities characterising extent of external and internal exposure of an individual person, namely effective dose (**E**), equivalent dose (**H**), committed effective dose (**E(τ)**)and equivalent dose (**H(τ)**) in individual organs or tissues; facilities, by which are personal doses measured, are marked as personal dosimeters and summary of measurements and assessments of personal doses is marked as personal

	dosimetry.
10.	**Operator** Is natural person – entrepreneur or legal entity, which in his name and on own responsibility performs activities leading to exposure or other working activities, on which relates Governmental Order no. 345/2006 Coll.
11.	**Natural ionising radiation** It is an ionising radiation of natural earth or space origin.
12.	**Natural radionuclide** It is a radionuclide that was formed or forms in nature spontaneously, without human intervention.
13.	**Radiation extraordinary event** Is the radiation event, by which occur not planned or unexpected exposure of persons on the level lower as the relevant limits of radiation or occurs dispersion of radioactive substances on workplace or its surrounding on the level, which ensures that radiation of persons caused by release or dispersion of radioactive substances cannot be on the level of relevant limits of radiation.
14.	**Radiation incident** It is an unintended event caused by loss of control over IR sources that can lead to exposure of persons at a workplace with IR sources on the level of radiation limits of employees or higher or by which occur unacceptable release of radioactive substances.
15.	**Radiation accident** It is an extraordinary event caused by loss of control over IR sources that results in leakage of radioactive substances or ionising radiation into environment, which can cause exposure of habitants on the level of radiation limits or which require establishment of measures for their protection.
16.	**Radiation protection** It is protection of persons and environment against radiation and its effects including the means for its achieving.
17.	**Radioactive contamination** It is the contamination of any material, surface or environment or individual by radioactive substances. By radioactive contamination of human body is understood external contamination of skin and internal contamination regardless the way of radionuclide acceptance.
18.	**Radioactive substance** It is any substance that contains one or more radionuclides, of which activity or mass activity or volume activity is not nominal regarding the radiation protection.
19.	**Radioactive waste** Any no utilisable material in gaseous, liquid or solid form, which for the content of radionuclides inside or for the level of its contamination by radionuclides cannot be released to environment.

20.	**Radioactive emitter** Is a radioactive substance, of which activity or mass activity exceeds the values the activity or mass activity stated in table no. 1 of Appendix no. 2 of Governmental order no. 345/2006 Coll. (radioactive substance, which cannot be released under administration control).
21.	**Very low level waste** is waste that does not necessarily meet the criteria of exempt waste, but that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near surface landfill type facilities with limited regulatory control. Concentrations of longer lived radionuclides in VLLW are generally very limited. of which activity is slightly higher than the limit value for release into environment.
22.	**Internal exposure** It is a personal exposure by radionuclides occurring in the body of this person, usually as a consequence of radionuclide intake by ingestion or inhalation.
23.	**External exposure** It is a personal exposure to ionising radiation originating outside the body.
24.	**Discharge** Place from which is radioactive substance released from the workplace with the sources of ionising radiation into air, surface waters or communal sewage.
25.	**Health damage** Is the estimation of risk life length shortening and worsening of life quality in population after being exposed to ionising radiation. It includes damage as a consequence of somatic damage, tumour disease and serious genetic disorder.
26.	**Source of ionising radiation** It is a radioactive substance, equipment or facility able to emit ionising radiation or produce radioactive substances.

PART A BASIC DATA

I. BASIC DATA ABOUT THE SUBMITTER

1 TITLE

Jadrová a vyraďovacia spoločnosť, a.s. Bratislava

2 IDENTIFICATION NUMBER

35 946 024

3 SEAT

Tomášikova 22

Bratislava

Post code: 821 02

4 AUTHORIZED REPRESENTATIVE OF THE SUBMITTER

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Ing. Miroslav Obert	- Vice-chairman of the Board of Directors and Decommissioning and PMU Director
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II. BASIC DATA ON THE PROPOSED ACTIVITY

1 TITLE

Enlargement of National Radioactive Waste Repository (NRR) in Mochovce for disposal of low and intermediate level waste (LILW) and erection of the repository for very low level waste (VLLW).

2 PURPOSE

The purpose of the prepared investment action is to provide change in accordance with the Act no. 24/2006 Coll. in utilisation of the site of NRR in Mochovce in order to be prepared for disposal of radioactive waste (RAW) inventory, which is and will be in accordance with the acceptance criteria of packaged forms of RAW suitable for disposal. To achieve that it will be necessary to extend the existing double-rows of repository boxes and increase the storing capacity for LILW from operation and decommissioning of Nuclear Power Plants (NPPs) in the Slovak Republic and to provide disposal of very low level waste safely and effectively.

On the National Repository of Radioactive Waste in Mochovce is within the proposed change in the concept of RAW disposal and in the connection with the enlargement of the storing capacities intended the implementation of the following activities:

- Enlargement of NRR capacity with the additional double-row for disposal of low and intermediate waste in accordance with the current concept,
- Separate disposal of VLLW [1] on NRR site, either in the new separate disposal structures for VLLW, or within the disposal boxes of NRR via the easier technological procedure (e.g. without FCC).

Further activities, which are not defined as a change in utilising the site, but will be implemented on NRR, are the provision of transition to the 2nd double-row before beginning of disposal in this row and completion of RAW disposal in the 1st double-row. These activities should be implemented prior to the enlargement of disposal capacities in NRR.

For Changes of the proposed activities in the facilities for processing, conditioning and disposal of intermediate and low level waste from operation and decommissioning of nuclear power plants and the use of radionuclides (Power industry, item no. 10, Appendices no. 8 of the Act no. 24/2006 Coll. On Environmental Impact Assessment as amended [L-1]) is a prescribed mandatory environmental impact assessment, without limiting the size of facility or the change. Pursuant to the letter from NRA SR [L-101] all changes in documentation according to § 2 letter u) of the Atomic Act [L-6], which were assessed and approved by the authority, shall go through the EIA process before issuing a decision according to the amended Act on Environmental Impact Assessment [L-2] and also through the connected proceeding on the level of European Committee with the directive applying the interpretation of § 37 Euratom Treaty [L-103].

[1] Separate disposal of VLLW will require separate management of the relevant waste by its producer.

3 USER

Jadrová a vyraďovacia spoločnosť, a.s. Bratislava (Nuclear and Decommisioning Company) as the operator of NRR in Mochovce.

4 PLACEMENT OF THE PROPOSED ACTIVITY

The NRR Mochovce Complex is located in c.a. Mochovce, municipality Kalná nad Hronom, district of Levice and the Nitra self-governing region. The plots the NRR area is located on, are owned by the Submitter and are registered as other areas ouside the developed area of municipality. Geographical coordinates are: 18° 26´ 11“of east latitude, 48° 16´ 18“ of north latitude. The activity shall be performed on the lot No. 3505/3.

Area of NRR is situated on the border of districts of Levice, Nitra and Zlaté Moravce. In terms of territorial and administrative division of the SR, NRR was built in the eastern part of the Nitra region, in north-west corner of the district Levice, about 12 km from the district town Levice, which is the largest city within the 20 km area of NRR. From other towns, town Tlmače is situated 7 km, Zlaté Moravce 14 km, Nitra 27 km and capital city Bratislava 90 km from NRR. The nearest municipality (air line) Nemčiňany is situated 4 km and municipality Čifáre around 4.5 km from NRR.

Geografically, NRR Mochovce area belongs to the northernmost part of Hronská upland – geomorphologic subdivision of Bešianska upland. Height above sea level of NRR is 215 m a.s.l. with the gentle incline to south and 2 % sloping. The NRR is situated in the valley Husárske, which lies between the hills “Pod Dobricou” and “Včelie”. The stated valley has from the closure lying aproximately 400 m north from the northern border of the area up to the distance aproximately 1 km south from the souther border of NRR, general direction north - south, with incline to south. The length of NRR is in respect of this matter 650 m. NRR lays in the lowest places of valley (fluvian plain) in the width 200 m. The distance from the eastern border of NRR to distributing board against the valley of Telinský stream (i.e. to the east) is 300 - 400 m. To the distribution board against the west valley from the west border of NRR is approximately 300 m. By the southern ending of NRR the distance decreases to zero, as a consequence of both valleys connection. Mountain range along the sides of NRR reach up to the height +270 a.s.l., bottom of valley decreases from the original +224 m a.s.l. (on the north border of NRR) to +206 m a.s.l. on the southern border of NRR.

The repository has been put into operation in 1999 after two double-rows have been erected as **National Radwaste Repository**. (Initial name Regional repository – for disposal of RAW from the operation and decommissioning of nuclear facilities in the Slovak Republic. Similar repository in operation is in Dukovany – for disposal of RAW in Czech Republic.) Therefore, already during the selection of site and putting in operation of the first double-row, it has been envisaged that the repository will be extended according the requirement in order to enable disposal of RAW from the operation and decommissioning of NPP in the Slovak Republic.

5 OVERVIEW SITUATION OF THE PROPOSED ACTIVITY PLACEMENT

The summary situation of the location of SE-EMO and NRR Mochovce is stated in Chapter C-IX on the picture Fig. C-IX. 1, Fig. C-IX. 2 and Fig. C-IX. 3..

6 REASON FOR PLACEMENT AT THE GIVEN SITE

The need for enlargement of the existing disposal structures in NRR Mochovce is indirectly connected with the Governmental Decision of the Slovak Republic (decision no. 801/1999) on the early shutdown and decommissioning of V-1 NPP in Jaslovské Bohunice. The consequence of the immediate V-1 NPP decommissioning is, that the waste from decommissioning should be disposed earlier as it was expected and sooner as some operational RAW, for which has been the existing double rows in NRR initially erected.

The place for existing RAW in Mochovce was selected in the second half of the seventies of last century by the organization responsible at that time for land-use planning (TERPLÁN) in cooperation with the nuclear facilities and research organizations. **The requirement was to have in each of the Republic of former Federation one near-surface repository for low and intermediate active waste from nuclear power plants**. From the 34 considered sites, were by TERPLÁN finally selected twelve areas, from which was given location selected using the selection criteria. For selection were used at that time already formulated general criteria for the placement of nuclear power plants. The criteria for site selection were specified based on at that time current legislation and safety guidelines of IAEA, using at that time already formulated general criteria for the situating of nuclear power plants.

The parameters characterizing the NRR site were latter for the needs of demonstration of long-term safety of repository developed in detail and discussed in the last two relatively large versions of Pre-operational Safety Report [L-37], [L-38]. From today's view, none of the values characterising the area represent absolute or conditional exclusion criterion.

Analyses of long-term safety of the repository have demonstrated that by meeting the relevant limits of radionuclide inventory of disposed RAW and other acceptance criteria for disposal of waste (Limits and Conditions of safe operation) the existing repository will be inherently safe for the long-term period.

NRR is placed approximately 1.5 km northwest from NPP EMO (in the protection zone), which is another advantage. The advantage is that for the actual area of NRR (as nuclear facility) it is not necessary to create an individual protection zone. The Implementation of monitoring programs for both facilities can be divided in order to increase efficiency and quality of the monitoring in the whole area.

In the previous studies [L-36], [L-37] it was not considered, that new disposal capacities would be somewhere else than in the present site of NRR Mochovce. In the study for the project C9.1 [L-29], which preceded to the development of intention to this report, the attention has been paid also to disposal of VLLW in existing NPP´s and in the new area, which would be the most suitable. Such possibilities were at the end in the last of the studies to the project C9.1 [L-31] refused due to the fact that from the offered solution alternatives based on the multi-criteria analysis (for details see Chapter V.1 in Part C) as the most preferred option was selected – the erection of the repository for VLLW on NRR Mochovce site within its enlargement (in accordance with the option III. of this report). Ministry of Environment in letter no. 8702/2010-3.4/hp of 2.9.2010 ceased the site alternative solution and agreed that the Intent and Impact Assessment Report on the Environment would include one site alternative and one alternative zero.

NRR is built on the area of approximately 11.2 ha and currently is used approximately 20 % of the area. Designer have, based on an analysis of the anticipated production of radioactive waste at nuclear power plants in Slovakia in the first stage, proposed to build two double-rows of repository boxes. Connection and distribution of energy, roads, sewage and rainwater collection tanks and drainage water were designed on the capacity of 10 double-rows of similar structure as the existing two double-rows. In case that independent repository for VLLW would be erected in the southern part of the area, remains available space for erection of 7.5 double-rows for disposal of VLLW.

The advantage of this locality utilisation for the erection of further spaces for RAW disposal lies in the fact, that the area has been already used for RAW disposal. The whole site of NRR is placed on the plot owned by the state (JAVYS, a.s. as the operator of repository and the submitter of its enlargement is the joint stock company established by Ministry of Economy of the SR), what is the necessary conditions for placement of the RAW pursuant to § 21 para (6) of the Atomic Act [L-6].

Safety of radioactive waste disposal in the repository has been confirmed in particular engineering geological and hydrological survey within the completion works on NRR from 1996 to 1999 [L-40]. The repository has been operating more than 10 years and for this entire period, there was no serious violence of operational instructions. Within the periodic assessment of operational safety of NRR Mochovce in year 2009, conducted in accordance with the relevant regulation of NRR [L-6] were identified only findings with low safety significance (in total 5) with the degree of non-compliance no. 2, to which were applied the corrective measures – see also Chapter. A-II.8.1.3.4.

7 THE DATE OF BEGINNING AND COMPLETION OF THE ERECTION AND OPERATION OF THE PROPOSED ACTIVITY

Designing and licensing process of the construction and operation of the enlarged repository shall be provided within the project BIDSF C9.4 “Design and Licensing of New RAW Disposal Space at the National Radwaste Repository, Mochovce”. Within this project shall be elaborated and approved the documentation necessary for the placement of the construction and obtaining of the building permission for the erection of the new double-rows for VLLW and repository for VLLW, as well as the licence (authorization) for the operation of LILW after the enlargement and for the operation of the repository for VLLW.

Preliminary schedule repository life with the considered changes could be as follows:

- Continue in operation – disposal of the first double-row and after filling the first one, passing to the second double-row.
- Additional engineering, geological and hydrogeological survey of the site for the erection of the storing structures within the years 2013.
- Pre-project preparation – documentation for issuance of land-use decision 2013-2014.
- Design preparation for the enlargement of the repository within the years 2014-2016.
- Commencement and completion of the erection within the years 2016 - 2018.
- NRR should be operated throughout the operation and decommissioning of nuclear installations in the Slovak Republic. Only at the site of Jaslovské Bohunice should be the operation and decommissioning of existing nuclear facilities completed around 2100 [L-34]. On the site EMO it should be finished latter due to the completion and putting in operation of the Unit 3 and 4 of NPP EMO (MO34). Disposal of RAW in the first double-row will proceed also during the

implementation of the shelter on the second double-row and erection of the third double-row and during the preparation and implementation of the area for the disposal of VLLW. The suitable technical and organisational measures shall be taken in order to enable these activities to run in parallel.

- Filling of empty spaces in boxes and implementation of the phase 1 of the coverage of the first double-row after its backfilling.
- After backfilling of all disposal structures (both existing and the ones built within the enlargement) and after the implementation of phase 1 of its coverage, the final coverage (phase 2) and closing of the repository shall be conducted. The design of construction and operation of the repository for VLLW shall decide, whether the coverage of the repository will be decided on phases.
  The final coverage and closing shall be solved (as well as licensed) as the individual phase of the lifetime of repository.
- After the final coverage and closing of the repository, the operational monitoring shall be performed with the aim to control activity in order to demonstrate, that the closed repository as a whole is a stable structure and its impact on environment is nominal in that time from the safety aspect. Post-operational monitoring is a part of institutional control according to [L-9] and follows the operational monitoring – see Chapter C.VI.1.3.

8 BRIEF DESCRITION OF THE TECHNICAL AND TECHNOLOGICAL SOLUTION

8.1 Characteristics of the current state

8.1.1 Management of RAW in the Slovak Republic

8.1.1.1 *Overview of RAW, the inventory and activity*

RAW in the Slovakia originates in nuclear and power industry and by using of radionuclides in other industries, e.g. in medicine, education and in research etc. RAW which arises while working with the sources of ionizing radiation in other then „nuclear and power“ industries are called institutional RAW (IRAW). The special type of RAW is seized radioactive material. It is different radioactive material withold on the territory of the Slovak Republic or found on the wastes dumps or junk yards. Most of it is of illegal nature, produced by unknown producer.

RAW according to the Atomic Act [L-6] represent any not used material in gaseous, liquid and solid form, which due to the content of radionuclides or the level of its contamination by radionuclides can not be released into environment. The most significant element of RAW by volume or safety are the wastes produced by the operation and decommissioning of the nuclear power plants.

Most of RAW from operation and decommissioning are low and intermediate active waste - LILW (except the spect nuclear fuel, which according to the definitions does not belong to RAW). Some of these, regarding the activities of some gamma and alpha nuclides (very small amount of part of the waste from decommissioning from WWER plants, more significant part of A-1 NPP decommissioning) cannot be according to the current accesses neither after processing not after the conditioning disposed in the surface type of repository but in the deep disposal.

Currently, the states with advanced nuclear power industry support the new approach to disposal of so-called **very low level waste** (VLLW) to repositories of low technical and building level with lower considered period of institutional control, in packages with less integrity; maintaining the required level of nuclear safety. This waste type belong under the valid legislation procedures to the level of low and intermediate level waste and its activity only in small amount exceeds the limits for free release into environment. In accordance with the new regulation of NRA SR no. 30/2012 is very low level waste an independent waste class.

In our case are the VLLW provisionally defined as such wastes that will be possible to dispose even without use of FCC and without special "backfilling" after filling of disposal structures. Their maximum specific activity for radionuclides important in terms of safety is usually 100 Bq/g, by some radionuclides it can be higher even by a order [L-28], [L-30].

To determine whether a particular type of radioactive waste falls into the category of VLLW, the acceptance criteria must be derived, which are applicable for particular facility (i.e. disposal). The acceptance criteria depends on the conditions and design of specific facility from the engineering barriers. For these reasons, the generally applicable requirements cannot be presently determined and acceptance criteria shall be determined based on the results of safety analysis derived from the development scenarios. Assumed types of VLLW are: contaminated soil, building debris, insulation material and metallic waste, etc.

Radioactive waste generated during the operation and decommissioning

During the operation and decommissioning of nuclear facilities are produced:

- Non active waste,
- Radioactive waste of lower activities, which can be released into environment (if it meets the limit values according to the appendix no. 8 of the Governmental Decision of the SR no. 345/2006 Coll. [L-4]; these can be:
  - In gaseous and liquid form- these are released to the atmosphere only after the inspection (through the ventilation chimney), or eventually into hydrosphere,
  - Contaminated material of the solid state – these are released under the institutional control into environment (for recycling or eventually waste dumps),
- Radioactive waste and spent nuclear fuel.

Overview and brief characterization of NPP in the Slovak Republic contains the following Tab.A-II. 1.

Firstly, RAW produced at NPP can be divided according to the state of matter on liquid and gaseous. The liquid operational wastes in NPPs are:

concentrates (including salts and sludges condensated in the tanks) - represent	85 - 90 % of the total volume of the liquid waste
spent resines -	5 - 10 %
filling of filters -	0 - 1 %
sludges -	3 - 5 %

Tab.A-II. 1 NPP in the Slovak Republic

Nuclear facility	power MW(e)	Type	Present state
NPP Bohunice A-1	150	HWGCR	Decommissioning
NPP Bohunice V-1 (NPP V-1)	2X440	WWER 400/230	I[st] Decommissioning phase
NPP Bohunice V-2 (NPP V-2)	2X440	WWER 400/213	Operation until 2020
NPP Mochovce -1,2 (NPP EMO12)	2X440	WWER 400/213	Operation until 2040
NPP Mochovce -3,4 (NPP MO34)	2X440	WWER 400/213	In erection

Radioactive waste generated during the operation of NPPs

The assumed volume of the liquid RAW (v m^3) prior to processing, produced during the operation of the individual NPP as follows:

NPP	Sludges and concentrates	Spent resins
V-1	998	184
V-2	1949	188
EMO12	3105	243
MO34	2000	200

Operational solid waste is divided on:

- compactable - 10 - 40 % volume
- combustible - 30 – 60 - “ -
- metallic - 5 – 15 - " -
- other non-compactable and combustible - 5 - 10 - " -

The following Tab.A-II. 2 states the overview of the volumes of the operational solid wastes from NPP before treatment.

Tab.A-II. 2 Production of the operational solid waste [m^3] prior to treatment [L-29]

Volume [m^3]	LILW			VLLW		
	Compac-table	Non-compactable	Combustible and cementation	Combustible	Non-combustible	Combustible and cementation
NPP V-1						
Stored at the end of 2006	74	183	106	45	0	32
Expected production	96	8	8	384	32	32
NPP V-2						
Stored at the end of 2006	37	9	45	153	26	192
Expected production	48	8	59	193	33	235
NPP EMO12						
Stored at the end of 2006	13	0	11	53	0	47
Expected production	88	15	108	354	61	430
NPP MO34						
Expected production	107	18	130	429	74	522
Total	464	242	467	1611	225	1489

Radioactive waste generated during the decommissioning

Expected flows of the waste from NPP decommissioning is activated metallic material, contaminated metallic components, contaminated surfaces of the buildings, contaminated concrete waste, contaminated soils, combustible waste, compactable non-metallic solid waste. Contaminated soils, depending on the activity will be disposed of in the repository of VLLW or LILW. Data on the mass of the solid waste produced during the NPP decommissioning are stared in Tab.A-II. 3 and Tab.A-II. 4.

Estimate of RAW from decommissioning of nuclear facilities regarding the type, amount and activity is a part of the conceptual decommissioning plans. The same as the conceptual plans are updated, is updated such estimate. Estimates of the types, amounts and activities of RAW result from the real measurements.

Tab.A-II. 3 Mass of solid waste [t] produced during the decommissioning activities

Nuclear facility	Solid waste not conditioned, [t]					Representation [%]	
	ND*	LILW	VLLW	Total	LILW & VLLW	LILW	VLLW
V-1 NPP	317	4903	6078	11298	10981	44.65%	55.35%
V-2 NPP	321	6230	7515	14066	13746	45.33%	54.67%
EMO12	321	6230	7515	14066	13746	45.33%	54.67%
MO34	321	6230	7515	14066	13746	45.33%	54.67%
A-1 (I) NPP	3	334	11141	11479	11475	2.91%	97.09%
A-1 (II) NPP	0	1405	3575	4980	4980	28.21%	71.79%
A-1 (III-V)NPP	148	2297	4161	6606	6457	35.57%	64.43%
A-1 (total) NPP	152	4036	18876	23064	22912	17.62%	82.38%

ND not disposable in the near surface repository

Tab.A-II. 4 Treated liquid wastes* [m³] from decommissioning

Nuclear facility	Type of liquid waste [m^3]				
	Concentrates	Spent resins	Sludges	Others	Total [m3]
V-1 NPP	617	66			683
V-2 NPP	1070	96			1166
EMO12	1070	96			1166
MO34	1070	96			1166
A-1 NPP (I)		11	536	309	856
A-1 NPP (II)	258				258
A-1 NPP (III-V)		7279			7279
A-1 NPP (total)	258	7290	536	309	8393

* - *In case of liquid waste the information exist only about the treated waste – volumes (m^3) of the treated waste, data on the initial production before treating is not accessible.*

Instutional and seized radioactive waste

Company JAVYS, a.s. is obligated following the Governmental Decision of the SR no. 610/2009 to erect the facility for management of institutional RAW and seized radioactive material, which is the part of system solution of this specific problematic. It is assumed that the significant part of such RAW is possible to dispose (after processing and conditioning using the technology of Bohunice radwaste treatment centre and final processing of liquid RAW) in NRR Mochovce. The facility for taking over, sorting and long-term storing of institutional RAW and seized radioactive material is planned to be erected in the nearest area with the NRR site in Mochovce [L-113].

Large group of institutional RAW represent disabled ionizing fire emitters which are used in the SR in mass scale (the estimated number of detectors in the SR is more than 100 000 pieces) without previous observation of their overall inventory and accurate placement. JAVYS, a.s. overtook in the period from 2001 to 2004 disabled ionising emitters of type ^{241}Am in order to condition them and dispose of in NRR. Between the emitters of ^{241}Am from fire alarms are a number of those that are releasable under the control of radioactive sources. As a form of emitters´ package form was chosen bituminisation to 200 l MEVA drums. Only one drum was inserted together with the operational waste from NPP to FCC and it was cemented. In the period of years 2004 - 2005 were produced and to NRR disposed 30 FCCs with emitters ^{241}Am of total volume 7,0.10^9 Bq.

Balance considerations stating the requirements for the capacity of the disposal places in time, were the subject of some studies. In the output from the project C9.1 „ Enlargement of the National Repository at Mochovce“ [L-29] financed by BIDSF is stated the overall amount of RAW, of which disposal is considered. By the abovementioned, the operation and/or decommissioning of A-1 NPP, V-1 NPP, V-2 NPP, EMO12, MO34 is considered plus the not significant amount (in terms of volume and activity) of institutional radioactive waste.

Volume and radiological inventory

According to the requirements of the submitter, the capacity of NRR Mochovce after the enlargement should respond to the total volume of RAW, which was stated in the feasibility project [L-29]. **The total volume of the treated RAW from the operation and decommissioning was in the study estimated to 50 000 m^3 of LILW and 68 000 m^3 of VLLW.**

Expected total radiological inventory of radioactive waste from operation and decommissioning of NPP in the Slovak Republic according to Tab.A-II. 1 for repositories of LILW and VLLW is stated in Tab.A-II. 5. Inventory was stated in the report of DECOM [L-109] based on the inventory databases for decommissioning, accompanying letters of FCC and using of operational instruction U-19 [L-112], based on which were calculated the values of activities of hardly measured radionuclides limited for NRR. Inventory of activities is stated independently for LILW and VLLW as a summary of the activities from the operation and decommissioning. The characteristics of the radionuclides included into the waste contains the table Tab.A-II. 6.

In this table are not stated radionuclides with short half-life of decay, most of which decay (radioactive decay is converted into a stable isotope) even before they get into the repository. Radionuclides with intermediate half-time of decay (order of years) mostly decay prior to the possibility of release from repository (after a lifetime of engineering barriers). Activity of radionuclides with very long half-time of decay (hundreds and thousands years) is not significantly reduced during the lifetime of barriers, and therefore the limits for their disposal are the most strict.

Tab.A-II. 5 Expected total radioactive inventory for repositories of LILW and VLLW from operation and decommissioning of NPP in the SR [L-68]

Nuclide	Inventory [Bq]	
	LILW	VLLW
^{14}C	1.31E+13	7.656E+09
^{41}Ca	7.55E+11	3.453E+08
^{59}Ni	9.40E+12	1.137E+09
^{63}Ni	3.82E+14	1.200E+11
^{79}Se	3.66E+11	4.826E+07
^{90}Sr	8.80E+15	3.797E+09
^{93}Mo	2.80E+11	6.957E+07
^{93}Zr	2.19E+12	3.443E+07
^{94}Nb	3.43E+10	3.190E+07
^{99}Tc	2.11E+12	6.607E+07
^{107}Pd	1.71E+13	4.571E+07
^{126}Sn	3.94E+10	1.920E+07
^{129}I	2.53E+10	5.371E+07
^{135}Cs	1.36E+11	1.722E+05
^{137}Cs	4.39E+16	1.332E+10
^{151}Sm	1.05E+14	7.517E+07
^{238}Pu	2.79E+11	5.646E+07
^{239}Pu	1.07E+12	1.581E+08
^{241}Am	1.98E+12	2.664E+08

The table below (Tab.A-II. 6) shows the Conversion factors for intake of radionuclides by ingestion [Sv/Bq], which reflect the size of radiological risks in the case it gets into the human body by drinking water or food. Because of the risk of external radiation (so-called intrusions scenarios) are these radionuclides less significant, due to the fact that they are mostly clear β emitters, or emit low energy γ radiation.

The most risky are α emitters - transuranium Pu and Am, due to the fact they emit α, β i γ radiation in addition to the relatively long half-life of decay.

Conception of RAW management is based on the principle, that there is no fundamental difference between the waste management initiated during the operation and wastes initiated during the decommissioning of nuclear facility. Naturally, its amount, type and composition will differ. Under RAW management is meant the collection, sorting, storing, treatment, conditioning, handling, transport and disposal of radioactive waste – see Fig. A-II. 1. The cycle of RAW management in this scheme results from the division of RAW in accordance with § 5 of NRA SR regulation no. 53/2006 Coll. [L-9] into the following classes:

a) transitional RAW, of which activity during the disposal decreases under the limit value and its release into environment (Appendix no. 8 of Governmental Decision no. 345/2006 Coll. [L-4]),

b) low and intermediate level waste, which meet limits and conditions of safe operation of the surface repository of RAW,

c) RAW, which do not meet limits and conditions for disposal in the surface repository of RAW.

Tab.A-II. 6 Characteristics of the radionuclides in the waste

Nuclide	Properties of the nuclide		Energy [MeV]			Conversion factor h_{ing} for acceptance of radionuclide by ingestion [Sv/Bq]
	Half-life period [year]	Method of transformation	Alpha	Beta	Gamma	
^{14}C	5730	β	-	0.049	-	5.8 10^{-10}
^{41}Ca	1.3 10^{5}	EC	-	-	-	1.9 10^{-10}
^{59}Ni	7.5 10^{4}	EC	-	-	-	6.3 10^{-11}
^{63}Ni	96	β	-	0.017	-	1.5 10^{-10}
^{79}Se	650	β	-	0.056	-	2.9 10^{-9}
^{90}Sr ^{90}Y	29 64 hour	β β	- -	0.2 0.94	-	2.8 10^{-8}
^{93}Mo	4.0 10^{3}	EC	-	-	-	3.1 10^{-9}
^{93}Zr ^{93m}Nb	1.5 10^{6} 14	β	-	0.02 0.028	- 0.019	1.1 10^{-9}
^{94}Nb	2.3 10^{4}	β	-	-	-	1.7 10^{-9}
^{99}Tc	2.1 10^{5}	β	-	0.10	-	6.4 10^{-10}
^{107}Pd	6.5 10^{6}	β	-	-	-	3.7 10^{-11}
^{126}Sn ^{126}Sb	2.5 10^{5} 12 day	β β	-	0.17 0.28	0.057 2.8	4.7 10^{-9}
^{129}I	1.6 10^{7}	β	-	0.064	0.025	1.1 10^{-7}
^{135}Cs	2.3 10^{6}	β		0.067		2.0 10^{-9}
^{137}Cs ^{137m}Ba	30 2.6 min	β γ	-	0.19 0.065	- 0.6	1.3 10^{-8}
^{151}Sm	90	β	-	0.02	-	9.8 10^{-11}
^{238}Pu	88.7	α, β, γ	5.5	0.011	0.0018	2.3 10^{-7}
^{239}Pu	2.4 10^{4}	α, β	5.1	0.0067	-	2.5 10^{-7}
^{241}Am	430	α, β, γ	5.5	0.052	0.033	2.0 10^{-7}

This table summarized the basic properties of radionuclides and its products of half-life, which are differed by italics letters.

EC – capture of electron

α - decay of alpha

β - decay of beta

γ - decay of gamma

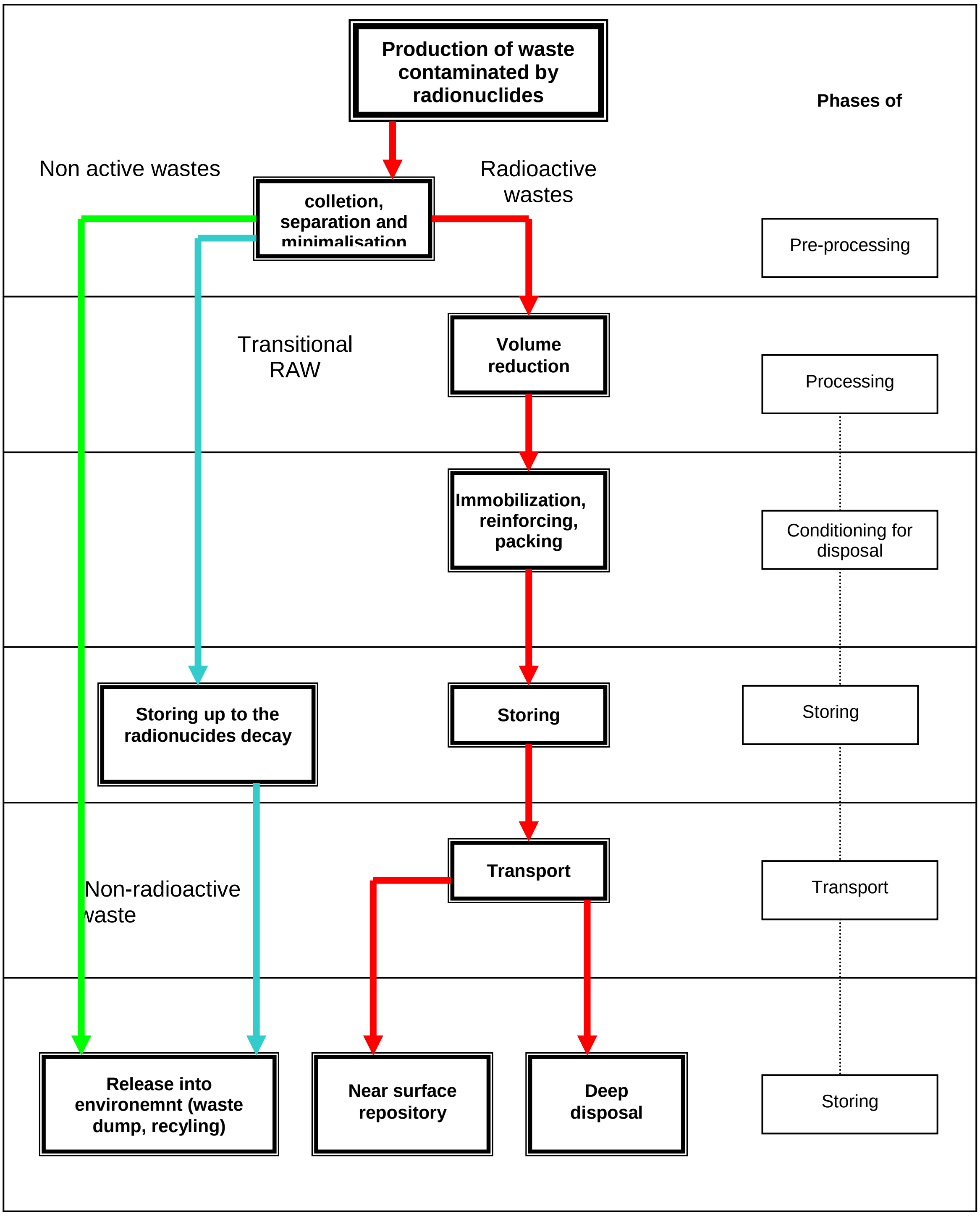

Fig. A-II. 1 Cycle of RAW management (conditioned with use [L-108])

8.1.1.2 *Treatment and conditioning of RAW*

By treatment of RAW are understood activities leading to the separation of radioactive components from non-radioactive, or eventually to gathering of radioactive elements into the smaller volume. In case of solid RAW it is compacting of compactable waste. As pre- treatment or (pre- processing) is sometimes defined collection, sorting, initial characterization and registration of the wastes.

For the characterization of waste is taken into account its appearance and form, especially radioactivity, or input power of effective dose on the surface of solid waste. When after sampling and measurement of e.g. liquid waste is found out, that the activity of the radionuclides is sufficiently low, it is possible to consider the release of the substance into environment. For release of radioactive substances into environment applies the limits of maximum accessible contamination by radionuclides, which are set forth in the appendix no. 8 of Governmental Decision no. 345/2006 [L-4].

Conditioning of RAW represents a targeted modification of their properties in order to meet requirements for safe disposal or for long-term storing. The substance of the modification of the liquid RAW is for example its solidification into the suitable matrix and insertion (packing) into the suitable package form. In Slovakia is the RAW treated partially also on nuclear facilities where it was produced and treating is performed on the individual, for that purpose stated nuclear facilities, of which operation is provided by JAVYS, a.s. Bratislava in Jaslovské Bohunice (RWTC) and in Mochovce (FS KRAO).

In Bohunice Radwaste Treatment Centre (RWTC) -Fig. A-II. 2– are used technologies on:

- sorting, fragmentation and high-pressure compacting of RAW,
- concentration or eventually thickening of liquid RAW
- cementation of the conditioned RAW,
- combustion of the solid and liquid organic RAW.

On the site of Jaslovské Bohunice there are placed also other technologies enabling the following processes of processing and conditioning of RAW:

- bituminisation of liquid RAW,
- sorting of solid RAW,
- vitrification of liquid RAW and inorganic sorbents,
- fragmentation and decontamination of the metallic RAW,
- fixation of the radioactive sludges into SIAL matrix.

The second centre in the Slovak Republic for processing of RAW is placed on the site of plant in Mochovce. In this centre – Final processing of liquid RAW – are installed the following technologies:

- bituminisation of concentrates into 200 dm^3 drums,
- bituminisation of sorbents and mixtures of sludges and sorbents to200 dm^3,
- thickening of concentrates for the needs of cementation,
- grouting of fixed liquid RAW packaged in 200 dm^3 by active cementation grout in FCC,
- logistic technologies (export of solid RAW from the site Mochovce for processing in RWTC in ISO container and the acceptance of the fixed liquid RAW in 200 dm^3 drums from the site Jaslovské Bohunice).

The basic technologies of inorganic liquid RAW processing are evaporating and processing in ion exchange resins. The results are given concentrates. Currently in the course of operation of NRR are the technologies of cementation together with bituminisation of the liquid waste and supercompacting of solid RAW, considered as the main methods of the waste processing. For the processing of RAW from A-1 NPP is approved also some thickened matrix - SIAL, vitrificate compacted by ash additive by paraffin.

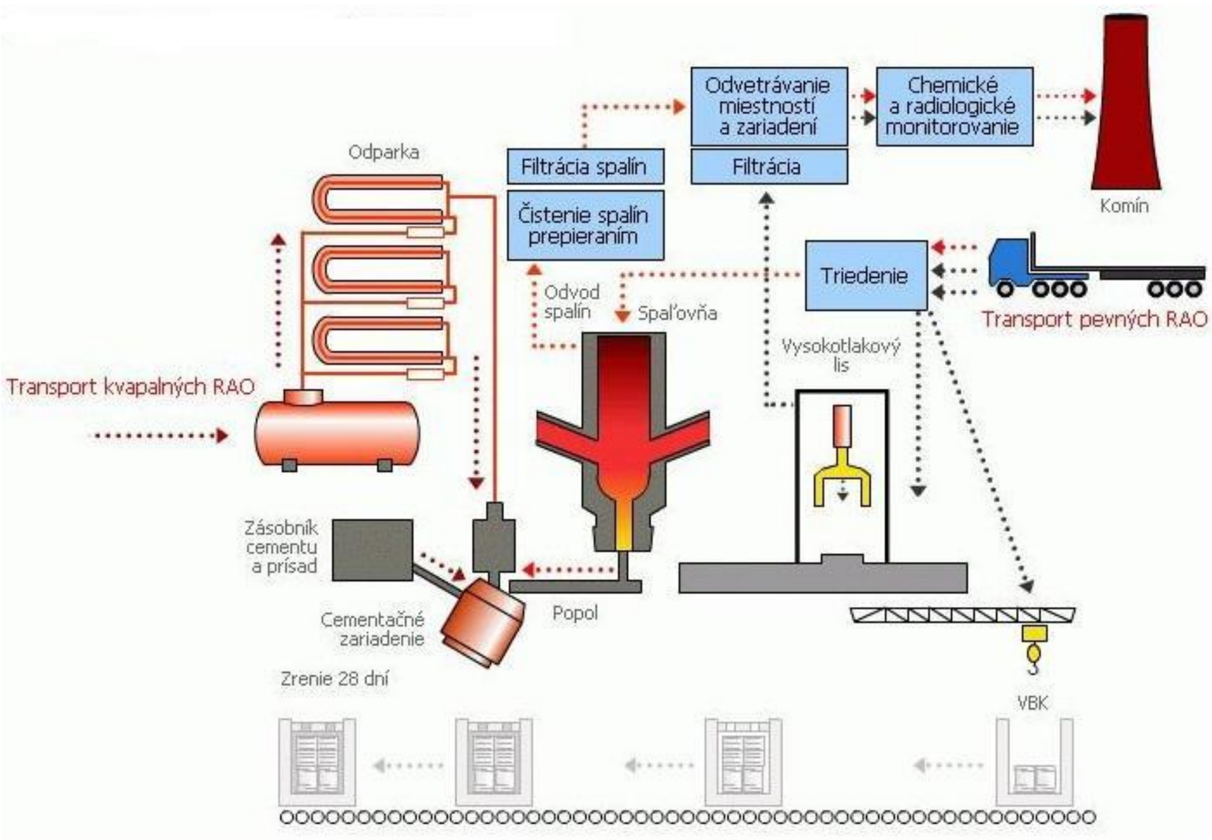

Fig. A-II. 2 Scheme of RAW management in Bohunice Radwaste Treatment Centre in Jaslovské Bohunice [L-66]

Bituminisation are thickened radioactive concentrates from A-1 NPP, V-1 NPP, V-2 NPP in Bohunice and from NPP Mochovce. As thickened matrix is used soft type of bitumen AP-80, produced in Slovnaft a.s. Bratislava. Dried salts of the concentrate, mixed with bitumen, are filled in 200 dm^3 drums.

For compacting of sorted non-compactable waste (PVC material, glass, glass-wall, small metallic material) from NPPs A-1, V-1, V-2 and EMO is used low-pressure compacting machine. By low pressure compacting is reached 4-5 multiple volume reduction. High-pressure compacting machine is used for compacting of MEVA drums filled with soft compacted waste after low-pressure compacting of drums with metallic waste (pipelines with maximum thickness of wall 6 mm). The result of high pressure compacting is pellet with height approx. 24 cm.

Chemical composition of matrix type SIAL is similar to the chemical composition of cements. SIAL is inorganic mixture, formed by polycondensation reactions of aluminosilicate clinkers. It is suitable for immobilisation of cold sludges, without exothermic reactions.

Vitrification, i.e by putting into galls matrix with temperature 1050 °C in inert argon atmosphere is processed cooling fluid after storing of fuel in NPP A-1, so-called chrompik (mixture of chromium and potassium dichromate).

In the cementmatrix are immobilised concentrates from NPP A-1, V-1, V-2 Bohunice and NPP Mochovce, sludges and gravel from the external tanks of NPP A-1 and contaminated water from cleaning of exhaust gas from RAW combustion. Cement grout (active and non-active) is filled also the empty space between pellets, drums and freely disposed types of RAW in FCC.

Part of RAW processing and conditioning is its packing into suitable package forms. For low and intermediate level wastes in the concrete or bitumen form are for that purpose used package forms of steel drums with the 200 l, galvanized from inside and outside. Such drums and other solid RAW of larger size are inserted into concrete packages (FCC – Chapter A-II.8.1.2.2), in which is free space filled with cement grouting, what helps to ensure better the disposed waste in the package form. Usually is in FCC stored 6 pieces of bitumen product in 200 l drums, or 4 drums and other empty volume is filled with pellets from high-pressure compacting. Such filled FCC grouted on the cementation facility by active cementation grout is (after tightening and curing based on the criteria, of which fulfilment is declared in Accompanying letter) shipped to NRR into Mochovce. The Accompanying letter contains all data – parameters of container from production, data on types and amounts of the individual waste, which were inserted into it, the results of analyses of the chemical control, the values from measurements of radionuclide composition and cement and the results of monitoring of radiation and safety characteristics. All this data is archived in written and electronic form and it is completed by data on position of the disposed container from the monitored repository.

It exists also RAW, not complying with the acceptance criteria on the operated repository and therefore it can not be disposed there. It is mainly some high level waste, waste with long-term radionuclides (see Tab.A-II. 3), used radionuclide emitters and mainly nuclear spent fuel, which are necessary to be disposed in deep disposal unless it does not exist to interim storage, in which are stored until the enlargement and erection and putting in operation of such deep disposal. It is assumed, that such repository will not be stored sooner than in second half of this century [L-34].

8.1.1.3 *Transport of the RAW package forms*

Transport of radioactive substances via road communication is managed under requirements of NRA SR set forth in Atomic Act [L-6] and in regulation of NRA SR no. 57/2006 Coll., by which are stated the details about the requirements for the transport of radioactive material [L-12] regulation of Ministry of Environment no. 545/2007 Coll., by which are amended the details about the requirements to provide radiation protection for activities leading to exposure and activities important regarding the radiation protection. These rules are basic and standard documents for the transport of radioactive substances generally via road communications and specific communication within the area of nuclear facility.

Shipments are subject to notification duty of NRA SR and PHA SR. For the transport are used trucks meeting the requirements of Convention on Road Traffic concerning the International Carriage of Dangerous Goods by Road – Convention ADR**.**

Transport of LILW in FCC via road communication of JAVYS, a.s. is provided by means of transport vehicle with semitrailer on which are two mounting trays in which are fastened and covered with sheet two FCC [L-13]. The main route leads from JAVYS, a.s. in Jaslovské Bohunice via Malženice, Trakovice, to the highway D-61 direction to Bratislava up to the crossroad with highway R1 by Trnava, then by highway R1 to Nitra and then via Vráble and Čifáre to NRR Mochovce. Frequency of the transport is stated by the capacity of the processing facilities. RWTC produces annually aprox. 280 FCCs, so the annual number of shipments is aprox. 140.

The transport of FCC with LILW can be combined also by transport via railway and road [L-14]. In such case are by railway transported 12 pieces of FCC fastened on the mounting tray TMR and covered with sheet on railway carriage RILS, type 9-212.04 from Jaslovské Bohunice to SE-EMO in Mochovce (external railway carriage no. 670/7). It is necessary to transport FCC from that place to NRR Mochovce on transport vehicle with semitrailer (as stated above).

The transport from final processing of liquid RAW from the protection zone of NPP SE-EMO is performed via the main gatehouse by the road to Čifáre and then by the specific communication to NRR. We assume that VLLW will be to NRR transported in the approved type of the package form by the similar routes.

8.1.2 Description of NRR in Mochovce

8.1.2.1 *Disposal spaces*

The NRR Mochovce is built on the area of the total 11.2 hectare and it consists of a complex of buildings, technological facilities serving for handling with RAW from their arrival to the repository up to the final disposal. The part of the area is fencing, access and interplant roads, retaining ditches, operational building, the object of the repository itself or eventually repository boxes. The repository area, if we understand under this term the area bounded by fencing, has the shape of trapezoid. The area width is 200 m and maximum length is 650 m with longitudinal axis oriented in the direction NEE–SSW. Currently, only 20 % of its area is being used – see Fig. C-IX. 4.

The object of repository itself consists now out of two double-rows of reinforced concrete disposal boxes constructed in the northern area of the NRR site and oriented in the direction east-west. One double-row consists of ten units dilated from each other (width 37.25m, length 123.2 m) – five in each row. Dilatation gaps between the units are 50 mm broad. There are 20 boxes in one row, 4 in one dilatation unit. The axis dimensions of disposal boxes are 18 x 6 m, internal dimensions are 17.4 x 5.4 m. The height of walls is variable, medium height is 5.5 m. The thickness of the reinforced concrete walls is 600 mm. A crane track with the span of 18 m, on which a portal frame crane with the bearing capacity of 20 t runs, is laid on the longitudinal walls of the double rows. On the inner cross walls are placed covering panels with thickness 0.5 m and length 6 m, gravitated always from the two disposal boxes into one discharge channel. These discharge channels in one double-row, into which is stored RAW in FCC, do not fulfil its function anymore, due to the fact, that double-row is covered by hall (Tab.A-II. 3), which prevents from the rain water flow. The steel hall has dimensions 52 x 156 m. The hall´s height is 16.75 m).

Fig. A-II. 3 Steel hall above the first double-row of NRR with the transport gantry crane

At the end of each row are long stop ways of crane track. The long stop ways serves for handling with FCC by its preparation for disposal (see Fig. A-II. 8), by short stop way is erected adjusting track, which serves for replacement of the gantry crane within the individual rows or double-rows of the repository.

As tightening element, separating the repository from the surrounding environment, was used compacted clay of the required attributes. Clay sealing forms "bath", to which s repository set. Around the side concrete walls of each row is set compacted clay layer wide 3.5 m. Under the concrete bottom of repository is 0.6 m gravel drainage layer, under which is the bottom of clay bath with thickness 1 m. In the are of both stop ways is the width of the vertical sealing clay 1 m.

From the inner side are concrete disposal boxes secured by damp proof paint and on its bottom is lied drainage gravel layer (granularity 8 – 16 mm), serving as levelling layer for disposal of containers. Gravel layer is covered by sealing permeable geotextile.

Due to the fulfilment of requirements of system for RAW disposal, mainly regarding the prevention of rainfall waters to repository, is the operated first-double row covered by hall. Cross-section of the first double-row is stated on Fig. C-IX. 11.

Currently, the first double row is in operation and the second is being prepared for its operation [L-26], including the erection of the covering hall. In the south part of area is erected the coverage model, on which are within the long-term period monitored the parameters of material (clay soil), which will be used for the implementation of the second phase of coverage in time of definitive closing of repository. The current state of built-up area is stated on Fig. C-IX. 4.

8.1.2.2 *Disposal container*

The RAW is disposed of into the repository in the fibre concrete containers (FCC). The containers have a cubic shape with the height 1.7 m and minimum wall thickness of 115 mm (Fig. A-II. 4).The inner volume of the container is 3.1 m^3. Overall weight of the empty container together with lid and two plugs is 4240 kg. Further parameters of FCC container are stated in Tab.A-II. 7.

Tab.A-II. 7 Parameters of FCC

Type, label	FCC with final processed RAW
Dimensions	1700 x 1700 x 1700 mm
max. weight after filling up	15 t
The ability of stacking	3 on each other
Stacking toughness of FCC	28 t + additional load from coverage
manipulation –grip device	upper 4 – point hanger with automatic shutdown
Overall volume (1.7 x 1.7 x 1.7m)	Approx. 4.9 m^3
Useful volume of FCC	Approx. 3.01 m^3
Weight of the container body (body + lid + plugs)	4.240 t
Maximum weight of the filling	10,760 t
Weight of the container body	3,500 t
The weight of the lid	0.690 t
The weight of plugs	0.025 t (2x)

Fig. A-II. 4 Cut through the fibre concrete container (FCC)

The containers are disposed into boxes pushed closed from the wall (Fig. A-II. 9) (the corner of the repository box) on the bottom of the box, adjusted into the level by gravel sand with geotextile. The inner space of every box provides for disposal of 90 containers. 7200 of such containers with the total volume of 22 320 m^3 can fit into existing double-rows (80 boxes).

8.1.2.3 *Drainage system*

It serves for draining and control of drainage waters from the repository area and its close surrounding (Fig. A-II. 6). It consists of a system of controlled and monitored drainage.

Controlled drainage–its function is to drain waters if it got into repository (gravel drainage layer in boxes-KD1, or between the bottom of repository boxes and the bottom of clay bath - KD2). Concrete galleries, enabling controlled water drain from every repository boxes separately and also from the gravel drain layer under the repository, are built along every row of repository boxes (of individual dilatation units) for control and monitoring of such waters (Fig. A-II. 5). The galleries are through, lit and ventilation enabled. They have vault profile of 1300/1900 mm and are dilated correspondingly with dilatation of repository boxes. The galleries are in the area of long stop ways ended with monitored reinforced concrete shafts. The shaft consists of four floors and in it are located devices for shaft ventilation, spaces for sampling of drain waters, collection and manipulation of drain waters.

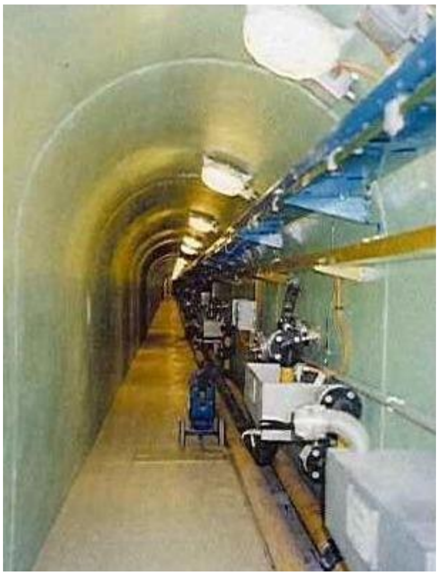

Fig. A-II. 5 Monitoring gallery of NRR Mochovce with the system of controlled drainage KD1 and KD2

Monitored drainage – it drains the seepage waters from outer side of the clay sealing and from the area under long and short stop way. It is built out of flexible perforated tubes laid into the gravel bed. It flows into original reinforced tanks fitted with stainless steel.

Rainfall water basins

Their purpose is retaining and control of surface rainfall waters from the repository area before their release into drainage ditches, possibly other disposal. They are two basins independent from each other, each with a volume of 490 m^3. The waters collected in basins are controlled before their discharge from the repository. Following the measurement results, they are either discharged into drainage ditch or transported for further processing. The drainage ditch and the artificial channel link to "C" tributary of Telinský stream. These surface flows mount into Čifársky pond, which presents virtually the only place of practical use (irrigation) of surface waters that are possibly affected by the repository - Fig. C-IX. 2.

Also drain waters (controlled drainage and monitored drainage) are pumped after the control from the respective basins in the control shaft. During the operation of the double-row, the water is situated in the gravel bed under the disposal boxes due to the regulation of the humidity of clay seal – the amount of water can be regulated through the controlled drainage (KD2) and device for moisturing of the clay of clay bath.

Waters from the monitored drainage are overdrawn from the control pit placed outside the disposal area in the long stop way- Fig. C-IX. 11. These waters are led into retaining basins via underground tube collector erected along the drive communication.

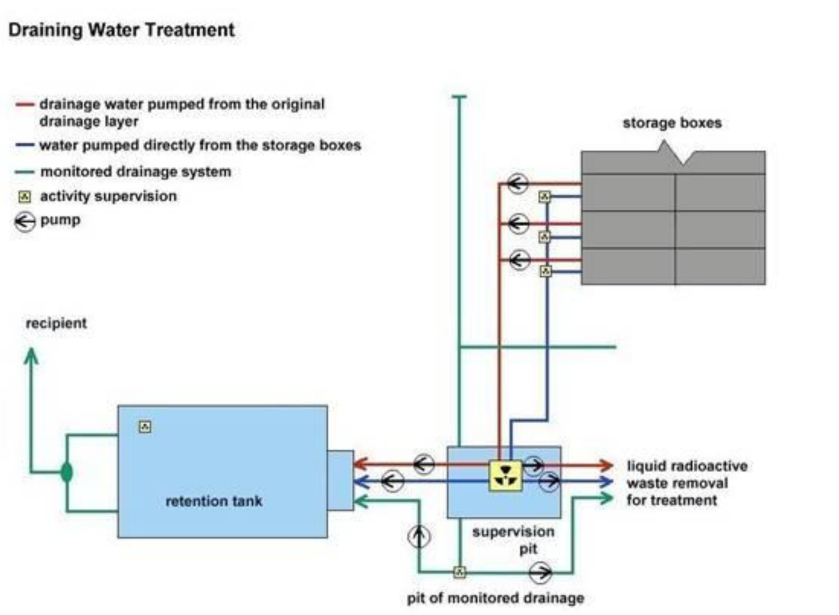

Fig. A-II. 6 Scheme of the drainage system and manipulation with drainage waters

8.1.2.4 *Technological equipment*

There is not classified equipment on NRR in terms of by legislation set forth definition (regulation of NRA SR no. 50/2006 Coll. [L-7]). Technological equipment significant regarding the operation reliability is equipment related to the manipulation with the package form of waste accepted for disposal. Disposal spaces are described in Chapter A-II.8.1.2.1. Amount the other technological equipment it is:

- Equipment for measuring of surface equivalent dose and contamination after accepting the package form for disposal,
- Crane runway,

- Gantry crane itself and gripping device,
- Equipment for collection, discharge and monitoring of water from the disposal boxes (in case of the presence),
- equipment for the regulation of the water amount in the gravel bed between the bottom of disposal boxes and bottom of clay bath,
- equipment for water level measurement and overdrawing of the water in the collection basins of the drainage system.

The gamma scanner serves for the control of the package form after the transport into NRR. Gamma scanner scans gamma spectrum on the surface of FCC in the pre-defined points. After processing of gamma spectrum, gamma scanner calculates the summary activities of the dominant radioactive isotopes ^{137}Cs and ^{60}Co and its decomposition in the volume of FCC, summary activity of isotopes difficult to measure and the map of dose rates on the surface of FCC. Gamma scanner consists of two basic parts, from the construction bearing gamma spectrometric detectors and electrical parts – see Fig. A-II. 7.

Crane runway has a length range of 18 m and length 141.9 m. A gantry crane of the class A4 is designed for unloading of FCC containers with RAW and for uncovering of the cover panels of the boxes. The technical characteristics are as follows: maximum loading capacity 20 t, maximum working height of the lift 12 m, range 18 m, angle of turning is 100°. Control of crane track settlement together with control of disposal boxes settlement is performed by geodetic measurement at least twice a half year – see Chapter C-VI.1.

Fig. A-II. 7 Gamma scanner for the control of the radiation characteristics of FCC

One of the conditions of NRR safe operation is, that in the disposal boxes, from which each has its drainage led into the tanks in the monitoring gallery, shall not be water. Detection is done by contact sensors in the collection basins placed in the monitoring gallery (Fig. A-II. 5), while the signal is led to the central panel in the control room in the operational building, equipped by the signalisation also on the individual panels in monitoring galleries.. Control of the signalisation functioning is performed once a moth.

8.1.2.5 *Assessment of the operating life of engineering barriers*

Within the pre-operational monitoring were verified parameters of the engineering barriers (lifetime, water tightness of FCC and fibre-concrete boxes, insulation properties of the clay bath) and stability parameters of the base on which has been NRR erected – see Chapter C-VI.1. The task of such monitoring was to specify or confirm the parameters of such engineering construction and environment which was taken into account in the design and which were used in the safety analysis of such procedure of VLLW disposal.

FCCs– are produced in the French licence and its integrity is by the producer guaranteed for the period of at least 300 years. Such containers are also transport containers. The tests of mechanical properties and accelerated durability test of fibre-concrete on the workplace of Slovak University of Technology in Bratislava confirmed its sufficient reliability [L-71], [L-72].

Reinforced concrete building construction

Reinforced concrete prefabricated panels of overlap and walls of boxes are an important barrier against the disturber and have irreplaceable function in the stability of the repository. For some radionuclides, concrete represents the significant retardation barrier.

Based on the repeated measurement of carbonation coating of boxes reinforcement, it was [L-43] stated, that main bearing reinforcement in the walls and ceiling prefabricates will not be endangered during the whole assumed lifetime of 300 years by corrosion..

Clay bath

The sufficient and continuous sealing force of the clay baths in the NRR Mochovce is one of the basic conditions of its safe operation and conservation. Permanent retention of the required sealing efficiency of the clay bath is significantly dependent from the maintenance of the humidity in the limited optimal limits. Therefore, it is necessary to continuously control its changes in time and in the real conditions and in particular the early detection of any exceeding of the specified admissible values of humidity of the clay bath and by that also eventual endangering of the sealing efficiency.

Erection of the monitoring shafts along two ferro-concrete boxes provided the possibility to measure in detail the humidity of the clay sealing for the period of approximately 10 years of its creation. According to design, the basic requirement for reaching of the required attributes of the clay tightness (coefficient of filtration $k_f = 1.10^{-9}$ m/s, or eventually less) the degree of compaction is at least 96 % according to the test of Proctor Standard for which the characteristic humidity of the clay is 17 %. The clay layer is also involved in a significant rate on the geotechnical stability of the entire disposal system. Maintenance of the required stability against the slide is significantly dependent from the maintenance of the humidity in the specified optimal limits – from 16 to 20.5 %. Such humidity is convenient for the long-term maintenance of the required hydraulic conductivity.

From a statistical evaluation of clay samples taken during the construction of monitoring galleries (in total were taken 149 samples of clay evenly from all 4 galleries) resulted 95 percent probability that the natural humidity of any sample of the clay from the clay bath is within the range from 16.76 % to 19.28 % and, therefore, lies in the optimal range of humidity [L-44].

Subbase

According to standards ČSN 73 1001, STN 73 1001 and Eurocode 7 - ČSN PENV 1997 – 1 it is necessary to assess establishment of each construction in respect of limiting state 1 and 2. First limiting state is the limiting state of bearing capacity; the second limiting state is the limiting state of applicability.

Limiting state of bearing capacity is a state, by which occur the overall loss of stability in a way, that the soil is under the base is impressed and the construction will sink. Moreover, if is the construction situated near excavations or by slope, the overall stability could be disturbed by landslide with the construction.

Limiting state of usability is a state of transformation of the subsoil, which is defined by the values of settlement, uneven settlement etc. In our case assessed ferro-concrete boxes, as rigid ferro-concrete construction, it is admissible the overall average settlement 200 mm and uneven settlement characterised angle deformation 0.003. If the limiting state of bearing capacity is not fulfilled, than it is not possible to state the settlement of foundations and therefore assess the limiting state of usability.

The calculation of limiting state of bearing capacity according to Eurocode is based on the principle of safety coefficient. In report [L-45] were by the comparison of bearing capacity of subsoil with the required bearing capacity demonstrated, that for fully filled two double rows of NRR FCC by containers including the loading from phase 1 to phase 2 of coverage is the level of safety $\mathbf{F_s = 6}$. Generally is marked the safety level 2 to 3.

The results of settlement measurements, performed in the course of the current operation of NRR show, that settlement of boxes proceeds in the expected limits (units of mm in comparison with the limiting average final settlement according to STN 73 1001, which is 200 mm). According to the current results of settlement monitoring (performed by means of specific levelling of disposal boxes and by means of dilatometers) it is showed, that neither long-term element of space displacements in dilatations nor slope of dilatation units, which characterise the uneven settlement are not significant compared to limiting uneven settlement– for more details see Chapter C-VI.1.2

Final coverage

Covering is a multifunctional system that drains rainfall waters by its surface and drains penetrated rainfall waters by drainage layer, prevents from penetrating of water into boxes (insulation function) and prevents from radionuclide penetration from boxes to the terrain surface. The significant attributes of coverage are thickness, material, technology of modification, draining of rainfall waters by system of drainage and gradients outside the area of double-row and repository as a whole. According to the current proposal will be the covering construction formed by sealing clay layer with thickness 2 m and covering layer of thickness 1 m.

Monitoring of the long-term influence of erosion for the future covered repositories is monitored on the Model of coverage, which is erected in the south-west part of the NRR site in Mochovce – Fig. C-IX. 4

and Fig. C-IX. 25.On this model are monitored also parameters of the main sealing element –clay – regarding the long-term acting of the climate conditions in the area of NRR- see also in detail Chapter C-VI.1.2.

8.1.3 The current operation of NRR

Into the operation of the repository belongs:

- Acceptance of the package forms for disposal and inspection of the waste and manipulation with the container with the waste from the moment of handover after its disposal in the box,
- Placing of containers on the stated place,
- Maintenance of information on the container localisation with the waste in repository,
- Operational monitoring of the environment.

8.1.3.1 *The process of waste acceptance for disposal*

The process of the waste acceptance for disposal is as follows:

a) Producer of FCC with RAW will send the copy of ”Accompanying letter to the shipment of RAW” and protocols providing the correctness of the parameters to technician – system engineer of NRR through the computer network - LOTUS NOTES /by e-mail/ and through the application ARSOZ.

b) Technician - system engineer will inspect data and assess the applicability of the prepared deliverable for disposal. In case of detecting any non-compliance in accompanying letter, he informs the technician of registration and inspection of FCC.

c) FCC Producer with RAW prepares the container with RAW and provides its transport on NRR Mochovce including the legislation provision.

d) Driver of the transport vehicle with RAW, after checking at the entrance by the employees of safety service, will stop the car on the stated and marked place on the repository site.

e) Employer responsible for disposal takeovers the accompanying documentation from each FCC with RAW from the driver and checks its completeness according to the limits and conditions of NRR.

f) Technician of radiation protection for NRR handover to the driver of the transport vehicle instruction for the entrance to the controlled area and ELD (electronic dosimeter).

g) Foreman of the repository operation shall provide transit of the route from the entrance gate up to the space of the long stop run of the first double-row (that is there shall not be any vehicles or constraints on the route before or during the transport, which would prevent from the smooth and safe transport of the truck).

h) After the verification of the data correctness shall employee responsible for disposal, give consent to the transport of the vehicle and informs the driver, into which stop way shall be the semitrailer with FCC parked.

i) Foreman of the repository operation will issue, by its signature in the accompanying letter, the permission for the transport of deliverable to the disposal boxes.

j) Procedure during the FCC taking over during the combined transport (by railway and by road communication) is the same as via the transport by the vehicle – see Chapter A-II.8.1.1.3.

If there is any non-compliance in the accompanying letter, technician- system engineer issues protocol on non-compliance.

The repository operator verifies the characteristics of the waste container, in respect of the chosen concept of waste disposal and from that derived design solution and designs itself, by the methods of audit by the waste producer. For the individual flows of the waste, repository operator inspects quality of the measurements leading to the declaration of characteristics of container with waste from the producer side, meeting of such parameters of waste accepted by the container producer with the waste and parameters of the conditioning process itself, which has got influence on the characteristic attributes of container with waste.

On the accompanying letter of the container with the waste is marked, which information about the container with waste were obtained by measuring and which the other way. All measurements for demonstrating the values, through which are directly or indirectly stated the characteristics of the container with waste, are performed with the stated measures in accordance with the metrological instructions [L-19].

The basic obligation, responsibility and authority of the NRR employee performing takeover of containers with waste for disposal, is to perform audit of correctness of the method of characteristic values declaration and properties of waste containers. Control is performed at least twice a month and always when there is a doubt about the correctness of the characteristic declared in the accompanying letter with the waste. Detailed inspection is performed also when the products, technological parameters of the process and/or type of the waste entering the process of conditioning is changed.

To repository is by licence holder disposed of only RAW package form, meeting the limits and conditions of safe operation of repository approved by NRR based on safety analyses. Safety analyses of repository represent complex risk assessment connected with RAW disposal and demonstration of its functionality and safety of the disposal system regarding the potential impacts on human and environment, taking into consideration natural development of repository as well as potential possibilities of its violation after the completion of disposal in repository and after the closure [L-9]. Safety analyses and connected licensing conditions determine requirements for the repository inspection. For example, during the development of acceptance criteria are safety analyses used in order to determine requirements for package forms and size of inventory for package form as well as for the whole repository

Activity limit values of radionuclides in FCC and activity limit values for the whole area of NRR are derived from basic population exposure limits and they were stated by the authorities of hygienic supervision in the period of repository design [L-24] and practically in the unaltered form are also set forth in the amended decision in the year 2011 [L-85], by which is the company JAVYS as the operator of the NRR in Mochovce allowed to operate repository and release radioactive waste from regulatory control by its discharging to surface waters. In this decision, the operator of NRR is obligated:

- To ensure that annual effective equivalent dose caused by disposed RAW at NRR in Mochovce for an representative individual of population shall not exceed the limit value of 100 μSv per year (0,1 mSv/year) in any year after the institutional control as a consequence of evolution scenario by which the violation of the repository structure by human intervention will not occur (scenario with the probability equalling to one),
- To ensure that annual effective equivalent dose caused by disposed RAW at NRR in Mochovce shall not exceed the limit value of 1000 μSv (1 mSv) for an representative individual of population in any year after the completion of the so-called institutional control as a consequence of intrusion intervention at repository, during which the violation of the repository structure by human intervention occurs (scenario, with probability lower than one).

To ensure compliance with reference levels of activity of radionuclides in the FCC and NRR Tab.A-II. 8 and respectively Tab.A-II. 9.

Tab.A-II. 8 The limit values of radionuclide activity in FCC disposed in NRR Mochovce

Radionuclide	The upper layer [Bq/FCC]	The middle/lower layer [Bq/FCC]
^{14}C	4.19E+10	2.79E+11
^{41}Ca	5.27E+10	5.27E+10
^{59}Ni	2.28E+10	2.78E+12
^{63}Ni	3.53E+13	9.33E+14
^{79}Se	1.07E+11	1.07E+11
^{90}Sr	5.89E+13	8.53E+14
^{93}Mo	5.27E+10	2.50E+11
^{93}Zr	7.07E+11	7.07E+11
^{94}Nb	1.42E+08	1.54E+08
^{99}Tc	1.39E+10	2.07E+12
^{107}Pd	5.70E+12	5.55E+13
^{126}Sn	9.08E+07	9.89E+07
^{129}I	5.92E+07	5.92E+07
^{135}Cs	4.43E+10	6.54E+11
^{137}Cs	3.13E+13	3.41E+13
^{151}Sm	3.53E+14	3.84E+14
Total alpha	400 Bq/g	400 Bq/g

Tab.A-II. 9 The limit values radionuclide activity for the area of NRR Mochovce

Radionuclide	Maximum values [Bq]
^{14}C	2.01E+15
^{41}Ca	3.78E+14
^{59}Ni	2.00E+16
^{63}Ni	N
^{79}Se	7.68E+14
^{90}Sr	6.14E+18
^{93}Mo	1.80E+15
^{93}Zr	5.08E+15
^{94}Nb	N
^{99}Tc	N
^{107}Pd	N
^{126}Sn	N
^{129}I	4.58E+11
^{135}Cs	4.72E+15
^{137}Cs	N
^{151}Sm	N
^{238}Pu	N
^{239}Pu	1.80E+15
^{241}Am	N

N - activity of the given radionuclide is not limited

Activity of radionuclides, of which inventory in is not limited in consequence of the high sorption for any of the barrier of the repository or reaching of the limit of solubility, was by the calculation evaluated on > 10^{20} Bq (Tab.A-II. 9).

The derived reference levels for activities listed in these tables may vary based on the current safety analyses, which sets out the progress of knowledge in the field. These analyses provide safety limits imposed on the activities of RAW, derived from the basic limits of exposure of the population above mentioned.

PpBS NRR was updated and by authority approved according to the periodical assessment of nuclear safety of NRR and a more detailed assessment will be made on the basis of the design solution for enlargement of the disposal capacities for low and intermediate level waste and for erection of repository of very low level waste at NRR site in Mochovce.

Especially were derived also limit values for the activity of spent sealed sources of radionuclides:

- ^{90}Sr 3,6 10^9 Bq,
- ^{137}Cs 3,5 10^8 Bq
- ^{241}Am 5,6 10^6 Bq.

For all disposed radionuclide shall apply, that the sum of ratio of the disposed activity and limit conditions of the individual radionuclides shall be less or equal to 1.

Compliance with these values, along with compliance with other criteria of waste acceptance for disposal, which have quantitative or qualitative connection with the safety analyses ensures, that the exposure of individuals from the critical part of population will not exceed the critical values of the authorized body of state health supervision [L-24] (see also Chapter C-III.1.1).

The process of accepting the packaged forms of waste for disposal and within this the verification of information of the accompanying letter of the packaged form is the key part of NRR operation, or quality system of NRR operation, which influences the inherent safety of the repository in the near or distant future. The properties of container with the waste verifies the repository with the following methods:

- Inspection by the producer of packaged forms - quality control of measurements, leading to the declared characteristics of the waste container from the producer side and their compliance with the parameters of waste and treatment process parameters, which have impact on the characteristic attributes of the container with the waste.
- Inspection of shipment by the acceptance for disposal- visual inspection and inspection of correctness of data in the accompanying letter in the packaged form.
- Measurement – of the FCC surface contamination, dose rate and non-destructive measurements on gamma scanner.

Measurements of radionuclide activity in each waste flows is performed by the producer of the waste. Activity of waste is inspected in the processing centre prior to the entrance of the technological process and in the final form of waste. Declaration of radionuclides difficult to detect is based on the indirect method. Its activity is calculated from ^{137}Cs or ^{60}Co by using of recalculated coefficients according to [L-112].

8.1.3.2 *Disposal of FCC into the boxes*

The RAW will be transported into FCC to the NRR after processing in the treatment centre into a form suitable for final disposal. After arrival of the transportation vehicle to the NRR, the operating staff shall check the completeness of accompanying documentation and compares it with the data from labelling of the concrete container with RAW. The transport vehicle with the FCC shall move to the location of disposal.

Disposal of containers with RAW follows the system of FCC backfilling in double-row that arises from generally formulated requirement for having the weight and radioactivity evenly distributed in the double-row after the containers were laid.

The unloading of the FCC from the transportation vehicle is carried out in the area of the long stop way by the design manipulation means – the portal frame crane with grip device (Fig. A-II. 8). After unloading and prescribed check, the FCCs are moved from the transportation vehicle into repository box to a place assigned in advance.

Regarding the optimization of the disposed activity, the disposal of containers follows only possibilities provided by the acceptance criteria i.e. that in general it is possible to dispose container with higher specific activity of certain radioactive nuclides into lower layer than into upper layer.

The position of FCC is stated by coordinates. Containers are disposed vertically, this is controlled by the operators visually, or eventually by plumb prior to the disconnection of the gripping device. Lower row of containers is disposed on geotextile, which overlaps the gravel drainage layer on the bottom of ferro-concrete box – Fig. A-II. 9. After disposal of 30 FCCs, disposal in another box starts according to the stated sequence.

The first package forms with RAW were in NRR accepted in year 2000 after the licence by the regulatory body was issued in 1999 for commissioning of NRR. In year 2001 NRA SR issued approval for the operation of nuclear facility NRR Mochovce. Currently, RAW is disposed into first double-row in boxes based on the licence for operation, which was by NRA SR updated in 2011 [L-21]. The overview of the amount of previously disposed packaged forms is shown in Fig. A-II. 10.

During the previous 10 year operation of NRR, all important technological equipment was in operable state. The values of collective dose and individual dose workers were practically void. There was no radiation events recorded neither the violence of rules of radiation safety. Neither to atmosphere nor to hydrosphere were discharged any radioactive substances.

Tab.A-II. 10 Overview of the number of disposed FCC and overall disposed activity in Bq within the years 2001-2010

Year	Number of FCC	Total activity [Bq}
2001	115	1.53E+12
2002	214	2.99E+12
2003	240	2.41E+12
2004	218	2.24E+12
2005	238	1.09E+13
2006	228	4.34E+12
2007	270	4.71E+12
2008	263	5.82E+12
2009	382	4.36E+13
2010	296	2,85E+12

Fig. A-II. 8 Take over and preparation of FCC with VLLW for the disposal in NRR Mochovce

Fig. A-II. 9 Disposal of FCC in the boxes [L-66]

8.1.3.3 *Archiving information about the localisation of containers with the waste in repository*

Information about the disposed containers including their locations is recorded and archived on NRR. Placement of containers is marked also on accompanying letter of container, which is archived on NRR. Quarterly, is the complete actual information on disposed containers with the waste handed to the department of radioactive waste of NRA SR.

After the repository closure, the operator provides the transfer of information on disposed containers with the waste to archiving for the period of institutional control.

Information system RAP serves for the record keeping on disposed radioactive waste. Its main function is the long-term archiving of the records on disposed RAW. System contains the complete accompanying documentation of disposed FCCs, so except own database of accompanying letters there is also digitized form of appendices of accompanying letters (i.e. e.g. Protocols on measuring drums on gamma scanner, protocols from the producer of FCC etc.). System enables an effective check of accompanying letters in the process of FCC acceptance on NRR (minimizing errors caused by human factor), generating of reports, and statistical surveys.

8.1.3.4 *Operational monitoring of the environment*

Monitoring of the surrounding is performed at NRR by own technical means, as well as by department of LRKO SE-EMO in Levice. The selected measurements are performed by the external organizations: WERT s.r.o Trnava, VUJE a.s. Trnava, and PF UK Bratislava. During the previous operation, there were not recorded any values, which would be above the long-term average of the radiation background in the environment. More detailed description of this topic is in Chapter C-II.17.1.1.2 “Monitoring of the impact of NRR on the surrounding environment” and in Chapter VI.1 “Proposal of monitoring from the commencement of construction, during construction, during operation and after termination of proposed activity operation”.

The operational safety of the nuclear facility of NRR can be evaluated as good. Within the periodical evaluation of the nuclear safety of NRR Mochovce (see Chapter VI.2) in the course of years 2009 and 2010 [L-83] was not identified any negative finding with high or medium safety significance. 5 negative findings were identified with low safety significance. All such findings were classified as the partial fulfilment of criteria. In order to remove these negative findings, six corrective measures has been adopted, some of them already in implementation. For the implementation of other corrective measures were proposed and by NRA SR agreed dates of implementation. It is possible to state, that reached state in the given area is suitable and gives an assumption of the positive development for the following period.

8.2 The proposed solution

The proposed activities can be characterised as Change in accordance with the Act No. 24/2006 Coll utilisation of NRR. This change requires distinguishing between the requirements and conditions for disposal of RAW in NRR according to its activity.

Current operation and project of NRR itself in Mochovce issued from the fact, that on the repository are disposed low and intermediate level waste, which are according to § 5 of NRA SR regulation NRA no. 53/2006 Coll. [L-9] assigned into the class b) and meet limits and condition of safe operation for the surface repository of RAW. Limits and condition for NRR Mochovce were approved by NRA in 2001 after completion of the trial operation of the repository [L-22]. These limits and conditions were regularly updated – last time in 2009 [L-23]. See also Chapter A-II.8.1.3.1.

The repository shall within the proposed change in the concept of RAW disposal and in connection with **the enlargement** of disposal capacities include implementation of the following activities:

- Put in operation of second double-row and completion of RAW disposal in the first double-row
- Enlargement capacities of NRR to new disposal structures for disposal of LILW in accordance with the current concept,
- Separate management with VLLW and its disposal on NRR site, either in the new separated disposal structures for VLLW or within the storing boxes of NRR by the simpler technological procedure (e.g. without FCC).

The implementation of such activities shall require also change (specification) of limits and conditions – acceptance criteria for RAW on repository according to the type of RAW (VLLW and LILW), which shall be part of the safety documentation assuming also with the application for activities according to the specific instructions.

The new solution compared with current ideas about RAW disposal from the V-1 NPP operation and decommissioning is the fact that for the class of VLLW is considered separate management and also disposal of such type of RAW. Such change was caused mainly by the fact, that as a consequence of the immediate decommissioning of V-1 NPP is assumed production of the larger amount of waste of this type and its disposal in FCC into the erected reinforced concrete boxes proved as ineffective. The analysis of the different solution of this problem was the subject of the project C9.1 financed by BIDSF “Enlargement of the National Repository at Mochovce“ [L-29].

In the stated project were solved also balance considerations setting forth the requirements for the capacity of the disposal area. The output of the project states the overall amount of RAW, disposal of which is considered for the whole period of operation and decommissioning of A-1 NPP, V-1 NPP, V-2 NPP, EMO12, MO34 plus not significant amount (regarding the volume and activity) of institutional RAW. According to the requirements of submitter, the capacity of NRR Mochovce after enlargement should respond to the overall volume of RAW, which was stated in this project of Feasibility study [L-29] – 7,5 double – row for LILW and 68 000 m^3 for VLLW.

Tab.A-II. 11 Review of activities and characterization of alternatives.

Alternative	I	II	III	IV
[1]Volume treated RAW	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3
[2]Required area for disposal/number of double-rows	At least 97 000 m^2 (14 double-rows)	78 200 m^2 (7,5 double-rows for LILW and about 4 double-rows for VLLW)	68 000 m^2 at the NRR areal (thereof 52 000 m^2 , i.e. 7,5 double-rows for LILW and 16 000 m^2 for VLLW)	68 000 m^2 (thereof 52 000 m^2 , i.e. 7,5 double-rows for LILW in the NRR areal and 16 000 m^2 for VLLW outside the NRR area)
Activity	Put in operation the second-double row (see part A-II.8.2.1.1)	Put in operation the second-double row (see part A-II.8.2.1.1)	Put in operation the second-double row (see part A-II.8.2.1.1)	Put in operation the second-double row (see part A-II. 8.2.1.1)
	Completion of RAW disposal in the first double-row (see part A-II.8.2.1.2)	Completion of RAW disposal in the first double-row (see part A-II.8.2.1.2)	Completion of RAW disposal in the first double-row (see [part A-II.8.2.1.2)	Completion of RAW disposal in the first double-row (see part A-II.8.2.1.2)
	Construction of the new disposal structures in line with existing RAW disposal concept (alternative does not distinguish LILW and VLLW) in the NRR area as it is described in the Chapter A.II.8.1.2	Construction of the new disposal structures in the NRR area for LILW (see Chapter A.II.8.1.2) and within them allocation disposal boxes for disposal of VLLW in a different waste package as FCC.	Construction of the new disposal structures in the NRR area for LILW (see Chapter A.II.8.1.2) and new repository for disposal of VLLW in the current area of NRR, procedure is described in Chapter A-II.8.2.1.7.	Construction of the new disposal structures in the NRR area for LILW (see Chapter A.II.8.1.2) and construction of VLLW repository outside the current borders of NRR, but immediately adjacent to it see Chapter A-II.8.2.1.7.

Note 1: This table contains volumes of treated waste before its disposal. The real occupied volume differs from this value, because the way to fill each repository has some constraints.

Note 2: Disposal area does not include infrastructure. After its inclusion Alternative I and IV requires about occupation of land outside existing borders of the NRR, with at least 4 ha, Alternative II area 2 ha. For Alternative III is sufficient current area of NRR.

Establishment of VLLW as an individual class will require also change in RAW management already by sorting and processing of RAW by its producer, as well as in the operation of technologies for further processing and conditioning (packing) of RAW stated for disposal and also by the transport of RAW to repository.

Near NRR facility will be implemented also other activities, of which implementation directly does not condition the operation of this repository, or it is not directly connected with RAW management from operation and decommissioning of nuclear facility in the Slovak Republic.

By this activity is the Intent of construction of new facility for disposal of institutional RAW connected with the erection of Information Centre within the Administration building. This proposed activity „Facility for management with institutional RAW and seized radioactive substances in Mochovce" is currently under the process of assessing the environmental impact.

8.2.1 Submitted alternatives of the proposed activity

The proposed investment plan is in the area of NRR Mochovce presented in four alternatives. Alternatives differ only in implementing disposal solution of VLLW (Table-II. 11). All four alternatives are considered common features, which are further described below.

In all alternatives are considered with put in operation of second double-row and completion of RAW disposal in the first double-row and classic or standard enlargement of existing structures for disposal of RAW packaged in FCC into boxes of steel concrete, which are arranged into dilatation units in double-rows as it is described in the Chapter A-II.8.1.2 and A-II.8.1.3.

The enlargement of the capacity for disposal means the construction of additional double-rows in the NRR area according to the original concept (disposal of solid and solidified RAW in FCC into disposal boxes). The actual design solution for standard enlargement should be based on the project, according to which the first two double-rows were built and on the project of the completion of the first double-row – more specifically from the as-built documentation, which should include the knowledge and experience from the previous operation of NRR as well as general progress of knowledge in the given field.

In all alternatives, the "standard enlargement" is based on the fact that at present the only approved form of package for disposal of LILW in NRR is FCC. If the future proved that modified forms of packages were more suitable, it would be necessary to take into account (in addition to radiation safety requirements) also requirements for static parameters of disposal boxes in the course of operation (even settlement) as well as during the period of institutional control (I. and II. stage of covering) in the process of their review and approval.

A definitive solution to the classic (standard) enlargement from the viewpoint of geotechnics may also be affected by the additional geological and hydrological survey, which should precede the design solution. Project based on additional engineering-geological survey and geotechnical assessment of the stability of disposal structures as a whole should decide on the orientation of disposal boxes (analogically according to the current orientation or perpendicularly to it) - Fig. C-IX. 18.

The project should also decide whether (or when) it is necessary to solve the issue of gravity draining of the ground water from the area of the northeast border of NRR. According to the study "Proposed measures to reduce ground water levels on the NE border of NRR Mochovce" dated 2004 [L-58], it was recommended to drain the ground water (Fig. C-IX. 25) from the slope area at the northeast border of NRR by gravitational line drainage wall, which can be built later based on the progress of the situation (since the stability of the repository construction at present is not jeopardized and there is no threat of the ground water penetration to the clay isolation). The latest solution may be considered when the repository is provided with final covering together with the solution of gravity drainage of drainage water from the repository.

Regarding the repository site it is obvious, that the construction of new disposal structures for the standard enlargement will be implemented in terrain, which shall be artificially increased compared to the presence. It would be wise, that the terrain should be increased with the necessary layer of clay compacted in a way, that the clay layer will have suitable properties regarding the engineering geology, hydro-geology, but mainly retention properties for the safety significant radionuclides in the disposed waste.

Part of the geologic survey will also be finding of borrow pits in repository surrounding that will provide sufficient amount of clay soil. First information regarding this was gained within the project of covering model implementation [L-61].

Within the enlargement project, it is also necessary to take into account the liquidation of boreholes line for the potential underground water contamination monitoring if they are located in the area of new projected repository structures (double-rows). The quality liquidation of these boreholes in a way that they do not represent preferential ways of radionuclide spreading, will be one of the key aspects from the long-term safety of new disposal structures point of view. The point is that within the repository enlargement as a whole, there has to be new concept of underground waters long-term monitoring elaborated and implemented.

8.2.1.1 *Put in operation the second-double row (all alternatives)*

As it was already stated in Chapter A-II.8.1.2, the repository is formed by two double-rows of ferro-concrete boxes. In this part is the first row of double-row marked by letter A and second row by letter B. On the second double-row is the first row marked with letter C and second row by letter D. Each row of disposal boxes is from one side (from east side) finished by so-called long stop way serving for the manipulation with FCC and its lifting from the transport vehicle to disposal into disposal boxes. To that purpose serves a gantry crane, which is moving on rails in the direction of longitudinal axis of boxes. Replacement of the crane to second row of disposal boxes is performed by the sliding vehicle. Sliding rail is placed in the area of short stop ways of crane rail, which are on the opposite side of double-rows (on west side). Above the first double-row of disposal boxes including the long stop runs of crane rail and siding rail of short stop runs is situated a steel hall. The hall is single-aisle with saddle roof with the range 52 m and length 156 m. The whole area of the steel hall including the disposal boxes is solved as controlled zone – operated area.

For the transition to second double-row and continuance of the operation is required approval from NRA SR while it is required to solve the requirement of NRA SR related to the coverage [L-35] of disposal boxes during the disposal of FCC (or other approved forms of packages with RAW) together with the crane. By the first double-row was this requirement solved in a way that the hall has been erected above the whole double-row. Due to the continual disposal of FCC with RAW into the second double-row immediately after filling of the first double-row, it was decided that above the second double-row shall be erected the coverage hall into which will be put crane from the first double-row, or eventually shall be equipped by the new crane [L-26].

Design documentation [L-26] is solving the proposal of new constructions, changes and building modifications, which shall be performed in connection with the operating of the second double-row of the disposal boxes. The plan assumes beginning of works on the second double-row and after its completing on the first double-row as well. **On the existing second double-row** of disposal boxes shall be solved:

- Erection of the new hall above the second double-row,
- Dismantling of the mobile shelter above the row C and the reconstruction of the existing crane tracks,
- Reconstruction of the concrete constructions of the second double-row, insulation of the walls of disposal boxes including the coatings and levelling of the bottom of the disposal boxes by the drainage layer,
- Reconstruction of the dilatation gaps and cracks in the monitoring galleries and controlling galleries and reconstruction of coatings of vertical walls and floors,
- deliverable and installation of missing equipment of the checking and control system in the monitoring galleries and controlling galleries of the second double-row.

Works **on the first double-row** will proceed under the existing steel hall in the controlled area, and will be in respect of time separated from the new hall erection and building modifications of the second double-row. Due to the installation of the new hall above the second double-row is in the hall above the first double-row proposed demolition of covering on the south lengthwise wall. In order to separate the controlled area from the erection, operation of the first double-row shall be separated by the provisional fencing up to 2.0 m placed on the concrete area in the row B. During these works will be FCC disposed in the first double-row only in row A.

The assumed period of works implementation is 2.5 years. After the works on second double-row are completed and after the backfilling of the first double-row, the first double-row shall be closed.

Dismantling works

For the new steel hall it is necessary to demolish existing concrete reinforced areas in the place of new foundation constructions. In the row B is proposed demolition of the reinforced areas above the existing bases for new anchoring of the steel columns. Further will be demolished ferro-concrete walls of substaining wall in row B in the places of new columns imbedding.

On the current ferro-concrete construction of the disposal boxes of the second double-row will be demolished the upper part of the lengthwise disturbed walls including the crane track. On the south lengthwise wall of existing steel hall will be demolished sliding gate of 9.0x11.0 m and circuit coat from the trapezial tin plate.

Demolished will be also mobile shelter placed on the crane track of the row C by which will be created metallic non-active waste with the mass 10 t. Dismantling works will not affect the quality of repository barriers of the site or lower level of security.

8.2.1.1.1 Erection of the new hall above the second-row

For operating of the second row and draining of rain waters outside of the repository is above the second double-row of the disposal boxes proposed roofing by steel hall. The roofing will improve the operational conditions and prevent from penetration of rain waters into the disposal boxes during the period of disposal of containers with VLLW. Above the first double-row will be the hall kept as minimum for the period of the backfilling of the disposal boxes in this double-row, backfilling of interim spaces and phase 1 of the final coverage.

New hall above the second double-row is proposed as the steel single-aisle building with saddle roof, coated by the easy circuit coat from the trapezial tin plate. Circuit coating is completed by the ferro-concrete substaining wall with width 250 mm. On the eastern part are proposed for the entrance to the hall two withdrawable rolling gates and two of the entrance doors. On the south and west side are proposed exit doors.

Coating between the double-rows will be new, performed after the implementation of the steel construction, by the adjusting track will be preserved the opening of 9x11 m. In the circuit coating of the hall (first and second double-row), in the lengthwise and gable walls, are proposed venting openings and imbedding of the regulation blinds.

Steel construction

Steel hall has got dimensions 52.0 x 156 m, height 16.75 m. Crosswise bonds form two-hinged frames, anchored into the ferro-concrete basic bases. Distance from the bonds is 9.0 m, or eventually 10.5 m in the outer field of the adjusting track.

The hall consists of the two dilatation units, connected with the inserted dilatation field, with the axis distance of the steel frames in the dilatation 1.5 m.

Concrete constructions

Steel hall is based on the gravitation of ferro-concrete bases (pilot ϕ 420 mm). Anchoring of the steel frames is in the axis ‚B‘ (among the rows B and C) on the existing foundation bases, in axis C (on row D) are proposed new foundation bases 4490x2880 mm. Two columns of the dilatation field are anchored on the one base 4490x4540 mm. In the gabled walls are for anchoring of the steel columns foundations with the dimension 1700x600 mm. Among the bases are the foundation beams for anchoring of intercolumns and for establishment of the ferro-concrete circuit substaining walls.

Ventilation equipment

Ventilation equipment will ensure efficient venting of steel hall of the first and second double-row for the offtake of thermal loading from sunblind. As ventilation will serve four inlet and four outlet openings with the dimensions 4000x1000 mm. Inlet openings will serve on the southeast wall of the hall of the first double-row and offtake openings will be placed on the southwest wall of the second double-row. For support of ventilation will serve 2+2 pcs of openings of the similar dimensions on the back front wall and 2+2 pcs on the wall of the entrance part of the both halls. Openings are equipped by antirain blind with the with the screen against insect and regulation valves controlled by the servodrives or manually. Interconnection between both halls provide 4 openings (4000x1000) offset by the screens against insect. Closing valves will enable the positions O(open) – Z(close) with the signalisation on the control panel at the entrance to the hall of the second double-row. The system will be also equipped by rainwater sensor, which in case of rain closes automatically all opened regulation valves.

Drainage of rain waters

Rain waters will be on the south side drained by means of roof leak into the new dewatering concrete channel. In the row B is proposed drainage of the adjacent roofs into the eaves gutter and further in the sewage to the external drainage gutters, by connecting of the external gutter behind the fencing of the site.

8.2.1.1.2 Rebuilding of the second double-row

The second double-row is since the erection (in 1995) exposed to atmospheric influences. Therefore it is necessary to perform its rebuilding before putting in operation. From the inner side of disposal boxes are proposed repairs and reconstructions of the ferro-concrete walls, grouting of the cracks, insulation of the coatings of the walls and further repairs of the asphalted bottom. The walls will be treated by mastic, by penetration and painted by the acrylate colour. On the bottom of the boxes shall be lied gravel layer, covered by geotextile, which serves at the same time as the levelling layer for the disposal of containers.

On the lengthwise walls of the disposal boxes (for each row) is placed crane track with the range 18 m for electric gantry crane. Due to the damaging of the external walls is proposed reconstruction of the upper ferro-concrete rim and the reconstruction of the existing crane track. It is proposed to newly imbed the crane track by meeting of the dilatation and rectification of the rails and modification of buffers.

Internal road communications

Within this building will be solved:

- Extension of the existing communication in front of the second double-row as it was additionally done also in front of the first double-row. The extended part shall have the width aprox. 4.10 m. The total width will be 12.75 m. Extension is necessary due to the safe approach of the vehicle with FCC inside the hall. The proposed extension will be, within the continuity keeping with the first double-row, from the cement concrete.
- Sealing of the pump of inner gutter by ferro-concrete spigot pipes TZH-Q50/250 in the concrete bed in length 54.25 m, in order to enable implementation of the extension.
- drainage of the rain waters from the roof of the second double-row and from the south side of the first double-row on the south-east side with opening by the monolithic channel, throughout the communication on two places by dewatering line channels led up to the external gutter. Channels in the road communication with the cast iron grid cover will meet strength criteria for communication loading of the class E (600 kN) and will be concreted, width of concrete is 250 mm.
- Pavement from paving along the south-west coating of the steel hall or eventually along the opened monolithic channel, i.e of width 1.20 m.
- Fencing of the area before entrance into the hall of the second double-row by the fence from coated with plastic wire gauze of height 2 m (green colour) and coated with plastic steel pillars. Fencing of the first double-row will be kept in the current route including the gates. The entrance and access into the area in front of the second double-row will be insured by the gate of the same type as for the first double-row.

8.2.1.2 *Completion of RAW disposal in the first double-row*

Completion of RAW disposal in the first double-row after backfilling with containers with LILW represents:

- Implementation of the backfilling of free spaces between FCC containers and walls of ferro-concrete boxes and
- Implementation of the phase 1 of coverage of this double-row.

8.2.1.2.1 Backfilling of the free areas

The task of the backfilling is to fill in the empty spaces of boxes filled with FCC in order to secure that the filled box acts firmly as the compact unit and filling material did not influence negative processes, by which starts migration of radionuclides from the source member. Implementation of the backfilling is possible after backfilling of boxes with containers. Such procedure results from the requirement of NRA SR in order to make the containers during the disposal period withdrawable [L-35].

Procedure of backfilling of interim spaces

By disposing the containers tightly to each other from one corner will be created area in the box for backfilling by the opposite walls in width approximately 400 mm along the width of box and 300 mm along the length of the box. Within the innovation solution of the phase 1 of the coverage of the first double-row of disposal boxes after the filling by FCC containers and backfilling of interim spaces and walls of the boxes, was in 2003 [L-25] proposed procedure of interim spaces backfilling by the concrete C12/15. The theoretical requirement of such backfilling material for filling of vertical interim spaces in box makes approximately 37 m^3.

8.2.1.2.2 Coverage of the disposal boxes of the first double-row

After filling of boxes with containers containing waste and after backfilling of the vertical interim spaces by the walls begins the first phase of the coverage. The composition of coverage [L-25] will be (in the direction of the disposal containers, bottom up) as follows (Tab.A-II. 12)

Tab.A-II. 12 The composition of first phase of coverage

Asphalt concrete ABJ	50 mm
Geograte reinforcing the asphalt surface	
Asphalt concrete ABH	70 mm
Packing aggregate as a base for asphalt concrete	100 mm
Gravel drainage layer (fraction 16 - 32 mm)	150 mm
Filtration geotextílie	
Surface drainage oneway (HF 20)	
Geotextile	
Waterproof layer GSE	
Monitoring layer	
Geotextile Sensom	
Waterproof layer GSE	
Geotextile Sensom	
Screed of concrete	50 mm
Reinforce-concrete gravity panel (C25/30 - XC1)	200-450 mm
Existing reinforce-concrete pre-fabricated panels	500 mm
Screed of concrete	85 mm
Asphaltboard A500 H	
Screed of concrete	50 mm
Reinforce-concrete protection panel (concrete C25/30 - XC1)	250 mm

Such performed composition of the individual layers ensures the correct functioning of phase 1 of the coverage into the period of the second phase of coverage.

The whole area of coverage will be performed in the gradient in a way that creates overlaps trough the lengthwise walls of the double-row. Such overlaps will create full coverage of the ferro-concrete walls and boxes of the double-row and at the same time enable drainage of the potential leakage water outside the disposal double-row.

After filling of all double-rows and after the implementation of the phase 1 of the coverage on the last double-row will be the repository closed, of which part will be the implementation of the phase 2 of the coverage. It is necessary to bear in mind, that the solution of the phase 1 coverage remains also the part of the final coverage and therefore the definite proposal cannot be developed regardless of the connected phase 2 of the coverage, even though these will be implemented within the significant time range.

On the Fig. C-IX. 12 there is imaged structure of the coverage stage 1 and 2, while the structure of the phase 2 responds to the composition of the layers of the coverage model, implemented in the south part of NRR site- see Fig. C-IX. 4.

8.2.1.3 *Alternative I - Enlargement of the NRR capacity without the special VLLW treatment*

Enlargement of NRR repository in Mochovce without the special VLLW treatment involves continuous (i.e. pace, as necessary) construction of the other disposal boxes (double-rows) according to the similar concept as in the case of the first two double-rows (disposal of packaged RAW forms into the storage boxes with clay sealing as described in Chapter A.II.8.1 and A.II.8.1.3). The concept of the disposal of LILW has not changed – processed RAW will be disposed into repository boxes in FCC as described in Chapter A.II.8.1.2.2).

Alternative I expected to be performed according to existing project (project of real implementation with the potential application of improvements resulting from the previous practical experiences). The possible alternatives of standard enlargement of NRR as it was considered in PpBS NRR from 1999 are described in Chapter C-IX on Fig. C-IX. 18 [L-39]. The final alternative of the standard enlargement will be selected within the design solution of NRR Mochovce.

The capacity of NRR Mochovce after the final enlargement should be such that it is possible to dispose of the total volume of RAW generated over the whole period of operation and decommissioning of A-1 NPP, V-1 NPP, V-2 NPP, EMO12, MO34 plus the not significant amount (in terms of volume and activity) of institutional radioactive waste. Total volume of the conditioned RAW was in the study [L-29] estimated to 50 000 m^3 of LILW and 68 000 m^3 of VLLW.

In order to dispose of the considered volume of RAW according to this alternative, it would be necessary in the future to extend the borders of NRR site, due to the fact, that whole considered volume of RAW from NPP operation and decommissioning, which can be disposed of (including NPP EMO 3,4) requires 14 to 15 double-rows [L-31] and within the current NRR site it is possible to place max. 10 double-rows. This alternative requires as min. 2,8 ha of disposal area outside the NRR site. Further area is necessary for access communications, drain channels etc. and therefore the whole area of site is at least 4 ha

8.2.1.4 *Alternative II - Enlargement of the NRR capacity with separated VLLW disposal in NRR repository boxes*

Alternative II anticipates the disposal of LILW using the current method of disposal in FCC as it is described in Chapter A.II.8.1.2 and A.II.8.1.38.1.3 and this would require 7,5 double-rows. VLLW would be disposed in a simpler way –without FCC. The method of disposal - common disposal of LILW and VLLW into boxes or separate disposal of VLLW into specific boxes depends on the choice of waste package for disposal of VLLW and on the solution of other specific issues (selection of other technical means of disposal, prevention of controlled drainage clogging, backfilling, closing of the box before the implementation of the first stage of covering, etc.), which should be included in project documentation. Disposal of 68 000 m^3 of VLLW e.g. in MEVA drums would require less than 4 double rows.

New double-rows would not differ from the double-rows of alternative I and similarly to alternative I, it would be necessary to enlarge the existing borders of NRR area about 1.3 double-rows, taking into account the demands on infrastructure it is an area of about 2 ha. Regarding the activity of disposed VLLW, barriers of repository designed for LILW would be for VLLW uselessly pre-dimensioned and already nominal radiation impact would not be changed. With regard to the activity of disposed VLLW, the repository barriers designed for LILW would be unnecessarily overdesigned for VLLW and already negligible radiation impacts would remain unchanged.

8.2.1.5 *Alternative III - Enlargement of the NRR capacity with separated VLLW disposal in NRR area*

Alternative III anticipates disposal of LILW using the current method of disposal in FCC as it is described in Chapter A.II.8.1.2 a A.II.8.1.3 (required capacity is 7.5 double-rows) and that a new object for disposal of VLLW will be built in the current area of NRR Mochovce. Its building procedure is described in Chapter A-II.8.2.1.7. Regarding the fact, that available space at NRR is limited, it is necessary to optimise use of area by double-rows in order to create sufficient area for placing of VLLW Fig. C-IX. 15.

Due to the limited space at NRR, it is necessary to stack the VLLW up to the height of 5m in order to be able to dispose all waste and by the operational procedures ensure that the bottom layer of waste (about 1m thick) consists of solid packages of waste, such as metal drums or other suitable packages. It is also necessary, in this case, to pay special attention to stacking of waste to avoid that the angle of inclination is too steep, as it may lead to sliding of waste downwards [L-31].

This alternative requires a detailed assessment of the contribution of VLLW repository to the radiological impact of the NRR area as a whole. Characterization of the area, placement of repository for VLLW within NRR acceptance criteria and detailed design solutions as well as licensing process is the objective of BIDSF project C9.4 [L-32].

8.2.1.6 *Alternative IV - Enlargement of the NRR capacity with separated VLLW disposal in NRR area but outside the area of NRR*

Alternative IV anticipates the disposal of LILW using the current method of disposal in FCC as it is described in Chapter A.II.8.1.2 and A.II.8.1.3 (required capacity is 7.5 double-rows) and the construction of VLLW repository outside the current borders of NRR, but immediately adjacent to it. In this case the procedure of VLLW repository construction described in Chapter A-II.8.2.1.7. The particular location of this repository is yet to be specified on the basis of geological survey and survey of geotechnical conditions of the land near the NRR area. As a potentially suitable area, the space of “borrow pit” on an elevation about 200 m east of the operational building of NRR area is considered. From this area, the clay soil for the model of covering was mined - Fig. C-IX. 13.

The alternative of external location of VLLW repository, bordering to NRR facility would require a new license, obtaining of which would probably be considerably easier against the licensing process for any other “new” area. Location of VLLW repository, according to the Alternative IV, would utilize all advantages of NRR area and moreover, it would probably enable to eliminate its disadvantages (limitation of the area). A major disadvantage of this alternative is that the settlement of land is still pending, other disadvantages include necessary consumption of the agricultural land and need to complete the infrastructure. Pursuant to Article 21, Section (6) of the Atomic Act [L-6] the radwaste repository can be located only on a piece of land which is owned by the State (in accordance with approved National Spatial Development Concept of the Slovak Republic and other approved territorial planning documentation).

8.2.1.7 *Technical and technological solution separated VLLW disposal (alternative III and IV)*

The effort to dispose of VLLW separately in repositories with lower requirements for some engineering barriers mainly regarding the packaging form of the disposed waste itself as well as concrete storage structures, in general improves the economy of disposal with not changed nuclear safety (operational short-term and long-term) and also with the fact that regarding the lower activity of disposed waste it is possible to count with shorter period of the institutional control of the relevant repository.

The VLLW repository resembles to the higher construction level landfills. It will consist of following sections and/or systems [L-29]:

- Section for waste disposal that will occupy larger area and will include disposal structures
- supporting directly connected equipment such as drainage pipes, control leaked water pits and rain water collectors,
- Supporting objects (if necessary).

The same procedure apply for VLLW disposal as for LILW disposal in surface repositories There are these differences:

- Lower requirements for engineering barriers which in practice represent:
  - Usage of less damaging and less costly packages in comparison with FCC in which the LILW are disposed,
  - Smaller thickness of insulation barrier – compacted clay layers above and under the disposed waste,
- Lower requirements from long-term mechanical stability of the disposal facilities point of view – solid waste is disposed into the repository directly or after the pressing or in drums,
- Lower requirements for backfilling – disposed waste is mostly covered with soil with improved retention characteristics (higher ratio of clay compound, adding of zealots and betonies),
- Shorter period of required institutional control, if the VLLW repository would be implemented far from the existing site.

In terms of the project considerations and existing analogical facilities abroad there are also these facilities and supporting construction recommended for the VLLW disposal:

- Light protection cover for disposal structures against rain,
- Drainage system and potential infiltration water control including end control tank,
- Rain water drainage system,
- Access roads to disposal cells.

Alternatives III and IV differ in the fact that within Alternative III the structures for VLLW disposal would be constructed within the existing NRR, Fig. C-IX. 15 and within Alternative IV outside the NRR (nearby) at suitable chosen location Fig. C-IX. 16.

Repository of very low level radioactive waste is an engineering construction able to isolate the waste in a way that the included radioactive substances have no or no negative affect on safety, health and on individual components of the environment in the short or the long-term horizon. Principles and criteria for designing of repository for RAW disposal of VLLW type issue from the experiences from the countries with advanced nuclear power industry. The similar type of repository for LILW is in France Morvilliers [L-110] – see Fig. C-IX. 5 and Fig. C-IX. 6 in Chapter C.IX – or in Spain in El Cabril Fig. C-IX. 8 and Fig. C-IX. 9.

The primary protection against the danger that comes from disposed wastes are engineering barriers (layer of clay, bentonite, geobentonite, geotextiles, HDPE sheet layer etc.), which together with the natural geological barrier prevents migration of radionuclides from the repository into the environment. Geological barriers must be of sufficient thickness, necessary qualities and stability and the ability to retain the characteristics required for a sufficiently long-period (design life of the repository). Geological barrier is supplemented and reinforced by engineering barriers that contribute to increase of the insulation capacity of the whole repository. Institutional repository control after waste disposal and its closure will ensure that insulating barrier properties were maintained until the waste would be no longer regarded as the radioactive in terms of current legislation, respectively until the contamination level drops below the value of release into the environment. Geological barrier, engineering barriers and institutional control of disposed waste create together a secure insulation system.

In the following sections, respectively subsections is indicated a possible technical solution of VLLW repository, based on analogy with similar repositories, on which were protective layers, a drainage system and waste water disposal system designed and implemented in accordance with applicable laws and standards for hazardous waste storage sites.

The exact technical solution will be designed, assessed and approved after the implementation, respectively based on the results of additional geological survey in the design and safety documentation for land-use and building proceeding in accordance with applicable legislation.

Repository of VLLW shall be designed and operation of repository must be organized in accordance with the following basic rules:

VLLW repository shall be designed and the operation of the repository organised in compliance with the following basic rules:

- Operational area exposed to the rainfalls shall be minimised in order to minimise the amount of water, which will get in contact with the waste.
- All leakages since beginning of operation shall be collected, checked, and if necessary, decontaminated.

- Waste shall be disposed the adequate way into stripes and cells in order to ensure stability of the waste stack.
- In case that, the repository is divided into the partial cells (sections), each of them shall have the protective system of soil and water, system for the collection of leakages, as well as the sufficient surface with the fundamental insulation, in order to use partial cells independently from the rest of the cells.
- Capacity of each partial cell shall be in compliance with the amount of waste deliverable chosen, in order to quickly fill in and minimise the production of leakages and to prevent from the drop of subbase of the partial cells.
- The method of repository operation shall ensure short-term and long-term mechanical stability.

8.2.1.7.1 Pre-construction period

Pre-construction period for the erection of the repository of VLLW is mostly geological, hydro-geological and engineering-geological survey. Such survey should provide data for the design of repository enlargement. It is necessary to state, that the area of repository was in the past surveyed in detail, (e.g. [L-38], [L-56]) and we can assume, that due to the enlargement of the repository it will be not necessary to perform within the scope any significant geological survey. Of course, for the purposes of alternative evaluation for VLLW repository outside the existing site (Alternative IV), it will be necessary to perform detailed engineering-geological and hydrogeological survey.

Regarding the repository side it is obvious, that new disposal structures for disposal of VLLW will be erected on terrain, which shall be modified (adjusted slopes of natural or man-made slopes (barriers)), on which it is possible to apply tightening and insulation elements according to the Fig. A-II. 13. The main emphasis should be put on the correctly applied clay soil (sealing clay in the base and after backfilling of the relevant lane also lap layer). Suitable insulation properties should have also the created side slopes on places, where it is not possible to use natural slopes. Therefore the part of geological survey and also for the VLLW repository erection shall be crucial to find borrow-pits in the area of repository, which would provide the required amount of the clay soils [L-61]. **All stated pre-construction activities should result in the design documentation of the new disposal structures in 2014 - 2015.**

8.2.1.7.2 Construction

Construction will consist of:

- Modification of the landscape and the side slopes of the module (cell),
- Implementation of the system of the tightening elements (compacted clay, sealing and protection shield) and drainage elements, which shall secure the monitoring of the water presence or eventually its activity and also controlled dewatering of the disposal structures,
- Erection of the long-term monitoring system of the underground waters for the part of VLLW,
- Erection of the sliding shelter.

The preparative work, carried out on the whole surface of the disposal cell, will include the following main activities (see Fig. A-II. 10).

  - Excavation, cleaning and preparation of the natural soil for the placement of the lower protection layers.

- Slopes will be constructed in such a way that a high degree of stability and the insulation against water leakage is achieved.
- Construction of the slope stages and side ditches required for the operation and of the necessary access ways.
- Preparation of the lower drainage layer (0.30 m of gravel) and insulation and tightening layers.
- Preparation of a dam (or eventually its modification) with 2H:1V slopes in both sides, in the lower part (in the direction of the bottom gradient) of disposal cell (module) as the support to the drainage layer and disposal waste.

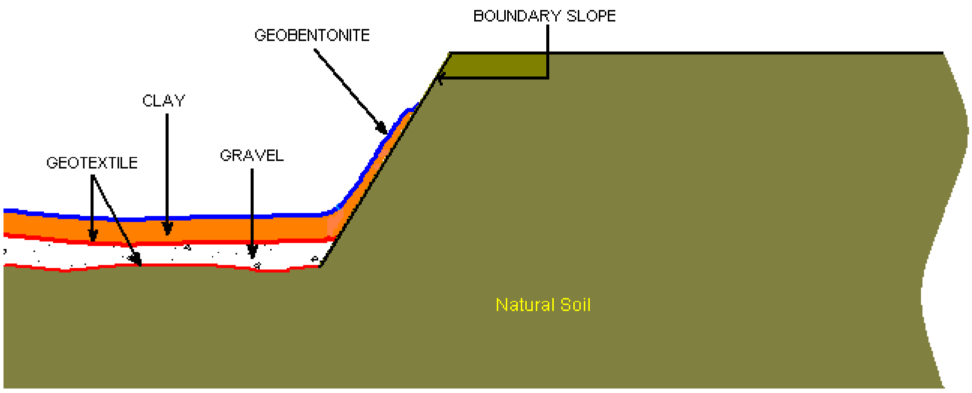

Fig. A-II. 10 Layout of the preparation of the base layer of the cell

Protective layers

The disposal cell (module) contains various protective layers above and also under the waste. Regarding its analogy are on the similar repositories these layers proposed and implemented in accordance with the valid legal procedures and standards for repositories of the hazardous waste..

The basic barrier against the radionuclides migration will be the barrier which responds to at least 5 m of the clay with the coefficient of permeability $K \leq 10^{-9}$ m/s. This can be achieved by the combination of 1 m of the layer of compacted clay with the thinner layer of bentonite. As the insulation against the water a waterproofing sheet layer of HDPE with thickness 2 mm will serve. In connection with the repository of VLLW are the most important two layers of geotextile, which are designed for the protection of HDPE sheet layers and these, which are placed under the waste with own protection clay layer with thickness.

After the modification of base will be created protection layers and after backfilling with waste also the layer of coverage. All layers placed under the low drainage layer with the thickness 0.30 m, will be created (bottom up) in the following sequence (see Fig. A-II. 11):

1. Lower drainage layer of gravel (0.30 m)
2. Geotextile of lesser strength (0.7 kg/cm²) against contamination.
3. Clay layer of 1 m thickness, permeability equivalent to 5 m of clay with $K< 10^{-9}$ m/s.
4. Bentonite layer (geobentonite) of 10 mm thickness with $K< 10^{-11}$ m/s.
5. Waterproofing sheet layer of high-density polyethylene (HDPE) of 2 mm thickness.

6. Geotextile of greater strength against punching (1.6 kg/cm²) for the protection of the HDPE sheet layer.
7. Gravel layer of 0.3 m thickness, for the losses drainage, with its corresponding piping network.
8. Geotextile of greater strength against punching (1.6 kg/cm^2) for the protection of the HDPE sheet layer.
9. Waterproofing sheet layer of HDPE (2 mm).
10. Geotextile of greater strength against punching for the protection of the HDPE sheet layer.
11. Gravel layer of 0.5 m thickness, for leakage drainage with its corresponding piping network.
12. “Filter” Geotextile (greater strength) to avoid clogging of the gravel.
13. Protective soil layer of 0.10 m thickness.

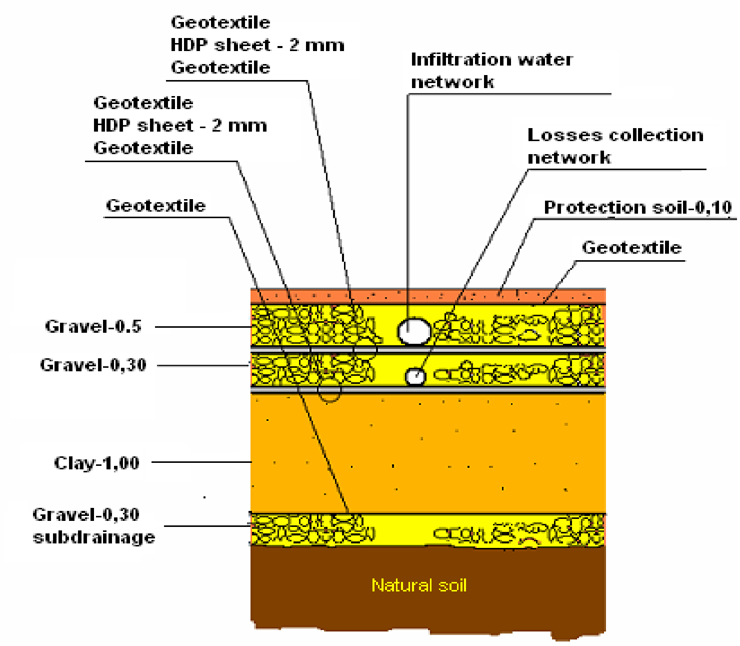

Fig. A-II. 11 Layout of the protective layers of the bottom of the cell

Once the disposal surface corresponding to one operational section has been prepared in the manner described above, the waste will be placed following the operational lines (sections, lanes), until the capacity of the cell has been reached. After this has happened, the cell closure will be carried out. The final cover will consist of the following layers listed from the bottom up (see Fig. A-II. 12):

1. Soil regularization layer of 0.30 m minimum thickness.
2. Clay layer of 0.5 m thickness.
3. Waterproofing HDPE sheet layer of 2 mm thickness.
4. Geotextile against punching, for the protection of the HDPE layer.
5. Gravel layer of 0.3 m thickness for rainfall drainage.
6. “Filter” Geotextile to avoid gravel clogging.
7. Layer of selected soil of 0.6 m thickness.
8. Anti-intrusion layer of coarse gravel, 0.30 m thickness.

9. Vegetal soil layer of 0.3 m thickness.

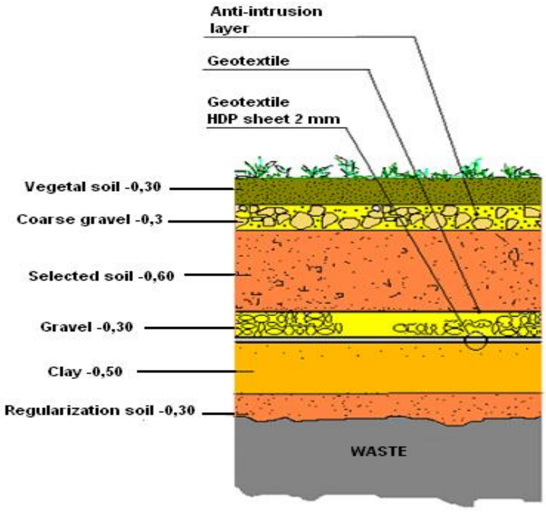

Fig. A-II. 12 Layout of the protection layer of the coverage

Storage cell for VLLW will have a system for monitoring and collection:

- surface water
- infiltration water
- leaks
- subsurface water
- system of groundwater monitoring wells

The collection system of surface water

Rain water from surface of repository, which is not covered by shelter will be collected by system of rain trenches and rain water canalisation and drained into the collection tank. System capacity will be calculated so that system can absorb volume of rain water in case of rainfall rains. Surface water collection system must perform its function even after the conclusion of final repository coverage.

The collection system of infiltration water

Infiltration water network will collect potential liquids coming from drains through waste by means of drain layer and drain waters a by its porous tubes network into control tanks. In order to achieve draining of water to the mentioned spaces, the low clay layer shall have suitable inclination. Drained water shall be before discharging to environment checked for contamination.

The collection system of leaks

The collection system of leaks is designed to drain water from drainage layer of leaks, which can get to area by violation of the upper HDP sheet layer. In the event of leakage it will be necessary to close down the site operation or part, locate the leak and fix the insulating layer. Leakage water will be drained to control tanks, analysed for the purposes of potential contamination detection. The collection system of leaks is recommended as an additional safeguard for the collection of leaks due to defects or failure of capturing sealing layers. It creates a backup safety system. Fig. A-II. 13 show the location of the leakage system and network losses.

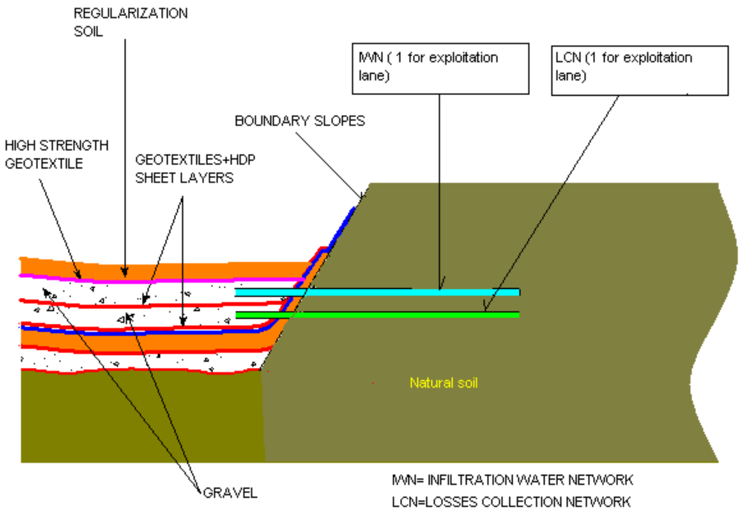

Fig. A-II. 13 Layout of infiltration water net (IWN) losses control net (LCN)

The collection of subsurface water

To avoid increasing of the water pressure from below as a consequence of underground water level increase, drainage system shall be erected. The lower drainage layer will consist of a layer of gravel with a thickness of 0,30 m, which will include a porous PVC pipe system to drain any water from this area - Fig. A-II. 14. At the top of the bottom drainage layer is a layer of geotextile, to avoid clogging the drainage layer of the upper layer of clay.

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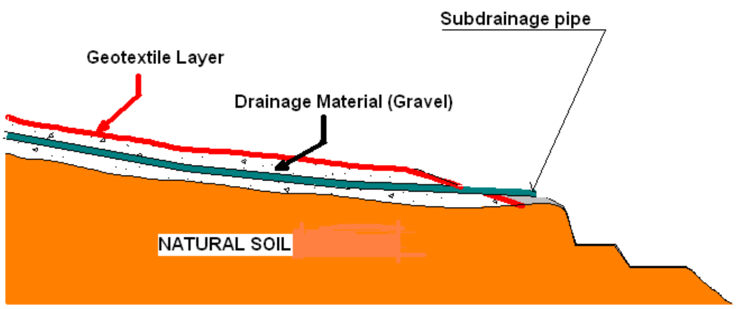

Fig. A-II. 14 Layout of the drainage systems erection

System of underground water monitoring

Near the VLLW repository will be installed file of monitoring boreholes for monitoring and sampling from underground waters. For that purpose, the drawing systems shall be available. The depth of monitoring boreholes shall exceed the bottom of disposal cell. In any case, placing and depth of borehole shall be such, in order to enable sampling of underground water in the direction of flow from repository. After the samples analysis it will be possible to assess the impact of repository on the quality of underground waters.

Building of a mobile shelter

To protect the working area of disposal cell, lighten cover will be built during the placement of waste in order to cover all disposal lane. Such cover shall have width aprox. 20 m and length responding to disposal lane. It must be demountable and shall be transferred to an adjacent lane, it also must be able to adapt to the different length of each lane. Once the disposal lane is filled, after reaching of expected heights, the disposal lane shall be protected with a layer of HDPE and portable roof removed and placed in the next lane (see Fig. C-IX. 5B, Fig. C-IX. 8 resp.).

8.2.1.7.3 Modification of VLLW and its packing for transport

In the area of repository of NRR Mochovce, it is not planned any treatment or conditioning of RAW (or VLLW). Conditioning of VLLW prior to its disposal will be performed by the producer, what shall guarantee, that such operations will be performed in the suitable conditions, preventing the dispersion of the radioactive material, together with the system of the control of discharged liquid and gasses in order to prevent the contamination of the environment. VLLW shall be treated and packaged in order to achieve meeting of the acceptance criteria, inter alia also the following requirements for the disposal units:

- Chemical stability,
- Structural stability,
- Preventing from the radioactive dispersion.

An example of VLLW packaging of the granulated structure is in the Fig. A-II. 15.

Disposal units will be currently also transported, it shall meet also the conditions for the transport of the radioactive material, mainly the requirement, that the effective dose on the surface of the package would be < 2 mSv/hour in order to prevent from the dispersion of the radioactivity by the extraordinary situation during the transport.

Fig. A-II. 15 Packages of VLLW of granulated structure suitable for disposal [L-110]

8.2.1.7.4 Operation

Into the repository will be disposed of only waste forms containing solid VLLW (contaminated soil, building waste, concrete rubble, insulating material, etc.) and no gaseous or liquid waste will be accepted. Repository waste acceptance criteria will be based on the international experience and properties are set to be met waste form and equipment for its disposal. These criteria will be obligatory for all waste producers. The operation of repository consists of disposal of RAW according to its type:

- LILW are stored into ferro-concrete boxes (in the approved type of package – currently it is FCC),
- VLLW will be stored into the repository for VLLW (also in the approved type of the package in the suitable not only for disposal but also for the transport of VLLW from the producer).

As for the separate disposal structures of VLLW, operation of each section consists of organized waste disposal, with the objective to use the best the disposal area and stability of the disposed waste.

he waste shall be transported to the entrance of the repository in the suitable package form on the trucks and into the disposal area will be placed by means of a mobile crane, or other suitable mechanism – Fig. C-IX. 5.This crane will dispose the packing units at the bottom of a stable stacking. When finished one layer of waste stacking a soil layer of 0.30 m minimum thickness will be placed on top of the waste and compacted to perform a secure basis for the supporting of the crane and the trucks during the emplacement of further layers – Fig. C-IX. 7.

The cross-section of the operational lane in the course of works is trapezoidal with a width that can be variable and adequate to be maintained under the protection of the cover. Once an operational lane is completely backfilled, the cover will be moved to the adjacent lane and the process will start again until the cell has been completely filled.

8.3 Selection of the solution according to the current state of the technique

Safety principles, which are applied by all RAW management activities, are stated in safety standards IAEA (the last version is from 2006 [L-114]). These principles were ethical and conceptual base of so-called common agreement on the safety of nuclear spent fuel and RAW management, which was elaborated under the patronage of IAEA and signed in Vienna in 1997. The National Council of the Slovak Republic expressed an agreement with the Joint Convention and it entered into force on 18th of June 2001 [L-115]. Requirements for the radiation safety states the international basic standards against the radiation and safety of the radiation sources. Many of these requirements and visions were derived from the recommendations of International Commission for radiation protection [L-116]. The requirements for the radiation safety establishment by disposal of RAW during the operation and even after the closure of the repository is stated by IAEA document Disposal of radioactive waste [L-117].

The disposal of RAW means placement of RAW into repository without the possibility to remove it after the repository is shutdown. The objective of the disposal is to keep and separate the waste from the surrounding biosphere, lower the probability of all possible consequences of unaware entrance of human to waste, slow down, decrease and defer the migration of radionuclides from waste into biosphere and secure, that the activity of radionuclides if it gets into biosphere, was so low, that the possible radiological consequences for the whole period will be accepted.

In the world there is currently over 90 near surface repositories of RAW differing by the depth of placement on the surface and by construction solution. As it is described above, the repository of low and intermediate level waste in Mochovce belong to the modern near surface repository, with the latest methods of RAW disposal in compliance with the best available techniques in the given area. The technical solution of the repository is based on the so-called multibarrier concept. The set of barriers (the form of waste, FCC, ferro-concrete construction of the boxes, clay bath) prevent from the uncontrolled leakage of the radionuclides. Multibarrier system is a system of mutually linked elements in which the individual barriers supply and complete each other, in order to prevent from the contamination of the biosphere in inadequate level, i.e. not to exceed the limit value of the effective dose for the surrounding habitants.

The repository of LILW in Mochovce was erected per sample of the French repository Centre de l´ Aube (in operation since 1993) and Spanish El Cabril (in operation since 1992). Among the mentioned types of the repositories it is possible to state also the repository of low and intermediate level waste, which is placed in the southeast part of the site of NPP Dukovany in Czech Republic (commissioned since 1995). Compared to the repository in Mochovce, the packaged form for disposal represent 200 l drum and basic insulation barrier of the repository is asphalt-propylene-concrete. The leakage of rainfall water into the box, where is currently disposed, is prevented by the movable roof.

Design of the VLLW repository for NRR was proposed in the feasibility study (see Chapter A-II.8.2), where the authors used the experiences from the already operated repositories of such type in - El Cabril in Spain and Morvilliers in French.

Generally it applies, that into the near surface repositories are disposed solid or solidified waste containing the radionuclides with the short period of half time and low concentrations of the long lived radionuclides. Limits for the disposal of long-lived radionuclides is approved by NRA SR based on the safety analyses of the repository. For long-lived alpha radionuclides was accepted in France, USA, Spain and Great Britain for the repositories of LILW, the limit of the average mass activity 400 Bq/g (and maximum 4000 Bq/g in the individual containers). In our country NRA SR for this case strictly specified the requirement – maximum 400 Bq/g for FCC container and 4000 Bq/g for any place in FCC. For long-lived beta and/or gamma radionuclides such as ^{14}C, ^{36}Cl, ^{54}Ni, ^{95}Zr, ^{94}Nb, ^{99}Tc a ^{129}I can be acceptable the average activities substantially higher (up to the tenths kBq/g) and are specific for the site or repository.

Previous experience of operating surface repository abroad and in Mochovce show that it is real and practical method of the safe insulation of wastes ensuring the protection of human health and environment.

9 ALTERNATIVES OF THE PROPOSED ACTIVITY

In this intention is the enlargement of NRR essential and it is proposed in four versions. The individual alternatives of the given intention implementation were, also with regard to the results of the project C9.1 [L-29] after analysis of possibilities, therefore developed so that they are different from each other exactly in the solution of VLLW disposal. Every considered version contains **classic enlargement that** is in this case represented by the construction of the third double-row of NRR for LILW disposal.

In particular, are proposed the following alternatives:

Alternative I **Enlargement of the NRR capacity without the special VLLW treatment**, i.e. construction of third (and further) double-rows according to the actual concept and continuation in RAW disposal without distinction of RAW between LILW and VLLW.

Alternative II E**nlargement of the NRR capacity with separated VLLW disposal in NRR repository boxes,** i.e. construction of third (and further) double-rows for LILW disposal according to the actual concept and VLLW disposal in a simpler way (e.g. without FCC) directly in the boxes of NRR.

Alternative III **Enlargement of the NRR capacity with separated VLLW disposal in NRR area,** i.e. construction of the third and further double-rows for LILW disposal (according to the actual concept) and construction of VLLW repository on a separate places in the NRR area outside the NRR boxes (see Fig. C-IX. 15).

Alternative IV **Enlargement of NRR capacity with separate VLLW disposal in the NRR are but outside the area of NRR.** In technical terms it concerns construction of VLLW repository following the same concept in the new area located near the NRR, e.g. in the area of borrow-pit (see Fig. C-IX. 16), from which the material of appropriate properties for construction of model of covering was used.

In alternative setting a version of independent VLLW disposal in the location of its origin, which was subject of some previous proposals and was also analysed in the project C9.1 [L-29] is not considered. The reason is that this version was not recommended in the result of said project C9.1 [L-31] – see Chapter C-V.3. Except that, Ministry of Environment of the Slovak Republic based on the application of the submitter ceased from the site alternative solution of the enlargement of the disposal capacities of the repository in Mochovce and agreed, that Intention (and consequently also Report on environmental impact assessment) contained one site alternative (erection of the repository for disposal of VLLW in Mochovce) and zero alternative [L-106].

Alternative Zero

Within the Alternative zero (Fig. C-IX. 22) it is considered not to extend the NRR. In the history of sequential repository backfilling practice there are two alternatives how sequential repository backfilling can be performed: as a continuation of disposal of operational waste from NPP and waste from A-1 NPP decommissioning in FCC packages in existing double-rows and long-term storage from NPP decommissioning or as disposal of NPP operational waste and waste from decommissioning “in order” with subsequent long-term storage of waste that “has not been involved”. The capacity of two built double-rows of disposal boxes in NRR Mochovce location provides storage room for a total of 7,200 pieces of FCC with a total volume of 22.320 m^3.

The entire area of the repository was dimensioned for construction of ten double-rows to dispose RAW in FCC from the operation and decommissioning of all nuclear power plants in Slovakia, which are currently operated (NPP V-2 in the area of Bohunice and NPP EMO12 – including Units 3 and 4, which are under construction – in the area of Mochovce), or which are in the decommissioning process (NPP A-1 and V-1 in the area of Bohunice).

From the moment of fulfilment of existing disposal structures, the not yet disposed RAW should have been stored until the final process of its management was implemented. In terms of environmental impact, this is the worst solution, since the disposal of liquid waste in tanks in the areas of the nuclear power plants means a higher risk for the environment than its solidification and disposal in NRR. Moreover, this approach would adversely affect the intended process of decommissioning of nuclear power plants in Slovakia and contradicts the international obligations the Slovak Republic has adopted in the area of safety of RAW management [L-115]. This solution is not in compliance with the Strategy of Nuclear Energy Back End in Slovakia [L-34].

The acceptable way of LILW management from today's point of view is the disposal in suitable repositories**.** Therefore, from today's point of view, **only Alternative Zero represents postponing of disposal of waste** that was not disposed in the existing structures, its long-term storage in sufficient volume storage capacities and subsequent disposal **from tens to hundred years later** in new repository in new location. Costs for Alternative Zero would not be low, since for the long-term disposal of RAW it would be necessary to construct and operate suitable premises in the same volume as for its disposal

10 TOTAL COSTS

For the construction of the new LILW double-row inside the limits of the existing NRR, the Submitter estimates the overall costs for years to be approx.**14 840 000 €**.

The costs for VLLW repository construction inside the limits of existing NRR were estimated in the feasibility study [L-29] on **11 800 000 €**.

These costs for the erection of VLLW repository can be considered as minimal, due to the fact that erection of the repository outside the NRR (**Alternative IV**) would represent higher costs estimated on 30 -40 % more i.e. approximately from 15.3 to 16.5 mil. € (the need of the more detailed additional engineering-geological and hydro-geological survey and erection of the whole system of discharging the rain and drainage waters, power supply, erection of the roads, operational building, sewage, fencing, ...).

Also the solution for VLLW disposal for Alternative I and Alternative II would represent significantly higher costs. Disposal of VLLW in the assumed amount (68 000 m^3) according to **Alternative I** (packaged in FCC) would represent erection of approximately six double-rows only for the VLLW disposal (estimated costs are 89 mil. €). The disposal of such volume of VLLW according to **Alternative II** (without FCC) would require aprox. half of the capacity and also approximately half of cots (45 mil. €).

11 AGGRIEVED VILLAGES

The aggrieved villages are:

Kalná nad Hronom (Levice region) – from the NRR localization point of view. The NRR Mochovce lies in the land registry of Mochovce village that was cancelled in relation to the NPP Mochovce construction and came under the administration of Kalná nad Hronom.

Čifáre (Nitra region) – from the point of view of potential radiation impact on the habitant in the far future.

12 SELF-GOVERNING REGIONS CONCERNED

Nitra Self-governing Region.

13 AUTHORITIES CONCERNED

District Environmental Office Levice,

District Environmental Office Nitra,

Regional Environmental Office in Nitra,

Ministry of Health of the Slovak Republic - Public Health Authority of the Slovak Republic,

ObÚ Levice, Civil protection and crisis management,

ObÚ Nitra, Department of Civil Protection and Crisis Management,

District Office for road transport and communication in Levice

District Office for road transport and communication in Nitra

municipality Kalná nad Hronom

Common Building Office in Levice.

14 APPROVING AUTHORITIES

Licensing authority according “Atomic Act” is the Nuclear Regulatory Authority of SR. The authority according to § 5 section (3) of the quoted act [L-6] issues **licence for the erection of nuclear facility** (“building permission”– item a) of the state section), **licence for the operation of the nuclear facility** (letter c) of the stated section) and **licence for shutdown of the repository and institutional control of** RAW repository (letter e) of the stated section).

Submitter in this case will require **Licence of NRA SR for change (extension of the usage) of NRR Mochovce** in accordance with **§ 2** letter **by** the Act of National Council of SR no. 541/2004 Coll. on Peaceful Use of Nuclear Energy [L-6]. In order to start implementation of NRR it is necessary to obtain building permission of NRA SR and consent with construction placement – **land-use decision** – on the relevant local building office in municipality Kalná nad Hronom (or Common Building Office in Levice).

15 DEPARTMENTAL AUTHORITIES

Ministry of Economy of the Slovak Republic.

16 DECLARATION ON EXPECTED TRANSBOUNDARY IMPACTS OF THE INTENT

Currently, will be not performed any activities on the repository, which would result in the air pollution by the radioactive substances. Disposed can be only waste which is solid or solidified in the approved package form. Due to this is the influence on air in the surrounding of the repository and also in the surrounding states always void.

Thanks to the barrier system, repository will not produce or discharge radioactive waters **during the operation** and will not influence surface and underground waters in the surrounding area and also in the surrounding states. In reality, only rain and leakage drainage waters will be released.

In the far future, after the closure of the repository and degradation of the barriers, the influence of the underground and consequently also surface waters near repository is possible by the blowdown residual activity of the leakage waters (see Chapter C-III.1). The influence of the surface and underground waters of the adjacent countries states the geographic position of the repository. The underground waters of the adjacent states regarding the distance of the repository from the boarders and tapering off underground water approximately 700 m from the repository will not be influenced. Through the system of the several streams is the repository site connected only with one adjacent state - Hungary. The repository is dewatered by Telinsky stream, which flows to Žitava, which flows to Nitra, Nitra flows to Váh closely before its mouth to Dunaj by Komárno.

Radiological influences of the extended repository in the phase after its closure are in the report evaluated for the various scenarios. Pursuant to the best international praxis it is assumed, that the customs and the consumption of the habitants will be the same also in the future, as it is now. Conservatively it is assumed that so-called critical individual lives and consumes contaminated food from the near area of the repository. Based on the exposure of individuals, it is stated, which inventory of the repository can be disposed. In no case, even when the barriers will not be functioning anymore, can the radiation of the individual exceed the limits stated by the hygienic procedures. By the protection of the critical individual in the surrounding area of the repository is ensured the protection of the habitants also in the adjacent state.

All waste waters released from the repository during the operation of the repository and instructional control shall be controlled. Within the working exchange of the radiological data it is possible to provide data from the repository monitoring also by the relevant office in Hungary.

Even the potential accident (failure of the technological equipment, fire, explosion, floods, and extreme rainfalls) will not cause endangering of the nuclear and radiation safety.

As a conclusion it can be stated, although NRR Mochovce as facility designated exclusively for RAW disposal means facility, which according to the appendix no. 13 of the Act no. 24/2006 Coll.[L-1] as amended is subject to the obligatory international assessment regarding the environmental impacts exceeding the state boarders, that the real radiation impact exceeding the boarders will be nominal. Not even the general criteria according to the appendix no. 14 of the stated act for stating of the negative impact exceeding the borders are not applicable for NRR in Mochovce as for the proposed activity regarding the scope, placement and other impacts. Any of the environmental elements in the adjacent states will not be influenced by the proposed activity, including its options.

PART B DATA ON THE DIRECT IMPACTS OF THE PROPOSED ACTIVITY ON ENVIRONMENT INCLUDING HEALTH

The proposed activity is the enlargement of capacities of disposal of low and intermediate level wastes by extending the existing NRR in Mochovce. The solution alternatives for this activity differentiate by how they will solve the disposal of so-called very low level wastes (see Chapter A-II.9). The required inputs will be slightly different for each of the proposed 4 alternatives. In the following part are based on the current state stated the inputs and outputs assumed for the individual alternatives and also the assumed impacts on environment.

I. REQUIREMENTS FOR THE INPUTS

The proposed activity does not have significantly different demands on the inputs compared to the present state: energy, raw material, water, etc. The NRR site is equipped by the required data in connection with the power, water, transport as well as safety infrastructure, systems monitoring the environment and other means in the view of the present operation of such site of VLLW repository.

1 SOIL

Alternative I – this alternative would need to be enlarged the future existing area of the NRR. Construction of new disposal structures would lead to permanent land occupation area at least 4 ha (4 double-rows with infrastructure - Tab. A-II.11).

Alternative II – according this alternative the future existing area of the NRR would need to be enlarged. By erection of new buildings, the permanent land occupation would be about 2ha (2 double-rows with infrastructure—see Tab.A-II. 11.

Alternative III - enlargement for the **alternative III** will be implemented in the fence site of NRR and does not require the new land occupation, however regarding the building act can get to extension of the land occupation by the buildings.

Alternative IV has requirements for the premises for the erection of the own VLLW repository and occupation of the forest, or eventually agricultural soil and also requirements for the modification of the access roads, erection of the protective fencing, or the modification of the fencing of the existing area, in order to integrate both area of the repository. It will be also necessary for this alternative to complexly solve discharge and control of the drainage, rain and leakage waters.

2 WATER

Portable water is to NRR supplied from the source Červený Hrádok, and the annual consumption is 208 m^3. The consumption of the portable water will not be significantly increased even after the repository enlargement.

The consumption of the water during the implementation of the second double-row, completion of the first double-row operation and during the construction of new disposal structures is estimated on 170 m^3 per month.

3 RAW MATERIAL

Concrete

By the classical enlargement of NRR, for the erection of the disposal boxes for one double-row it will be necessary approximately 6 700 m^3 of the concrete. During the erection of the 1st and 2nd double row of the disposal boxes were used pre-fabricated panels of the disposal boxes coverage. Unless the project states, that during the operation the covering panels of boxes according to the original design will not be functional, by the erection of the third double-row shall be coverage of boxes solved the other way.

Insulation clay soil

The main additional input for the enlargement of the repository will be clay soil. For the erection of the clay bath of the third double-row will be required aprox. 12 900 m^3 of clay. For the construction of the engineering barriers of the VLLW repository (which means lower protection layer and latter also the coverage of the disposal structure) will be required aprox. 20 000 m^3 of the clay soil. Clay materials were widely used during the impermeability provision of the existing disposal structures. It is understandable, that the sufficiency of such material in the surrounding area was one of the reasons for the selection of this site for the NRR.

Within the erection of the coverage model, which is placed in the southern part of the NRR site Fig. C-IX. 4 has been implemented selecting geological survey for the purpose of the amount of the clay soil specification in the area of borrow-pit Fig. C-IX. 16. Such selecting geological survey confirmed the existence of not only sufficient amount of the suitable natural material for the erection of the clay insulation layer of the coverage model but also other works in connection with the repository enlargement, or eventually with its closure. In the direct continuation of the examined bearing (borrow-pit for the coverage model) were calculated assumption sources in the volume of aprox. 212 000 m^3 of the resources. In order to keep these sources of the insulation clay for the future use in enlargement and erection of the definite coverage of the repository, it would be convenient to consider the settlement of ownership relations, together with the implementation of the detailed geological survey in order to specify the volume of the assumption sources of the suitable material [L-61].

The place of borrow-pit (hoisting pit) was in the survey field limited by probes Z-2, Z-4 a Z-6 and takeover older probe MO-4 - Fig. C-IX. 17. The access to the borrow-pit was by asphalted communication from NRR with diversion to the forest path and with passing aprox. 90 m long through the agricultural plot, with the overall length of the route aprox. 700 m. Stripping is in the place of borrow-pit formed only by 50 cm layer of humus soil. The soil material was created by the cohesive soils, granulometrically classified as clay soils to clays, less sandy clays mainly brown or yellow-brown colour with different shades, consistency and mainly solid to hard.

Based on the geotechnical analyses of the unbroken samples from the boreholes and reference samples, taken in the place of borrow-pit up to the depth 5.0 m (assumed maximum depth of the extraction), were the cohesive soils in compliance with the standard STN 73 1001 [L-62] classified as the soils of class F6 with the symbol CI.

Some other values are as follows:

-	Average natural humidity	%	17.3
-	Average limit of fluidity	%	40.0
-	average limit of plasticity	%	20.0
-	index of plasticity	%	20.0
-	index of consistence	%	> 1.11
-	content of carbonate	%	< 1.8
-	content of organic substances	%	< 0.41
-	Proctor Standard		
-	Maximum volume mass	kg/m^3	1760
-	Optimum humidity	%	17.1

- Coefficient of permeability after concretion m/s within the scope $k_f = 3.45.10^{-10}$ to $4.72.10^{-10}$.

Based on the documented values, it is clear that the cohesive soils from the borrow-pit meet the requirements for usage as insulation material. Proximity of the values of the natural humidity and optimal humidity enabled to use soil directly without its further processing.

Coefficient of the filtration was on the concreted samples reached by order equal to 10^{-10} m/s, in comparison with the required value $k_f \leq 10^{-9}$ m/s.

The soils in the borrow-pit were not influenced by underground waters (they are in the depth under 27.0 m, responding to the level of 206 m a.s.l. Balt p.v.) and against the surface rainfall waters was secured by the circuit gutters. In excavation was the potential occurrence of the rainfall water captured into the collection galleries placed according to working procedure, from which was water overdrawn, if necessary.

Borrow-pit was conveniently situated also regarding the mining ad technical conditions of the clay soils extraction. It enabled the selection of the extraction pit in the place, where the high quality material was verified in the relative and sufficient depth and where the stripping reached relatively smallest depth. Stripping should be placed near the extraction pit. Area scope of the extraction pit enabled to choose the depth of the material extraction within the scope 3 - 5 m (availability for the excavators with normal arms). The costs for extraction in this depth were optimal. In parallel with the extraction was provided also backfilling of the unloaded material gained either by extraction or after the modification of the repository.

Extraction of the material and backfilling of the borrow-pit after the completion of the extraction was solved regarding the trouble-free continuance of the material extraction in the future. For the liquidation of the borrow-pit was used soil from the compacting attempt and the rest was completed by the soil from the repository – it was taken after levelling of the terrain under the base concrete panel of the coverage model. On the surface was from the interim stock-pile covered humus soil and made biological recultivation. Such borrow-pit was after the completion of works handed to the user for the original agricultural usage of the soil.

In the future, after the continuance of material extraction from the borrow-pit, it will be necessary to remove not suitable material (aprox. 2000 m^3) under the humus soil and possible to use for the extraction.

Putting the second double-row in operation will require a limited amount of building materials, building constructions, supply and installation of new building constructions.

Similarly, erection of disposal and other double-rows for disposal of LILW will require except the concrete and clay soils also other building material and construction elements in the volume, which shall be specified by the detail design of these constructions.

4 POWER SOURCES

The average annual consumption of the electric power for NRR is 8140 kWh. The supplying is from 400 kVA trafostation, what is the only supply of the electric power on NRR.

5 REQUIREMENTS FOR THE TRANSPORT AND INFRASTRUCTURE

Requirements for the transport shall increase mainly during the building works during the erection of the disposal structures for LILW and the VLLW repository. During the operation (disposal of RAW into disposal structures) of the repository after enlargement, shall the requirements for the transport slightly increase what would depend on the design intensity of the disposal. Requirements for the protection and other safe infrastructure including the requirements for monitoring will be similar as in the current operation. The project of monitoring with the emphasis on monitoring of the surface waters shall be specified also in the NRR itself and rebuilt it regarding the new particular disposition of the monitoring buildings of the repository area. Alternative IV. requires erection of new infrastructure.

6 REQUIREMENTS FOR MANPOWER

Requirements for the operational staff of NRR after the LILW repository enlargement and erection of the repository for the VLLW disposal will not significantly differ from the current state. Regarding the integrated character of the repository operation, new working force in number of 3 employees will be required for the operation of VLLW repository.

II. DATA ON THE OUTPUTS

The outputs and its impact on environment are in the principle identical or very similar in each of the considered alternatives of the NRR enlargement. During the enlargement of NRR and its further operation it is necessary to consider, regarding the environmental impact, the following outputs.

1 AIR

Groundworks will be the temporal source of air pollution during the erection. This area source of air pollution is time restricted from the beginning of the building works to the insulation layer disposal. Acting of dustiness during the construction represents not very significant impact on air also regarding the site characteristics.

During the erection and operation will be the source of air pollution also the operation of the equipment and vehicles transporting the material and waste – exhaust fumes of this equipment. This impact on the air quality is nominal.

2 WASTE WATERS

Sewage waste waters, in the amounts responding to the requirement of the portable water consumption for the sanitary purposes created during the erection and operation will be according to the need, transported for disposal to the contracted sewage plant. In the future, it is considered to erect small waste water treatment facility.

During the current operation of NRR were not produced waste service waters at all. From the area are discharged only waters from the surface offtake in the amounts depending on rainfall. During the current operation of NRR were from the retention rainfall tanks discharged within the individual years the amount of water stated in Tab. C-IX. 1. In average it was annually 6 242 m^3 water. Concentration values of indicators of the discharged waters from the surface offtake stated in the decision of the water management body were not during the current operation exceeded.

Formally, due to the fact that it is nuclear facility, NRR shall meet authorized limits of liquid radioactive substance activity stated by Public Health Authority of SR in the discharged waters such as annual balance values and volume activities. Water is currently discharged from two concrete basins placed in the area close to entrance, or operational building. Into the tank are supplied:

- Water from the parallel dewatering channel from the inner side of the fence of discharged rainfall water and water from the melting snow from the site,
- Water from the so-called controlled drainage,
- Water from the so-called controlled drainage, which is discharging the leaked rainfall water, which flows off the clay insulation bath of existing double-rows,
- From the reinforced area of repository site and from the roof of the hall above the 1st double-row.

Discharged water is before discharging monitored for the content of safety significant radionuclides which are set forth in Decision of PHA SR [L-84] permiting to release radioactive substances from administration control by discharging to surface waters (in this case: ^{3}H, ^{137}Cs, ^{90}Sr, ^{60}Co, ^{239}Pu). Decision of PHA SR was the last time updated after the periodical assessment of nuclear safety in 2011. Each increase of the volume activity above the background values indicates abnormal situation on the repository and is subject of the examination and relevant corrective measures.

It is expected, that the drainage collecting system on the VLLW repository, will collect certain amount of the water, though the leakage of the rainfall water through the barriers is reduced, but not completely eliminated. Leakages will be most likely easily contaminated with movable radionuclides. These leakages collected in the tank of leakage waters will be removed after inspection. In the event that the release is not possible it will be necessary to transport it to the place of liquid RAW processing in JAVYS, a.s. and condition it the standard way..

Control of the possible contamination of the underground waters in case of insulation damaging on the VLLW repository will be provided by drainage and monitoring system placed above and under the repository in the direction of underground waters flow in order to enable the monitoring system state immediately abnormality and its position. In this sense it will be necessary to redevelop also the whole monitoring system of the underground waters after backfilling of the repository in order to in case of any leakage of radioactive substances from any place of repository was this leakage captured in some of the monitoring boreholes.

By the erection of the hall above the 2nd double-row and its putting into operation will change the whole area from which will be the rainfall water discharged to rainfall basins. From the roof of the 1st double-row will be the rain water discharged into rain basins only from the half (north) area of the roof. The rainfall water from the second half of the area (south) roof of 1st double-row and from the whole area of the roof of the 2nd double-row will be lead to the external channel (gutter) which flows off the repository along the fence from the external side and falls into the tributary C of Telinský stream in the south of repository. Reinforced area from which is rainfall water discharged into rainfall basins will not change significantly.

Collecting area will not significantly change either after the enlargement of NRR. The volume of the controlled waters will increase after its discharge into the basins. Design solution of disposal capacities enlargement and erection of the repository for VLLW shall consider the capacity of existing basins and adjust to this also the mode of rainfall basins discharge.

Sewage waters from the sanitary facility in the existing operational building are discharged by the pipeline into the cesspool with the volume 87 m^3. The sewage water from the laboratory and from the emergency shower in the hygienic loop of the operational building are discharged by leakage of the special canalisation into the collection basin of waste waters in front of the building with the volume 10.5 m^3. The stated system of sewage water discharge and system of the special canalisation will not change.

3 WASTE

RAW repository is designed for **disposal** of radioactive **waste.** Other “production” activities by which waste could be produced are not expected. The classical building waste can be produced by the construction activities – type, the amount and concept of liquidation will be stated during the project development.

Similarly, the second double-row commissioning represents the limited volume of the building waste from dismantling and installation, but also the need of building material, building construction, deliverables and installations of the new building constructions. Temporal accumulation of such building waste can be solved near the construction of NRR building site. Waste will handed to facility, stated for disposal or appraisal of waste (waste dumps, incinerations, sorting, appraisal of waste). It will be solved within the awarding of contractual relations between the contractor and investor.

During the implementation of the building and installation works within the putting in operation the second double-row will be produced the following waste (expert estimates):

Tab.B-II. 1 Tape of waste generated during the building and installation works within the putting in operation the second double-row

No. of waste type	Title of waste type	Waste category
08 01 11	Waste paints and varnishes containing the organic diluents or other hazardous substances	N
08 04 09	Waste glue and insulation material containing the organic diluents or other hazardous substances	N
15 01 06	Mixed wrappers	O
15 01 10	Wrappers containing residuals of hazardous substances or the wrappers contaminated by these substances	N
15 02 02	Absorbents, filtration material (including the oil filters not specified differently), cleaning fabric and protection clothes contaminated by hazardous substances	N
15 02 03	Absorbents, filtration material, rags for cleaning and protection clothes other than stated in 15 02 02	O
17 01 06	Mixtures or separated fraction of the concrete, bricks, tiles and a ceramics containing the hazardous substances	N
17 01 07	Mixtures or separated fraction of the concrete, bricks, tiles and other than stated 17 01 06	O
17 02 03	Plastic	O
17 04 05	Iron and steel	O
17 04 11	cables	O
20 01 01	Paper and cardboard	O
20 01 02	Glass	O
20 01 10	Clothes	O
20 01 21	Beginning of the form Fluorescent lamps and other waste containing the quicksilver	N
20 03 01	Blended communal waste	O

Note: not sorted residuals of blended building or demolition waste, containing hazardous substances, shall be removed on the waste dump of the hazardous waste.

N- hazardous waste

O- other waste

Waste, included into the group 08, 15, 17 are the wastes, which are produced during the building and installation activities and wastes of the group 20 (eventually of the group 15 – wrapper waste) are wastes from the operation (e.g. from the sanitary equipment, changing-room, canteen) on the site.

The waste, which is produced from the operation of the tracks and building machines (subgroup 16 01), will be disposed by the repair and maintenance of the building mechanisms in the service centre. Waste, produced by the operation and building mechanisms will be solved by the contractor within his own overhead expenses.

Generally, the waste management will be solves as follows:

- Sorting of hazardous element of the waste (e.g. cans from the residuals of paint, rags), temporal accumulation and provision of its removal for the hazardous waste dump, or in the incineration plant (regulation of the Ministry of Environment no. 283/2001 Coll., on performance of some provisions of the waste act),
- Sorting of the usable elements of the waste (e.g. wrappers, demolished material, tin plate, steel elements, etc.) and its temporal accumulation on interim stock-pile with consequent sorting and reuse,
- Metallic waste represents secondary raw material (in concerns e.g. dismantling of the mobile roof on the crane track of the line C after putting the 2nd double-row into operation),
- Wastes produced in the course of construction implementation (soil, debris, etc.) will be according to the type stored on the public waste dump,
- Building debris and residual soil will be continuously, after sorting (or dosimetric control) transported to the waste dump up to the distance 5 km,
- Registration of waste in compliance with the programme of waste economy, which shall provide investor in cooperation with the contractor,
- Meeting of internal procedures of the contractor and investor regarding building reconstruction [L-95], [L-97].

All these activities in connection with waste management (with its appraisal, disposal or its liquidation), produced by the implementation of the individual buildings, will be modified in the contract between the contractor of the construction and investor. The contractor is immediately obligated to inform, about the waste produced from its own activity, in the written from, the technician of the waste economy in JAVYS. This waste shall be disposed in the position of waste originator on its own expenses.

For disposal, sorting and handling of waste in the course of the civil works will be used containers for the sorted waste- container for communal waste, container for the paper, container for building waste, container for metallic waste, container for hazardous waste. Containers will be placed in the restricted area. The area for placing of accumulate waste will be properly secured and marked by table in compliance with internal procedure.

All wastes produced during the dismantling works in controlled area (hall of the 1st double-row) shall proceed through the dosimetric control.

During the operation of NRR will be after its enlargement produced smaller amount of waste in the amount and structuring according to the existing state in the presence. Over the last 5 years were produced annually:

–	Blended communal waste	350 - 2500	kg
–	Ni-Cd batteries	18 - 95	pcs
–	wrappers, containing the residuals of hazardous waste	5 – 11	kg
–	polluted oil rags	3 – 7	kg
–	waste from cleaning of cesspool	56 – 220	m^3

Within some years were produced: paper, cardboard, oils, fluorescent lamp, waste paints. Transport and liquidation of the communal waste, produced during the operation is provided under Contract for Works SE, a.s. - Bratislava, plant Mochovce (EMO). It is assumed that it will be similarly provided also during the NRR operation after enlargement.

The small amounts of RAW from the laboratory, which can be created by the special works, are and will be transported for processing into processing centres of JAVYS.

4 NOISE AND VIBRATIONS

Noise and vibrations will be produced mainly by the dismantling works within the implementation above the 2nd double-row. Regarding the distance from the nearest inhabited area, it is possible to assess this impact on the surrounding habitants as less significant. Own disposal of RAW into the boxes shall not limit the noise.

In the course of RAW transport can be expected in consequence of these vehicles transit not very significant noise impacts, which can not in any case influence any found way the noise situation of the transport roads.

The repository does not create any new source of vibrations or thermal emissions.

5 RADIATION AND OTHER PHYSICAL FIELDS

Contribution to the dose rate equivalent to the external radiation from the repository on the level of fencing and within the site will be significant nominally (within the experimental mistakes of radiation background measurement- see Chapter C-II.16.2).

Radiation impacts will not exceed, in the course of the package forms with RAW, the limit values for the operation, which are in the conditions of the regular transport as follows:

- ≤ 2 mSv/h dose rate on any place of the external surface of the transport container,
- 0.1 mSv/h in the distance of 2 m from the surface of the transport vehicle.

Regarding the dynamic of the transport, it is the nominal value.

Similarly, regarding the current operation of NRR it can be stated, that from the results of monitoring, there are no differences in the radiation situation before and after putting NRR into operation– see Chapter C-II.17.1.1.

Owing to the way of filling the package forms of RAW in the processing centres, no new source of the radiation pollution of the released air is created. From the closed package form transported into the repository, there are not created any gaseous radioactive substances or aerosols. Liquid substances are not and will be not disposed in the package forms.

6 SCENT AND OTHER OUTPUTS

The activities performed within taking over and disposal of RAW or RAW disposal itself are not connected with the production of any scent.

7 ADDITIONAL DATA (E.G. SIGNIFICANT TERRAIN MODIFICATIONS AND ITS INTERFERENCES INTO THE COUNTRY SIDE)

The assessed activity does not require any significant terrain modifications or interferences into the country side for alternative III. If future estimates of the volume of waste fill, some terrain modification would be required under alternative II and especially I. Terrain modifications will require alternative IV and erection of borrow-pit for the provision of the necessary amount of clay soil for the erection of the hydro-insulation structures of the third double-row for LILW disposal and for the implementation of the protective layers of the bottom and coverage of the repository for VLLW – see Chapter A-II.8.2.1.7.2. The erection of the borrow-pit will be the part of “geological task”, which provides the specification of the borrow-pit localisation, its implementation, including the recultivation of the relevant area after extraction of clay soil – see Chapter B-I.3.

PART C A COMPREHENSIVE DESCRIPTION AND ENVIRONMENTAL IMPACTS ASSESSMENT, INCLUDING HEALTH

I. DEMARKING OF BORDERS OF THE AFFECTED ENVIRONMENT

At Mochovce site are placed two individual sites of nuclear facilities - namely:

The site of nuclear facilities SE-EMO includes operational two-unit NPP EMO12 and Unit 3 and 4 under construction (double unit MO34). Double unit EMO12 and MO34 represent two individual plants of SE, a.s. Bratislava. Double-unit EMO12 is connected to nuclear facility for Final processing of liquid RAW (FS KRAO), which provides the conditioning of liquid RAW from the operation of NPP EMO12 by bituminisation and cementation.

The site of NRR Mochovce (aprox. 1.5 km northwest from the site SE-EMO), which is operated by Jadrová a vyraďovacia spoločnosť, a.s. Bratislava (JAVYS). This company is also operator of nuclear facility FS KRAO, which is situated at the site of nuclear power plants in Mochovce.

Regarding the radiological protection of population around NPP, SE-EMO is declared as *sanitary protection zone* without the permanent settlement up to the distance of 2 - 3 km from the area of nuclear facility. In terms of using this zone as agricultural production, are not stated any specific conditions, except the performance of radiation situation control of the possible contamination of the agricultural production. Built-up and permanently populated areas of the municipalities are located outside the *zones of sanitary protection*. In terms of radiation situation control is the area around NPP declared as *control zone* (3-4 radiuses of sanitary protection zone (9-12 km) and *monitored zone* up to the area of aprox. 20 km, in which is provided the radiation situation control.

The site NPP Mochovce is placed in the zone of sanitary protection of NPP SE-EMO. The repository itself does not represent for the surrounding population risk of reaching or eventually exceeding by the act stated conditions for the declaration of the endangering zone – calculated conservative values of doses are lower as the values of targeting levels for the population protection in accordance with the provisions of the NRA SR regulation no. 55/2006 Coll. [L-10] also by the most serious possible accidents on NRR. Based on that the NRA SR in his decision no. 98/2006 [L-107] stated the size of area at risk of nuclear facility of NRR in the area of Mochovce as an area bounded by a barrier of protected area, i.e. fencing of NRR Mochovce.

The boundaries of the relevant area regarding the NRR impact on the surrounding population were determined by elaborators of this Report in order, to include the area, as subject of analyse of safety demonstration and deriving of activity criteria of waste package forms acceptance for disposal – see Chapter A-II.11 – and municipality Kalná nad Hronom, due to the fact that this municipality administers the area of the former municipality Mochovce.

According to that, the borders of the relevant area affect the area NRR repository itself and the nearest surrounding including the basin of tributary C of Telinský stream and river basin itself of Telinský stream from mouth of the tributary C up to the water reservoir Čifáre (Čifársky pond), further also the agricultural soil in the surrounding of this reservoir and municipality.

II. CHARACTERISTICS OF THE CURRENT ENVIRONMENTAL STATE OF THE RELEVANT AREA

For development of this Chapter were used basic documents about the area provided by submitter– data from the PpBS NRR [L-38], the results of the impact assessment of nuclear facility operation at site on surrounding area, which are regularly submitted to the regulatory authority [L-63] a [L-90], published in company magazines on Internet[L-65], [L-66] and in journals [L-74], [L-75], [L-76] also the results of research [L-54], [L-55], [L-88], [L-89]. Used were also documents processed in the process of environmental impact assessment under the Act no. 24/2006 Coll. in designing of the buildings and activities at the given site [L-67].

1 GEOMORPHOLOGIC CONDITIONS

The nuclear facilities at Mochovce (SE-EMO, FS KRAO and NRR) and all above stated zones, relevant and areas of interest from the geomorphologic standpoint belong to the land area of the Danube downland and the landscape unit of Danube upland. The site of nuclear facilities in Mochovce is situated on the area of two landscape subunits - Hronská upland and Kozmálovské hills. Fault valley of Hron belongs to the parts Breznické podolie and Slovenská brána. The northeast part of the land territory extends to the landscape subunits Štiavnické hills. The highest peak of the area is Veľká Vápenná (349.8 a.s.l.) and the lowest parts near the Hron in surrounding of Kalnice around 161 a.s.l.). The centre of the former village Mochovce was located at an altitude of 195 a.s.l. and village within 180-350 a.s.l.

2 GEOLOGIC CONDITIONS

Danube lowland and the structural element Komjatická depression emerged as a sedimentation area on the interface of Sarmat and Pannonian. Its pre-tertiary subbase is formed by Mesozoic complexes of chočský and highier thrust plate. Subbase forms raised thrust limited by faults and decreasing southward to a depth of 2 600 m. Sedimentation of rock fills of north-eastern part of the Danube downland lasted from Badenian through Sarmat, Pannonia, Pont, Dak to Ruman to Quaternary. Neogene is represented by sedimentary parts of Sarmat and Pliocene (clays, sandy and silty clays, sands, claystones), which are in horizontal and vertical position very variable. The individual positions often changes, it is fingerlike wedged and it forms lens. The top position under the quaternary sediments are unevenly grained aluminous sands yellow-grey and yellow-brown extending into the depths of 15-20 m. Quaternary sediments represent mostly from yellow-brown to brown soils. Neogene and Quaternary was in detail analysed for the purposes of the site of nuclear facility area Mochovce erection and creating a zone of sanitary protection in terms of the geological structure.

Based on the results of previous engineering, geological, hydrogeological and geophysical surveys can be concluded that in the present site to a depth of 100 m are present anthropogenic deposits, Quaternary sediments and sediments of Neogene represented by deposits of the Miocene, including a Pliocene volcanic rocks.

Quaternary is represented:

Anthropogenic sediment forming the fillings and backfilling in the repository site. It is represented by heterogeneous clay-sandy and a gravel material. It occurs mainly in the area of repository double-rows, by perimeters of the area under the local roads and on the southern edge of the entrance. It reaches power aprox 8.0 m. Fluvial and proluvial sediments of Holocene age occur by the southern edge of repository site, forming the bottoms of dry and semi-dry valleys. It is represented by clay soils up to sandy clay soils with the local positions of small gravel. The thickness of complex of strata is 2 - 4 m.

Deluvial sediments of Pleistocene – of Holocene age are widespread at site the most and occur in several types:

- Sandy gravel soils form the bottoms of dells and sometimes the lower parts of the slopes. It is yellow-grey or grey colour.
- Sandy clays with occasional gravels and rock fragments occur on the lower edge of the slope in contact with sand, strongly weathered gravels of volkovský complex of strata. It is grey, yellow-grey, sometimes with bright colours with chaotically scattered gravel. Its power does not exceed 4.0 m.
- Clay with rock fragments of vulcanite are located around the perimeter of the hill Dobrica, where by the influence of slope processes, the pyroclastic fragments of lava flow and get into the lower elevations. Filling of fragments consists of clay, loam and coarse-grained sand. At the foothill, the achieved power is more than 10.0 m. It is often watered and based on the clay subsoil drained into the valley.

Neogene is built by sediments from Pliocene and Miocene.

Pliocene is represented by complex of strata (dak), whose lower members enter the surface in steeper slopes of dells in the surrounding of repository. Lithologically, it is formed by medium to coarse sands, various sandy or limonited clays, with local appearance of coal clay. In it are present positions of finely and medium grained clays. It is characterized by large variability in the vertical and horizontal direction and the thickness reaches about 20 m.

The top parts of volkovský complex of strata are extended mostly on the surface of backs of upland. Largely dominate gravels and sandy weathered gravels with the positions of subtly to medium sands, occasionally grey sandy clays. Colours are mostly rusty to reddish with grey clay plugs.

Miocén represent deposits of pannonian and sarmat which prevail on location of depth 100 m.

Pannonian sediments represented by grey, grey-green to sandy clays were found in several boreholes. These sediments also known as Ivánske complex of strata are grey, grey-green and in the upper position also yellow-brown. Sometimes in upper parts of strata occur the positions of fined gravel with sandy fill. Based on the assessed boreholes at repository site, it can be concluded that the sediments reached a thickness of up to 17 m. Sarmat sediments are represented by clay layers and clay to gravel inserts, by pyroxenic andesites and its volcanoclastics. Pyroxenic andesites build morphologically expressive altitude Dobrica northeast from NRR site and northwest from SE-EMO site – see Fig. C-IX. 3. It is a black, black-grey fine-grained rocks with rusty grey patina, which alternate with pyroclastic - Fig. C-IX. 10. Volcanoclastics are represented mainly by volcanic breccia type of agglomerate tuffs.

The surface deposits of volcanic slopes varies in tendencies from 10 to 20 %. Lithologically, it is roughlyclastic sediments of volcanic origin. In the area of site above the lava flow reach the power from aprox. 3 to 10 m.

Lava flows represent the amphibole -pyroxenic andesites with biotite with a thickness of 15 to 45 m.

Tectonic conditions: The Danube Basin has neoalpine fault-flexture construction. Faults violate especially older elements of the filling, while the younger elements, from Pannonia, are by faults significantly violated only in peripheral zones of the pelvic structures. Geological profile between Komarno and Mochovce documents mutual structural relationship of high komárňanský thrusts on the south to želiezovská depression and to dubnícka platform, on which the northern edge the Mochovce plant is located. In southern part, the profile points to the old pre-neogene slip of transdunube unit on central carpatian unit along the line Hurbanovo – Diósjenö. Uppermiocene extensive mode in this area is documented by sliding faults. Further geological profile, perpendicular to the previous one, runs from the Tribeč mountains through depression and Dubnica platform with cranking to želiezovská depression.

Recent activity of sliding faults is observed in surface exposures. Current relevant vertical movements reach 1 mm per year and stated is also sinistral moving element. Declining block includes komjatická depression and conversely territory Štiavnický stratovolcano seems increasing. Based on recent movements in the faults, the possibility of future moderate seismic shocks cannot be theoretically excluded, as confirmed by an earthquake in the area of Levice with epicentre on hontiansky fault system of north-south direction.

With analysing of boreholes of cores in profiles of boreholes “R” from the additional geological survey implemented within the completing works on erection of NRR Mochovce [L-56] and construction of isolines of interfaces of Sarmat- Pannonian, it was possible in the subbase under the vaults of NRR to allocate morphologically positive relief (weir) oriented approximately east-west [L-57]. The origin of this weir was interpreted tectonically. Since the discordant disposal of sediment of Pannonian on its subbase i.e. sarmat rocks it is clear that, the sediments of Pannonian settled on the tectonically unsettled sarmat subbase, which were subhorizontally covered. This finding is significant due to stability of NRR area. According to that the Pannonian sediments are not in the relevant area influenced by fault tectonic, from which it was included, that faults, which unsettled sarmat rocks were in Pannonian already inactive.

The youngest faults in the wider area of Mochovce, which were active in Pliocene (there is not the evidence about the recent activity), have the perpendicular direction on the presumed pre- pannonian fault in the subbase of NRR. In terms of its orientation and major east-west oriented extension, it is not assumption of the recent animation of the assumed fault in the subbase of NRR.

2.1 Geodynamic effects

2.1.1 Seismicity

In terms of earthquakes occurrence it can be concluded that in the surrounding of Mochovce was not identified significant epicentre. Weak earthquakes in the area of Levíc respond to geological segmentation on faults and movement tendencies. Estimated appearance of dynamic effects of Macroseismic intensity is 5-6º MSK-64. The values of risks for the given area calculated by seismic and statistic method demonstrated, that for the period of repeating of 100 years, it is possible to expect macroseismic effects of 5-5.5º MSK-64 and for the period of 10 000 years from 6.0 to 6.5º MSK-64. Horizontal peak acceleration for that macroseismic intensity is estimated on 60 $cm.s^{-2}$.

In terms of the impact of local characteristics of subbase on seismic motion, the area is assigned to category B. Based on the seismic and statistic assessment of seismic hazard of site the design earthquake was specified to intensity 5º MSK, i.e. maximum design acceleration is 0.25 $m.s^{-2}$ and calculated earthquake responds to intensity 6º MSK, i.e. computing maximum acceleration is

0.5 $m.s^{-2}$.

2.1.2 Slope movements and erosion processes

In the affected area occurs the modulation of the terrain of slope and partially subslope parts, which translate into the occurrence of debris cones, its erosion and levelling of water floods. On the steeper slopes of vulcanite is applied surface diluvium sliding. After heavier rainfalls are in places of collected flow of water created shallow erosion trenches. Through the area flow two small water streams, causing a slight lateral erosion. Eolian power activity partly applies here, demonstrated by streaming of fine particles of surface soil.

The results of geotechnical site survey of Mochovce showed the absence of sandy soils capable to be changed to liquid state. Sands form only isolated and mutually incoherent position in the Neogene strata of clay. Sands are fine to medium grained, mostly in admixture with clay and are dense. It reaches the maximum power of several cm. The assessment of the whole territory showed that the clays and claystones, volcanic rocks and the materials used in fillings cannot change to liquid state even at the level of seismic load of 0.1 g [L-45].

2.2 Minerals deposits

In the affected area and its surroundings are not reserved any mineral deposits. There are only Neogene and Quaternary sediments and in the smaller scope also neovulcanites. In the wider surroundings are important fluvial, eolian and deluvial quaternary sediments of a representing gravel, sand and loess from which extraction of most of them have only local significance. The Neogene sediments are mainly of pliocene pellets, sand and gravel that are used for construction purposes.

3 SOIL CONDITIONS

3.1 Soil types, kinds and its evaluation

In the northeastern part of the territory dominate shallow layers on soil forming substrates on the solid ground, while in the southwestern and western part it is the deep layers on soil forming substrates. This is related to the occurrence of deep and shallower soils.

The plane by the river Telinský stream is formed with the soil type fluvisoil typical (grain clay-loam soils). Smaller enclaves of forest represent soil types ranker typical and ranker kambizemný, aluminous or clay-loam.

The western part of the territory is formed by much wrinkled area built by neogene sediments, loess and loessloam. The positions on slopes with greater steepness have complex of soil types: regosoil typical and brown soil typical, which are grain and aluminum. Shallow valleys are built on brown soil pseudogleid on neogene sediments, or eventually fluvisoil typical and fluvisoil gley on quaternary alluvial sediments, regarding the granularity, it is the clay soil or clay-loam soils.

3.1.1 The degree of tendency to mechanical and chemical degradation

Mechanical degradation of soils depends on several endogenous (coherence, consistency and adhesion) and exogenous factors (topography, vegetation cover, atmospheric rainfalls and wind). Chemical degradation of soils in the affected area can cause a number of factors (acidification of land resources, soil contamination with heavy metals, organic pollutants, fertilizers and pesticides). Urbanized areas are characterized by strong antropisation of land.

A serious threat of soils represent wind and water erosion. By wind erosion are threatened soils without the vegetation cover, at site are situated mainly on loess. Vulnerable to water erosion are soil on slopes with high steepness without the vegetation cover (at sites are mainly brown soils and regosoils in the south of NRR site on the slopes of tributary C of Telinský stream).

4 CLIMATIC CONDITIONS

From the climate and geographic view, the affected area belongs to the type of lowland climate, mostly warm, dry to slightly dry, with mild temperature inversion. The area of Veľká Vápenná belongs to the type of upland climate, slightly warm, moist to very moist, with a small temperature inversion.

4.1 Rainfalls

The prevailing part of rainfall amount in the relevant area form vertical rainfalls. Their average annual total varies within the range 550-600 mm. In the area of central Slovak upland, which is located north of the area is total amount of rainfall about 100 mm higher. The average rainfall at the station of SHMÚ Mochovce for the period 1994-2004 reached 601.9 mm. The highest rainfalls are in June and the smallest are in July.

4.2 Temperatures

Within ten-year period - the period from 1994 to 2004 the average annual temperature ranged from 9.6 to 11.0 ºC, the coldest month of the year was January, when the average daily temperatures ranged from -3.7 to 2.0 ºC. After April's rise in the second decade of May there was a cooling influence of the invasion of cold arctic air. The similar situation is also in the second decade of June. According to measurements in this period, the highest period was in July, since then gradually decreases steadily until the end of year. The average annual temperature is about 9 ºC. In the last measured year it reached 9.4 ºC. Minimum average temperature in January was –3.7 ºC, the maximum average temperature in August was 20.1 ºC. Absolute maxima ranged from 32.8 to 37.4 °C, the absolute minima in the range – from 12.5 to -17.6 °C.

Growing season with temperatures above 5 ºC takes about 240 days, starting around March 20th and ends around the 14th November. Number of days with snow cover above 5 mm per year is around 30 days. Annual average relative humidity of air varies within the range 73-74 %. (Yearbooks of climate observations of SHMÚ Bratislava).

4.3 Windiness

According to data of SHMÚ Bratislava, in the areas prevails northwest and northeast airflow. In winter are the wind conditions influenced by circulation conditions of Asian anticyclone, Iceland and the Mediterranean depression, as well as the nature of relief. Northwest winds prevail. The spring period is characterized by frequent changes in weather situations accompanied by rapid changes of temperature. During this period, is the minimum frequency of winglessness in all seasons due to the frequent unstable atmospheric stratification. In summer, prevail east and south directions, as well as during the winter months. Autumn period is a transitional period and it is similar to the spring one.

The maximum average wind speed is around 3.6 m/s, minimum is 2.9 m/s and in average it is 3.3 m/s. On the Fig. C-IX. 19 there is the average frequency of direction and wind speed (wind rose) for Mochovce site, according to the Yearbook of climate observations of SHMÚ within the period from 1994 to 2004.

5 AIR

Overview of air pollution sources in the affected area and pollutant emissions in the year 2008 contains the following table:

Tab. C-II. 1 Overview of air pollution sources in the affected area

Cadaster area	Title of the source	TZL [t]	SO_2 [t]	NO_2 [t]	CO [t]	TOC [t]
Kalná nad Hronom	Boiler plant – high school Kalná nad Hronom	0.004	0.001	0.086	0.035	0.006
Kalná nad Hronom	Pumping station of fuel Kalná	0	0	0	0	0.718
Kalná nad Hronom	Boiler plant	0.016	0.002	0.305	0.123	0.021
Kalná nad Hronom	Pumping station of fuel Jurki Kalná	0	0	0	0	0.828
Kalná nad Hronom	Drying of grain	0.326	0.001	0.125	0.051	0.008
Kalná nad Hronom	Boiler plant	0.001	0	0.022	0.009	0.001
Kozárovce	Bakery Pekný deň	0.005	0.001	0.101	0.041	0.007
Kozárovce	Primary school Kozárovce	0.551	0.447	0.318	2.687	0.367
SE Mochovce	Dieselgenerator station	0.114	0.002	0.403	0.064	0.009
SE Mochovce	Boiler plant of GDT	0.009	0.001	0.178	0.072	0.012
SE Mochovce	Boiler plant of Locksmith workshop	0.001	0	0.027	0.011	0.002
SE Mochovce	Boiler plant Oblicovka	0.005	0.001	0.099	0.04	0.007
SE Mochovce	Boiler plant SA-3	0.013	0.002	0.255	0.103	0.017
SE Mochovce	Boiler plant Šala	0.004	0.001	0.084	0.034	0.006
SE Mochovce	Boiler plant PSV	0.003	0	0.052	0.021	0.004
SE Mochovce	Main Boiler plant	0.009	0.001	0.185	0.075	0.012
SE Mochovce	Boiler plant Strážny areál	0.009	0.001	0.178	0.072	0.012
SE Mochovce	Auxiliary boiler plant	0.055	0.007	1.211	0.406	0.052

6 HYDROLOGICAL CONDITIONS

The site of nuclear facility in Mochovce is located in the Danube upland on the southwest edge of the Štiavnické hills and is located in the upper part of basin of Telinský stream. The location belongs partially to the river Nitra (NRR site), north-eastern and eastern part of the area (own area of areál NPP EMO) to the basin of river Hron.

6.1 Surface flows

6.1.1 Watercourses

The recipient for waste (and rainfall) waters from NRR is the tributary C of Telinský stream.

Telinský stream rises in the height of +215 a.s.l. in a valley lying eastwards from the hollow Husárske. The basin area of Telinský potok (stream) in the delta is 37.91 km^2. The valley length is 15.8 km and the forest coverage in the basin area is up to 20 %. In the rkm of aprox 10.5 a water reservoir Čifáre is erected. Telinský stream is in the area of NPP Mochovce covered in the section of around rkm 15.1 (profile 1) to 13.7 (profile 2), and from there it again flows in open cover. In the place of inlet into covering in rkm 15.1 also non-regulated reservoirs flow into it which trap percolating waters and soil waters from northeastern and eastern slope.

In the relevant area were on Telinský stream erected three flow meter stations Fig. C-IX. 2

- measurement weir L1 aprox. 600 m under junction with tributary C,
- measurement weir L2 aprox. 720 m above junction with tributary C and Telinský stream – against the flow of tributary C and
- measurement weir V under the weir on Čifárska reservoir.

Note: The flow in the right-hand tributary C is influenced by the mode of discharging retention tanks of wastewater from the NRR site – the flow is measured in the distance of around 700 m from its inlet (measurement weir L2 - Fig. C-IX. 2).

Tributary C

The tributary stream C drains the NRR site – the valley Husárske and a nameless valley located more westwards that joins the valley Husárske right under the southern edge of NRR disposal site and further for the connected valley in the length of about 2800 m under the disposal site to the Telinský stream.

In the valley Husárske above NRR and up to the distance aprox. 750 m under it, the tributary C does not form any surface flow. The amount of water in this part is not dependent on the precipitation intensity and on the wastewater discharge from NRR retention tanks.

Rainfall waters from the disposal site area are drained by a system of internal open drainage ditches into two basic retaining accumulative storm-water stand-by tanks. The capacity of each of them is 490 m^3. The quality of retained water is checked in the retaining tank.

Part of the flow under the disposal site is subsidized from surface springs. The first spring of groundwater to the surface occurs (probably from the first shallow collector only, i.e. H horizon) in a mire about 750 m southwards from the south end of NRR on the spot height about +197 m above sea level (a.s.l.). The second spring (probably from base collectors P1 and P2) occurs in another mire 600 m further to the south. After another about 1.2 km long flow the tributary stream C flows from the right side into the Telinský stream in the altitude of +180 m above sea level. The average falling gradient of the brook is 9.5 ‰.

The flow's bed is lined with concrete bricks from the south edge of the NRR for about 750 m in the direction of the flow. The bed's bottom in this section is 1.0 – 1.3 m deep under the level of the surrounding grounds. The size of the basin's collecting surface over the northern edge of NRR is 265,000 m^2 and the size of the collecting surface of inter-basins between northern and southern edge of NRR is about 320,000 m^2 (out of that the surface drained into the NRR's internal drainage system amounts to 105,000 m^2). The collecting surface of the whole basin of the nameless stream flowing through NRR to the hydrometric profile with measurement weir L2 amounts to about 3,670,000 m^2 (=3.67 km^2).

Level of surface waters pollution

In the Slovak Republic was quality of surface waters monitored in 2001 in 178 basic and 3 special places of sampling. The basic approach of surface water quality assessment in the SR is the classification of surface water quality according to STN 75 7221 (valid since January 2000), under which is the quality of surface water classified by individual indicators into classes, using the system limit values.

Since the area and its surroundings belong to the basin of river Nitra (Telinský stream directly draining the relevant site), it is shown in the following table the classes of water quality for section of the flow of Žitava (which is the recipient of Telinský stream) according to the groups of indicators.

Classes of surface flows Žitava in 2001, station Žitava	Biological indicators	Physical and chemical indicators	oxygen mode	Microbio-logical indicators	Micro-pollutants	Nutrients
	III.	II.	III.	IV.	IV.	III.

6.1.2 Water reservoirs

On Telinský stream is erected water reservoir Čifáre. It is situated in rkm 10.3 of the Telinský stream – Fig. C-IX. 2. Water reservoir Čifáre (Čifársky pond) Fig. C-IX. 14 has the following parameters:

The maximum operating level	176.6	a.s.l.
the minimum operating level	173.7	a.s.l.
The total manageable volume	$0.270968.10^6$	m^3
the flooded area	0.17	km^2
The maximum depth at the dike	4.7	m
The minimum sanitary flow	0.005	$m^3.s^{-1}$

The pond is approximately at a distance of 4.2 km from NRR's concrete boxes. The tanks are used for fish farming – serves as stud pond of Slovak fishing association in Žilina. The pond is used for fish culture and as a source of water for irrigation of agricultural soil in its close vicinity (about 200 ha of soil of agriculture cooperative farm at Telince). Currently, is the equipment of irrigation station dismantled (it was erected by State melioration administration, branch Bratislava).

On another flow of the Telinský potok to the mouth into the river Zitava there are no other water reservoirs nor surface water take-offs for agricultural or industrial purposes. In the surrounding of cadastral area Mochovce are situated water reservoirs Kozárovce and Veľké Vozokany.

6.2 Undergroud water

In this area, in Sarmatian sediments alternate permeable and impermeable layers - collectors, semi-insulators and insulators. Lenticular development of collectors, common facial transitions to insulators and some faults cause creation of hydraulic barriers, which prevent either from the overflow of the underground water or it enables.

The main (first watered) collector of underground waters in NRR site (marked as collector H) is the layer of fine-grained to silty Sarmatian sands, disposed under the quaternary sediments. This watered layer has free water level. The speed of underground water flowing in this collector is according to data the biggest and the infiltration of rainwater is visible there as first. Groundwater flow at NRR site is drawn on Fig. C-IX. 20. In the subbase of the collector H are placed two collectors, which have strained level of underground water and its piezometric level is higher than in collector H.

Underground water in this part of the area, in the quaternary deposits does not form continuous dewatering. However, the presence of part of atmosperic rainfalls cannot be excluded in the period of increased rainfall activity especially where aluminum cover is placed on the clay subsoil. Given the low permeability of quaternary soils and rugged terrain morphology, most of rainfall water is led by surface offtake and usually cumulated on the surface in terrain depressions.

In the future, the impact of repository may influence underground water. Therefore, three water monitoring systems has been erected near disposal boxes. The presence of water in disposal area alone is the reason to inspect the cause and to implement the suitable corrective measures. The complex monitoring system of underground waters is the main part in the environmental elements monitoring at repository – between the disposal structures and place of underground water taper off on the surface is placed the system for boreholes monitoring Fig. C-IX. 20), which issues from the detailed hydrogeological survey of the area and the site. The long-term results of the monitoring do not show any impact of the repository – for more details see Chapter C-II.17.1.1.2 and Tab. C-IX. 1.

Just before putting into operation were in the north-east area of NPP implemented monitoring boreholes N-14, N-15, N-17, N-18 a N-19 – Fig. C-IX. 21. The objective of these works was to specify the spatial placement of H collector in north and north-west part of site, including the exact stating of the course of hydraulic barriers and gaining knowledge about the space-time distribution of groundwater in this area. Within this task were from those drilled probes collected groundwater samples to determine the basic chemism of groundwater in the study area and evaluate its properties in terms of aggressive action against the building - particularly against the concrete and steel [L-59] - Tab. C-II. 2. At the same time were also collected waters from the drainage system of monitoring.

Tab. C-II. 2 Basic chemism of undergroundwater in the north and northwest area of NRR Mochovce [L-59]

Basic analysis of water		Drilling probe					Drainage system of monitoring	
		N-13	N-14	N-15	N-17	N-18	SDa	SDb
Sample apperance		1	2	2	2	2	1	1
Parameter		value					value	
conductivity	[mS/m]	81,5	48,1	108	119	158	87,6	109
pH		7,29	8,07	7,04	7,03	6,79	7,28	7,24
Langelier's index		+0,23	+0,09	+0,04	+0,09	+0,24	+0,26	+0,34
KNK	[mmol/l]	6,31	1,94	7,21	7,64	15,1	6,96	8,78
ZNK	[mmol/l]	0,71	0,04	1,43	1,54	5,18	0,81	1,11
$CHSK_{Mn}$	[mg/l]	0,98	0,88	0,93	0,67	1,14	1,12	1,21
Residue	[mg/l]	543	293	658	781	1 002	548	646
Na+	[mg/l]	28,5	43,8	35,2	63,2	53,3	38,4	51,3
K+	[mg/l]	3,06	4,12	2,89	6,49	5,06	4,69	5,22
NH_4^+	[mg/l]	0,14	0,29	0,51	0,63	0	0	0,43
Mg_2^+	[mg/l]	32,8	9,97	52,5	47,9	96,1	29,4	40,6
Ca_2^+	[mg/l]	120	39,3	125	140	189	119	130
Cl^-	[mg/l]	30,5	36,2	49,3	18,1	63,1	18,1	26,2
NO_3^-	[mg/l]	4,55	56,4	11,1	4,25	17,1	6,42	0,23
HCO_3^-	[mg/l]	384	118	439	466	921	425	536
SO_4^{2-}	[mg/l]	134	45,2	165	271	126	123	129
CO_2	[mg/l]	31,2	1,66	62,7	67,6	228	35,3	48,4
Eqlib. CO_2	[mg/l]	42,2	2,01	65,3	73,8	265	49,1	71,5
Aggressive CO_2	[mg/l]	0	0	0	0	0	0	0

Springs and springs areas

On E, NE and SE of the relevant site, in cadastral area of municipality Nový Tekov are situated water sources operated by Západoslovenská vodárenská spoločnosť, a.s. Nitra, OZ Levice.

Water protection areas and zones of sanitary protection

Directly in the affected area, the water management areas are not present. In the surrounding of the relevant area are situated the following zones of sanitary protection of level 2 of underground water:

- Southeast from the affected area and partly in the affected area (defined between the municipalities Levice, Podlužany, Čajkov, Tlmače, Nový Tekov, nuclear power plant Mochovce and Kalná nad Hronom)
- about 4.7 km NNW from the affected area (zone is located near the stream Širočina under the municipality Nevidzany).

Other second zones of sanitary protection of groundwater water level 2 in the surrounding area are more distant than 5 km from the place of report implementation.

7 FAUNA AND FLORA

7.1 Characteristics of biotopes and their significance

7.1.1 Flora

According to the phytogeographic classification, this location is placed in the area of Pannonian flora (Pannonicum), in the circuit of the eupannonian xerothermic flora. The northern border of the location is in the contact with the area of west Carpathian flora (Carpaticum occidentale) with the district Štiavnické hills *(Futák, 1980).* The real vegetation in the previous period has been evaluated within a radius of 4 km from the nuclear facility Mochovce. Units were classified mainly by units used in the catalogue of biotopes of Slovakia (Ružičková, Halada, Jadlička, Kalivodová, 1996). The groups of forest types are classified according to Križová (1998) and according to forestry economy plan. Vegetation cover area is as follows:

Natural forests of the territory consists of willow alder (Saliceto–Alnetum), elmy-hronbeam mountain ash (Ulmeto–Fraxinetum), oak wood (Quercetum), hornbeam oak wood (Carpineto–Quercetum, beech oak wood (Fageto–Quercetum, hornbeam -maple oak wood (Carpineto–Quercetum acerosum), cornelian cherry oak wood (Corneto–Quercetum).

Secondary forests of the territory consists of monoculture pines Pinus sylvestris (Pinetum culti) and monoculture of secondary acacia plantations (Robinietea).

Bushes and grassy communities form thermophilic fringing communities- specific rich edges of shallow waters Geranion sanguinei), bushes and shrubwood communities of forests mantles (Prunion sinosae, Prunion fruticosae), xerothermic grass-herbs communities on andesite (Festucion valesiacae), oat-grass lowland meadows (Arrhenaterion, Alopecurion), damp meadows (Molinietalia), wetland communities, pastures and fallow lands.

Anthropogenic biotopes types consist of orchards and vineyards, gardens and agricultural land.

Other types of plant communities which occur on the assessed area are e.g. freshwater vegetal communities of class Potametea (water tanks), rock communities and rock cracks of class Asplenietea trichomanis.

7.1.2 Fauna

According to zoogeographical regionalization is the affected area situated on the dividing line of Panonian district of European provinces of steppes and Subcarpathian district of deciduous forest, which extends to the territory of Kozmálovske hills [L-67].

Evertebrata (invertebrates)

At site were casually examined mainly the representative of classes Ectogonatha – insect. Based on the presence of some taxons (Atomaria atra, Diodesma subterranea, Lycoperdina bovistae, Barypeithes chevrolati) in the forest biocenose can be concluded that forest soils have a high degree of originality. To more detail were examined some of the groups of hymenopteran insect – bees, bumble-bees and wasps.

The occurrence of the amount of Mediterranean and pontomediterranean species was also confirmed. On water reservoirs, streams and channels was observed occurrence of 29 types of may-flies (more than 40% of types in Slovakia).

Vertebrata (vertebrates)

Amphibians and Reptiles *(Amphibia a Reptilia)* - are linked to natural and secondary biotopes (forest steppe and rocky slopes mesophyl wet vegetation in the valley streams, water reservoirs and wetlands). More detailed research of the area was not published. The appearance of e.g. Hyla arborea (tree toad), Hyla arborea (salamander), Rana esculenta (green frog), Rana sp.(frogs), Bombina bombina, Lacerta agilis (sand lizard), Lacerta muralis (wall lizard Lacerta viridis (green lizard), Anguis fragilis (blind-worm), Elaphe longissima, Natrix natrix (ringsnake) was noticed.

Ornithofauna: Species representation was studied in the period from 1991 to 1997 on 20 characteristic biotopes in the area of 5 km from nuclear facility Mochovce. It was found out that in the area are: 93 kinds of nesters, 61 types of hibernates a 10 migrants. Many of them belong to the endangered and rare species. From the nesters occur e.g. sparrow-hawk (Accipter nisus), kingfisher (Alcedo attis), silver heron (Ardea cinerea), eagle owl (Bubo bubo), fern-owel (Caprimulgus europaeus), woodpecker (Dendrocopus medius), the eurasian wryneck (Jynx torquilla).

Mammals: In the area of the Mochovce the increased attention was devoted to mikromamalia (Insectivora, Rodentia, Muridae), due to the type representation for biomonitoring status of radiation protection. The documentation was obtained from sites by Mochovce, Nevidzany and Čifáre. Biotopes were abandoned orchards and vineyards, forest glade, oak forest and the creek bank of Podegarský stream by Nevidzany. From 503 specimens was determined 14 types, e.g. Sorex araneus (shrew-mouse), Sorex minutes, Neomys anomalus, Crocidura leucodon (Etruscan shrew), Cricetus cricetus, Arvicola terrestris (water rat), Arvicola flavicollis (dominant rat), Clethrionomys glareolus, Microtus arvali (field-mouse), Apodemus flavicolis (long-tailed field mouse), Apodemus sylvaticus (yellow-necked mouse) and also Micromys minuttus (small mouse).

From the hunting point of view, the plain and upland geocomplex take part in this area, with a wide scale of species. That is what makes the diversity of kinds of the well-known hunting fauna. When it comes to deer (Cervus elaphus) an outbreak was noticed. It was noticed at the wild sculd (Susu scrofa). The natural predators do not take part in the natural ecosystems. The other kind is a buck (Capreolus capreolus), the presence of mouflon (Ovis musiom) was noticed in Kozmálovské hills. The rabbit (Lepus europaeus) is quite frequent. The pheasant and other species are parts of the so-called hunting species (the wide spectrum, includes species as e.g. fox (Vulpes vulpes), marten (Martes martes), weasel (Mustela nivalis), badger (Meles meles), hedgehogamong (Erinaceus europaeus).

7.2 Protected, rare and endangered types and biotypes

Between endangered and rare kinds at Mochovce site belong many from the mentioned types of flora and fauna. It is connected with various biotopes, of which variety is quite big, as well as the concentration of landscape elements, that positively affect the ecological stability. In the territory concerned and its surroundings can be found the following genetic locations:

- Chríb (190 a.s.l., cadastral area Kozárovce) – andesite island emerging from Holocene sediments of Hron, former pasture,
- Kusá hora (274 a.s.l., cadastral area Rybník nad Hronom) – residuals of xerothermophilic oak woods on the left bank of the river Hron in the area of Slovak gate,
- Skala (239 a.s.l., cadastral area Kozárovce) – genetic area is the peak part and rocky slopes above the railway track,
- Veľká Vápenná – Starý vrch (240-280 a.s.l., cadastral area Nový Tekov) – vineyards, which pass through mowed orchards to thermophilic oak wood, appearance of traditional fruit trees (mulberry, sorbus domestica, quince),
- Martinec (203 a.s.l., cadastral area Mochovce, Nemčiňany, Nevidzany, Malé Vozokany, Červený hrádok) – sloppy hay meadows in the valley Podegarský brook on the northern edge of the forest of Kozí range,
- Klčovisko (260 a.s.l., cadastral area Mochovce) – islands of foreststeppe vegetation in the vestures of subxerophilous oakwood, attached rock subbase,
- Dobrica (320 a.s.l., cadastral area Mochovce) – rocky steppe and foreststeppe on the eastern slopes right from stone quarry. Valuable are abandoned orchards and vineyards with growing turkey oak.
- andesite rock above Čifárska water reservoir with foreststeppe communities,
- willow-poplar coppice in alluvium of Podegarský and Rohožnický brook.
- In the examined site of nuclear facility in Mochovce were discovered endemic species (type or other (gender, class...), which occurs only in a certain small area and nowhere else), 4 endangered taxons (title of the file of individuals differing by certain attributes from other taxons), 9 rare taxons, 10 vulnerable taxons, 17 very vulnerable taxons and 22 unfiled taxons.

7.3 Significant animal migration corridors

Important animal migration corridors are generally ecologically significant segments of the country, often line vegetation communities. Their function is linked to biocentres of different levels. It enables migration of organisms. Within the territorial system of ecological stability are identified as corridors. The important animal migration corridors in the affected area and in the wider area are:

- hydric supra-regional biocorridor: Hron and adjacent stream side vegetation,
- terrestrial supra-regional biocorridor: Gbelce – Patianska cerina – Zudrok – Včelár,
- proposed regional biocorridor: Patianska cerina – Čifárský háj – Kozí chrbát – Rohožnická hôrka – Slance,
- proposed regional biocorridor: Patianska cerina – Podkamenie – Veľká Vápenná – Skala – Štiavnické vrchy,
- proposed local biocorridor: Čifársky háj – Kozí chrbát,
- proposed local biocorridor: Plešovica – Zadný vrch – Rohožnícka hôrka,
- proposed local biocorridor: Klčovisko – Bôbové,

- proposed local biocorridor: Čifársky háj – Podkamenie.

8 LANDSCAPE, LANDSCAPE IMAGE, STABILITY, PROTECTION, SCENERY

8.1 Structure of the country

The current landscape structure is the result of the historic acting of man on the original landscape. To forming and transformation of the natural elements significantly contributes human activities (transport and communication, agriculture and development of the rural settlement, service development, industrialization, cultural and spatial management together with the development of urban, economic and technical structures. Up to now, agriculture has been the dominant activity in the development and changes of the affected area.

Settlement (with the traditionally dominant agricultural function) is situated mainly on downland and slight upland. Characteristic feature is relatively balanced distribution of seats fall within the bigger central settlement, which is usually disturbed only by belt settlements along waterways.

In the territory predominates arable land, smaller areas of orchards and vineyards, small enclaves of forest and rural settlements with buildings. The territory belongs to intensively used agricultural area (grain-beet area with advanced fruit production, viticulture and livestock), in which an intensive way of land use, land consolidation, elimination of ecostabilising landscape elements, pollution and other civilisation factors disturbed various ecological relations in the landscape systems.

8.2 Scenery

Scenery of the landscape around Mochovce site indicates its location on the border of the Danube download and the southern slopes of Pohronský Inovec and Štiavnické hills. Natural phenomenon is the dominant Slovak gate formed by spurs of Pohronskej upland and southwest slopes of Štiavnické hills, through which flows water stream Hron. Scenery is mostly affected by nuclear power plant, especially by the eight cooling towers. Part of the relief of Kozmálovske hills has been changed.

9 PROTECTED AREAS AND BUFFER ZONES

9.1 Protected areas

The relevant areas do not underlie to any special preservation regime of nature protection and there are neither large nor small conservation areas. The basic first degree is connected with the free lands, in line with the act of National Council of SR no. 543/2002 Coll. on the country and nature protection [L-16]. The exception are four bonded areas (Čifárska skala, Kusá hora, Plešovica and Slovenská brána – Skala), 2 conservation areas (Patianska cerina and Krivín) and conservation area Štiavnické hills, which are placed on the borders or in the tight closeness of the relevant area. The 4th and 5th protection degree is valid in the protected areas and the 2nd degree in the protected country area pursuant to the above mentioned act.

9.2 Buffer zones, specific protected species of fauna and flora

The is not any buffer zone at Mochove site. Only in the wider surrounding are situated buffer areas of gas distribution, sewage network, electrical distribution, buffer zone of railways, high-voltage power line and the buffer zone of the radio relay Bratislava - J. Bohunice – Mochovce.

10 TERRITORIAL SYSTEM OF ECOLOGICAL STABILITY

The wider area has an extremely important position for the operation of regional and super-regional system of ecological stability. It is located at the interface of different geological development of the south-western Slovakia in terms of geomorphological and climatic conditions. Through the relevant area passes also the border of central European biogeographic provinces and phytogeographical areas and districts. In the wider area of nuclear facility Mochovce, including the affected area are located the following subregional and regional bio-centres and bio-corridors of terrestrial and hydric type:

10.1 Regional bio-centres (RBc):

- Kozárovce – Skala (former pastures in succession state of growing Crataegus monogyna a Crataegus laevigata),
- Kozmálovské vŕšky (in the ecologically important landscape dominate forest unit complexes of oak-hornbeam Carpathian forests, with local islands of vegetation forest steppe vestures – Plešovica, Veľká Vápenná, Klčovisko),
- Slance – Zadný vrch – Rohožnická hôrka – Kozí chrbát (forest complex of oak- hornbeam forests with a higher representation of cerium and acacia, aluviums of Podegarský and Rohožnicky stream with stream-side willow-poplar vestures, core is the space of Dobrice with communities of rock steppe and forest steppe).

Bio-corridors of regional significance (RBk):

- Patianska cerina – Čifársky háj – Kozí chrbát – Rohožnická hôrka – Slance – Pohronský Inovec,
- Patianska cerina – Podkamenie – Veľká Vápenná – Skala –Štiavnické vrchy.

Local biocentres (LBc):

- Staré vinice – Chladnov – Podkamenie (centre of area is forest steppe andesite cliff above Čifárska water reservoir).

Local biocorridors (LBk):

- Čifársky háj – Kozí chrbát,
- Čifársky háj – Podkamenie,
- Veľká Vápenná – Dobrica.

Other elements of the territorial system of ecological stability and gene pool sites are stated in Chapter C-II.7.2 and also other significant landscape segments such as Slovak gate and Nevidzanská water reservoir.

11 POPULATION, ITS ACTIVITIES, INFRASTRUCTURE, CULTURAL AND HISTORICAL VALUES OF THE AREA

11.1 Population in the assessed area

In the municipality Mochovce lived in 1970 498 inhabitants. Most of the inhabitants of the village were employed locally by local Uniform Agricultural Cooperative which was established in 1952. The gradual relocation of municipality habitants was finished by 1980. Currently, in the *sanitary protection zone of* Mochovce NPP does not live any habitant.

The nearest municipalities behind the sanitary protection zone are situated in the districts Levice, Nitra and Zlaté Moravce. According to the census of population and housing census in May 2001 lived in the nearest municipalities in total 11774 habitants, namely 5661 men (48.08 %) and 6113 (51.92 %) women. The overview of population and average population density by the individual municipalities of the relevant area are shown in Tab. C-II. 3.

Tab. C-II. 3 Population of municipalities nearest to SE-EMO and NRR Mochovce nuclear facilities (2001,2009)

District	Municipality	Number of inhabitants					
		Total		Men		Women	
		2001	2009	2001	2009	2001	2009
Levice	Kalná nad Hronom	2073	2099	978	1009	1095	1090
	Malé Kozmálovce	402	410	185	185	217	225
	Nový Tekov	835	848	402	422	433	426
Nitra	Čifáre	591	626	298	315	293	311
	Telince	277	376	125	184	152	192
Zlaté Moravce	Nemčiňany	784	712	367	342	417	370
	Total	4962	5071	2355	2457	2607	2614

When comparing the population according to available data from the years 1999 and 2001, in three of these municipalities the population increased namely: in Kalná nad Hronom by 1.12 %, in Starý Tekov by 0.48 % and in Čifáre by 4.97 % - see Chapter C-II.11.4. In other municipalities the population decreased.

The affected municipalities for the proposed activity are Kalná nad Hronom – regarding the localisation of NRR and Čifáre – regarding the potential radiation of habitants – Chapter A-II.11.

11.2 Age structure of population in the assessed area

Age structure of population in the affected villages now has a less favourable composition compared to the national average. Compared to worldwide average, it is characterized by a lower share of pre-productive age and a higher proportion of in the productive and post-productive age.

Tab. C-II. 4 Age structure of population in the affected villages (31.12.2009) [L-113]

Village	Pre-productive age		Productive age		Post-productive age	
	Population	%	Population	%	Population	%
Malé Kozmálovce	62	15,12	240	58,54	108	26,34
Kalná nad Hronom	308	14,67	1400	66,70	391	18,63
Nový Tekov	121	14,27	531	62,62	196	23,11
Čifáre	93	14,86	388	61,98	145	23,16
Telince	87	23,14	219	58,24	70	18,62
Nemčiňany	98	13,76	428	60,11	186	26,12

11.3 Population health status

The population health status at the affected villages is not monitored regarding its size and it is included into the statistic monitoring for the individual districts. The population health status influences the following criteria:

Medium life expectancy: In district Levice and Nitra, into which belong the relevant municipalities varied the medium life expectancy in 2001 (last census of people) in the range of 66-69 years (men) and 75-76.8 years (women).

Overall mortality: District Levice, which is for the relevant area material, belongs to the regions with the highest morbidity and mortality in Slovakia. Natality (birth rate) in this district has in recent years (1999-2002) decreasing trend and ranges between 8.02-9.19 %. Development of mortality in this district in the years 1999 - 2002 was in average approximately 12 ‰.

According to the causes of death in Levice, the mortality on circulatory system diseases dominants there, especially coronary heart disease. Other groups in order of most frequent causes of death are cancer, digestive system diseases and respiratory system diseases. From the risk factors in the region, the most workers are exposed to noise, dust, chemicals, and vibration.

11.4 Seats

Municipality **Mochovce** was situated in the north part of Hronská upland on the southmost spurs of Štiavnické hills. The basics of the history of this municipality began in the old Stone Age (more than 23 000 years ago), what is evidenced by the excavations, which has been done in its surrounding before the erection of nuclear power plant EMO. The intensity of settlement is periodically changed, but as time passed, gradually increased. Excavations of ceramics in this area show the existence of several “settlements” scattered in the near but also more remote area, usually near rivers or on the southern slopes of the surrounding hills.

Further development of the settlement accelerated the development of pottery, stone industry (stone quarry below the peak Dobrica is still visible), but also farmery especially growing of cereals, life stock breeding, fishing in near ponds or vinery or fruit growing.

The oldest Slavic settlement may be associated with the period of the existence of Great Moravian Empire in the 9th century. The evidence is two settlements and one burial discovered directly in the municipality Mochovce. The settlement of the area is after the end of the Great Moravian Empire (from the 12th century) already supported by written sources. Municipality of Mochovce was first mentioned in written sources as a "villa Muhy" in 1295, as the property of Matus Cak of Trencin. At this time led through the village well known "Čakov path" connecting the valley Žitava with Pohronie.

Over time, the village has been owned by various owners. Since 1388 belonged to castle estate Levice. In 1534 it had 10 seats, in 1601 it had 66 houses and in 1828 it had 95 houses and 607 habitants.

In early eighties of last century the village was displaced due to construction of nuclear power. Of all the buildings, only a former local Calvinist church built in 1787 (renovated) and the local cemetery at the end of municipality remained- see Fig. C-IX. 27.

The Cadastre of Mochovce municipality was in 1990 (in that time it was already nuclear power plant site) connected to municipality Kalná nad Hronom in Levice district.

Current municipality **Kalná nad Hronom** is situated on the right waterside of bottom land Hron. The centre of municipality is situated 160 a.s.l., surrounding part 160-200 a.s.l. Plane to slightly multiple upland surrounding part forms cainosoic deposits with thick sheet of loess and loess loams. It has brown soil, flood plain soil and bottom land soil.

Site municipality was inhabited in neolith (beginning of massive use of metallic - mainly cooper). On the area of current municipality is archeologically proven Neolithic settlement with fluted pottery, settlement of north panonian culture from the older Bronze Age, Hallstatt, Lateen Roman and barbarian settlement.

The municipality Kalná nad Hronom is documented from the year 1209 as Kalon. It belonged to the abbey in Hronský Beňadik, part of the local village squire, which in the 15th century got the whole village. In 1601 it had two mansions, landlord mill and 65 houses in the year 1720 had a mill and 18 taxpayers in the year 1828 had 76 houses and 527 inhabitants. Habitants are primarily dealt with agriculture. Currently, the municipality had (according to data from the Internet of 2007) total 2073 habitants (1005 males and 1068 females). Current title of Kalná nad Hronom is used from 1960. This year was to this municipality connected also the individual municipality **Kalnica.**

In Kalná nad Hronom and its parts is placed various sacral buildings. In the municipality, there is classicistic reformed church from 1806, currently under reconstruction. Further it is church in Kalnica, chapel on the local cemetery and baroque roman catholic church from 1773. In terms of impacts (especially potential) of NRR **Mochovce** on the surrounding population is mainly affected the municipality **Čifáre** (Csiffár). The municipality lies in the northern part of Pohronská upland at a distance of about 6 km of south-western direction from the NRR in the valley Telinský stream. It closes the eastern part of the district Nitra. Upland village form cainozoic younger clays, sands and gravels with sheet of loess. It is largely deforested, in the southeast and northwest are remains of oak forest. It has brown soils and muck soils. Altitude of municipality in the centre is 175 m, in the surrounding area is 170 - 240 m. In the east of surrounding area is on the Telinský stream erected water reservoir Čifáre on the area of 16 ha – Fig. C-IX. 14.

The first written mention of the municipality Čifáre comes from the year 1209, when the village is mentioned as Villa Chefer. At that time it was the property of Saint Benadic Abbey. A few decades later however, the village became the property of knighthood of Johanits, who lived in Ostrihom (1235). Soon after Ostrihom fell into the hands of the Turks, it was destroyed by Turkish troops and later had to pay taxes on their residents to Turkish administration in Ostrihom. In 1601 the village had 75 houses, in 1715 vineyards and 30 households, in 1720 had 35 taxpayers, in 1828 had 82 houses and 571 inhabitants. In the early 20th century, the population has stabilized to around 700 [L-79] habitants. In the post-war period, the number of residents reached 800 and more (in 1952 the village had 840 habitants), but by the end of 20th century it dropped to 600 habitants. In 1993 the village had 625 inhabitants, with 9 baptisms and 16 funerals. Even these figures show that the population is declining – in 2000 up to 568 [L-79].

At present, according to data from the Internet from 2007 has the municipality in total 649 habitants.

The village was agricultural. Historical sources specifically mention the local wine growing vineyards (1715) [L-79].

From the historical monuments of the village remained roman catholic church in the classic style from 1774.

From the village Čifáre in the south direction leads the way to the former hunting mansion, which is situated in the picturesque area of leafy forest in the protected area “Patianska cerina” – see Fig. C-IX. 28. This building was erected in 1911. In the last period in 2007 was the mansion used within the special project school for children and young people from the surrounding area, even from aboard. 2 km southwest from the village on the slightly hilly terrain “Túlat” are situated local vineyards which are connected with vineyards of the neighbouring village Telince. The viticulture tradition has in this village deep history. The stated municipalities have historical buildings from the end of 19th century and 1st half of 20th century. House fond is in municipalities quite old and partially unused, what is reflected in the number of not inhabited houses and flats -Tab. C-II. 5. In the relevant municipality Čifáre within last years the number of not inhabited houses decreased, due to the fact that it has been bought by people from bigger towns and are rebuilt to weekend seats or to other purpose [L-78].

Tab. C-II. 5 House and flat fund of the relevant area (2001)

Municipality	Houses total	Permanently inhabited houses		Not inhabited houses	Flats total	Permanently inhabited flats		Not inhabited flats
		Total	Of which FH*			Total	Of which FH*	
Kalná n. Hronom	451	368	323	83	771	663	321	99
Čifáre	343	289	288	54	343	287	286	50
Total	794	657	611	137	1114	950	607	149

**FH - family houses*

11.5 Economic activity of population

Economic activity of population in the municipalities of the affected area but also in the surrounding area of Mochovce NPP, on one hand positively influence its erection and operation, on the other hand it has been significantly affected by the social changes of recent decades, when there was a significant restructuring of production and non-manufacturing sector and from that resulting changes in the economic activities of habitants of the whole region. Based on census in SR in 2001 is the number of economically active population in the affected municipalities as follows:

Tab. C-II. 6 Number of economically active population of the relevant municipalities (2001)

Municipality	Permanently Residing	Economically active persons			The share of economically active persons in %
		Total	Men	Women	
Kalná nad Hronom	2073	1042	542	500	50.3
Čifáre	591	281	169	112	47.5
Total	2664	1323	711	612	49.99

Municipalities in this region are characterized by transformation of the economy with the loss of jobs and population migration outside the municipality, district and region, which is reflected in the increased unemployment.

11.5.1 Industry

The focus of the affected area in terms of industrial production is an industrial area of the NPP Mochovce, which is in terms of industrial production and in terms of services essential for the economy of the SR. In the distant location of the affected area is situated town with advanced engineering industry. Other industrial centres Levice and Vráble are situated in the distance aprox. 10-15 km from the site. Smaller industrial facilities are located in Kalná nad Hronom and in Santovka. Industry of the local importance and local production economy are placed in further municipalities.

Construction production in the affected area is focused in particular on the completion of NPP Mochovce (namely erection of MO34).

11.5.2 Agricultural production

In the affected area, agriculture is the most widespread activity. The area has very good natural conditions for growing almost any crop. There are virtually all basic types of agricultural land - arable land, hop gardens, vineyards, gardens, orchards and grasslands. The area is characterized by a high proportion of arable land to other agricultural land. Permanent grasslands are located mainly in mountainous areas and on lands of worse evaluation, steep or sloppy, but it occur also on steep plots of uplands and narrow strips along the streams on the downlands. On sunny slopes are situated vineyards and generally on the slopes are situated orchards. The gardens are most often situated in conjunction with housing communities. The structure of sowing areas have the largest representation of densely sown cereals, maize, sugar beet and fodder crops on arable land. Livestock production has recently represented all sectors, the most productive have been breeding cattle, pigs and poultry farming. In recent years, are the local farms (Agricultural Cooperative in Kalná nad Hronom and Klastel-nova s r.o. in Telince) oriented mainly to crop production (growing of cereal crops and sale of agricultural products [L-105]). Watering systems have been erected in Želiezovce and Veľké Kozmálovce. Čifárska reservoir was also used for watering. Currently, is the watering pumping station, which belonged to state amelioration administration, branch Bratislava in a dysfunctional state (devices are removed).

11.5.3 Forest management

The territory extends into the forest area of Podunajská upland and Štiavnické hills. From the woody plants predominate deciduous trees such as oak, poplar, cer, acacia, beech and other hardwoods.

Coniferous trees occupy only a tiny percentage of vegetation. In particular it is - pine, spruce and fir. In forestry production slightly outweighs the extraction activity, followed by cultivation activities and other forest production. Parts of the forests of affected area have also a protective function, which is directed mainly to the preservation and use of the forest as a valuable natural environment, particularly by their originality. Recreational function is used mainly in the peripheral positions of forests, often joined to subforrest orchards and vineyards. Forestry basic industry in the state forests provides branch of forest plants (Levice) and organisations of private forests. Regarding the regionalization of hunting territory, the land belongs to the breeding areas for deer and small animals. There is also a genetic base of fallow deer.

11.5.4 Services and civic amenities

Services and amenities in the affected municipalities are more or less a comprehensive range of services and amenities for the implementation of the basic needs of daily life, including basic education, cultural and social needs. Implementation of more advanced needs (education, health, culture, sports and recreational activities, etc.) of these municipalities are provided by main towns Levice, Tlmače and Vráble, which are situated in good time and communication distance.

11.5.5 Recreation and Tourism

In the affected area and its surrounding are small water reservoirs, which serve mainly for agriculture. In the wider surrounding of the affected area is the large number of cottages, vineyard cottages, gardens and vineyards used as recreation residence. For the water sports can be used reservoir Veľké Kozmálovce on the river Hron. More often are used the excavated reservoirs, or distributaries of streams (Horná Seč). Within the area are also conditions for sport fishing on the suitable parts of streams, but also on agricultural reservoirs and ponds. Other conditions for recreation of habitants within this area and for the tourism are in the wider surrounding of the relevant territory. In this region, mainly in Levická kryha, has been recorded large occurrence of geothermal waters. These waters are used recreationally on existing thermal swimming pools Santovka and Margita - Ilona. Other potential occurrences of geothermal resources are recorded in Želiezovce.

11.6 Infrastructure

11.6.1 Transport

Road transport: The main roads near the affected area are national road I/51 Vráble- Levice in the direction of west-east and the national road I/76 Hronský Beňadik –Tlmače - Kalná nad Hronom – Želiezovce in the north-south direction. Outside the affected is the road network completed by - national road, class 2 no. 564 Tlmače- Levice, national road, class 2 no. 580 Šurany- Kalná nad Hronom, national road, class 2 no. 511 Nové Zámky – Tesárske Mlyňany. In the north from the affected area is national road I/55 Nitra Zlaté Moravce. The road net is completed by local roads of class 3.

Area of nuclear facility Mochovce is connected to the road network by local road of class 3 Čierne Kľačany – Nemčiňany – Mochovce – Čifáre, or eventually Mochovce – Kalná nad Hronom. In connection with the Mochovce NPP and the need to build an exit route from Nový Tekov to Starý Tekov, it is considered to build a bridge over Hron and connect the roads I/76 and III/05156.

Railway transport: through the relevant area is passing railway no. 150 Hronský Beňadik – Tlmače – Levice – Kalná nad Hronom - Šurany and railway no. 141 Zlaté Moravce – Levice. From the area SE-EMO leads railway siding into the railway station Kalná nad Hronom. Railway transport is not sufficient, given the economic importance of the region. Its development is conditioned by building of high-speed railway trough the Slovak territory.

Other kinds of transport are not present in the relevant area. In the wider surrounding are placed only small airports with grass surface with a focus on agricultural and sporting purposes (Levice, Nitra).

11.6.2 Pipelines and power lines

The wider area is one of the most important sources of electric power the distribution system of SR - NPP EMO, which is operating two units, each with power input 440 MWe. In Veľký Ďur and at a distance of about 12 km from the site, east-southeast, is built transformer substation of high and very high voltage, which are on the electric distribution network of SR connected with lines of 400 kV, 220 kV and 110 kV. These stations are major junctions of electric distribution network with the national interest.

Through the territory in the direction of Ipeľské Úľany-Semerovce-Santovka-St. Hrádok-Kalná nad Hronom is lead very high pressure gas transit system 1 x 1400 + 3 x DN 1200. In the direction from Plášťovce to Slatina, Krškany, Nová Dedina and Tlmače is lead interstate gas pipeline VVTL DN 700.

11.6.3 Waste and Waste Management

In affected are is situated the controlled waste dump in Kalná nad Hronom. This waste dump serves as a facility for final disposal of waste with regard to hygiene, geological and environmental aspects so that, the threat to the environment is avoided. It is intended for the disposal of waste - communal and other waste (other categories with a higher proportion of biodegradable components, waste categories with a lower proportion of other biodegradable components) and hazardous waste. The waste dump is dully secured, meets all criteria and regulations (in construction and operation), its safety is monitored by regular monitoring. This waste dump (has cassette for hazardous waste) is operated by SITA Slovakia, a.s. Bratislava.

In the relevant municipality Čifáre is provided the collection of communal waste with its transport once in two weeks. Preferred is a separate collection (plastic, paper, glass), which is favoured. Batteries, tires and oil is collected in the collecting yard - periodically also iron.

12 CULTURAL AND HISTORICAL MONUMENTS AND SIGHTS

The wider surroundings of the area in question belong to a specific traditional cultural and historic region, which is the region around Levice and Zlaté Moravce. The oldest traces of settlement in the area of interest originate from the Palaeolithic, and the intensive inhabitation occurred during the Neolithic period (5000 - 1900 years B.C.). In the period of older and middle Bronze Age, the area of Mochovce was not inhabited. The settlement began to increase gradually from the late Bronze Age (1200 - 700 years B.C.) to an earlier period of Iron Age (700 - 500 years B.C.). The early period of the Bronze Age is documented by settlement material of so-called čačianska culture from the cadastre of municipality Nový Tekov. The entire territory later entered into the strategic role in connection with the entry to the mountainous region of central Slovakia. This is suggested by relatively dense network of settlements from Great Moravian period which were detected from Veľké Kozmálovce to Hronský Beňadik. Within the younger period became an important historical centre Hronský Beňadik with its monastery, Levický castle from 14th century and today already extinct Tekovský hrad. Cultural and historical monuments and sights of the municipalities Kalná nad Hronom and Čifáre see also Chapter C-II.11.4 “Seats”.

13 ARCHAEOLOGICAL SITES

In the wider surrounding of the affected area, there is a large number of archaeological sites both of regional and European importance. From the well-known sites of Levice district should be mentioned Horný Pial and Želiezovce.

In the municipality Čifáre are situated findings from settlements from the Neolithic, Roman and Barbarian and Slavic period. In Kalná nad Hronom is situated the Neolithic settlement, settlement with fluted pottery, settlement north-pannonian culture from the older Bronze Age and Hallstatt, Lateen and roman-barbarian settlements. In municipality Telince is placed settlement from Neolithic, Lengyel culture settlement, settlement from Roman times and destroyed medieval settlement.

14 PALEONTOLOGICAL SITES AND SIGNIFICANT GEOLOGICAL SITES

There are not situated any significant paleontological sites or geological sites near the area of nuclear facility Mochovce and NRR.

15 CHARACTERISTICS OF THE EXISTING SOURCES OF POLLUTION AND THEIR IMPACT ON THE ENVIRONMENT

15.1 Air Pollution

In the surrounding of NRR Mochovce was in 2008 situated 23 large and medium pollution sources which are registered in the system NEIS (National Emission Information System). There are 9 sources located directly at the SE-EMO site.

Air pollution situation in the area is not monitored.

NRR Mochovce itself is not a source of air pollution in the affected area.

15.2 Water pollution

15.2.1 Underground waters

The main source of undergroud water pollution in the relevant area and its surrounding is agricultural production and infiltration of polluted surface waters.

15.2.2 Surface waters

The main source of surface water pollution in the relevant area and its surrounding are domestic and industrial sources. The lack of sewage plant and insufficient treatment of waste waters from house holds and industrial waste waters in existing plants is considered the main source of polluting river Žitava.

15.3 Soil contamination and soil erosion risk

In general, the soil of agricultural land is more contaminated by nitrogen compounds and heavy metals than the soil forest land, which is connected with intensive use of agricultural land and the removal of vegetation cover. This fact implies a threat to agricultural land and water and wind erosion. At NRR Mochovce and its surroundings it is mostly soil on massive slopes without the barrier effect of the vegetation lines on the south from the site.

According to the analyses samples from soil of Kalná nad Hronom the content of phosphorus (as stated by Egner) is high, content of potassium (as stated by Schachtschabel) is good, the overall content of metals (cadmium, lead, chromium, mercury, arsenic, copper, cobalt, zinc, and nickel) for the individual metals reached background values and values in blowdowns 2M HNO_3 are below the limit.

15.4 Geologic Environment pollution

According to the present knowledge, the geological environment in Mochovce NPP and its surroundings is not significantly contaminated by liquid, solid or gaseous pollutants.

15.5 Dumps, landfills, devastated areas

In the cadastre of the municipality Kalná nad Hronom – approximately 3 km south from NPP EMO is situated waste dump – see also Chapter C-II.11.6.3 “Waste and Waste Management”. This waste dump is extended by the pellets for hazardous waste disposal and currently is been erected to Integral facility for waste disposal [L-125]. District waste disposal is situated in the south-east part of the district, in the cadastral area of municipality Nový Tekov. Locally, in the surroundings of the municipalities are placed spontaneous waste dumps and landfills. Devastated areas, such as e.g. areas of the constructions, were located also in Mochovce and its surrounding. Recently, has been performed technical and biological recultivation of these areas.

15.6 Other sources of non-radioactive pollution

Other non-radioactive pollution sources, except the above stated are not present in the area.

15.7 Damaging of vegetation by emission

One of the effects of emission on vegetation is e.g. acid rains, decreasing of pH of soils and damaging surface of the plants. The result is also smaller resistance against pests and vermin, which means sooner mortification of the singulars. Positive species composition of larger part of saved or planted vestures and quite good dispersion conditions in air in the relevant area eliminate partially this negative impact.

15.8 Protected biotopes of animals

Protected biotopes of animals in the relevant area and its surrounding are stated in Chapter C-II.7.2.

16 COMPREHENSIVE ASSESSMENT OF CURRENT ENVIRONMENTAL PROBLEMS

16.1 Current population health status and overall quality of the environment for human

Data on the health of the population in the affected municipalities are specifically stated in Chapter C-II.11.3. Regarding the terrain barriers and the distance of municipalities from NPP Mochovce (more than

4 km) we can assume, that the overall environmental quality of the population is by the nuclear facility operation affected to the minimum extent (increased transport frequency), or not at all. The same can be stated also on the impact of NRR – not only regarding the operation but also its existence as a whole.

16.2 Impact Assessment of radioactivity and ionizing radiation in the area on population

Impact assessment of nuclear installations on the environment is generally based on monitoring the activity of radionuclides in gaseous emissions and discharges in the waters. The measured values are then by means of validated models and programs calculated as committed effective dose for individuals of critical groups of habitants (see below). To the radiation load of habitants exclusively contribute nuclear facilities in the area of SE-EMO, i.e operational units of EMO12 and FS KRAO. In the future, to this can be added operation of MO34, and latter also nuclear spent fuel storage. The operation of NRR does not practically contribute to the radiation of habitants.

The impact on the environment also demonstrate measurements, which are performed within the monitoring of the environmental elements by the Laboratory of radiation control of the Levice surrounding. For this assessment it is necessary, even prior to nuclear facility commissioning, to perform relevant measurements in advance in the given area, for long-term period, at least one year. In case of a nuclear power plant in Mochovce this requirement has been met, since the continuous and systematic monitoring of environmental components has been proceeding at the workplace of Laboratory of radiation control in Levice since 1986. Monitoring of radiation situation at Mochovce, however, began in 1979 [L-54],[L-55].

The overall radiation situation is characterized by the following factors:

- level of external radiation,
- presence of radionuclides from global gradient, with an emphasis on artificial radionuclides in various environmental components:
- ground layer of air,
- soil,
- surface and groundwater,
- fodder and food.

The overall level of external radiation, measured since 1979, shows spatial variations depending on the nature of rock subbase. The activity of natural radionuclides in loesses, clay, loess, fluvial sediments and alluvial sediments of Hron is approximately similar, which corresponds to a relatively stable value of dose rate external gamma radiation in air 1 m above ground (average temperature **95 ± 6.1 nGy.h^{-1}**) [L-54]. On the eastern side there is a modest strip of andesites, causing an increase of exposure input power of about 30%. The level of cosmic radiation above the water, calculated for the Mochovce site, represents 34 nGy.h^{-1} [L-55]. According to the value of the terrestrial component of the external gamma-radiation it is in average 61 nGy.h^{-1}, while the individual radionuclides (in 1979) share the following:

isotopes U -	23.2 %
isotopes Th -	39.9 %
^{40}K -	35.5 %
^{137}Cs -	1.4 %

Measurements of Laboratory of radiation control Levice in 1992 on 15th places in the surrounding of nuclear facility Mochovce demonstrated the average value of external radiation 94 ± 7.4 nGy.h^{-1} [L-63], which is in compliance with data from the previous period. All these measurements were made in the period prior to commissioning of nuclear facility - this means that it represents so-called radiation background (radiation level from the sources, unaffected by human activity on the relevant area – an artificial radionuclide ^{137}Cs originates from the global gradient).

General radiation background of Mochovce site is very low. The prevailing part of detected activity in the air, water and soil forms radioactivity of the natural isotope ^{40}K.

Short-term increase of activity value in the elements of environment was reflected in April 1986 after the nuclear accident in Černobyl plant. The increased activity ^{137}Cs mainly in uncultivated soil in places where the was the increased gradient as a consequence of rainfall during the transfer of radioactive cloud in the first two weeks was measured even approximately 10 years after the accident. For example, in the area Vráble were in 1992 measured activities ^{137}Cs and ^{134}Cs, which influenced the level of dose rate of external radiation from terrestrial component equal to 1 m above the ground. In 2005 the contribution of gamma radiation of artificial RN ^{134}Cs and ^{137}Cs to the total DP decreased from external radiation. Also the value of DP measured by ionization chamber decreased in 1 m above the ground – Tab. C-II. 7 if is to the value of DP terrestrial component, calculated from area activity of radionuclide measurements of 1 m above the terrain added the DP value from cosmic radiation for a given altitude, we get compliance (within the experimental errors) with DP, measured by ionization chambers in the same height at the same level above the ground. Data in table document, that the decrease of measured DP value on the selected place (from 101 to 94 nSv.h^{-1}) was caused by the decrease of the activity of artificial RN deposited on the surface of the ground especially after the Chernobyl NPP accident in 1986. From the statistical processing of measurements results that stated values of the typical levels of radioactivity in the elements of environment in Mochovce site are within the standard limits, which respond to the current global radioactive pollution of the biosphere.

At Mochovce site was in the period prior to implementation and commissioning of nuclear facility (SE-EMO and NRR) performed so-called pre-operational monitoring of environmental components, in order to create an reliable base for impact assessment of erected nuclear facilities after its commissioning. The first measurements were made already in 1979 by external organizations [L-54], [L-55] and since 1986 has been in operation already The Laboratory of radiation control of Levice surrounding, which organisationally belong under Slovenské elektrárne, the only former operator of nuclear power facilities.

Generally it can be stated, that the contamination of the biosphere by artificial radionuclides reached the maximum at the time of testing nuclear weapons in the atmosphere - from 1962 to 1963. For example, according to the measurements of SHMÚ, the average annual beta activity of atmospheric rainfalls on SHMÚ stations was in that time 100 - 120 Bq/l (for comparison in 1986 – in the year of the Chernobyl accident - it was about 20 Bq/l) [L-77]. Since (year 1963), as a consequence of the restriction of nuclear weapons tests in the atmosphere, the activity of artificial radionuclides in the biosphere generally decreases. This drop was for short-term period interrupted by nuclear power stations accidents – in 1986 by Chernobyl accident and in 2011 by accident in NPP Fukushima. This last incident, for example showed increased activity of short-term artificial radionuclides in the atmosphere of the RAW Mochovce site in late March and early April 2011 - see Tab. C-II. 17.

Tab. C-II. 7 Results of terrain gamma spectroscopy in Vráble area (in 1992 and 2005)

Radionuclide	Activity		Dose rate [nGy/h]	
	Year 1992	Year 2005	Year 1992	Year 2005
Artificial	[Bq/m^2]			
^{134}Cs ^{137}Cs	620 ± 90 8660 ± 170	< 273 5090 ± 280	2.2 ± 0.3 11.5 ± 0.2	< 0.3 6.27 ± 0.35
Natural	[Bq/kg]			
^{40}K U-series Th-series	530 ± 10 33 ± 8 (1) 34 ± 7 (1)	583 ± 30 30 ± 2.6 (1) 37 ± 6.4 (1)	22.8 ± 0.6 14.4 ± 3.4 (2) 22.1 ± 4.7 (2)	24.3 ± 1.3 14.4 ± 0.7 (2) 22.3 ± 0.9 (2)
DP calculated from the surface activity of measured RN			73.0 ± 5.0	67.57 ± 1.8
DP from cosmic rays (3)			34 ± 3	
		Total	107 ± 6	101.6 ± 3.5
Measured by ionization chambers together with cosmic radiation			101.0 ± 4.0	94 ± 4

(1) - activity of one member of decay chain,

(2) - dose rate calculated from all members of decay chain in balance

(3) - the level of cosmic radiation stated by ionisation chamber RSS 111 above water level, calculated for the Mochovce site *(air pressure 724 Torr) [L-55].*

17 THE OVERALL QUALITY OF THE ENVIRONMENT

17.1 Synthesis of the current environmental problems assessment

17.1.1 Radiation burden of the population from the existing sources

17.1.1.1 *Radiation burden from operation of SE-EMO and NRR*

Radiation burden from the operation of SE-EMO

To assess the impact of SE-EMO on the surrounding population, the analysis of the radiation dose burden of the surrounding population is carried out once a year based on the real values of activity of radioactive substances released into atmosphere and hydrosphere by means of calculation programme RDEMO (VUJE, a.s. Trnava) [L-73].

Gaseous radioactive substances are discharged into the atmosphere through a ventilation stack. Details of the meteorological situation in the area of SE-EMO are obtained from the Slovak Hydrometeorological Institute.

Liquid radioactive substances are discharged into the hydrosphere, i. e. through the collector pipe into the river Hron under the weir of reservoir by Kozmálovce. The river is used for recreational purposes and for watering.

The calculations show that the area with the highest annual individual equivalent doses (**H**), effective doses (**E**) and also the collective effective doses (**S**) is located in the east-southeast and the northwest area of SE-EMO in the direction of prevailing winds (see Fig. C-IX. 19) and in the flow direction of the river Hron.

Zone with a permanent settlement with the highest value of the calculated equivalent dose **H** is in the east-southeast direction, in the distance 3 to 5 km. In this zone is located municipality Nový Tekov.

The results of the calculation of **H** for all municipalities in the surrounding of SE-EMO to a distance of 20 km and for various age groups are reported annually in the summary reports of released radioactive substances and its radiological impact on the environment [L-51], which operator submits to regulatory authorities (NRA SR and PHA SR). The results show that the highest values of annual **H** are for the age category infants 0 - 1 year. To the value of annual **H** dominantly contributes hydrosphere (up to 98 %) before the atmosphere (1.3 %). The critical exposure route for the radiation burden of the individual from this zone (Nový Tekov) is the exposure from ingestion of contaminated drinking water with tritium dominant radionuclide, with the share of 96 % on **H** from hydrosphere. For the radiation burden from the atmosphere, is the critical route the exposure from the cloud of radioactive noble gasses (^{41}Ar, ^{88}Kr, ^{135}Xe) with share 1 % on **H**. By the level of activity and radionuclide composition (prevails ^{41}Ar, which is not produced in reactor as a fission product) is evidenced, that current operation of NPP EMO12 is managed with undamaged packages of fuel elements.

The calculated values of annual IED **H** for the site of Nový Tekov from 2000 (after commissioning of both units) to 2005 were at:

611 ± 47	nSv/year	for infants
330 ± 24	nSv/year	for adults.

For the years 2006 -2010 were calculated annual IED for this site at:

125 ± 45	nSv/ year	for infants
96 ± 39	nSv/ year	for adults.

The calculated values of IED from years 2006 - 2010 are significantly lower than the values calculated for the previous period. This decrease is related to updating of data entering the calculation:

In the years 2000 - 2005 were by program RDEMO used conservative initial input data for calculating population doses. Since 2006 has been gradually updated [L-52] conversion factors for ingestion and inhalation, the values of the amount of inhaled air, data on the meteorological situation of the weather station located in the area of SE-EMO and the real value of water flow through Hron. In 2010 the shielding factors have been updated, the period of residence and age composition of the population. The result is that the calculated values are closer to real values. The real values are so low they are virtually immeasurable. For comparison - the calculated value **of the annual** individual effective dose for infants **H** (125 nSv/year) responds to effective dose (aprox. 100 nSv/h), received by each individual of the population (worldwide) from natural external radiation **per hour** (cosmic radiation, radiation of natural radionuclides in surface area) – see Tab. C-II. 7.

Based on monitoring of released radioactive substances into the atmosphere and hydrosphere, which were released from the NPP SE-EMO after commissioning, it can be stated, that the annual balance limits for discharges of radioactive substances were not exceeded and as well as the daily limits for gaseous emissions and concentration limits of radionuclides for discharged waters approved by PHA SR [L-85]. Similarly, the radiological impact of operation of SE-EMO on the environment at that time was negligible compared to the influence of background radiation. The value 125 nSv represents only 0.05 % of the permitted annual limit 250 μSv for individuals of critical groups in the area of nuclear facility, set forth as limit dose in Governmental Order no. 345/2006 Coll. [L-4].

Radiation burden from the operation of the NRR Mochovce

The operation of the repository is the period when the disposal of packaged forms of RAW is performed or other activities connected with it. Impact of NRR Mochovce on the surrounding population during the operation is practically void.

Radiation protection of NRR personnel is provided by the spatial layout of the repository and by the handling of FCC from the moment of its taking over to the actual disposal to the stated place in the box. The critical exposure route is external radiation exposure of personnel from the FCC. The dose rate on the surface of FCC is ≤ 2 mSv/hour (it follows the regulations for the transport of radioactive material – FCC serves also as transport container). Exposure from the FCC in the box is minimized by the distance and by the panels of box coverage. There are not performed other activities of RAW handling (expect from disposal of packaged forms of RAW into the disposal boxes) in NRR. The radiation load of employees in NRR Mochovce coming into contact with the packaged forms of radioactive waste since acceptance of FCC to its disposal into boxes is mostly under the measurable value using standard individual dosimeters.

The radiation load of the local population during the operation of NRR (disposal of packaged forms of LILW and VLLW) is zero. From NRR are not discharged any gaseous or liquid radioactive substances. Discharged is only rain water from the retention tanks, containing only those radionuclides, which are contained in normal rainwater. Not even the leakage of radionuclides into underground water is considered, since there are no liquid radioactive substances in NRR (only solidified RAW are disposed here). Rain water or water from leakages cannot get into contact with packages in which are radioactive substances disposed of, due to the fact, that it is prevented by engineering barriers (area to which are stored LILW and VLLW are protected against the rain water by hall and against leakage water are protected by the insulation layer of compacted clay with thickness up to 3.5 m – in case of LILW). If despite the prevention, water got into the repository, it would be discharged by the drainage system into control galeries and further after the inspection to the surrounding water recipient. Occurrence of radionuclides in drainage waters and in groundwater and surface waters in and around the repository is controlled by the monitoring system, erected in order to perform the corrective measures immediately after the slightest non-compliance is detected from the so-called normal background radiation – see the following Chapter C-II.17.1.1.2.

Radiation impact on the surrounding population can be considered only for the future, when it is assumed that the knowledge of the existence of the repository will be lost and when engineering barriers to prevent the penetration of radionuclides blowdown by rain or drainage water loose its functionality. This situation is considered in the safety analyses and conservatively it is assumed, that the situation will not happen sooner then in 300 years. Even in this case would not be the radiation impact on the surrounding population higher than the approved and accepted limits set forth in limits and conditions for acceptance of the disposed RAW into repository. These limits and conditions are stated and approved already when the design and licence for the erection of repository is granted – for more details see Chapter C-III.1.

17.1.1.2 *Monitoring of the impact of NRR on the surrounding environment*

The basic strategy of the environmental monitoring of the repository site and its surroundings is a comprehensive review of the potential impact on the environment and monitoring of important parameters of the components of the surrounding environment, or long-term monitoring of trends in the values of measured quantities. The relevant strategy, together with the requirement to separate the impact of close NPP EMO in the monitoring program has been applied in the monitoring project of NRR Mochovce [L-86].

The system of important parameters monitoring of NRR Mochovce and its operation in terms of the monitoring program [L-87] provides information relevant to the assessment and safety evaluation of NRR safety and its impact on the environment during its operation. Operational monitoring follows the pre-operational monitoring and after repository closure proceeds to post-operational monitoring, i.e. monitoring during the institutional control. The scope of monitoring and monitored components are not identical for all time phases.

The objective of environmental monitoring is to early detect and assess potential leakage of radioactive substances from NRR into the surrounding environment (with regard to trends and changes in the environment) and prepare the basic documentation for the acceptance of qualified measures to address the situation. In respect of RAW disposal it is the inspection of barrier tightness, and the barrier means any man-made and natural structures that are used to separate radioactive waste disposed from the environment and to prevent the penetration of radionuclides into the environment. The same applies in the full extent to operational monitoring and especially to post-operational monitoring. The objective of the pre-operational monitoring is to determine the starting position and to test the monitoring system prior to putting the repository into standard operation.

The whole environmental monitoring system is divided into 4 main subsystems:

- Monitoring of drainage waters.
- Monitoring of groundwater.
- Monitoring of surface water.
- Monitoring of air, soil and food chains.

The reference levels derived from the results of pre-operational monitoring

The relevant measurements and assessment of measurement results files in the pre-operational monitoring of NRR Mochovce were performed in VUJE. The scope of pre-operational monitoring corresponded to pre-operational stage of comprehensive monitoring program of the NRR Mochovce [L-86]. Statistical analysis of measurement results involving the assessment of the basic statistical parameters of long-term background files is described in detail in pre-operational safety report, that was prepared and submitted as part of safety documentation for NRA SR with the application for the license to test the commissioning of NRR Mochovce [L-38].

In this context it is necessary to emphasise the relatively low activities of ^{137}Cs in soil samples at the actual NRR site. The soil samples were collected at six locations at NRR site. The low content of ^{137}Cs is caused by the fact, that the soil at repository site was not exposed directly to the gradient after the Chernobyl accident. This is the result of extensive landscaping at NRR site, where the most of the original topsoil was uncovered and transported (Chernobyl deposit mainly contaminated upper layer of ground).

In Tab. C-II. 8 are stated assessed basic statistic parameters (diameter, specific deviation, and frequency of file) of the statistical files of the monitoring results associated according to the inspection radiation program of the NRR area surrounding [L-87].

Tab. C-II. 8 Summary of parameters of reference levels for monitoring at NRR site based on pre-operational monitoring - r.1999

Monitored value	Units	Number N	Diameter X	Specific deviation s	$L_C(B)$	MMA=B_m
Groundwater (NRR) – horizon H						
Volume overall beta (1	Bq/l	21	0.29	0.17	0.57	0.85
Mass overall beta (1	Bq/g	21	0.43	0.15	0.68	0.93
^{3}H *	Bq/l	69	6.4	1.5	8.9	11.4
^{40}K	Bq/l	54	0.14	0.06	0.24	0.34
Underground waters (NRR) – horizon P 1, 2						
Volume overall beta (1	Bq/l	15	0.3	0.25	0.71	1.1
Mass overall beta (1	Bq/g	15	0.55	0.4	1.21	1.9
^{3}H *	Bq/l	69	6.4	1.5	8.9	11.4
^{40}K	Bq/l	15	0.25	0.15	0.50	0.745
Surface waters, Drainage waters, Rainwater						
Tributary “C”						
Volume overall beta (2	Bq/l	31	0.16	0.011	0.18	0.20
^{3}H *	Bq/l	80	6.4	1.5	8.9	11.4
^{40}K	Bq/l	31	0.13	0.043	0.201	0.27
^{90}Sr	Bq/l	34	0.031	0.009	0.046	0.061
Čifársky pond and Telinský stream						
Volume overall beta (2	Bq/l	60	0.33	0.13	0.54	0.76
^{3}H *	Bq/l	80	6.6	1.5	9.1	11.6
^{40}K	Bq/l	60	0.27	0.1	0.44	0.6
^{90}Sr	Bq/l	60	0.029	0.007	0.04	0.052
Bottom sediments - Čifársky pond, 0-10 cm						
^{137}Cs	Bq/kg	36	50	9.1	65	80
Soil – site, 0-5 cm						
^{137}Cs (3	Bq/kg	55	0.95	0.5	1.78	2.6
Doses of external radiation at NRR site						

Monitored value	Units	Number N	Diameter X	Specific deviation s	$L_C(B)$	$MMA=B_m$
Doses – DP, area	nGy/h	324	82	5.4	91	100
Doses– TLD, area	nGy/h	286	75	6	85	95
(1 – According to data of VUJE from 1991						
(2 – Estimated according ^{40}K (70 %)						
(3 – for comparison activity ^{137}Cs in near forest - aprox. 150 Bq/kg of soil						
* - present MMA by measurement ^3H are regarding the progress in the device technique 10 times less						

N number of measurements, $L_C(B)=X+1.65s$, B_m = MMA=X+3.3s

Based on the performed analysis can be generally stated, that any more significant radiology anomaly was not by pre-operational monitoring and by its statistical assessment discovered.

In the monitoring program stated in Chapter II.8 PpBS for NRR Mochovce [L-38] are based on the results of pre-operational monitoring derived also reference levels (recording and controlling) for the assessment of monitoring results during the NRR operation on site.

Recording level $L_C(B)$ – with regard to character of expected data, it records all obtained data from monitoring. For the result of the type “less than” is the result declared if the number of impulses does not exceed the critical border of number of impulses of given measurement system. By means of method of the serial statistics also such data can help in quantifying the background level to the detection possibilities of applied method.

Inspecting level B_m – For the inspection level in the phase of pre-operational monitoring was accepted the value of the minimum measured activity of the monitoring system – MMA derived according the periodically specified statistic parameters of the background file. MMA and also the value of the inspection level is dependent from the parameters of the used background. As within the innovation of the device equipment are improved the parameters of devices for the detection of the individual monitored quantities, it improves (decrease) MMA and as a consequence of that specify also the results of monitoring. Therefore, in the course of operational monitoring are the monitoring levels specified based on the particular results of monitoring during the operation. In exceeding the measured value above the inspecting level is “inspected” the reason of exceeding.

Initial statistic parameters characterising the relevant background file prior to NRR Mochovce site commissioning with derived quantities – critical values of background B_m (L_c) and inspection levels - MMA for the individual monitoring quantities are stated as a summary in Tab. C-II. 8.

At NRR site was within the pre-operational monitoring stated also the content of ^{14}C in the ground layer of atmosphere. The results of measurement ^{14}C in atmosphere of NRR Mochovce in November 1997 and April 1999 are stated in the following table (Tab. C-II. 9). For comparison, there are stated also values of ^{14}C in Bratislava and in Žlkovce.

Content of ^{14}C in the atmosphere is indicated as relative elevation above its natural level. Natural levels of the content ^{14}C in the atmosphere represents 95-% limit of the confidence interval of the current activities of the international radiocarbon standard.

Relative elevation ^{14}C in the atmosphere is given by:

$$\delta^{14}C = \frac{N - N_0}{N_0}.100 \qquad (\%)$$

where N – is the frequency of sampling and

N_o is 95% of confidence interval radiocarbon abundance of international standard.

Balance concentration ^{14}C in the atmosphere has been violated as a result of nuclear weapons tests, when the large amount of ^{14}C got in the atmosphere. In 1963 was in the atmosphere in the northern hemisphere measured 100 % increase in activity of ^{14}C above the natural level. Since 1963, after signing a moratorium on the banning nuclear weapons tests in the atmosphere, the concentration of ^{14}C in the atmosphere decreases and approaches to natural levels. Recently, a decrease of concentration ^{14}C in the atmosphere has slowed since the operation of nuclear power plants also contribute to the production of ^{14}C.

It would be desirable to repeat such measurements during the operation, to update background levels of radionuclides in the atmosphere in the NRR Mochovce.

Before NRR commissioning was by means of radiocarbon dating determined the age of groundwater in the individual horizons. Based on content analysis of hydrocarbonates and activity of ^{14}C in taken samples of underground waters from the first circuit of borehole (in the south of NRR) was stated the age of underground waters in the individual horizons as follows:

top horizon H (borehole MON-2A): 4 000 years,
medium horizon P1 (borehole MON-2B): 4 000 years,
lowest horizon P2 (borehole MON-2C): 5 000 years.

Tab. C-II. 9 Results of stating ^{14}C in the atmosphere of NRR site performed on FMFI UK [L-82]

Site	The period of sampling	Volume activity A_0 [mBq/m^3]	Relative increase $\delta^{14}C$ [%]
NRR Mochovce	November 1997	44.5 ± 1.4	12.3 ± 0.8
Bratislava	November 1997	44.9 ± 1.5	13.4 ± 0.8
Žlkovce	November 1997	44.3 ± 1.5	11.9 ± 0.8
NRR Mochovce	April 1999	47.6 ± 1.5	14.2 ± 0.6
Bratislava	March 1999	46.1 ± 1.4	10.6 ± 0.7
Žlkovce	March 1999	46.3 ± 1.4	11.1 ± 0.7

Although sampling from a borehole MON 2A is coming from shallow horizon, it has a relatively low radiocarbon. This suggests that this water comes from a closed system (Fig. C-IX. 20), which is not recharged by surface water [L-38]. In contrary, water in borehole N-13 in the north-eastern corner of the NRR (see Fig. C-IX. 20) represents the current surface waters which penetrated from the ground surface.

The results of monitoring of NRR surrounding during the current operation

Groundwater

Schedule of groundwater sampling is shown in Tab. C-II. 10.

Results of chemical and radiochemical analysis of ground water in 2009 and 2010 are shown in Tab. C-II. 11.

Tab. C-II. 10 Schedule of groundwater sampling in NRR Mochovce

Monitored characteristics Volume of sample	Monitored objects, monitoring intervals		
	Once a month	**Once a quarter**	**Once a year**
Volume activity ^{3}H (1 dm^3)	N-13, N-18, N-19, MON 1A/P, N-2, N-3, N-4, MON 2B, MON 2A/P, N-6, N-7, N-8, N-9, N-10	MON 1A, MON 2A MON 1B, MON 2C	J 3, N 5, SRK 3, PSRK 3A, PSRK 3B, SRK 1, SRK 1A, SRK 3A
Number of samples	14	4	8
Total volume activity beta (2 dm^3)	N-13, N-18, N-19, MON 1A/P, N-2, N-3, N-4,	MON 1A, MON 2A MON 1B, MON 2C	N 6, N 7, N 8, N 9, N 10, SRK 3, SRK 3A, J 3, PSRK 3A, PSRK 3B
Number of samples	7	4	10
Gammaspectrometry (10 dm^3) (Co^{60}, Cs^{137})		N 13, N 18, N 19, N 2, N 3, N 4, MON 2B,MON 1A	
Number of samples		8	
^{90}Sr * (10 dm^3)		N-19, N-13	N-2, N-4, N-7
Number of samples		2	3
Alpha spectrometry * (10 dm^3) (Pu^{239})		N-19	N-2, N-3, N-4, N-7, N-10
Number of samples		1	5
pH and conductivity monitoring	This characteristics will be monitored by portable ph meters and conductometers in water samples from boreholes for total beta activity.		

Tab. C-II. 11 Results of chemical and radiochemical analysis of ground water in 2009 and 2010

Monitoring period		Year 2009		Year 2010	
Measured parameter	**Unit**	**min.**	**max.**	**min.**	**max.**
Volume activity ^{3}H	[Bq/l]	0,95	1,25	0,95	1,25
Total β - activity	[Bq/l]	0,08	0,28	0,08	0,38
γ - spectrometry ^{137}Cs	[Bq/l]	<0,021	<0,027	<0,021	<0,027
^{60}Co	[Bq/l]	<0,016	<0,025	<0,016	<0,025
pH		6,59	7,92	6,59	7,92
Conductivity	[μS/cm]	721	2238	721	2238

Drainage waters

Radionuclides from the FCC, which are disposed in individual boxes of individual double-rows, would by the violation of FCC tightness appear first in drainage waters of the controlled drainage KD1. It would have had to penetrate into the boxes water, which washed out the released radionuclides. Water penetration into the boxes during operation is excluded (double-row into which FCC is during the disposal covered by hall) and after the implementation of the phase 1 of coverage reliably controlled. Drainage water from the controlled drainage KD1 and KD2 are after the inspection discharged into rainfall tanks, which collect rain water from the reinforced areas in the surrounding boxes from the entrance communication. Into these tanks are discharged also waters from the controlled drainage (from the external side of clay bath).

Results of chemical and radiochemical analysis of monitored drainage SD A and SD B (total number of samples in year 2010 was 105 from SD) and amounts of discharged water from monitored drainage of I. double-row in NRR Mochovce are shown in Tab. C-II. 12

Tab. C-II. 12 Results of chemical and radiochemical analysis of drainage water SD of I. double-row in 2009 and 2010

Monitored period		Year 2009				Year 2010			
Monitored drainage of I. double-row		SD A		SD B		SD A		SD B	
Measured parameter	Unit	min.	max.	min.	max.	min.	max.	min.	max.
Volume activity ^{3}H	[Bq/l]	0,98	1,15	0,98	1,25	0,98	1,25	0,98	1,25
Total β - activity, Σβ	[Bq/l]	0,15	0,45	0,08	0,38	0,08	0,38	0,08	0,38
γ-spectrometry ^{137}Cs	[Bq/l]	<0,015	<0,025	<0,021	<0,029	<0,021	<0,029	<0,021	<0,029
^{60}Co	[Bq/l]	<0,019	<0,024	<0,014	<0,023	<0,014	<0,023	<0,014	<0,023
$^{239,240}Pu$	[Bq/l]	-	-	-	-	<0,004	<0,020	<0,010	<0,016
PH		7,85	8,10	7,74	7,89	7,93	7,98	7,93	7,97
Conductivity	[μS/cm]	560	661	915	971	573	583	669	678
Cl^-	[mg/l]	9,1	11,9	10,4	12,1	9,1	11,9	10,4	12,1
SO_4^{2-}	[mg/l]	47,8	67,8	43,8	57,9	47,8	67,8	43,8	57,9
Volume of water	[m^3]	60		32		256		46	

Waters discharged from rain tanks

Waters from rain tanks are after inspection discharged into the surface offtake from NRR site, which is connected to tributary “C”of Telinský stream. Other waters, which should relate to the disposal of radioactive waste from the NRR site are not discharged. **This condition shall apply even after the extension of repository and erection of the repository for VLLW.**

For formal reasons (it is a nuclear facility) were for the operation of NRR stated the limit values of radionuclides in the discharged waters, although in fact discharged is an ordinary rainwater. It checks also underground waters in the monitoring boreholes and the activity of surface waters – mainly in the reservoir Čifáre. During the operation of NRR is performed the monitoring of air, soil and food chains, mainly, due to the fact, that NRR repository is placed near operated NPP SE-EMO. Air monitoring of NRR site is also implemented due to the fact, that as maximum accident by the operation of NRR (disposal of FCC) is considered also fall of FCC container by box disposal, while the fragile fractions of solid part of radioactive substances stored in FCC can be released into environment.

The results of monitoring of water discharged from the NRR into Telinský stream and the results of monitoring of other elements of environment for the year 2009 and for the year 2010 [L-90], [L-91] are stated in the following tables. The selected results of monitoring at NRR site in Mochovce and in its surrounding from the commissioning of the repository up to 2008 are stated in table Tab. C-IX. 1 [L-82]. In Tab. C-II. 13 is stated the comparison of the qualitative characteristics of the discharged waters with concentration limits. Concentration values of discharged water parameters from surface offtake, which were established in the decision of the water economy body, were not exceeded in the monitored period.

Tab. C-II. 13 Comparison of qualitative concentration indicators with the limits for discharged waters from NRR in 2009 and 2010

Indicator	Measured values		Permitted limit concentration
	min.	max.	
^{3}H [Bq/l]	0.95	1.25	4 690
^{60}Co [Bg/l]	< 0.19	< 0.024	5.6
^{137}Cs [Bg/l]	< 0.016	0.021	5.7
$^{239+240}$Pu [Bg/l]	< 0.005	< 0.013	0.139
^{90}Sr [Bg/l]	< 0.028	< 0.61	61.0
Total beta [Bq/l)]	0.08	0.4	-

Note: Value marked as < (less than) represent MMA of the given RN. It means, that the real activity could not be measured, because it is less than MMA.

In Tab. C-II. 14 is stated the percentage assessment of total activity of individual radionuclides in the discharged water from surface offtake in NRR within the period 2009 - 2010 to the limit values set forth in the Decision licensing the operation of NRR Mochovce [L-21], [L-84].

Tab. C-II. 14 Percentage assessment of total activity of radionuclides to limits and conditions in waters from the surface offtake of NPP, discharged in 2009 and 2010.

Radionuclide	LaC [Bq]	Discharged activity [Bq]		Fulfilling of LaC [(%]	
		2009	2010	2009	2010
^{3}H	$1.88 . 10^{10}$	$8.69 . 10^{6}$	$2.05 . 10^{7}$	0.046	0.109
^{137}Cs	$2.28 . 10^{7}$	$1.11 . 10^{5}$	$3.5 . 10^{5}$	0.487	1.535
^{60}Co	$2.24 . 10^{7}$	$1.54 . 10^{5}$	$3.93 . 10^{5}$	0.688	1.754
^{90}Sr	$2.44 . 10^{8}$	$1.79 . 10^{5}$	$1.6 . 10^{5}$	0.073	0.066
^{239}Pu	$5.56 . 10^{5}$	$2.70 . 10^{4}$	$3.0 . 10^{4}$	4.821	5.357
Volume of discharged water [m^{3}]		5 960	11 126		

Note: Data on discharged activity is except ^{3}H overestimated, due to the fact that other radionuclides are mostly immeasurable. Therefore the balances of such discharged radionuclides are in the radiation protection considered as the values equal to MMA. The values of the discharged activity stated in this table are then *the result of composition of MMA and volume of discharged water (except ^{3}H). It is significantly overestimated in comparison with the real measured values.*

Surface water

In the system of potentially affected surface water to which are discharged rain waters from the surface offtake of NRR is the significant element of water reservoir Čifáre (Čifársky pond) on Telinský stream. Surface water in the stated system is monitored (measured are once a year volume activities ^{3}H, total volume β activity (Σβ), ^{60}Co, ^{137}Cs, príp.^{239}Pu) on measured weir L1 (on Telinský stream) L2 (on tributary C) and on measured weir V (MPV) on the output of Čifársky pond – Fig. C-IX. 2.

The permitted limit concentration of the individual radionuclides activity with which is compared the volume activity of radionuclides in discharged water (real measured value, or MMA in case that the real activity is immeasurable) was derived in the safety analyses from so-called limit dose, specified in the current legislation for the critical group of population near the relevant nuclear facility. The dose limit for the radionuclide intake from the hydrosphere was at the time of NRR commissioning set forth as 0.050 mSv per year. (Limit for the individual from habitants represent 1 mSv/per year).

Groundwater monitoring is carried out following the procedure T-141 [L-94]. Analysis is carried out annually from about 150 groundwater samples. Measurement cycles are divided into three groups based on the distance of the monitoring boreholes from disposal boxes. Similarly, the frequency of setting of each parameter is chosen according to the difficulty of setting. The volume activity of tritium and activity of Σβ are performed more frequently – once a month in the samples from the horizon H in repository site, quarterly in horizon P1 in the area and in boreholes outside the site in the direction of the underground water flow, quarterly is in the selected samples performed gamma spectrometry and similarly is in the selected samples performed alpha spectrometry. In the individual boreholes is relatively often measured groundwater water level (most frequently in week intervals in boreholes, which are closest to the erected double-rows of the disposal boxes).

In groundwater, surface water and drainage waters, activity of individual radionuclides in the year 2009 and 2010 ranged, as it is stated in Tab. C-II. 15.

Tab. C-II. 15 Measurement results of surface water in the surrounding of NRR Mochovce in 2009 and 2010

Sample mark	^{3}H		Σβ		^{60}CO		^{137}Cs		^{239,240}Pu	
	[Bq/l]									
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Čifársky pond	1,15	1,21	0,25	0,39	0,017	0,019	0,021	0,024	0,012	0,006
L1	1,05	1,15	0,28	0,25	0,019	0,016	0,022	0,021	-	-
L2	1,15	1,21	0,15	0,32	0,016	0,017	0,019	0,024	-	-
MPV	0,96	0,98	0,08	0,15	0,021	0,019	0,024	0,026	-	-

According to the stated values, these are volume activities, confirming that the water in terms of artificial radionuclides content do not differ from conventional surface water not affected by the operation of nuclear facilities. According to the current results of monitoring, from NRR is in respect of radioactivity discharged only rain water.

Soils

In 2009 and 2010 were taken total of 15 soil samples in accordance with schedule of sampling. The scope of the values of specific activity of measured radionuclides is given in Tab. C-II. 16

The activity of the artificial radionuclide ^{137}Cs is relatively low due to the landscaping during the site erection (Chernobyl deposit was removed).

Tab. C-II. 16 The scope of the specific activity Σα, ^{137}Cs a ^{60}Co in the samples of soils on NRR in 2009 and 2010

Radionuclide	Measured values	
	min. [Bq.kg^{-1}]	max. [Bq.kg^{-1}]
Σα	152	218
^{137}Cs	< 1.17	< 4.75
^{60}Co	< 1.01	< 4.21

Activity Σα represents the activity of natural decay products of uranium and thorium order. In the surrounding forest soil were measured mass activity of this RN one order higher.

Air monitoring

Further, obligatory monitoring of the radiation situation is performed in the ground layer of atmosphere by inspection of the aerosols activities and gradients and by measurement of the spatial dose equivalent H* [nSv/h]. Radiation situation in the surface layer of the atmosphere is characterized well by activity of aerosols and gradients, which ultimately affect the overall activity of artificial RN accumulated on ground surface, but also the plant contamination of the food chain elements. In monitoring of the activities of air aerosols is therefore emphasized the artificial element, and significant are mostly long-term radionuclides ^{137}Cs, ^{90}Sr, ^{239}Pu, ^{241}Am. Monitoring of these radionuclides on the level of real value enables to record changes very sensitively, which would characterize the deviation from the standard development.

The volume activity of ^{137}Cs in aerosols in the surface layer of the atmosphere from the Chernobyl NPP accident decreases with an effective halftime of decrease aprox. 6.33 a year – Fig. C-IX. 23. In recent years this figure has dropped to below 1 μBq/m^3 in air. Such low values can be measured only by using powerful sampler and the relatively long sampling time (on month) and also the relatively long measurement times (aprox. 60 hours). The above stated requirements are met by monitoring of aersosols activity in NRR.

In Fig. C-IX. 23 there is given the time course of the average volume activity of ^{137}Cs and ^{7}Be in the air in the surface layer of atmosphere in years 1993 - 2004 from SHMÚ stations (Bratislava, Lučenec, Liesek and Stropkov) – red points with blue edging–and the results of similar measurements at NRR site since commissioning (r.1999) up to 2010 (yellow points with green edging [L-82].

Measured data on the activity of ^{137}Cs in aerosols in NRR Mochovce for the period 1999 - 2010 (yellow points with green edging) agree well with the extrapolated values of the average volume activity of the Slovak Republic (red continuous line). (Note: Into the average values of volume activity of ^{137}Cs in aerosols from the territory of the SR were not included the results of the Bohunice site.) Halftime of decrease of the activity of global ^{137}Cs in the surface layer of atmosphere in the territory of the SR from the data on this figure is $T_{ef}(^{137}Cs, SR)$ = 6.33 year. Since 1st January 2005 are the average values on the territory of SR delivered data from NRR (red points with green edging), due to the fact, that other measurements in the network of SHMÚ demonstrate the values under MMA.

One value from measurements of volume activity of ^{137}Cs at NRR site (January 2009) is overvalued compared to other values. After verification of the single increase (33 μBq/m^3 compared to aprox. 3 μBq/m^3) can be stated that it was not caused by the operation of NRR (no other anomaly has been recorded, which would indicate violation of design barriers against the spread of contamination from the disposal inventory of radioactive substances in NRR) and that also has not been caused by operation of the near NPP SE-EMO (comparing with the results of monitoring of SE-EMO area [L-51]).

This single increase was on the basis of above mentioned contributed to unspecified external natural factors. From the radiological point of view, this increase is not significant, because whole year breathing of such air with this volume activity of ^{137}Cs would create an effective dose at 1.10^{-6} (one millionth) of the dose from natural background. The higher value was also recorded as a result of an accident of NPP Fukushima – see Tab. C-II. 17 and Fig. C-IX. 23. Besides ^{137}Cs was also measured short-term ^{134}Cs with half-life 2.065 year (is not produced directly as a product of fission, but requires long-term exposure to neutron flow of fission products) and ^{131}I with half-life only 8 days.

Activity of ^{7}Be as the natural product of cosmic radiation acting, it is not affected by the operation (or accident) of the nuclear facility.

From these results it is evident that the activity of ^{137}Cs in aerosols on NRR corresponds to the activity of aerosols in the rest of the SR and, therefore, the NRR operation (or the operation of near EMO12 NPP) does not significantly influence the level of aerosols activity in the surface layer of the atmosphere.

Tab. C-II. 17 Activity of artificial radionuclides and ^{7}Be in aersosols at NRR Mochovce as a consequence of Fukushima accident [μBq/m^3]

Collection	Activity of artificial radionuclides and ^{7}Be in aerosols at NRR Mochovce as a consequence of Fukushima accident [μBq/m^3]			
	^{137}Cs	^{134}Cs	^{131}I	^{7}Be
1.3. - 28.3.2011	1.74	0.433	36.2	3010
28.3. - 1.4.2011	246	183	2020	4120
1.4. - 18.4.2011	26.8	21.9	162	3650
18.4. - 2.5.2011	7.66	4.8	15	5960
2.5. - 31.5.2011	2.2	1.08	4.16	5200
31.5. - 1.7.2011	0.43	< MMA	< MMA	4370

In Fig. C-IX. 23 is stipulated the time dependence of volume activity of ^{7}Be in aerosols in ground layer of the atmosphere in the SR (data from the same sources - blue continuous line) and at NRR Mochovce site (blue point with red edging). Activity of ^{7}Be is produced by cosmic radiation in the surface layers of the atmosphere and the level of volume activity in the surface layer of the atmosphere is approximately 1000

– times higher (units mBq/m^3 in air) as the volume activity of ^{137}Cs, while the activity of ^{7}Be in summer months is approximately three times higher than activity in winter months. From the long- term aspect is the activity of ^{7}Be at levels comparable with the values from measurements at NRR Mochovce site and elsewhere in the SR, including Bohunice site [L-76].

At NRR Mochovce site (it can be generalized to the Mochovce site as a whole) is therefore measurable from the artificial gamma radionuclides in aerosol form only ^{137}Cs. Similar situation applies also to other artificial RN such as e.g. ^{90}Sr, $^{239+240}Pu$ and ^{241}Am, which are part of a "global gradient" [L-88], [L-89].

The results of monitoring of RN activities in samples of drainage, surface water and groundwater, as well as the results of monitoring of soil and air shows, that measurable are only RN occurring in the global gradient and are on the level of radiation background– see Tab. C-IX. 1. Therefore, the radiation exposure of the population in the surrounding of NRR corresponds to background radiation load see Chapter C-II.17.1.1.

17.2 Ecological capacity

The term ecological capacity means the ability of country to absorb new elements and inputs without changes in the balance level, in which are the relationships between elements of the landscape system maintained by self-regulatory processes in a particular ecological stability. Its violation is dependent primarily on the vulnerability of the natural elements of landscape system and sensitivity of anthropogenic interference within the natural landscape elements themselves, the links between them and the quality of the anthropogenic component links and links to elements of natural ecosystems.

The relevant area and nuclear facility Mochovce is in the view of macro a meso climatic characteristics quite homogeneous territory, which, without detailed microclimatic measurements cannot be differentiated further. Regarding this is the vulnerability of the air constant for the relevant area as well as for the nuclear facility. Thanks to its location in an open area of the Danube upland and to that following good dispersion conditions, it can be stated, that the vulnerability of the air here is relatively small.

Regarding the geological attributes in the areas and the geological environment during the erection it can be concluded, that in the area of nuclear facility Mochovce itself is the vulnerability of geological environment quite small, intermediate in the coherent rock of Kozmálovske hills and big in the positions of valey and overbank sediments.

The vulnerability of relief is quite small on built-up and reinforced areas of nuclear facility site, intermediate and big on slope positions (depending on the gradient of the slope, attributes of the rock and character of the vegetation cover) and small on the plain terrain.

In the prevailing part of the relevant area is considered small and intermediate vulnerability of the surface and underground waters. The big vulnerability of underground waters close to Telinský, Mochovecký and Malokozmálovský stream, as well as Hron itself, is connected with the pollution of surface waters of such streams.

Regarding the nature of terrain and functional use of areas is the relevant area characteristic by big vulnerability of agricultural arable soil against water and wind erosion and chemical degradation as well. Vulnerable to water erosion are also forest soils on the steep slopes with weaker vegetation cover and soils of vineyards and slope positions. Less vulnerable are soils with permanent grass vestures and soils of forest vestures, soils of fruit groves and gardens. The high vulnerability can occur also in the surrounding of not controlled waste dumps, where the leakage of contaminants into environment is possible. In the built-up area can be as less vulnerable soils considered kultizem urbic thanks to permanent care and an intensive cultivation by the owners. On the other hand, very vulnerable are soils urbically degradated.

Vegetation cover of the dominant part of the relevant area form one year agricultural monocultures with the high level of vulnerability. A bit less vulnerable are permanent grass vestures and permanent vegetation cover of vineyards, fruit groves and gardens. In the built-up area are the most vulnerable one year cultures (vegetable patch), less vulnerability have the vestures of trees and bushes by the family houses, which are kept regularly. From the ecological point of view, the most stabile are the areas of forest crop.

Unlike the vegetation, the level of fauna vulnerability is decreased by the bigger migration ability of the individual animals, further natural enlargement of areas of progressive types or eventually artificial introduction. The most vulnerable are zoocenosis of fields or meadows, less vulnerable are zoocenosis of vestures near water streams and forest vestures.

In the relevant area are less vulnerable biotopes of forest areas; the most vulnerable are biotopes of monocultures on arable soil. Among the most vulnerable biotopes in the relevant area belong regarding the nature also gene pool locations mentioned in the previous chapters.

The microclimate of the built-up area of assessed municipalities, regarding its size and the concept of building up, is strongly influenced by the external open agricultural landscape. Good airing in built-up areas is degradated by the increased dustiness of fields during not growing season. Stenches or dustiness sporadically penetrate during the vegetation period into the habitable area of municipalities from manuring and protection of agricultural cultures. Near stock-raising and farmyards, which are placed at the edge of municipalities, it is also stench of these premises. In winter period and by the snow cover, the penetration of cooler air roughs up the microclimate of the municipalities.

17.3 Synthesis of ecological capability of the area and its classification according to vulnerability

The assessed area is considered a part of the region characterized by high productivity of economic activities and high levels of functional land use. This achievement is the result of long-term development, in which the production elements of the country, namely soil and vegetation, has been transformed. Transformation of these two elements were area wise and affected the prevailing part of the cadastral area of the assessed municipalities. Their transformations involves mainly agriculture. In less extent were transformed original forests, rock subbase, surface water and groundwater. Air quality has changed even less. All these changes induced by human activities disturb the balance of natural ecological system of the environment.

In terms of ecological stability, as the most stable element can be in the assessed area considered rock subbase, as one of the benefits, for which nuclear power plant was situated in this area. Similarly, also the changes in the quality of surface and underground waters, in respect of its natural ecosystems, did have not reached the threshold of the ecological capability. It is closer to the threshold of the health capability (e.g. Telinský stream, Hron) and its usage for human, but also to the threshold of the capability usage.

Given the low ratio of built-up areas in the territory, the character of buildings and good airing of the built-up area, there are not critical concentrations of emissions in the air and air of the assessed area therefore cannot be considered a limiting factor of human activities or ecological capability.

A critical situation is in land using and vegetation cover. Agriculture in the assessed area in terms of size and intensity of exploitation reached a technological maximum and practically exceeded the ecological capability of the original country. Induced changes are irreversible, respectively reversible in the very long terms.

Built-up areas of the municipalities reduce the environmental capability of the area regarding the surface and quality only to the slight extent. Quite significant area is nuclear facility Mochovce, which by its protection zone, necessary distributions in the assessed area creates mainly barriers to development. Outputs from the nuclear facility to the natural components of the natural environment are strictly limited and controlled in order, not to endanger health and safety of workers inside the site as well as health of habitants of the near or far surrounding. Values of these limits are below the thresholds of ecological irreversible changes. The situation is even more favourable from the standpoint of output assessment from the NRR into the environmental components.

18 ASSESSMENT OF ANTICIPATED AREA DEVELOPMENT IF THE PROPOSED ACTIVITY IS NOT IMPLEMENTED

The proposed activities within the NRR enlargement does not have the direct impact on the development of the area. Therefore, even in case, that these activities would not be implemented, it shall not have the impact, because RAW has been already disposed of at NRR.

19 COMPLIANCE OF THE PROPOSED ACTION WITH APPLICABLE LAND USE PLANNING DOCUMENTATION AND OTHER RELEVANT STRATEGIC DOCUMENTS

The activities considered by enlargement of NRR are in the direct connection with the operation of repository at the location and have the same character. It will be implemented at NRR site, on area, of which the functional use for these activities were already approved in land use documentation of Nitra self-governing region and in land use plan of the municipality Kalná nad Hronom, or eventually in other connected land use documents.

The problematic od NRR enlargement is mentioned also in Strategy of Nuclear Energy Back End in Slovakia [L-34], approved by the Governmental Resolution no. 328 from 21st of May 2008. Strategy points to the need to develop EIA documentation, or eventually implementation study – if within the conditions of Slovakia is sensible to dispose VLLW separately, or if is exclusive disposal of quite expensive FCCs optimum solution. Study C9.1 [L-29], [L-30] was devoted also to this problematic. In the conclusions it is recommended in the Slovak conditions to separately dispose VLLW and to use FCCs again for disposal of RAW for LILW disposal.

III. ASSESSMENT OF EXPECTED IMPACTS OF THE PROPOSED ACTIVITY ON THE ENVIRONMENT INCLUDING HEALTH AND ESTIMATION OF THEIR SIGNIFICANCE

1 IMPACTS ON POPULATION

1.1 Assessment of direct impacts on population

The nearest residential area from the NRR in Mochovce is located about 4 km by the most direct route in municipality Nemčiňany and is separated from the NRR by compact forests of Kozí Chrbát and Dobrica. The distance of the residential area of the second nearest residential area in municipality Čifáre is about 4.5 km by the most direct route through the agriculturally cultivated land.

Course of preparation and operation of the enlargement of NRR will not negatively affect the population. Noise of the civil works cannot affect the nearest municipalities with regard to the distance from populated areas. Only the motor transport used for transportation of material and waste may be disturbing. Its extent, however, will not exceed important level - the routes respect the main communications. It can therefore be reasonably assumed that the load of population resulting from the transport associated with construction and enlargement of NRR will not grow to proportions, which may be unacceptable from the health aspects.

Potential direct impacts on the population and resulting health risks for concerned population are associated primarily with the possible radiation exposure, and secondarily with related transport, or noise emissions and pollutants resulting from it.

1.1.1 Direct impacts during operation

The release of radionuclides from the repository into the atmosphere is unlikely because the NRR is intended only for disposal of incombustible solid or solidified liquid wastes in approved waste packages.

Health risk due to the NRR operation is zero. Radiation situation in the surroundings of the repository corresponds to a common background in other areas of our country and the NRR existence does not have any negative impact in a demonstrable manner. New addition to the forthcoming enlargement of the repository to effective radiation dose in the nearest villages will also be zero. Current level of basic indicators of population health is the same in the more remote areas of Nitra region as in the vicinity of the repository. From the psychological point of view, the population is well adapted to the closeness of the nuclear power plant. Potential new load from the repository, although insignificant, is not demonstrated in the territory, of which the population should have had impaired health conditions or disturbed mental balance.

From closed packages containing waste, there is no release of radioactive substances, which could spread to the surrounding area. Inside the storage hall only very low intensity of penetrating gamma radiation, which was not retained by the walls of packages, will be emitted.

Because the repository is located in the area with fencing, it is guaranteed that no person who does not belong to workers working with sources of radiation can be irradiated by the repository activity outside the fence, and if so, it can only be the activity of natural resources. Dose rate equivalent from natural sources (other than radon) is commonly at the level of 1 mSv throughout the country.

Activities connected with NRR enlargement or its operation itself do not cause increase of concentration of radionuclides in released liquid wastes from NRR as a whole. It is assumed that the values of activity of radionuclides released into the environment will stay below the limit with sufficient reserve. Also the radiation exposure of the population should stay below the limit (with sufficient reserve).

Safety analyses which are the key parts of the NRR pre-operational documentation showed that the possible release of radioactivity in liquid waste on the level of limit values into the tributary "C" of Telinský stream could lead to annual effective individual dose of individual from critical population group on the level or around 50 μSv [L-37] (which is around 20 % of the natural radiation background). The experience of previous, about 10-year long operation of the repository shows that the activity of discharged rainfall water and drainage water is at the level of activity of normal surface water, unaffected by the operation of nuclear facilities.

Neither the analysis of the impacts of the greatest operational emergency (fall of the container containing waste) leads to the impact on population. Even the irradiation of staff during such occasion will be significantly lower than the limits of irradiation of individuals from population.

1.1.2 Direct impacts at the post-operational stages

Direct impacts in the stage after the repository closure are subject matter of the analysis of the long-term repository safety. Status of the repository after a period of institutional control is different from the release of an area with nuclear facility from under the control after it has been decommissioned in a sense that the exclusion of the repository area for unrestricted use is not foreseen[L-117]. Acceptance criteria of waste limit the consequences for population with specific requirements (by limiting the effective dose for expected normal repository development as well as for unintentional intrusion of the repository) also in case of loss of information of its location. Current methodology of proving the long-term safety of the repository is based on the construction scenarios of repository development in future.

The long-term safety analysis of the Mochovce repository is based on the two types of scenarios:

- **Evolution scenario –** describes normal repository development. The scenario assumes the loss of functionality of engineering barriers due to natural degradation, subsequent radionuclides leaching, transfer through clay insulation into groundwater, transport through groundwater and their transfer into biosphere to the humans. Probability that such scenario happens in the distant future is equal to one. Analyzed are also alternative of evolution scenario which could occur during disfunctioning of clay barriers (so-called bathtub effect, or uptight bath). Bathtub effect means that the inflow of water to the repository will be bigger than its infiltration through the functioning clay bath, water will be accumulated in storage areas, leaching from waste packages will be more intense and contaminated water can, as a consequence of outburst of water, penetrate the repository surroundings from where it may contaminate water-saturated layer through soil. Scenario with non-insulated bath considers the preferential method of radionuclide transport through damaged clay bath. In case of clay bath damage, contaminated water will penetrate the water-saturated layer directly.
- **Intrusion scenarios –** they are based on the assumptions that after the expiration of the institutional control period (300 years) when the location will be released for unlimited use, there may be such activities at the repository such as location survey by drills on the core, road

construction, building construction or permanent residency at the location **not knowing** that the radioactive waste is present in the location. Long-term probability of such scenarios is lower than one; on the other hand their solution lies in the same approach as in the case of normal evolution scenario.

Along with determining the scenarios of safety analysis, the list of safety significant radionuclides is determined. In general these do not have to be radionuclides which are contained the most in radioactive waste; some of them are even in such concentrations in waste which are not detectable by direct measurements. This fact has recently lead, from the point of view of long-term safety of radioactive waste disposal of safety, to determining whether the factor was characteristic of radioactive waste (i.e. determining and/or declaring the safety significant waste characteristics or their packed forms).

Individual scenario sequences are then covered by mathematics relations which are solved directly or numerically. Another key problem of safety analyses are their quantitative parameters. Uncertainties in parameters are solved in the safety analyses in two ways:

- by using conservative values,
- by expressing uncertainties by distribution of probability and probability simulation.

Another step is own calculation using today also commercially available models. Calculation as it was mentioned may be done:

- Deterministically, i.e. with specific parameter values which lead to obtaining numeric value of the result,
- Probabilistically which may lead to the result having form of probabilistic quantity.

The last of the safety analysis steps is the uncertainties and sensitivity analysis which is done in order to increase credibility of analysis results.

Safety analyses are done iteratively: typically at the beginning is determined the activity of disposed waste and the result of analysis is compared with authorized values of effective dose for individual from critical group of population. If the result is higher, for further round of calculation lower inventory of activity is considered. If the result is lower, it shows that all considered waste may be really disposed or it may be considered to add something to the considered activity. Both options admit another round of calculations.

Authorized values of limits of deposited RAW, which are determined on the basis of safety analyses, are reviewed and approved by relevant regulatory authorities. In Slovakia for this repository, they were issued by the authorities of hygienic supervision in the period of construction and putting the NRR in operation [L-24] as follows:

- annual effective equivalent dose 100 mSv for an individual from a critical group of population in any year after the waste disposal for the scenario of “transport by ground water”, i.e. such that may occur with the probability equalling to one,
- annual effective equivalent dose 1 mSv for an individual from a critical group of population in any year after the expiration of the so-called institutional control for residence scenario and intrusion scenario, i.e. such which may not exclude that they would occur but with probability lower than one.

Results presented below are based on the assumption that the radionuclide inventory according to Tab.A-II. 5. This inventory was estimated for operation and decommissioning of NPP in the location of Bohunice and Mochovce (including MO34). Technologies of radioactive waste treatment were the same as in Chapter A-II.8.1.1.2.

Evolution Scenario Assessment

The time frame of radioactive waste impact is a part of the safety analysis. Typically the time dependence of concentration of individual radionuclides in various elements of the environment is prepared (see Chapter C-III.5), through which the radionuclides migrate according to the evolution scenario or according to its variations up to the biosphere and to the humans. The result is a time dependency of effective dose for an individual in the critical group of population from individual radionuclides and time dependence of the resulting effective dose which is given by the sum of individual radionuclide contribution over time.

Calculations were made first for the repository of VLLW and LILW separately and then their common impact was assessed. Doses are calculated for drinking of ground water in the location of its first spring. It is also assumed that presence of radionuclide activity in Čifárska reservoir will cause exposure of population in its surroundings due to drinking of water, fish consumption and agricultural products contaminated by irrigation from pond.

For VLLW repository, total dose - maximum 5.0E- 6 Sv from drinking of water in the location of spring of the Collector H is achieved in 555 after the repository closure. ^{129}I is a critical radionuclide. ^{14}C is the most significant contribution to the maximum of total dose (6.5E-7 Sv in the year 1610) from exposure since the use of Čifárska reservoir. Contributions of other radionuclides are insignificant.

In case of LILW repository, total dose – maximum 8.9E-5 from drinking of water in the location of spring is achieved in 2635 after the repository closure. ^{129}I is a critical radionuclide (maximum 8.6E-5 Sv). In case of Čifárska reservoir, total dose of 9.9E-6 Sv is achieved in the year 7350 and ^{14}C is a critical radionuclide.

Time course of total effective dose from drinking of water from common impact of VLLW and LILW repository (Fig. C-III. 1) up to the period by 1000 from the repository closure corresponds with the course of dose from LILW repository. Maximum of total dose from VLLW repository is achieved incomparably earlier than in the case of LILW repository. Contribution of VLLW to total dose is 18.6 times lower than the contribution of LILW, because expected inventory for VLLW is only a fraction of expected inventory of LILW and is shown from the beginning of considered timeframe.

Maximum of total effective dose (8.94E-5 Sv) from common impact of repositories for the exposure route by drinking of water in the location of collector H spring is below the limit of 0.1 mSv.

Maximum value of total dose of population using Čifárska reservoir (Fig. C-III. 2) (9.93E-6 Sv in 7300) does not achieve radiological limit for evolution scenario – i.e. 0.1 mSv.

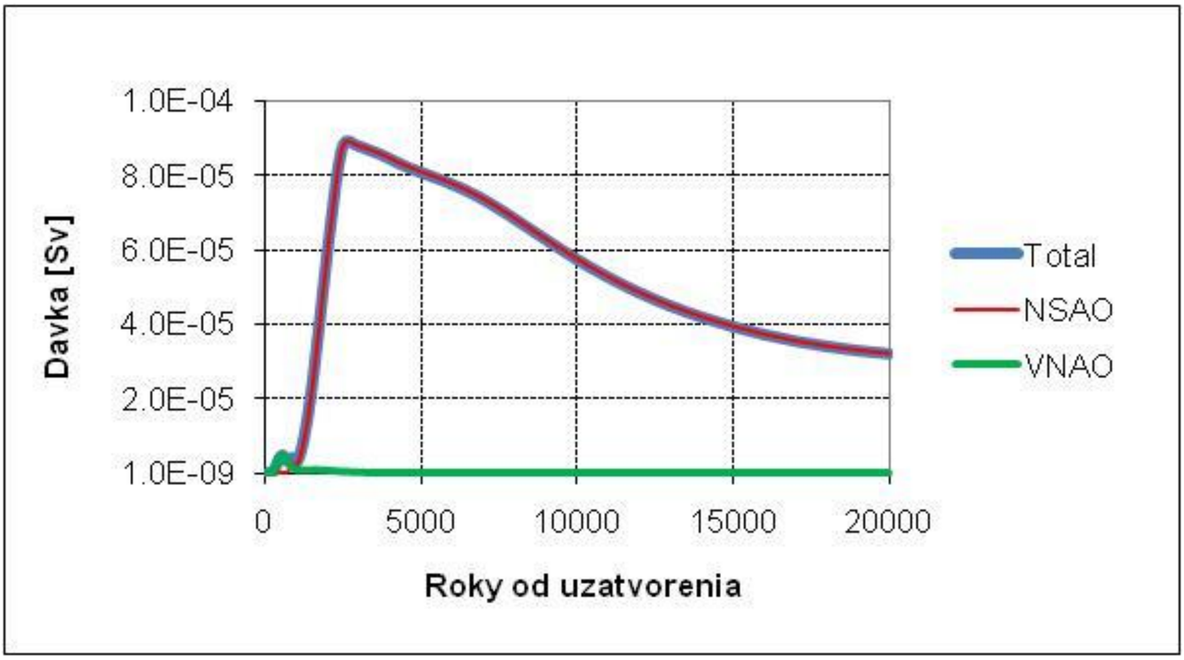

Fig. C-III. 1 **Comparison of effective doses for VLLW and LILW repository and total dose from both repositories for drinking of water in the location of spring of collector H**

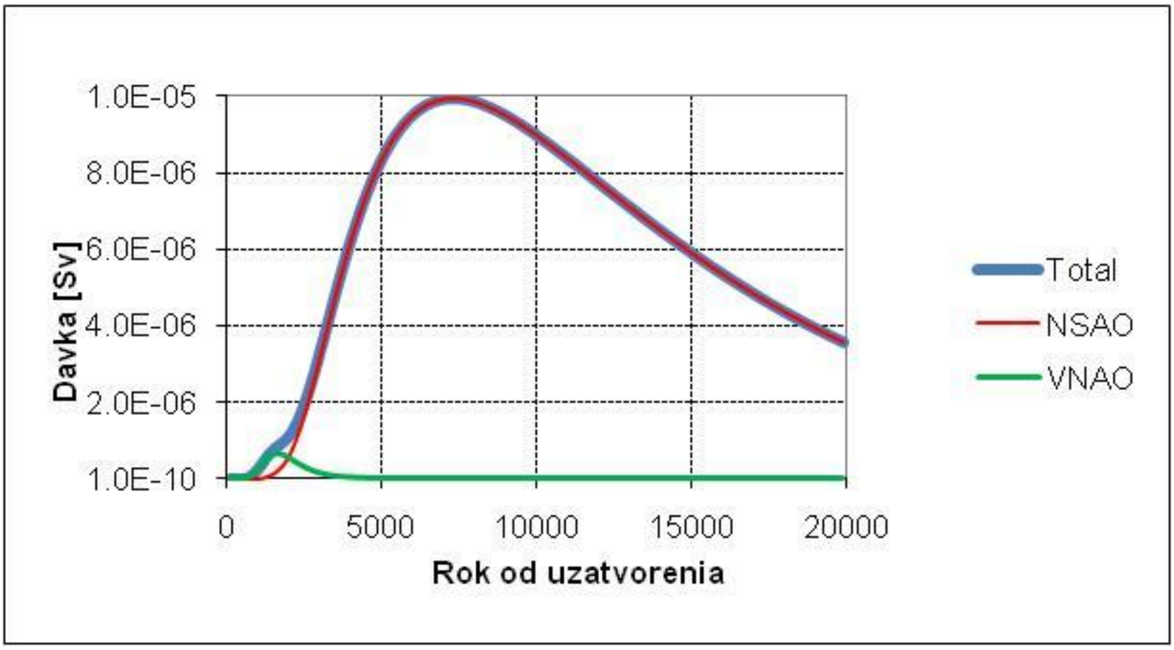

Fig. C-III. 2 **Comparison of effective doses for VLLW, LILW repository and total effective dose from both repositories for exposure from water of Čifárska reservoir**

Assessment of intrusion scenarios

Intrusion was considered into both repositories, with radionuclide activity according to Tab.A-II. 5. Conservatively, it was assumed that construction scenarios (core-drilling and residential) will occur after the end of institutional control period, i.e. after 300 years. VLLW repository is co-located with LILW repository, therefore there is no reason to assume that in a part of the area containing VLLW repository institutional control would be finished earlier. Intrusion into LILW repository was calculated after 500 years and after 300 years for VLLW repository. Intrusion scenarios are related only to the repository area and are not connected with impact on the neighbouring countries.

Fig. C-III. 3 illustrates the results for LILW repository. Construction of multi-storey house with foundations up to the bottom of the repository is a critical scenario with total dose of 4.5E-5 Sv. Radiological impacts are the highest from ^{137}Cs and ^{241}Am. For residential scenario and scenario of road construction across VLLW repository (Fig. C-III. 4), doses are by two orders lower (2.2E-7 Sv) than for LILW repository. In this case ^{94}Nb is a critical radionuclide.

Specified radiological limit of 1 mSv is observed with sufficient reserve in case of assumed scenarios for both types of repositories.

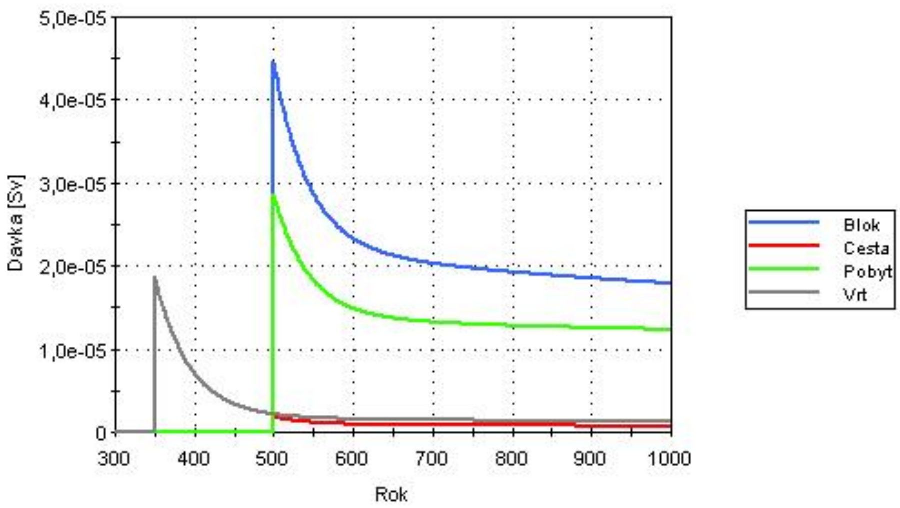

Fig. C-III. 3 Comparison of total effective doses from 19 radionuclides for intrusion scenarios for LILW repository

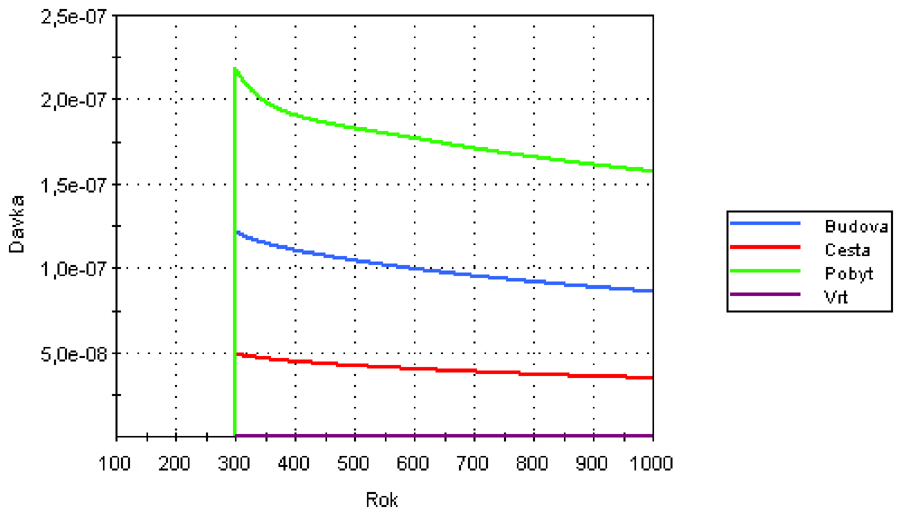

Fig. C-III. 4 Comparison of total effective doses from 19 radionuclides for intrusion scenarios for VLLW repository

It is obvious from the graph that some radionuclides with relatively high content in waste, e.g. ^{137}Cs or ^{90}Sr, do not almost at all get from the source term based on model calculations. This is the reason why total inventory ^{137}Cs for NRR is high – radionuclide decays apart earlier than it leaves the repository. Total radiation exposure is determined only by LILW repository. Contribution of VLLW repository is - despite the simpler barriers – not significant and that **regardless of** which **alternative** is considered.

Credibility of assessment results

Verification of models, input data and calculations were carried out in cooperation with foreign institutions Neptun and Company from the USA [L-119], or SCK•CEN Mol from Belgium [L-120]. Used model MODFLOW of the ground water flow and transport of radionuclides developed by US Geological Survey was tested and very well documented. Its application for NRR was carried out in cooperation with State Geological Institute of Dionýz Štúr in Bratislava [L-121]. Flow model was calibrated on the basis of results of ground water level monitoring in the NRR area.

Methodology of safety analyses reflects the procedures proposed during the implementation of IAEA projects ISAM and ASAM, with active participation of the authors of analyses for NRR between 1999 and 2007[L-104]. Methodology, calculation approaches of safety analyses and input data were verified by an independent organization [L-122] and last time by the Nuclear Research Institute Řež in the periodic assessment of NRR [L-123] upon request of the Nuclear Regulatory Authority of the Slovak Republic for independent review.

1.1.3 Indirect impact

Indirect impacts of the object are mainly caused by the need of excavation of high amounts of soils and clay in various stages of construction and operation of the LILW and VLLW repository. In the stage of construction it is the need to build the repository including clay barriers. In the stage after closure it is necessary to transport and place the soil and amount of clay so that the repository is covered by insulation layers.

The only significant impact of the construction, operation and closure of the repository will be the transportation of a large quantity of RAW and aforementioned construction materials. From this perspective probably the most significant impact may be caused by an accident during the transportation to the repository. Since LILW is solid, packed in FCC and VLLW is a very low-level contaminated material, not even the least favourable scenario does represent a significant environmental risk.

From the social and economic point of view, the enlargement of NRR will be beneficial since it will provide jobs – on one hand (temporarily) during the construction period, on the other hand in the long term during the period of operation. Negative social or economic impacts are not anticipated. Negative impacts are neither expected in the psychosocial sphere.

Other indirect impacts in case of NRR are not known.

2 IMPACTS ON ROCK ENVIRONMENT, RAW MATERIALS, GEODYNAMIC PHENOMENA AND GEOMORPHOLOGIC RELATIONS

During construction, soil contamination is possible only in random emergency situations of construction and transport mechanisms, such as leakage of oil materials and hydraulic oils. During the actual operation of the proposed facility, there is a potential risk of soil contamination associated only with emergencies, however, with regard to emergency securing of the proposed operation, actually connected exclusively with emergency situations during transport.

In the event of such emergencies, relevant emergency plan has to be followed, the same as in case of emergency situations that may arise during execution of the proposed activity within the area of proposed facility. In the event of soil contamination the soil will be – depending on contaminant – disposed of in accordance with relevant legislation as dangerous or radioactive waste.

Repository does not produce heat, which could affect the quality of rock environment. At the same time it is not a source of vibration, which could pass into the subbase and disrupt the geological structure of the area, or impair dynamic stability or cause liquefaction of earth bodies and embankments, all backfills in the construction are compacted. Facility itself is, from the geological standpoint, a foreign element in the geological structure of the territory without further impact on its quality.

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3 IMPACT ON CLIMATE CONDITIONS

NRR currently does not influence climate conditions also by the enlargement of climate conditions stay unchanged. Produced residual heat of the disposed waste (maximum up to 2 kW/m^3) will not influence the climate characteristics of the area.

4 IMPACTS ON AIR

Only solid or solidified waste in an approved type of waste package is and will be disposed of in the repository. L&C of the repository do not allow disposing biodegradable waste. Repository will not be a source of emissions of waste dump gas or odorous materials. Repository will not change the current air quality in the area in any phase of its life cycle. In connection with operation and enlargement of repository will not be created any polluting source of air.

5 IMPACTS ON WATER CONDITIONS

All civil works will be carried out above the ground water level or above the level of the impact of its fluctuating. Mode of ground water and surface water will not be the solution proposed for the enlargement of the repository and will not be affected by subsequent operation.

Along the perimeter of the entire area, perimeter drainage gutters are built, so no surface water from the surrounding slopes flows into the repository area. Enlargement (according to Alternatives I, II and III) is located in its entire extent in the area of the repository and its implementation will not affect drainage conditions of the surrounding area.

Insulation structure of VLLW repository (according to Alternatives III and IV) provides an impermeable barrier. Its security is increased by drainage of seepage waters from the repository area into the tank of seepage liquids, which prevents formation of pressure gradients on insulation.

5.1 Impact on ground water and surface water

Preferential route for ground water from the repository to the surface water spring is a collector H. The main direction of ground water flow in collector H is NE - SW. This direction is maintained by the ground water up to the surface spring. Ground water penetrates the surface from quaternary clays south of the NRR facility Fig. C-IX. 3 and creates the tributary C of Telinský stream. The second spring (probably from the subbase collectors P1 and P2) occurs in another marsh 600 m further south. After further flow, approximately 1.2 km long, the tributary C from the right side flows into Telinský stream. The flow in this tributary is so small that the water from it is not used. Water of Telinský stream is retained in a retention tank at a distance of about 4.2 km from the repository (Čifárska reservoir) Fig. C-IX. 3.

In order to assess the impact of NRR on ground water, the model of ground water flow and model of radionuclide transport were developed in collaboration with the State Geological Institute of Dionýz Štúr

(ŠGÚDŠ) [L-121]. The model is based on two-dimensional model of stabilized ground water flow created in the environment of MODFLOW [L-124].

The reason of selecting the stabilized flow model was the need to simulate the transport of radionuclides in the timeframe of up to 10^6 years. It is not possible to assume a precise development of boundary conditions (particularly rainfall) in such timeframe, therefore the assumption of stabilized flow on the basis of current conditions was accepted. Transport of radionuclides is solved in the environment of MODFLOW by model MT3DMS [L-124], which uses the results of the calculation of ground water flow model and model of source element assessed in GoldSim.

When building a model of ground water flow in the area of NRR Mochovce, previous works of authors were taken into account and model boundaries were selected to approximately copy the surface distributions in the northeast, northwest and southeast. Southwest boundary of the model is in places where ground water penetrates into the surface flow.

Boundary conditions include rainfalls, drains and the level-dependent boundary condition (boundary conditions of III. type). Rainfalls were applied to the entire modelled area. The drains were used in place of surface drains in the immediate vicinity of the repository and the transfer of ground water to the surface flow was modelled by them. Boundary condition of III. type was used to simulate the gradual increase in flow rate in surface flow outside the modelled area.

The most important hydraulic parameter defining the water-saturated environment is the flow capacity coefficient, which is the primary data from pumping tests. When modelling continuous ground water flow, the most important data is the inflow of water that determines the dynamics of level fluctuations over time.

In the area of NRR and in its surroundings, a number of drilling works and pumping tests were carried out. The flow capacity coefficients in individual drills were the basis for calibration of hydraulic parameters. During calibration, not only compliance of modelled levels with monitored levels was important, but also correct progress of modelled levels in the area outside the repository. Since we do not have any data on ground water level available, we calibrated the hydraulic parameters so that the spatial distribution of ground water levels was in accordance with natural laws. The resulting distribution of the flow capacity coefficient in modelled area is shown in Fig. C-III. 5.

Volume activities in ground water

The result of modelling the transport of radionuclides by ground water is the time dependence of the volume activity in the location of its first spring about 650 m south of the NRR area (Fig. C-III. 6). Maximum values of volume activity in the location of collector H spring are included in Tab. C-III. 1. Of radionuclides with higher volume activity in the ground water (more than 1 Bq/m $^{3)}$, ^{129}I achieves the maximum in the location of spring as first, followed by ^{14}C and ^{93}Mo. The highest maximum is achieved by ^{107}Pd, radionuclide with a high activity of the inventory and since there is little information of its sorption on the barriers, conservative values of distribution coefficients were used for the calculation. Very low values of distribution coefficients were conservatively used also for ^{41}Ca, of which the volume activity is the second highest. ^{14}C has the third highest activity, followed by ^{59}Ni and ^{99} Tc.

Tab. C-III. 1 Maximal value and time of the volume activity maximum in ground water in the location of the collector H spring [Bq/m^3]

Radionuclide	Location of the collector H spring	
	Time of maximum [year]	Volume activity Bq/m^3
^{14}C	7350	2.77E+04
^{41}Ca	7700	3.78E+04
^{59}Ni	141 500	1.77E+04
^{63}Ni	1250	2.10E-18
^{79}Se	74 700	4.35E+03
^{90}Sr	977	1.55E-11
^{93}Mo	7350	2.86E+03
^{93}Zr	285 700	7.11E+03
^{94}Nb	72 700	4.90E-01
^{99}Tc	39100	1.16E+04
^{107}Pd	35 100	4.59E+05
^{126}Sn	87 200	3.01E+02
^{129}I	2595	1.08E+03
^{135}Cs	129 200	1.05E+03
^{137}Cs	490	3.25E-24
^{151}Sm	2098	4.86E-19
^{238}Pu	1100	4.25E-24
^{239}Pu	173 800	3.05E-01
^{241}Am	6800	1.71E-23

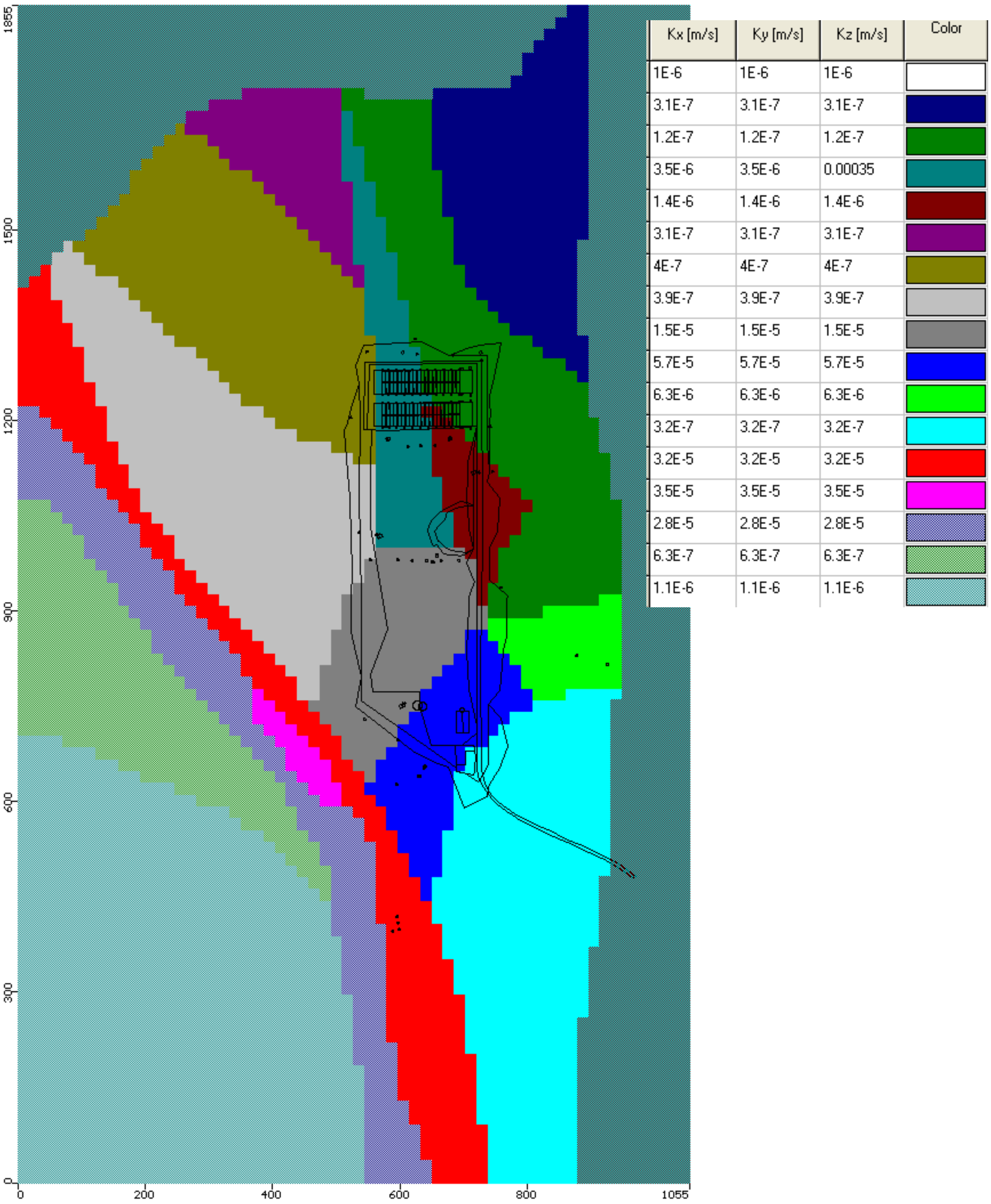


Fig. C-III. 5 Spatial distribution of the flow capacity coefficient after calibration for stabilized flow model

During construction and operation of the repository, the ground water will not be affected. After the repository closure in case of destruction of all barriers, the ground water outside the collector H will not be affected, since the preferential route for ground water from the repository is the collector H. It is conservatively considered that this will not happen earlier than 300 years after the repository closure.

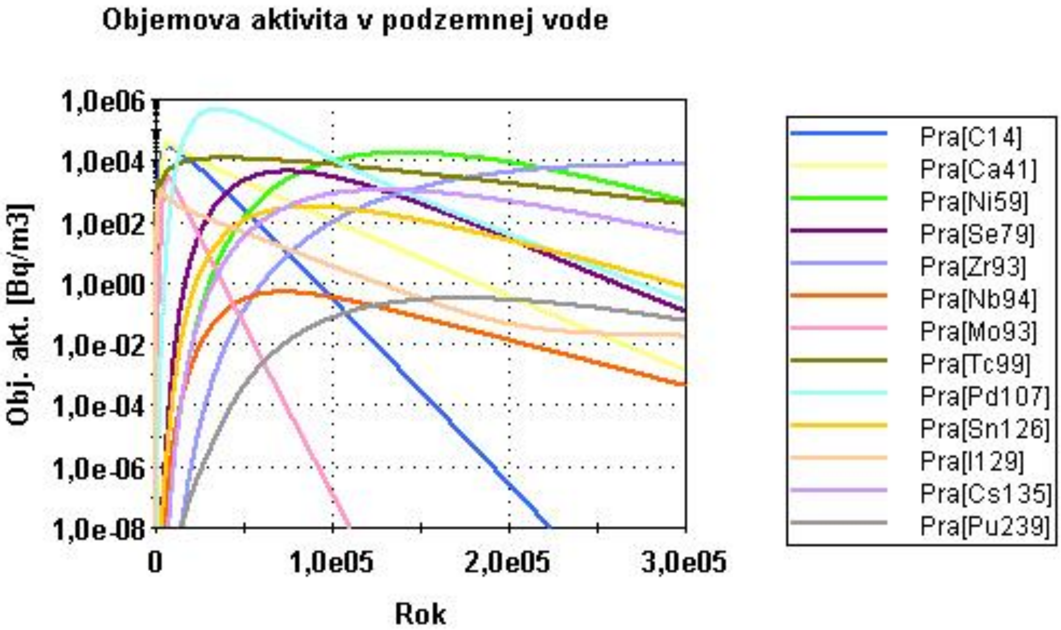


Fig. C-III. 6 Volume activity of radionuclides in ground water in the location of spring

Volume activities in surface water

After the repository closure, if there was barriers degradation, the Tributary C may influence Telinský stream. The water of Telinský stream is retained in retention tank at a distance of about 4.2 km from the repository (Čifárska reservoir). Volume activities of radionuclides in the Tributary C and in Čifársky pond, from the viewpoint of time course, actually copy the volume activity in the ground water. Their courses are shown in Fig. C-III. 7 and Fig. C-III. 8. Activity of radionuclides in the Tributary C is about 77 times lower than in the ground water.

All waste waters released from the repository during the repository operation and institutional control will be inspected. Current monitoring system of surface and ground water quality will be modified and completed with new monitoring objects. Within the frame of functioning Exchange of radiological data, it will be possible to provide data from the repository monitoring also to competent authorities in Hungary.

As mentioned in Chapter C.III.1 from the radiation point of view, volume activity in water is not important. However, the resulting dose for critical individual from the population is important.

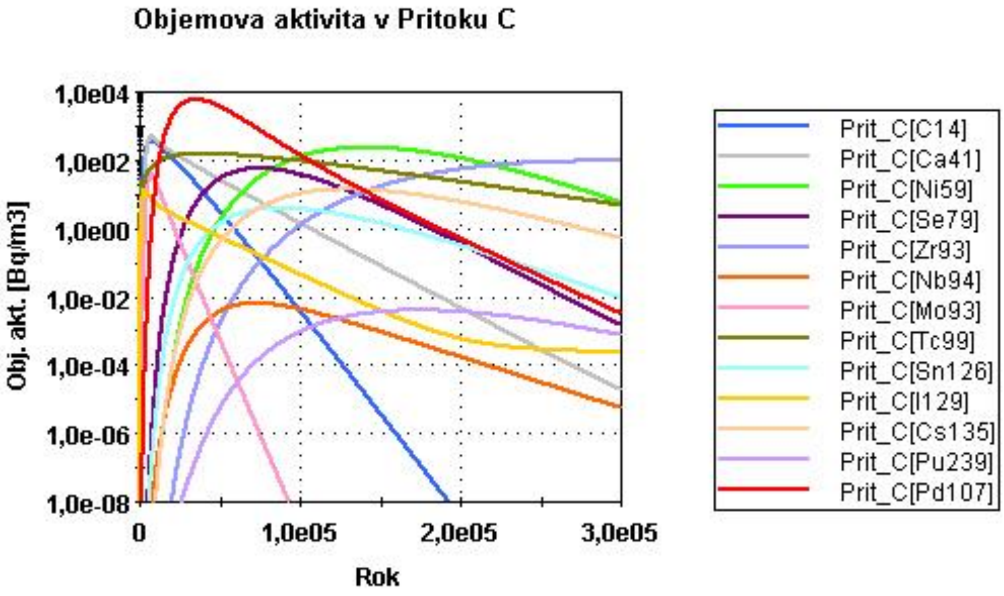


Fig. C-III. 7 Volume activity of radionuclides in Tributary C

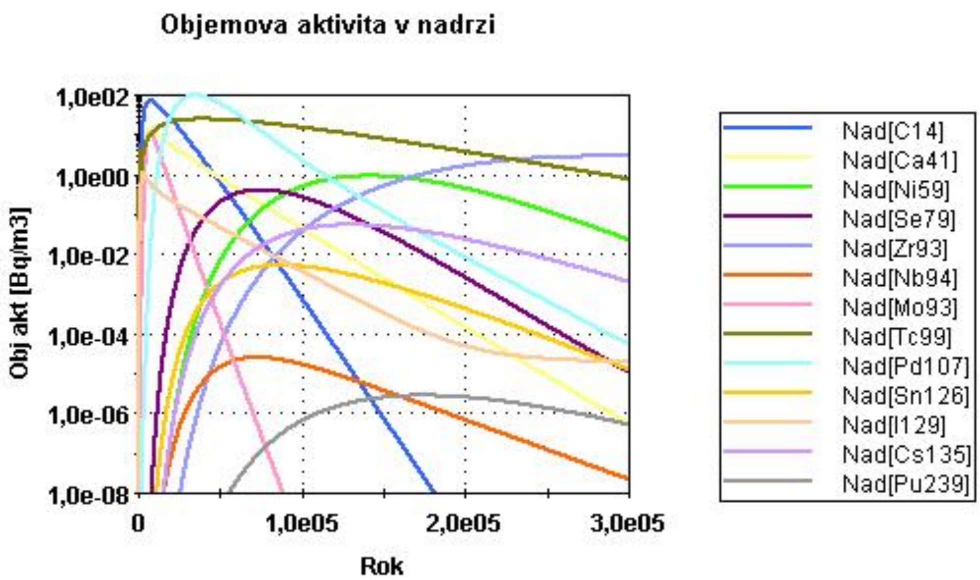


Fig. C-III. 8 Volume activity of radionuclides in Čifárska reservoir

6 IMPACTS ON SOIL

Impact on soil is related with permanent land occupation. Total occupation of land (disposal area plus area for infrastructure) for alternative I is at least 4 ha, for alternative II 2 ha and alternative IV 3-4 ha. Proposed technical solution for RAW disposal does not affect the quality of the surrounding soil.

7 IMPACTS ON FAUNA, FLORA AND THEIR BIOTOPES

The area where the activity is performed is currently grassland area, which is adjacent to agricultural land intensively farmed and at a distance of several tens of meters also to forest edge nearby. Therefore, the estimated occurrence of representatives of fauna and flora corresponds to current use of the area, while from the point of view of species predominantly representatives of synanthropic species communities populating borders of human settlements or communities populating agricultural monoculture and forest edges are expected.

With regard to the nearness of the forest, there may disturbance of representatives of some sensitive species in the existing fauna, both during construction and after the implementation of the proposed activity as a result of intensification of the movement in the NRR area.

Proposed activity will not be a source of pollutants or radiation, which would - in an expected extent - pose a risk for the health of fauna and flora around the area of interest (Slovak legislation does not set any standards for exposure of non-anthropoid biotopes).

8 LAND IMPACTS

Enlargement of NRR in Mochovce will not essentially change the existing state of land and condition of affected municipalities. The relief of the country or the ratio of representation of natural ingredients in concerned territory will not be changed by the proposed activities. Similarly, implementation of the proposed activities will not change the ratio between natural elements and anthropogenic components of the environment. Functional use of territory under consideration remains unchanged. The existing ratio of forests area, intensively farmed agricultural land and built-up area will be maintained. The manner of land use will remain unchanged. The implementation of the intention shall not affect the character of the built-up areas and the character of the territorial infrastructure networks.

Repository is a fenced area, the nearby territory is partially agriculturally used and a part is formed by the forest. With regard to the morphology of the territory in where the repository enlargement is considered, construction will not adversely affect the scenery of the surrounding land.

9 IMPACTS ON PROTECTED AREAS AND PROTECTIVE ZONES

In the affected area there are no special protected bird areas, territories of the European significance, a coherent European network of protected areas (Natura 2000), national parks, nature reserves or protected water management areas that could be affected by the operation of NRR in Mochovce, or by the implementation of proposed activities.

Radius within 50 km of planned enlargement of NRR in Mochovce includes the territories which are within the Danube-Ipoly National Park is protected (and in part strictly protected) areas of the national importance. It also includes special protected areas called Börzsöny and Vyšehradské upland with specially protected birds and protected natural areas of particular importance Börzsöny and Dolný Ipeľ valley (Natura 2000). With regard to the nature of assessed activity, the aforementioned areas will not be affected.

10 IMPACTS ON TERRITORIAL SYSTEM OF ECOLOGICAL STABILITY

Territorial system of ecological stability in given site was modified historically. Ecological situation in surrounding of NRR Mochovce is not influenced by NRR facility, its impact on the territorial system of ecological stability is not demonstrated so far, respectively. Impact on the landscape is also not assumed.

11 IMPACTS ON URBAN COMPLEX AND LAND UTILISATION

Fundamental changes in the urban complex and in land utilisation caused by the construction of NPP Mochovce and NRR facility took place in the second half of last century. Potential of job opportunities creates indirect positive impact on territorial development of municipalities, increased care for sights and so on. Other impacts are not anticipated.

12 IMPACTS ON CULTURAL AND HISTORICAL SIGHTS

There are no cultural or historical sights that would be of interest to residents in the region or visitors of the affected area in the NRR area or in its immediate vicinity. There are several objects of cultural and historical value in broader concerned area, but they will not be affected by the implementation of assessed activity with regard to its nature and proposed location. The closest cultural-historical sight is located in the territory of the former municipality Mochovce and it is the Calvinist church of the period – Fig. C-IX. 27.

13 IMPACTS ON ARCHAEOLOGICAL FINDING-PLACES

There are no known archaeological findings, which could be affected by the implementation of the proposed activity in the affected area itself. The occurrence of the archaeological finding-places is not expected.

14 IMPACTS ON PALAEONTOLOGICAL FINDING-PLACES AND IMPORTANT GEOLOGICAL AREAS

These impacts are not considered, since palaeontological finding-places and geological areas of great importance are not located near the nuclear facility Mochovce and NRR – see Chapter C-II.14.

15 IMPACTS ON CULTURAL VALUES OF IMMATERIAL NATURE

Cultural and historical sights and monuments of the region described in Chapter C-II.12 or similarly cultural values of immaterial nature will not be affected by the construction or operation of NRR after its enlargement.

16 OTHER IMPACTS

Other impacts of the construction of new disposal facilities in the area of existing NRR in Mochovce or disposal of RAW, acceptable for this type of repository, are not anticipated.

17 SPACE SYNTHESIS OF THE ACTIVITY IMPACTS IN THE AREA

Proposed activities will take place inside the existing area of NRR Mochovce. Part of them – civil works during the construction of the new disposal structures – will be carried out by contractors. Disposal of RAW after the repository enlargement – LILW to NRR and VLLW to VLLW repository will be provided by the employees. During the period of construction, there will be a short-term increase in traffic demand. Basic material inputs during the period of construction (concrete, clay soil and other building material) will be shipped by motor transport. Also basic technological inputs during operation, i.e. RAW packed in appropriate (approved) waste packages will be shipped by motor transport. This will affect the traffic frequency only in a minimal extent.

Unlike alternatives I-III., the implementation of proposed activity according to the alternative IV. would result in permanent consumption of agricultural land.

The real outputs of technological processes in broader affected area are mainly discharged radioactive materials (gaseous and liquid), which are discharged to the atmosphere and surface water primarily from the operation of NPP Mochovce in a controlled manner. NRR facility itself does not produce its own technological outputs. The outputs from NRR may include drainage and rainfall waters, which are concentrated in separated retention tank of rainfall water and drainage water, from where they are periodically discharged to surface drainage (Tributary C of Telinský stream) from the NRR area in a controlled manner. Here it must be noted that these waters define the affected area that is completely different from the affected area, which is defined by flow of surface waters into which the radioactive materials are discharged from the operation of NPP SE-EMO. While from the operation of NPP SE-EMO, limited activities of liquid radioactive materials are discharged by underground pipeline channel directly into the river Hron (the outlet is below the dam of the pond at Veľké Kozmálovce), Telinský stream flows through the pond Čifáre, along the municipalities of Čifáre and Telince and flows into the river Žitava behind the town Vráble. This results in different groups of population for the assessment of radiological impacts of NPP SE-EMO and NRR facility operation. The critical group for assessing the impacts of normal operation of NPP SE-EMO are the residents of village Nový Tekov (for more detailed radiation impacts, see Chapter C-II.17.1.1) Potential critical individual for the assessment of impacts of the NRR Mochovce existence after its closure in the distant future, when it is expected that the engineering barriers in the repository will no longer be functional - see Chapter C-III.1, would be the individual who drinks water in the location of collector H spring at a distance of about 650 m from the repository fencing or who will use the reservoir Čifáre. Since at that time NPP EMO will no longer be in operation, there will be no accumulation of impacts.

In the course of enlargement of NRR and its disposal capacities, including construction of repository for VLLW, anthropogenic load of the affected area will increase only slightly, and that mainly due to increase in frequency of traffic associated with transport of necessary material, both during the construction period as well during the operation of the repository after enlargement. This increase in anthropogenic load will have no substantial impact on ecological capacity of the territory, which is in this case mainly determined by the proportion of forests and permanent grassland.

Despite the fact that the Facility for disposal of institutional RAW and retained radioactive material will be built near the fence of NRR area at its entrance, with regard to its nature there will be no accumulation of impacts on individual components of the environment. Activities performed in this facility include acceptance, sorting and disposal of institutional RAW and retained radioactive material without its conditioning or processing. Under normal operating state emissions of radioactive substances into the water are virtually excluded. Any air emissions will be limited by leading the air mass through the filter equipment.

In addition to these impacts, accumulation of impacts or mutual interaction, in connection with the presence of non-hazardous and hazardous waste dumps located in the cadastral area Mochovce about 3 km from the NPP, are not expected. These waste dumps are a part of integrated facility for waste management, which is operated by company SITA Slovakia, a.s. Bratislava. In addition to non-hazardous and hazardous waste dumps, activities focused on conditioning, recovery of scrap value and waste disposal (biodegradation, stabilization, and composting of waste, their collection and complete sorting) are carried out. The outputs from the activity of this facility are waste dump gases (CH_4, CO_2, H_2S) and seepage liquids. These liquids, including liquid leachate from individual waste management processes are transported to be treated in waste water treatment plant Duslo a.s. Šaľa. Seepage liquids from the non-hazardous waste dump are transferred to separate accumulation tank and are used to spray the surface of this waste dump, or they are transported as waste to the aforementioned waste water treatment plant. Leachate liquids from the multipurpose area are drained into accumulation tank and then to the waste water treatment plant in Šaľa [L-125].

Cumulative impact in relation to the proposed activity and waste dumps can occur only in relation to freight transport and that only to a small extent.

The area of interest can be viewed as severely anthropogenically loaded. In compliance with the environmental regionalization, affected area is classified as satisfactory, i.e. the 2nd degree of a 5-degree scale. Anthropogenic load of the area is caused by the intensively farmed agricultural land, the existing NRR facility, and in particular the NPP EMO site and waste dump. Proposed intention does not present a new activity in the area, but continuation in RAW disposal, which began in 2001. Proposed activity will not substantially increase the current anthropogenic load of the territory, it will only relate to the existing load in the territory, i.e. the first double row will be closed, then the second double row will be used for disposal and building of the third double row for LILW and the repository of landfill type for VLLW disposal will begin.

For RAW disposal in NRR Mochovce, long-term consumption of land restricting the use of an area of about 11.2 hectares in the future can be identified as a major negative externality. Negative externality is also a need for a large volume of soil during construction of disposal structures for making of clay insulation and for making of coverage after the operation has been terminated. The opening of borrow pit will result in restriction of use of an area to original, mainly agricultural purposes for a necessary period of time. During the repository operation, disposal structures will reduce the aesthetic value of the territory after its termination and after the definite coverage will be made the area will be appropriately incorporated into the territory. The presence of NPP SE-EMO near the repository can be seen rather as a positive externality. Closeness of plants for conditioning and processing of radioactive waste can be used if necessary also for NRR facility (professional and technical assistance during accidents, company medical centre, etc.). Similarly, a combination of the surrounding monitoring programmes presents a possibility of a more comprehensive assessment of potential impacts on the environment. Only in the event of an accident in NPP, the closeness of NPP may be considered as negative. It may affect RAW disposal in the repository for some time – see Chapter C-III19.1.5.

The overloaded area may be specified as an area, where there is a significant concentration of adverse impacts of anthropogenic activities affecting the public health or elements of the environment. NRR area is located outside the residential structures. Regular monitoring of the existing NRR and NPP EMO did not show any negative impacts on the individual elements of the environment. It is assumed that in case of the same level of technical safety, the same disposal technology and subsequent closure of NRR, the standards of the environment also in case of the proposed activity will be observed.

On the basis of the aforementioned facts, selected area does not currently show the characteristics of an overloaded area and according to the assessment of impacts of the proposed activity in the proposed location, the occurrence of unsustainable load to an area is not foreseen.

Regular monitoring of all elements of the environment is carried out in the NRR facility. Based on its assessment one may confirm that the repository does not affect monitored elements of the environment and its operation is free of environmental problems.

18 COMPLEX ASSESSMENT OF EXPECTED IMPACTS IN TERMS OF THEIR RELEVANCE AND THEIR COMPARISON WITH APPLICABLE REGULATIONS

From the viewpoint of the time course of proposed activities and their expected impact on the environment, they must be divided into three phases:

- phase of construction works,
- phase of operation,
- phase after the repository closure.

From a complex point of view, ***the impacts during construction*** can be viewed as short-term, temporary and insignificant. During the construction period, the surroundings will be exposed to dust, fumes, noise and vibration..

18.1 Impact during the NRR operation

Impacts during operation will be of long-lasting and permanent nature. RAW produced during operation and decommissioning of NPP Mochovce and Bohunice will not be a burden on the environment in places of generating, but after conditioning, using the appropriate technologies into the solid phase, it will be disposed in the long term in approved waste packages in specific NRR facilities.

Technical and technological solution of the proposed activity takes into account the requirements for the best available technology, which to a maximum extent eliminates the negative impacts on the environment. The undisputed positive is that RAW is transparently disposed in an area defined for disposal in the long term and approved by competent authorities, avoiding further long-term restrictions of the territory for other activities in the new area. The proposed activities are in compliance with the Strategy of Nuclear Energy Back End in Slovakia and the Joint Convention on the Safety of Radioactive Waste Management approved by the Government, or by the National Council of the Slovak Republic.

From the viewpoint of the territory, the assessed activity does not directly or indirectly enter into conflict with occupied or built-up areas and the impacts on the nearest residential areas are not anticipated. Negative socio-economic impacts are not expected. Charges for waste disposal to the benefit of the municipality, in the cadastral territory where the repository is located can significantly affect the municipal budget.

The proposed activity will be implemented in the NRR area, or close to it (Alternative IV). Alternatives I-III. do not include any consumption of the agricultural land. Impacts on the rock environment, raw materials, geodynamic phenomena and geomorphologic relations are not anticipated. There will be no new source of air pollution. Noise situation during the operation will show only minimal changes compared to current situation and the noise limits will be observed. New radioactive waste will not be generated in the repository. The current structure and land use will remain unchanged. The activity will not jeopardize any element of the territorial system of ecological stability. Surrounding area is intensively farmed, the impacts on fauna, flora and their biotopes are assessed as insignificant.

18.2 Period after repository closure

Phase of the repository closing is a stage between the placing of last waste package and the beginning of the period after closure. During the closing stage, which can last from a few years up to the decades, the repository will be monitored and its maintenance will be carried out. Minor repairs will be required and in case no releases are detected, the extent of monitoring will be reduced. After decommissioning of closed auxiliary equipment, the area will be ready for the institutional control commencement.

Structural barriers, which include the final covering, will be built to ensure the integrity of the repository and provide essential hydrological containment, capture of radionuclides, minimize repairs, prevent intrusion and thus contribute to the adequate functioning of the entire disposal system. After the final covering of the repository, it will be necessary to solve the following issues:

- to create multi-barrier system, this time from above,
- gravity drain of drainage systems,
- to create conditions for retaining and drainage of surface water from the surrounding sloping surfaces or to prevent the water inflow to the repository area and drainage of the repository,

- to ensure access during the period of institutional control, to allow sampling, including the localisation of any points of damage to the barriers, in particular damage to the surface of covering due to erosion and removal of these defects,
- long-term identification and marking of the repository area,
- final landscaping works in the repository and its inclusion in the surrounding area,
- ensuring the maximum possible service life and minimizing the maintenance,
- urbanistic solution.

In terms of safety, the most important task is to minimize the infiltration of water into waste, which is provided by layers of clay. For the purposes of long-term monitoring of clay properties, the model of covering was built in the NRR area. Properties of clay as a primary element of covering are monitored in it. Monitoring results will be used as inputs in designing the optimal structure of the final covering of NRR facility. Long-term monitoring over 15-20 years depending on the need for enlargement of the repository capacity is assumed in the model of covering.

Repositories are located, constructed, operated and closed so that the protection in the post-closure period was optimized, social, economic factors were considered and so that it was with reasonable certainty ensured that doses or risks to individuals from the population did not exceed the limit values in the long term. Dose limit for an individual from the population for all activities is an effective dose of 1 mSv/year, and this dose or its equivalent value of risk is considered to be the criterion, which cannot be exceeded in the future. In order to meet this dose limit, NRR facility (considered as a source) is designed in a way that the estimation of an average dose of an individual from the population who may be irradiated in the future due to activities involving the repository does not exceed the dose limit.

Impacts on surface and underground waters of neighbouring countries are determined by the geographic location of the repository. Ground water of the neighbouring countries with regard to the distance of the repository from the borders will not be affected. The repository area is linked to only one neighbouring country – Hungary by a system of multiple river flows. Repository is drained by Telinský Stream, which flows into Žitava, it then flows into the river Nitra. The river Nitra flows into the river Váh just before its issue to the Danube near Komárno.

During operation and after its closure, the NRR in Mochovce will not affect the residents of the neighbouring countries. Safety of the critical individual using the biosphere of Čifárska reservoir located in the immediate vicinity of the NRR facility on Telinský stream was demontrated. Protection of the critical individual in the immediate vicinity of the repository ensures the protection of the population also in a neighbouring country and this even more because the water up to the border with Hungary will be considerably diluted by water of several tributaries. There are no special routes of exposure including food exports to other states.

During the process of documentation development, no factors which would indicate the exceeding of the legal limits or (if no limits are set) unacceptable impacts, were identified in any of the assessed groups (the impact on the population, air and climate, noise and other physical or biological characteristics, surface and ground water, rock environment and natural resources, fauna, flora and ecosystems, land, material assets and cultural sights, transport and other infrastructure or other).

Potential negative impacts, including considered impacts of the existing activities in the area (especially the nuclear power plant Mochovce operation, liquid RAW final treatment facility, hazardous waste dump Kalná nad Hronom) or planned activities (institutional RAW storage) in all groups are very small and insignificant, within permissible or acceptable values. In the most significant of assessed impacts (impact on the population), this argument will remain valid also in the distant future after the end of institutional control and possible degradation of engineering barriers.

Assessment of the impacts caused by the location of proposed activity did not show any significant differences between the individual alternatives. Based on this the specific assessment is common for all four alternatives.

On the basis of the aforementioned facts it can be concluded that the activity assessed in all considered alternatives with regard to its location and technical and technological implementation is without significant negative impacts, of bigger or smaller quantitative, territorial or time importance on any component of the environment of the affected area. Any provoked negative impacts are within the existing legislative requirements.

19 OPERATIONAL RISKS AND THEIR POSSIBLE IMPACT ON THE TERRITORY – POSSIBILITY OF ACCIDENTS

19.1 Operational risks

19.1.1 Failure of the technological devices

No accident associated with release of the radioactive substances and subsequent need of the population protection in the NRR facility during its operation can occur. Maximal accident during the repository operation is considered a sudden failure of the technological devices associated with the fall of FCC into the repository box with a violation of its integrity and consequent release of drums, pressed material or pieces of cement mortar in the NRR hall. No gases or liquids will be released since only solid waste is disposed.

In the worst case there may be a breakage of two FCC containers – the one that fell and the other one it fell onto. Consequences of the aforementioned event will only affect workers at the repository, because the accident and its extent will not exceed the borders of the repository area. Liquidation of the accident is not immediately necessary, it is possible to prepare for it in advance and thus minimize the irradiation of personnel. No threat to the population or the environment will occur.

A similar accident is also an accident during transport, or during transhipment of FCC from the wagon to the semi-trailer. This could have a negative impact on people accidentally moving nearby and will also relate in particular to staff performing the transport.

The same scenarios as for LILW in FCC were considered also for waste packages to transport VLLW [L-31]. With regard to – by an order - lower activities of VLLW, discovered impacts were significantly lower.

It may be concluded that the fall of waste package when handling it in the NRR facility or during transport does not result in a threat to nuclear and radiation safety.

19.1.2 The risk of terrorist attack

Protection of the repository against terrorism is primarily a matter of the country, which has its means available for this purpose (intelligence services, police, and army). Despite this the repository is secured by the physical protection system, which can prevent land-based terrorist attack. Aerial attack of controlled big airbus crash is (with the exception of measures managed by the State, airport operators and airlines) minimized by its location and its low height. Despite this according to the results of repository analyses in Germany and the USA, there will be no significant radiological consequences for the environment in case of intended attack by big airbus. Permission for operation can be issued for a nuclear facility only if the nuclear safety, radiation protection and physical protection of the repository are sufficient. If the protection is not sufficient enough, the relevant permission will not be granted.

19.1.3 Falling of aircraft

Near nuclear facility of NRR is not located any civil or military airport. The risk of aircraft falling on the NRR facility is limited also by the fact, that all air traffic corridors are spatially separated from the protected airspace above the NPP Mochovce site.

Unlike EMO, NRR facility is ground-floor building, so the probability of its risks will be even lower than for EMO therefore even in this case no technical or organizational measures are not necessary.

19.1.4 Fire, explosion

Limits and conditions of the NRR Mochovce do not allow disposal of flammable or explosive substances. Solid and solidified intermediate active waste is disposed in FCC and VLLW will consist of contaminated soil and concrete. The possibility of fire in the repository is therefore minimal. In case of fire, which is defined in the standards of fire safety, there can be no such effects that could substantially endanger the safety of waste packages and fire does not pose a safety risk.

An analysis of risk sources inside and outside the premises of the repository proves that there is no crucial initiation event which would cause an explosion. NRR facility is not included among the objects with an increased risk of fire. The analysis of an event shows that in the protection zone or in its immediate surroundings the initiating events do not occur. NRR facility is in sufficient distance from the area of NPP EMO and transport routes. No substances able to initialize an explosion will be disposed in the facilities for management of institutional RAW and retained radioactive material.

19.1.5 Risk of mutual impacts of NPP SE-EMO and NRR

Operation of the repository and operation of NPP EMO are independent of each other, so the accident in NPP cannot jeopardize the basic functions of the repository. In the event of an accident with radiological consequences in NPP, the operation of the repository will follow the principles of the internal emergency plan applicable to the plant, which are reflected in the emergency plan of the repository. There is no risk to the basic functions of the repository in such cases since the essential function of the repository (isolatation of radioactive waste from the environment) is independent of the presence of the operating personnel and is of passive nature.

Design accidents that may arise in the repository have no link to the important technological system of NPP and the impact of radiological consequences of design accidents (the fall of the container) on the surroundings of the repository is only minor. Accidents in the repository cannot therefore affect the operation of NPP.

19.1.6 Floods, extreme precipitation

Only events caused by external influences that could have been caused by flooding of the surface storm-sewage water would could have an impact of a minor extent on the environment. Repository is built above the ground water level and surface conditions of the repository area ensure drainage of maximum rainfall water and flooding will therefore not occur. A comparison of height data shows that the repository area is located above the maximum levels in rivers and that even if the assessment of historical extreme flows is considered. It is therefore obvious that in the event of freshet no flow can jeopardize the repository area. The flooding cannot occur in case the waterway is blocked by ice.

Despite these facts, we analyzed the flooding of planned VLLW repository due to storm rainfall and the release of activity into the surface waters. (In case of LILW disposed in FCC this unlikely event would not cause the release of radionuclides, since the FCC itself is resistant to penetration of water [L-72].)

Flooding of VLLW repository by storm rainfall with a daily aggregate of 100 mm (value higher than the annual maximum of daily precipitation with a probability of once in 100 years) just before its closure was considered. The release of activity into Telinský stream and Čifárska reservoir was anticipated. As the source element, the radiological inventory for VLLW repository according to the Tab.A-II. 5 was considered. Calculations were performed by a modified programme that is used in safety analyses of the NRR facility. The programme is developed in *GoldSim* [L-118] environment.

Despite these very conservative assumptions, the annual dose for residents from the contaminated water in Čifárska reservoir for the release from the backfilled VLLW repository is $1.0.10^{-5}$ Sv, which is by two orders less than the exposure limit of 1 mSv for the population specified by the Government ordinance of the Slovak Republic No. 345/2006 Coll. on basic safety requirements for the protection of health of workers and residents against ionizing radiation [L-4]. The critical path is the consumption of fish and ^{14}C is a critical radionuclide.

19.1.7 Earthquake

NRR facility is not located directly in the fault zone. Earthquake in terms of likelihood and possible consequences is not included among the initiating events of the internal emergency plan (this issue is further addressed in more detail in Chapter C-II.2.1).

19.1.8 Other events beyond the frame of the design event

Objects of the NRR facility are designed in a way that even extreme weather conditions do not endanger the safety of its operation. The most serious problem of meteorological nature during the NRR operation is the occurrence of extreme cold and creation of frost and ice on the access road during the transport of waste packages. The package forms of RAW are at repository transported only under the suitable climate conditions. Extreme coldness and glare ice does not have impact on the operation of repository itself.

19.2 Post-closure period

Approaches to repository safety are different from approaches to safety of other nuclear installations. The safety of repositories is their inherent characteristic and long-term matter. The repository must be safe at every stage of its life cycle, also after its closure and after the termination of institutional control when there is a loss of integrity of barriers in the future, or when the existence of the repository is forgotten. This can be achieved by imposing the restrictions for the parameters, activities and conditions of the repository during its operation. These restrictions, for example, for the activity of radionuclides in waste disposed in a container or in the repository as a whole, are calculated from an evolution scenarios and repository disturbance.

The evolution scenario considers the gradual degradation of barriers and release of radionuclides from waste, their transport through the repository barriers into the water-saturated layer, transport by ground water to the stream and Čifársky pond. It is assumed in the intrusion scenarios that after the termination of institutional control there will be unintentional intrusion of the repository by activities of people, e.g. exploration drilling, construction of roads and residence on selected material from the repository. This issue is described in more detail in the previous section.

IV. MEASURES PROPOSED FOR THE PREVENTION, ELIMINATION, MINIMISATION AND COMPENSATION OF IMPACTS OF THE PROPOSED ACTIVITY ON THE ENVIRONMENT AND HEALTH

Measures to mitigate the negative impacts of the proposed activity on the environment can be divided into territorial planning, technical- technological and organizational-operational.

1 TERRITORIAL PLANNING MEASURES

Territorial planning measures are applied when selecting the territory for the location of the nuclear facility. The territory is assessed from the viewpoint of ensuring the protection of the population both for normal operation and for maximum design accident. As an exclusion criterion, the Government ordinance of the Slovak Republic No. 345/2006 Coll. [L-4] defines the impossibility to ensure that the annual maximum (limit) dose of ionizing radiation for members of the public (critical group) 0.250 mSv - effective dose to the whole body during the normal operation, including the maximum design accident is not exceeded. With regard to the particular situation at Mochovce, this exclusion criterion was applied for the location of nuclear power plant SE-EMO, but it is also valid for the NRR facility, since it is located within the protection zone of NPP SE-EMO.

For NRR, the criterion used to determine Limits and Conditions for NRR, is valid. These Limits and Conditions may be accepted for disposal in disposal structures of the repository with respect to their engineering-technical parameters to prevent the penetration of radionuclides into the surrounding environment. For National Repository for Radioactive Waste in Mochovce, these criteria were defined during its construction and commissioning[L-24] as follows:

a) not exceeding the annual effective equivalent dose of 0.1 mSv for an individual from the critical group of population in any year after the waste has been deposited for scenarios of transport by ground water, i.e. those that occur with a probability equal to one (it is assumed that this situation occurs over a period not shorter than the period of institutional control, which for this repository was set at 300 years)

b) not exceeding the annual effective equivalent dose of 1 mSv for an individual from the critical group of population in any year after the expiry of the so-called institutional control period for residence scenario and intrusion scenario, i.e. those for which it cannot be excluded that they could happen, but with a probability less than one.

Meeting these criteria for disposal of LILW and VLLW in NRR after its enlargement is documented in Chapter C-III.1, where the effective doses of radionuclides significant from the safety point of view from both repositories in the NRR area are stated in dependence on time. It is documented that summary dose from the operation of both repositories or its maximum does not exceed the radiological limit of 0.1 mSv/year at any time.

Proposed activities will be implemented in the NRR area, while the limits for disposal of RAW specified for NRR will remain in force. The NRR area is owned by the operator of NRR and in the current territory planning documentation of Nitra self-governing region, it is specified for the disposal of RAW. The change in functional use of the territory is not considered in the territory planning documentation of the affected municipality (Kalná nad Hronom). With regard to the aforementioned facts and the nature of proposed activities, the new territory planning measures are not considered.

2 TECHNOLOGICAL MEASURES

- During the development of the project documentation to optimize use of space in the NRR area in order to obtain sufficient space in the southern part of the area (near the entrance) for VLLW disposal.
- In the project documentation to optimize the technology of seepage and drainage water management so that no water could get out of VLLW repository into the surrounding environment without being checked.
- In the operational procedures to ensure that fall, slipping or other distortion to disposed VLLW stability at the estimated stacking height of 5 m is avoided.
- In modified programme for ground water monitoring to ensure completion of monitoring drill wells in the space of NRR area to monitor any potential release of radionuclides into the ground water with respect to the specific location of the disposal objects in the repository.
- In the event of liquidation of monitoring drill wells (following the progress of enlargement) to ensure the professional insulation in order to prevent unwanted penetration of waters between individual collectors.
- Based on the results of survey works, (project C9.4 BIDSF) an optimum alternative of placing the new disposal premises for disposal of LILW and VLLW shall be proposed (design optimal alternative of classic enlargement and placement of VLLW repository.

3 LIMITS AND CONDITIONS

Limits and Conditions (LaC) for all nuclear installations are among the preventive organizational measures to prevent adverse development of the situation leading to threats to personnel or population or leading to equipment damage. Limits and conditions include a summary of organizational, technical and technological conditions that must be met to ensure safety during the operation of the specific nuclear installation - in our case when disposing RAW. The arrangement of Limits and Conditions is prescribed and has the following structure:

Purpose - the defined purpose of the limit condition.

Limit condition - according to the character of the limit conditions, the following is determined:

- range of parameters and rate of their changes,
- limits values and characteristics of the working media, their chemical composition, acceptable contents and forms of radioactive substances and their permitted releases into the operational premises and the surrounding environment,
- requirements for conditions and operational capability of the systems and equipment important for safe operation,

Validity - it is stated when the limit condition is valid,

Activity – is a specified activity for the operating personnel if the limit condition is not met, Requirements for inspection - the frequency, type and extent of inspections or tests of systems and equipment is determined, including calibration of equipment in order to maintain operability of the equipment at the required level. Limits and conditions are included in the application submitted by the operator to be approved by NRA SR. They are very strictly monitored already in the zone of below the limit values, depending on their severity. When the monitored value is achieved, it is always reported, recorded, the reason of achieving this value is investigated and corrective measures are applied.

When Limits and Conditions are not met, the operator is obliged to restore compliance with limits and conditions as soon as possible and if it is not possible, specific equipment must be put out of operation. Any breach of the limits and conditions must be recorded, reported to the NRA and a report on breach of limits and conditions is prepared. Exceeding the limits and conditions that lead or may lead to irradiation of personnel or population shall be notified to the Public Health Authority of the Slovak Republic. There is a general principle valid for the final disposal of the radioactive waste that it is only possible to dispose radioactive waste, which in relation to the specific system of the final disposal may cause the radiation doses to the population and the environment at present and in the future as low as can be achieved when taking into account economic and social aspects – principle ALARA. This requirement is then a basis for Limits and Conditions of the final disposal of RAW, which must define the characteristics of disposed radioactive waste, particularly radionuclides, structural stability, leachability and other characteristics that may affect the release of radionuclides into the environment. These limits and conditions must be based on safety analyses, which then represent a comprehensive assessment of risks associated with radioactive waste disposal and demonstration of the functionality of the entire disposal system in terms of its possible impacts on individuals and environment.

Formulating the Limits and Conditions, except the characteristics of disposed RAW, also defines the time interval during which the repository safety must be demonstrated. That is a substantial difference compared to reactor nuclear installations, in which the safety of operations, represented by not exceeding or by complying with the limits and conditions, will be manifested during the operation itself, or in a relatively short period of their decommissioning.

In case of RAW repositories, their safety, characterized by Limits and Conditions of safe operation will be demonstrated in a much longer period of time, especially in the period long after the operation has been completed and in the course of further stages of the repository existence (in the period of institutional control). Due to this, also properties of stability of the repository as a whole and the time characteristics of the engineering barriers to prevent the penetration of radionuclides into the environment are important for the safety of RAW disposal. These parameters enter the safety analyses most frequently as input assumptions.

Other system characteristics affecting safety are either invariable (characteristics of the area, design, method of implementation), or will be implemented after the operation has been completed within the closing of the repository and that under a separate approval process. This includes, mainly, the covering of the repository, of which the quality of implementation may affect the safety of the repository in a high degree. These assumptions are the basis for the safety analyses, resulting in determining the limits for the activity of individual radionuclides, which is controlled during the preparation (packaging) of RAW into transport and manipulation units at the producer of RAW for the purposes of disposal.

All these aspects, which condition the disposability of RAW in the repository are defined in “Limits and Conditions” for a specific repository, whose approval is a special condition of the license issue by the NRA SR for the repository operation (pursuant to Article 5, Section 3, Letter f) of the Atomic Act [L-6] – see also paragraph Territorial Planning Measures at the beginning of this Chapter C-IV. The limits for irradiation of population defined this way in safety analyses are then the basis also for limits of activity of disposable radionuclides (Tab.A-II. 8 and Tab.A-II. 9Limit doses for the surrounding population (in our case is 0.050 mSv/year) were used to derive limits of activity for waters discharged into the outside recipient during the repository operation(Tab. C-II. 14). Limits and Conditions for RAW disposal in the existing NRR in Mochovce [L-22] are included in the preoperational safety analysis report of the repository [L-40].

For disposal of RAW of LILW type and disposal of RAW of VLLW type in the NRR in Mochovce after its enlargement, the Limits and Conditions will be the result of safety analyses and analyses of disposal of LILW and VLLW in the enlarged repository. Safety analyses will be developed within the process of safety documentation development required for issuing the approval for placement of these new structures in the NRR Mochovce and for issuing the building permit and license for operation of enlarged repository NRR in Mochovce.

Preliminary assessment of radiological impacts on the surrounding population during the disposal of LILW and VLLW in the NRR Mochovce after its enlargement is presented in Chapter C-III.1.

4 ORGANIZATIONAL AND OPERATIONAL MEASURES

The plan of construction organization shall include preventive and control measures against the leakage of oils on site.

The plan of construction organization shall include the emergency order, in which activities in case of leakage of oils on site will be described.

Periodically check the site in order to detect any leakage of oils from the construction mechanism, in case the leakage of oils is found, the emergency order must be followed.

Closely monitor activities in collecting tanks of seepage and drainage waters under the repository of VLLW.

4.1 Organizational measures in case of accidents

Measures to protect the population in case of radiation accident are of preventive nature and they are prepared for handling the emergency situations in the complex of nuclear installation EMO as a whole and relate also to the area of NRR facility. For accidents of nuclear installations in general (particularly the operation of NPP), the intervention levels for the implementation of measures for protection against ionizing radiation – interventions are valid. The intervention is performed at occurrence of threat or radiation accident or radiation emergency situation. Basic principle for the intervention implementation is that it should be performed only if reduction of harm to health, which is achieved by its implementation, is sufficient to justify the harm and costs associated with its implementation, including the costs in social sphere. The intervention and way of its implementation, scope and duration must be optimized so that the difference between the benefit achieved by reducing the harm to health and costs and damages caused by the implementation of the intervention is as high as possible. Established limits of irradiation do not apply to interventions.

Instructions for dealing with situations in which intervention is appropriate are provided in emergency plans and guideline values of intervention levels, which are defined in Annex No. 10 of the Government Ordinance No. 345/2006 Coll. [L-4].

In case of an extraordinary radiation event in the operated nuclear power plant, the intervention is implemented by:

a) **urgent measures,** which are mainly hiding, iodine prophylaxis, prohibition of eating fresh food, no water use, animal housing, evacuation and by

b) **follow-up measures,** which include temporary relocation, permanent relocation, control of consumption of radioactively contaminated food and water, regulation of radioactively contaminated forage use, decontamination of an area, removal of residues or prevention of their spreading.

Intervention must be adjusted to the situation and implemented in relation to sources of ionizing radiation (in order to reduce the direct irradiation or prevent the emission of radionuclides) and to the environment (to reduce the transfer of radioactive substances to individuals from the population).

Implementation of the intervention should be considered if intervention levels and derived intervention levels are exceeded. Intervention levels are given in avoidable effective dose or avoidable equivalent dose. Derived intervention levels are usually specified in directly measurable values. It is assumed that when these are exceeded, the intervention level is exceeded.

Guideline values of intervention levels are given in Tab. C-IV. 1 and Tab. C-IV. 2 according to the Annex No. 10 of the Government Ordinance No. 345/2006 Coll.[L-4].

Tab. C-IV. 1 Guideline values of intervention levels for urgent measures in case of an accident in NPP

Measure	Guideline values of intervention levels		
	Avoidable effective dose or equivalent dose	Avoidable equivalent dose in individual organs and tissues	Recommended optimized avoidable dose
Hiding a)	5 mSv to 50 mSv		10 mSv
Iodine prophylaxis b)		50 mSv to 500 mSv	100 mSv
Evacuation of population c)	50 mSv to 500 mSv	500 mSv to 5000 mSv	100 mSv

a) It is assumed that hiding does not take longer than 48 hours, values of avoidable effective dose for the period of hiding.

b) Values of avoidable equivalent dose caused by radioisotopes of iodine in the thyroid gland.

c) It is assumed that the evacuation will take no longer than 7 days, values of avoidable effective dose for the period of evacuation.

Tab. C-IV. 2 Guideline values of intervention levels for the follow-up measures in case of an accident in NPP

Measure	Guideline values of intervention levels	
	Effective dose	Equivalent doses in individual organs and tissues
Control of the consumption of food, water and forage contaminated with radionuclides	5 mSv to 50 mSv	50 mSv to 500 mSv
Temporary relocation of the population a)	30 mSv for the first month and 10 mSv for the following months	
Permanent relocation (resettlement) b) c)	1Sv	

a) *These values are related to avoidable effective or equivalent dose.*
a) *This specific value is related to the expected lifetime effective dose.*
b) *If it is over a period of 1-2 years shown that the expected effective dose for one month does not fall below the intervention level for the completion of temporary relocation (10 mSv), the permanent relocation must be considered.*

For individual activities leading to irradiation or sources of ionizing radiation, associated with the risk of radiation incident and radiation accident, the intervention levels based on optimization of radiation protection and specific conditions are specified. Optimized intervention levels are typically in the range of guideline values of intervention levels. If the avoidable dose is lower than the lower limit of interval of guideline values of intervention levels, the intervention is implemented rarely in cases when it is possible to implement it by simple measures, usually for a group of population. If the avoidable dose is higher than the upper limit of interval of guideline values of intervention levels, the intervention is not implemented only in exceptional cases.

To conclude this section, it should be emphasized that the aforementioned measures relate to nuclear installations in general, but due to the nature of risks, which are for NRR facility (as a nuclear installation) comprehensively assessed in safety analyses, they are virtually out of the question.

In NRR Mochovce, on the basis of the internal emergency plan [L-98] the events of the first and second emergency class in compliance with the regulation of NRA SR No. 55/2006 Coll. on details concerning emergency planning in case of nuclear incident or accident are considered. This classification system consists of the following levels:

First level – Alert

is an event, in which fulfilment of safety functions is threatened or violated, the safety barriers are damaged or non-functional, there is a threat of radioactive material leakage that can lead to unauthorized irradiation of individuals in civil buildings of the nuclear installation and in case of adverse development, there is a threat of radioactive material leakage outside the civil buildings of the nuclear installation.

Relevant members of the Emergency Response Organization in the territory of nuclear facility must be notified.

Second level - State of emergency in the area of nuclear installation

is an event, which may lead to leakage of radioactive substances outside the civil buildings of the nuclear installation and its area.

The Emergency Response Organization is in a state of emergency and persons responsible for protecting the population according to the public protection plan and public warning preparation must be notified, the measures according to the public protection plan are implemented.

Consequences do not require protective measures implementation for the population in the surroundings of the nuclear installation.

Third level - a state of emergency in the vicinity of nuclear installation

is an event, which may lead to significant leakage of radioactive substances into the surroundings of the nuclear installation.

The consequences of leakage require the introduction of protective measures for the population in the vicinity of the nuclear installations resulting from the internal emergency plan and population protection plans.

According to the internal emergency plan [L-98] this event may be caused only by activities of the nuclear installation SE-EMO, which is only about 1.5 km away from the NRR facility by the most direct route. Since such a state is caused by the operation of NPP, the measures to protect the population are initiated from NPP. It is a responsibility of the NRR staff (whose activities are included in their internal emergency plan) to secure the objects of NRR and get ready for evacuation.

NRR is therefore not a source of events causing the need of the protective measures establishment for population.

5 OTHER MEASURES

The final selection of the location, method of VLLW repository construction and process of VLLW disposal must be adjusted in order to preserve the model of covering in the specific location and ensure the monitoring of changes of its critical parameters as long as possible in order to be able to achieve the purpose for which it was constructed.

6 COMPENSATORY MEASURES

Implementation of the proposed alternative to the enlargement of the NRR disposal capacity will not result in material loss of natural or legal persons, since this activity will be carried out within the current borders of NRR facility. Individual alternatives do not show any requirements for extending transport and other infrastructure outside the NRR area.

Impacts of disposed radioactive waste on the environment are very low and restricted mainly to the period after the institutional control termination, and therefore they will not significantly affect the environment and health of the population in the affected area.

For these reasons, no compensatory measures are foreseen.

7 STATEMENT TO THE TECHNICAL-ECONOMIC FEASIBILITY OF MEASURES

All anticipated measures for prevention, elimination and minimisation of impacts of proposed activities on the environment, violation of well-being of population and NRR employees are technically feasible.

V. COMPARISON OF ALTERNATIVES OF PROPOSED ACTIVITY AND PROPOSAL OF OPTIMAL ALTERNATIVE

1 CREATING A SET OF CRITERIA FOR THE SELECTION OF OPTIMAL ALTERNATIVE AND IDENTIFYING THEIR IMPORTANCE

1.1 Characteristics of selected alternatives

In accordance with Scope of assessment no. 8702/2010-3.4/hp from 2nd September 2010, for the proposed activity the Ministry of the Environment determined four alternatives except zero alternative for further evaluation:

Alternative I **Enlargement of the NRR capacity without special VLLW treatment,** i.e. construction of third (and further) double-rows according to the actual concept and continuation in RAW disposal without distinction of RAW between LILW and VLLW.

Alternative II E**nlargement of the NRR capacity with separated VLLW disposal in NRR repository boxes,** i.e. construction of third (and further) double-rows for LILW disposal according to the actual concept and VLLW disposal in a simpler way (e.g. without FCC) directly in the boxes.

Alternative III **Enlargement of the NRR capacity with separated VLLW disposal in the NRR area,** i.e. construction of third (and further) double-rows for LILW disposal (according to the actual concept) and construction of VLLW repository on a separate places in the NRR area outside the NRR boxes Fig. C-IX. 15.

Alternative IV **Enlargement of NRR capacity with separated VLLW disposal in the NRR area but outside the area of NRR.** In technical terms it concerns construction of VLLW repository following the same concept in the new area located near the NRR, e.g. in the area of borrow-pit (Fig. C-IX. 16), from which the material of appropriate properties for construction of model of covering was used.

Alternative Zero

Within the Alternative zero (Fig. C-IX. 22) it is considered not to extend the NRR. The capacity of two built double-rows of disposal boxes in NRR Mochovce location provides storage room for a total of 7,200 pieces of FCC with a total volume of 22.320 m^3.

The entire area of the repository was dimensioned for construction of ten double-rows to dispose RAW in FCC from the operation and decommissioning of all nuclear power plants in Slovakia, which are currently operated (NPP V-2 in the area of Bohunice and NPP EMO12 – including Units 3 and 4, which are under construction – in the area of Mochovce), or which are in the decommissioning process (NPP A-1 and V-1 in the area of Bohunice).

From the moment of fulfilment of existing disposal structures, the not yet disposed RAW should have been stored until the final process of its management was implemented. In terms of environmental impact, this is the worst solution, since the disposal of liquid waste in tanks in the areas of the nuclear power plants means a higher risk for the environment than its solidification and disposal in NRR.

Moreover, this approach would adversely affect the intended process of decommissioning of nuclear power plants in Slovakia and contradicts the international obligations the Slovak Republic has adopted in the area of safety of RAW management [L-115]. This solution is not in compliance with the Strategy of Nuclear Energy Back End in Slovakia [L-34].

Alternative I does not distinguish LILW and VLLW. All RAW disposable in NRR Mochovce are disposed packaged in a same way into FCC. This corresponds to the original concept, based on which NRR facility Mochovce was designed and constructed. In order to be able to dispose the entire volume of radioactive waste considered (see Chapter A-II.8.1.1.) according to this alternative, it would be necessary to enlarge the existing borders of the NRR area, since the entire specified volume of RAW taken into consideration for disposal from the operation and decommissioning of existing nuclear installations (including NPP EMO, Units 3 and 4) requires 15 double-rows [L-31]. According this alternative an overall permanent land occupation is at least 4 ha.

Alternative II anticipates the disposal of LILW using the current method of disposal in FCC. VLLW would be disposed in a simpler way – e.g. without FCC. The method of disposal - common disposal of LILW and VLLW into boxes or separate disposal of VLLW into specific boxes depends on the choice of waste package for disposal of VLLW and on the solution of other specific issues (selection of other technical means of disposal, prevention of controlled drainage clogging, backfilling, closing of the box before the implementation of the first stage of covering, etc.), which should be included in project documentation. New double-rows would not differ from the double-rows of alternative I and similarly to alternative I, it would be necessary to enlarge the existing borders of NRR area. It would be necessary to enlarge the existing borders of NRR area about 1.3 double-rows, taking into account the demands on infrastructure this area is about 2 ha. With regard to the activity of disposed VLLW, the repository barriers designed for LILW would be unnecessarily overdesigned for VLLW and already negligible radiation impacts would remain unchanged.

Alternative III consideres the construction of separate disposal structures for VLLW in the area of the NRR the way described in the Chapter A-II.8.2.1.7. Alternative of course consideres the standard enlargement for LILW. With regard to the fact that usable space in the NRR facility is limited, it is necessary to optimize the use of space by double-rows in order to create enough space for VLLW disposal at the southern end near the entrance **–** Fig. C-IX. 15**.** Alternative does not require new land consumption.

The assessment of the contribution of VLLW repository to the radiological impact of the NRR area as a whol is not significant (see Chapter C-III.1).

Alternative IV anticipates the construction of VLLW repository outside the current borders of NRR, but immediately adjacent to it. In this case the procedure of VLLW repository construction described in Chapter A-II.8.2.1.7. The particular location of this repository is yet to be specified on the basis of geological survey and survey of geotechnical conditions of the land near the NRR area. As a potentially suitable area, the space of “borrow pit” on an elevation about 200 m east of the operational building of NRR area is considered. From this area, the clay soil for the model of covering was mined. The alternative of external location of VLLW repository, bordering to NRR facility would require a new license, obtaining of which would probably be considerably easier against the licensing process for any other “new” area. Location of VLLW repository, according to the Alternative IV, would utilize all advantages of

NRR area and moreover, it would probably enable to eliminate its disadvantages (limitation of the area). A major disadvantage of this alternative is that the settlement of land is still pending, other disadvantages include necessary consumption of the agricultural land and need to complete the infrastructure.

Pursuant to Article 21, Section (6) of the Atomic Act [L-6] the radwaste repository can be located only on a piece of land which is owned by the State (in accordance with approved National Spatial Development Concept of the Slovak Republic and other approved territorial planning documentation).

Total occupation land (disposal area plus area for infrastructure) is 3-4 ha.

1.2 Criteria for selection of optimal alternative

In order to assess the alternatives and select the optimal one the following qualitative criteria were used.

- **Repository safety** is the exclusion criterion. The alternative which does not fulfill the safety requirement (including radiation impact on population) may not be implemented. Since the safety may be increased by improving the engineering barriers or by the change of criteria for waste acceptance, the intention does not consider any alternative which would not be in compliance with the safety requirements.
- **Availability of required area**. This criterion is again the exclusion criterion. In order for the facility to be built, a certain area has to be available. The assessment may be based on probability of obtaining necessary area from current owners providing that the land is not in the possession of the repository operator. Pursuant to Article 21, Section (6) of the Atomic Act [L-6], the radwaste repository can be located only on a piece of land which is owned by the State, in accordance with approved National Spatial Development Concept of the Slovak Republic and other approved territorial planning documentation. From this perspective, only Alternative III meets these requirements, because the NRR area is owned by the State and the consumption of new land for disposal of required volume of RAW, divided into LILW and VLLW according to the Tab.A-II. 11 is not necessary. All other alternatives require either directly (Alternative IV) or indirectly the consumption of a new land. Alternative I and Alternative II require the construction of new double-rows, exceeding the originally intended number of double-rows (the entire area is designed for 10 double-rows) in order to be able to dispose the entire considered volume of LILW and VLLW.
- **Infrastructure availability of the repository.** This is a classification criterion. In reality, the repository operation requires complete infrastructure. It is not only the availability of basic services such as water, electricity and connection to the system of public roads. The repository area shall have corresponding system of the monitoring, security guards and location fencing, there must also be relevant services of radiation protection, radiation situation monitoring in operating area as well as in the surroundings of the repository, etc.
- **Availability of site characterization study performed for the repository construction.** Any location for erecting the repository requires detailed characterization since the location safety depends to a greater extent on determined favourable place characteristics. So if such studies are available, they will be a significant contribution. Their implementation is usually costly and

time consuming. As a result the study availability of location characterization is the classification criterion when assessing the alternatives of NRR enlargement.

- **Costs of the alternatives.** This criterion belongs rather to the quantitative criterion. In our case (at the stage of each alternative development) we included it into the quality criterion since it includes only costs of implementation for the repository itself (disposal structures) but it does not reflect all costs including the induced costs, costs of operation, etc. Alternatives will differentiate only in costs of the designed way of VLLW repository construction because the costs of repository enlargement by double rows for LILW will be the same for all four alternatives.
- When applying this criterion it should be considered that in all types of costs estimates for the repository there are great uncertainties despite the fact that the costs were determined based on the experience when erecting the VLLW repository in Spain. In any case it is clear that for the operation of the VLLW repository in the NRR location there is the option to share the existing infrastructure, radiation protection services, area protection, qualified personnel with the LILW repository and also another nuclear facility which is in the vicinity of NPP EMO, which represents a significant contribution for the implementation efficiency in this location.
- **Aspects of license obtaining.** The level of difficulty when obtaining license is an important classification criterion. The project acceptability by regulatory bodies and all additional parties involved, time needed obtaining license for the repository construction and related requirements are the key aspects because they could have significant impact on the early availability of the repository and its total costs. The VLLW repository which shall be constructed in the unimpaired location should mean the greatest effort for obtaining license and it would require involving the concerned population, many concerned authorities, etc. such activities would be basic and time consuming. Obtaining license foe enlargement of existing repository within its boundaries would be much easier and less time consuming because it could be understood as the enlargement or modification of the existing license. This change is based on a new way of VLLW disposal in a new object, which should be constructed at the expense of two and a half double-rows of disposal boxes in the area of NRR Mochovce.
- **Institutional control.** One of the advantages of VLLW repositories is that in general the shorter period of institutional control is considered – several decades as in case of LILW repositories. In all alternatives except for alternative IV the institutional control will be given by institutional control of NRR as such. It is a question of future what institutional control would be attributed to VLLW repository in case of alternative IV. Several decades have to be considered.
- **The need of area adjustment and demands for the volume of clay for the insulation construction.** Erecting the VLLW repository has demand for building clay insulation in suitable characteristics from the point of view of engineering geology, hydro-geology but mainly the retention characteristics for safety significant radionuclides in the deposited waste.
- **Additional hydro-geological and engineering-geological survey** of the repository place and its closest vicinity. Need and demand of additional geological survey represent significant classification criterion for the selection of alternative. The selection of NRR location gives option to use the results of extensive geological surveys of the NRR repository itself and the closest vicinity as well as wider vicinity which were done with regard to the construction of NRR and

NPP EMO. Therefore also this requirements for the scope of additional geological survey for all alternatives will be lower than for the ”non-nuclear” location.

- **Evaluation criteria in terms of transport** were determined from two aspects: the first is the distance between the location of VLLW origin and repository and thereof resulting economic consequences that must be taken into account and the second is the general situation of transport. Potential risks associated with the transport route must also be taken into account. Based on these two aspects, the most appropriate way of disposal is disposal directly in the area, from which the VLLW originates. Since about 70% of the quantity of expected VLLW will be generated in Bohunice, all alternatives are evaluated as adverse. Mochovce and Bohunice are accessible using the roads of higher class and their areas are also linked by rail.
- **Impact on the environment.** For those cases in which high and irreversible impact on the environment is expected, this criterion is an exclusion criterion. With regard to the low activity of disposed VLLW, the impact of all alternatives on the environment will be insignificant.

2 SELECTION OF OPTIMAL ALTERNATIVE OR DETERMINATION OF THE ORDER OF SUITABILITY FOR CONSIDERED ALTERNATIVES

Proposed activity is submitted for review in four alternatives. The evaluation was carried out by a method for assigning numerical values within the range of 0-3, which quantifies the qualitative properties. Criteria of evaluating the alternatives were classified qualitatively as follows:

Favourable: This alternative is classified as optimal due to corresponding evaluation criterion.

Suitable: This alternative is classified as neutral.

Less suitable: This alternative is classified as less suitable compared to optimal due to corresponding evaluation criterion.

Unsuitable: This alternative is not suitable due to corresponding evaluation criterion – it requires more demanding compensations of adverse parameters of the alternative.

Results of evaluation obtained by the team of researchers are included in the Tab. C-V. 1. In order to simplify a quick visual analysis of the results, the values differ in colour, from dark green (favourable) to red (unsuitable). At the bottom of the table, there is a full evaluation, on the basis of colour identification based on the equal weighting of each criterion.

Overall, it is possible to evaluate all **considered alternatives as appropriate for implementation**, while in this specific comparison of considered alternatives of proposed activity, the **Alternative III** - E**nlargement of the NRR capacity with separated VLLW disposal in the NRR area** appears to be the most appropriate one. The second is varian II - E**nlargement of the NRR capacity with separated VLLW disposal in NRR repository boxes. In comparison to alternative III, alternative II requires higher costs.**

Tab. C-V. 1 Evaluation matrix

Evaluation criterion	ALTERNATIVES			
	I.	II.	III.	IV.
Repository safety	Favourable 3	Favourable 3	Favourable 3	Favourable 3
Availability of required area	Unsuitable 0	Less suitable 1	Suitable 2	Unsuitable 0
Infrastructure availability	Favourable 3	Favourable 3	Favourable 3	Suitable 2
Availability of characterization study	Favourable 3	Favourable 3	Favourable 3	Suitable 2
Costs	Unsuitable 0	Less suitable 1	Favourable 3	Suitable 2
Obtaining license	Favourable 3	Favourable 3	Favourable 3	Suitable 2
Institutional control	Suitable 2	Suitable 2	Suitable 2	Favourable 3
Need to modify the area	Suitable 2	Suitable 2	Suitable 2	Less suitable 1
Additional survey	Less suitable 1	Suitable 2	Favourable 3	Suitable 2
Impact on the environment	Favourable 3	Favourable 3	Favourable 3	Favourable 3
Overall assessment	Less suitable 19	Suitable 23	The most suitable 27	Less suitable 20

3 JUSTIFICATION OF OPTIMAL ALTERNATIVE PROPOSAL

Initially, in the deliverable D2 "Evaluation of the conceptual proposal of alternatives" of the Feasibility study of NRR Mochovce enlargement [L-29], up to 10 alternatives were considered. Individual variants were distinguished on the basis of:

Location: in place of VLLW origin (NPP EBO, NPP EMO), NRR Mochovce, new area,

Method of packaging: FCC, new waste package,

Method of disposal: VLLW and LILW together, VLLW separately.

With all these alternatives, it was considered that LILW will be disposed also after the enlargement of NRR using the current method and at the same time, the method of packaging into new waste packages (not into FCC) was considered.

The analysis of advantages and disadvantages of individual alternatives showed that the introduction of new waste package for LILW (other than FCC) does not lead to benefits that would justify this change in the concept of disposal.

Apart from the fact that the NRR area at Mochovce was selected and approved for RAW disposal and that already during this process gradual construction of disposal structures in accordance with the needs of nuclear power engineering in the study [L-27] was considered, also other areas for construction of VLLW repository location were considered:

- the place of origin, i.e. in the area of NPP EBO, or NPP EMO,
- the new area.

In all alternatives, it was considered that LILW with higher activity would be disposed in NRR Mochovce.

In order to evaluate the alternatives, a set of criteria was used (repository safety, costs, area accessibility, area suitability, environmental impact).

Based on the results of alternatives evaluation, in C-9.1[L-31] it was recommended to introduce a new category of VLLW in the Slovak Republic in compliance with international practice and build a repository in the area of an existing NRR Mochovce. Based on the conclusion of the study C-9.1, we selected alternatives of proposed activity according to the disposal method and we have not dealt with site alternatives. This solution is also in accordance with the statement of the Ministry of Environment, which upon request of the proposer abandoned the site alternative solution for the proposed activity "Enlargement of NRR in Mochovce for disposal of LILW and construction of repository for VLLW". The proposer in the application for abandonment of the site alternative solution emphasized particularly the fact that the area of NRR Mochovce was previously selected and approved for disposal of radioactive waste and that from the very beginning, gradual construction of disposal structures in accordance with the needs of nuclear power engineering was considered and that the NRR area is state-owned property, as required by Slovak law, since the **Atomic Act in Article 21 stipulates that NRR repository can be located only a piece of land owned by the state**.

In the aforementioned feasibility study, as the most suitable, was evaluated the alternative of erecting the module for disposal of VLLW in the NRR Mochovce boundaries together with constructing a third double row (**identically with alternative III in this Report**). It also points out to certain disadvantages of this solution – area limitation, relatively high level of ground water (compared to Alternative IV), existence of model of covering within the boundaries of NRR and the need to count with shortened period of its monitoring. As a result, as the sub-alternative of this most suitable alternative, it considers the construction of repository for VLLW on the east elevation in the area of borrow-pit (**identically with alternative IV in this Report)**. It also analyzes the Alternative Zero which considers the continuation of radioactive waste disposal of in FCC (without extending VLLW) in line with the original concept (**identically with Alternative I in this Report**). **Alternative II in this Report** is only small alternation to Alternative I which may bring considerable costs savings for disposal of VLLW.

It was also shown that the construction of repository for VLLW in locations with NPP has some disadvantages particularly related to the fact that the repository location would alter the nature of the potential uses of the location after the NPP decommissioning. NPP can be decommissioned onto the "Greenfield", while in areas with RAW repository there are permanent restrictions of their use. Moreover, in the area of Bohunice it would be necessary to pay additional, but significant costs due to unsuitable soil characteristics in the area. Majority of Bohunice area is covered with a layer of surface loess with a thickness up to 20 m. Permissible load of loess soils is quite low, therefore it would be required to carry out costly and complicated soil stabilization before the modul construction for the purposes of waste disposal. Additional costs, according to the study [L-30], that would be needed in Bohunice to adjust the subbase, are about 30% higher compared to the costs that could have been spent in other location.

In the study quoted [L-31] it was shown that the new area, regardless of where it is selected and what other benefits it offers, is the least favourable. Disadvantages of a new area are based on the fact that the area selection is time and money consuming and the licensing process does not lead to a successful conclusion under any circumstances (although the area is otherwise suitable). The experience of the EIA process for nuclear power projects have showed that the public around the operated nuclear installations was generally in favour of their implementation (better information and own experiences) compared with the public, which does not have any experience and knowledge of nuclear technologies.

Alternative Zero, which means non-implementation of the activity would adversely affect the intended process of decommissioning of nuclear power plants in Slovakia and is contrary to international obligations that Slovakia has adopted in the area of Radioactive Waste Management Safety. Current practice shows that the impossibility of radioactive waste disposal in NRR Mochovce would result in reduction of the overall nuclear safety of radioactive waste management system.

The recommended alternative requires no consumption of agricultural land or biotopes of forest communities. It will not result in need for the removal of significant quantities of excavated soil to be used for landscaping works. Caused traffic load of the area in connection with the operation of the NRR facility, compared to the current state (number of annual shipments of about 140), will increase slightly due to transportation of VLLW. Radiation load of individuals from the population during the NRR operation even after its closure will not exceed the limits for the expected activity of disposed waste in no time, approved by the regulatory authority for the scenario of ground water contamination even after the degradation of repository barriers or due to flushing out of the activity from the VLLW repository after the 100-year rainfall. Specified limit will not be exceeded in cases of unintentional penetration into the waste and its removal during construction or exploration activities after the end of institutional control.

It has been shown that humans and the environment are adequately protected against radiation and non-radiation impacts during the repository operation, and based on assessments using the reliable data and appropriate models even over a long period of time, when changes in the system occur. These assessments were prepared by conservative estimates of the impact relying on a representative set of evolution and intrusion scenarios.

VI. PROPOSAL OF MONITORING AND POST-PROJECT ANALYSIS

Although assessments of operation and possibilities of NRR enlargement as well as foreign experience related to disposal of VLLW so far confirm that it is possible to achieve the assumptions of safe implementation of repository enlargement and its safe operation after its enlargement, it is necessary to confirm these assumptions by detailed assessment of all (especially safety) aspects within the preparation and development of safety documentation, which will be part of Pre-operational safety report.

1 PROPOSAL OF MONITORING FROM THE COMMENCEMENT OF CONSTRUCTION, DURING CONSTRUCTION, DURING OPERATION AND AFTER TERMINATION OF PROPOSED ACTIVITY OPERATION

At present, the impact of operation of NRR Mochovce is evaluated based on the results of monitoring activities of specific radionuclides in water, which is periodically discharged (as required) from the retention tanks, in which both rainfall water from the surface of communications in the repository and water of controlled and monitored drainage is collected. Monitoring of water discharged from retention tanks is a part of the Monitoring Programme of NRR facility. The Monitoring programme as a part of Pre-operational safety report for NRR Mochovce [L-38] was prepared and implemented according to the Project of NRR important parameters monitoring [L-86]. The following parts were developed in the project:

1. Monitoring of ground water, drainage and surface water,
2. Monitoring of air, soil and food chains,
3. Monitoring of clay baths moisture,
4. Monitoring of erosion impact on the repository area,
5. Monitoring of reinforced structures of repository,
6. Monitoring of disposal premises settlement.

In accordance with the project, the monitoring system of individual important parameters of NRR facility was established. The monitoring programme of parameters itself was specified for each stage of the “lifecycle” of repository - pre-operational - operational and post-operational (a period of institutional control). In general, the monitoring programme aimed to determine the properties of structural elements of repository and parameters of the surroundings that are important for assessing the impact of disposed RAW on the environment and population in near and distant surroundings. In various stages, the emphasis is put on such activities to ensure the objectives of monitoring, which are characteristic for the specific stage. Degree of assessment of disposed RAW impact on the surrounding environment is a demonstrable detection of exceeding the activity of characteristic radionuclides in individual components of the environment **above the level of the so-called natural background.** Monitoring the properties of structural elements is also important since ensuring their designed parameters for at least a period of institutional control (for NRR Mochovce, the institutional control period was set at 300 years)[L-40]) [L-40]) is a prerequisite, with which they were specified in safety analyses of Limits and Conditions for acceptance of RAW to be disposed – see Chapter C-IV.3. In various stages of the repository lifecycle, the individual parts of monitoring may acquire a different weight.

1.1 Pre-operational stage of monitoring

In the pre-operational stage (exploratory sub-stage → sub-stage of creation and putting into operation of the monitoring system) – the aim is to identify the necessary characteristics of the environment in which the repository is to be constructed within a range of statistical indicators of common natural values of defined indicators – the so-called natural background [L-38]. In addition the functionality of the monitoring system before it has been put into standard operation is verified. In the pre-operational stage, during completion works of NRR facility in Mochovce, special attention was paid also to other components of monitoring aimed mainly to specify the parameters of reinforced concrete structures (boxes for disposal of FCC and FCC in particular) and other engineering barriers (clay seals moisture, settlements of dilatation units, etc.) and their confirmation with assumptions taken into account in the project. In the study [L-43] for example, based on measurement of concrete density and thickness of carbonated layer of reinforced concrete structures, the forecast that corrosion threat to the main load-bearing reinforcement of actual boxes of reinforced concrete and panels of covering would occur in the time horizon that by the order exceeds the required lifetime of 300 years was presented more specifically.

Construction of monitoring shafts along the bottom of the boxes of reinforced concrete boxes provided an opportunity to measure – in more detail – humidity of clay seal for a period of about 10 years since its origination. According to the project, a fundamental requirement to achieve required properties of clay seal (filtration coefficient [2] $k_f = 1.10^{-9}$ m/s or less) is the degree of compaction of at least 96% based on Proctor Standard test according to which the characteristic humidity of clay is about 17%. Clay layer also contributes significantly to the geotechnical stability of the entire disposal system. Maintaining required stability against slipping is significantly dependent on maintaining its moisture within defined optimal limits – between 16 and 20.5%. This moisture is also suitable for long-term maintenance of required hydraulic conductivity.

Specific collection of test samples of clay was carried out in accordance with progressing shaft sinking – and that in such locations to have the height profile of seal clay characterized. Under the circumstances, this basic set of control samples was completed by other samples – from the locations between monitoring stations. Based a statistical evaluation of the samples collected (total 149 samples of clay evenly from all four shafts were taken), there was a 95-percent probability that natural moisture of any clay sample from the clay bath was in the range between 16.76% and 19.28% and thus lies in the optimal range of moisture content [L-44].

In the pre-operational stage the studies which should have primarily confirmed the project assumptions of stability of the first two double-rows with regard to real parameters of the subbase were developed. Sampling of consistent soil [3] beneath the southern slope of the second double-row was carried out. Based on these samples, the parameters of shear strength parameters were specified (angle of internal

[2] filtration coefficient is a complex characteristics of filtration properties of the natural environment and liquid, which flows through this environment.

[3] In total, 15 consistent samples of soil from three excavated well up to the depth of 10 m were taken. In none of the excavated wells, the level of ground water was reached.

friction Φ '= 21 ° and cohesion c' = 19 kPa)[L-45]. Using these values, the limit load of the object according to the Eurocode 7 [L-46] – standard ČSN PENV 1997 was determined. Comparison of computational load of subsoil with required load capacity showed that for two fully backfilled double-rows of NRR by FCC containers, including load from the first and the second stage of covering, the safety degree was **F_s = 6**. Usually, the safety degree of 2 to 3 is required [L-45].

The conclusions of the report state the following:

Performed calculations and analyses show that the foundations of NRR Mochovce are sufficiently stable and the stability of construction is not jeopardized by its sinking.

- Construction will settle within acceptable limits. Real settlement will be smaller than the one determined by calculation.

- Settlement of construction is reviewed periodically so that the necessary measures can be taken in a timely manner and the method of construction load by disposed FCC containers can be modified. Monitoring system of settlement implemented in NRR Mochovce is thoughtful, functional and adequate.

- It is recommended to verify the parameters of shear strength of subbase soil also in the future, especially in connection with foreseen enlargement of disposal structures and with regard to the progress of theory and experimental determination of parameters of subbase when establishing constructions of this type.

The course of repository settlement significantly affects the process of FCC disposal – gradual loading of individual dilatation units. Therefore, measurement of settlement has greater significance during the operation. The efforts to avoid uneven settlement influenced also the process of FCC disposal into individual boxes and dilatation units.

1.2 Operational stage of monitoring

Radiation monitoring

In the operational stage, the monitoring system is in standard operation, focusing mainly on identification of any deviations from the projected behaviour of individual functional elements in the period of repository backfiling, possible leakage of contamination from disposal area and from the operational activities during the RAW disposal process and on monitoring of trends of monitored quantities. Basic monitored quality element is the content of defined potential radioactive contaminants in relevant components of the hydrosphere (in particular in ground water and surface waters). Monitoring programme of radiation control of the environment in the surrounding of NRR Mochovce [L-87] during the repository operation was prepared on the basis of monitoring results, which are described in Chapter II.8 “Environment characteristics” of the Pre-operational safety report of NRR [L-38].

Arrangement of monitoring objects in the area of NRR and in its vicinity is shown in Fig. C-IX. 20. Current state of the radiation situation in the affected area identified on the basis of monitoring results is described in Chapter C-II.16.2. Current results of monitoring during the operation of NRR Mochovce are described in Chapter C-II.17.1.1.2 and summarized in Tab. C-IX. 1.

Even at present, during the operation of NRR Mochovce, special attention is paid to the hydrosphere monitoring. Water from rainfall tanks in NRR is monitored. These tanks serve as the collecting tanks of drainage waters (monitored and controlled drainage of disposal boxes). Water from the tanks is drained by tributary C to Telinský stream, which flows into Čifárska reservoir, in an organized manner (after it has been inspected). The aim of the monitoring is to **check compliance with prescribed limits of water discharge from the area of NRR Mochovce.** Since virtually only rainfall water is discharged, the activity of monitored radionuclides is a negligible fraction of limit values - see in Chapter C-II. 17.1.1.2 and Tab. C-IX. 1. These data are even overvalued, since the value of minimal measurable activity (MMA) of the monitoring system is specified as the released activity, because the actual activity of measured radionuclides is usually lower than this MMA (except tritium). Tritium activity on measurable level can be found in ordinary rainfall water out of the repository.

Establishment of limit values for discharge of liquid radioactive substances from the repository does not have factual, but purely formal justification. The reason for it is the obligation to comply with legislative requirements focused generally on nuclear facilities. Collected rainfall water, which cannot be in touch with disposed waste packages and therefore has no connection with safety of the operation, is discharged from the repository area.

Monitoring of water from drainage tank is a part of surface waters monitoring. The entire process of monitoring of surface waters in the vicinity of NRR Mochovce, described in PP T-142[L-93], is performed to monitor and specify parameters of the hydrological regime of surface water systems in more detail and their relation to parameters of the ground water system [L-94] and radiological impacts of possible contamination caused by potential penetration of radionuclides from NRR facility. Any leakage of radionuclides into ground water and surface water (ground waters south of the repository taper off to surface waters) is critical “exposure route” for possible radiological impacts of the RAW repository existence of this type on the surrounding population.

In addition to hydrosphere, atmosphere, soil and other components of the environment are monitored. The importance of this monitoring is to verify, in particular, if the operation of nearby NPP (SE-EMO) does not show the impact on these components of the environment in the NRR area. Results of monitoring of parameters important for assessing the impact of previous NRR operation on the surrounding population are shown in Tab. C-IX. 1.

Other components of monitoring

During operation of the NRR facility, special attention is also paid to other components of monitoring with emphasis on **settlement of disposal structures,** depending on backfilling of reinforced concrete boxes with FCC containers with RAW. Measurement of the settlement is performed using precise levelling of disposal boxes and dilatometers. Measurement results show that current settlement of boxes is within the expected limits (units of mm compared to limit average final settlement according to STN 73 1001, totalling 200 mm). According to the current monitoring results it is shown that even long-term element of spatial movements in dilations and inclination of the dilatation units that characterize uneven settlement are not significant compared to limit uneven settlement determined for rectification of crane track (36 mm in the longitudinal direction and 27 mm in the transverse direction).

Model of covering

Monitoring the impact of erosion on the repository area is observed on a Model of covering, which is built in the south-western part of the NRR are in Mochovce – Fig. C-IX. 4 and Fig. C-IX. 25. In this model, also the parameters of the main sealing element - clayey soil - in terms of long-term impact of climate conditions in the NRR area on future covering of the repository are monitored.

Model of repository covering therefore serves for the long-term monitoring of properties needed to ensure long-term functionality of the final covering of NRR Mochovce. Model in situ is based on monolithic solution of covering with one clay sealing layer, 2 m thick, protected by overlapping layer of mixture of soil and gravel, 1 m thick. Dimensions of the model located on the bearing slab of reinforced concrete are approximately 50 m x 50 m with a slope inclination 1:2.3 and 1:4.6 – see Fig. C-IX. 25.

Properties of the most important element of the final covering – the sealing clay layer – are observed on a model. At the same time, properties of covering layer of soil, which protects the clay layer from the climatic influences are monitored. Monitoring results can also be used as input data for mathematical modelling of geotechnical issues of covering and in the future, they will also serve for designing the optimal structure of the final covering of repository. The long-term monitoring for a period of 15 to 20 years depending on the need for enlargement of the repository capacity is assumed.

Four parameters (geometrical shape of the model, surface erosion, deformation of the covering layer surface, condition of plant cover) and five variables (soil moisture of sealing and covering layer, temperature of soils of sealing and covering layer, bulk density of soil of sealing layer, filtration coefficient of soils of sealing and covering layer, climatic influences) [L-48] are monitored in the long-term on the model of repository covering in situ.

The geometric shape of the model of covering is monitored using standard surveying methods by measuring changes in the position of observation points. Positions of measured points in the space were accurate to cm (technical levelling) pinpointed in geodetic network in the area using three map points and height points of rigid stabilization built around the model of covering.

Bearing of the model body was performed one year after its completion in November 2005 and after the final grassing in spring 2006.

Surface erosion is monitored by visual inspections of the covering model surface and drainage gutters at the model footings. The results of visual inspection of the model of covering are recorded in the operational journal. The journal will record the presence and extent of erosion damage of the model of covering, possible occurrence of incidents, pinpointing of each new erosion furrow or new damage of the drainage gutter. At the same time, photo documentation is prepared to identify the location of the furrow based on the coordinates marked on the base plate. The journal will record all furrows longer than 20 cm and deeper than 3 cm.

Deformations of the covering layer surface, with an exception of damage caused by fauna on maintained slopes, are not redeveloped. They are monitored by visual inspections of the model of covering similarly to erosion disturbance during the same inspections.

Monitoring the condition of plant cover is used to evaluate the consequences of long-term climatic influences and method of model surface maintenance for the plant cover and its protective function and to evaluate long-term changes in the composition of the plant cover against the initial state.

Plant cover was professionally created on the surface of the model of covering after its completion and that by grass mixture suitable and natural for the specific area. The results of plant cover condition monitoring are recorded in the operational journal of the model of repository covering.

Soil moisture is an important variable describing the infiltration of rainfall water into the clay sealing layer and thus characterizing the long-term sealing function of this layer. Global changes of soil moisture are a sign of desiccation, or moistening of the sealing layer.

Soil moisture of sealing clay and soil cover layer is monitored continuously by measuring instruments built into the body of model of covering and also by single sample-taking with subsequent laboratory determinations using the gravimetric method, or determinations using the field methods and geophysical measurements in drills (drill logging).

Humidity sensors are placed in five layers of measurement, of which two layers are in the overlapping soil layer and three layers are located in the clay sealing layer. Positions of measuring layers in case of using the dimensioning from the construction base (surface of the foundation concrete monolithic slab) correspond to the positions of +20 cm, +100 cm, +180 cm, +220 cm, +260 cm, or - 40 cm, - 80 cm, - 120 cm, - 200 cm, and - 280 cm from the surface of the model of covering. This means that the clay sealing in the middle and in two layers of ± 80 cm from the centre (20 cm above the foundation concrete slab and 20 cm below the top edge of the clay layer) is monitored. Overlapping layer is monitored at two levels: 40 cm from the top and 20 cm from the bottom of this layer.

Volumetric soil moisture of clay sealing layer and soil cover layer monitored continuously by operational sensors built directly into the body of the model of covering is automatically recorded each day into an electronic database.

Sample-taking for laboratory determination of soil moisture during the construction of the model of covering was performed from each compacted layer. The points of sample-taking were located in a way to evenly cover the surface of compacted layer.

Measurements of these parameters and variables are carried out in accordance with the monitoring programme, which was prepared and approved for the implementation of model of covering "in situ" [L-48]. The results are processed in the annual reports [L-49]. After the conclusion of the fourth year of monitoring the model of covering (monitoring in 2010), it can be concluded that the purposes for which the model of covering of NRR Mochovce was constructed, are accomplished. The most important thing is to monitor the integrity of the sealing layer, which is maintained after sample-taking and after determination of physical properties of soil. This is supported by the results of measurements of volumetric moisture content, bulk density and fixed coefficient of filtration. Monitoring shows and verifies the basic assumptions used in assessing the long-term safety in the project.

1.3 Post-operational stage of monitoring

In post-operational stage, monitoring and control of the environment will continuously follow after the operational stage of the repository existence, i.e. it will relate to functions and evaluation of the results of operational monitoring system, while reflecting the real situation in the repository in the specific stage. It is based on the project of operation completion and repository closure confirmed by the safety analyses and also includes the project of post-operational monitoring and institutional control. Project of operation completion and repository closure is a subject to the approval process in accordance with Article 22, Section (6) of the Atomic Act [L-6] as an individual stage of the repository existence. In our particular case, it is reasonable to assume that this project is likely to have two separate parts related to the repository for disposal of LILW and repository for disposal of VLLW, with the period of implementation after the backfilling of disposal structures for RAW of specific type. Its implementation for both repositories assumes the following states:

- Operation in the repository has been completed – disposal of relevant RAW.
- Disposal objects are backfilled with RAW in a specified quality while respecting applicable limits and conditions.
- Disposal premises are closed in accordance with a project.
- Disposal objects as an area unit are covered by the system of final covering.
- Internal structures of the covered entity are provided with drainage system with gravity drainage of these waters outside the repository area and with ensured control of their activity.
- The area is provided with the system of surface water drainage.
- Activities and results of operational monitoring are evaluated.
- Revision of the project of monitoring has been developed and implemented in the operation completion period. It includes the results and all changes to the system during the operational stage and new requirements for the post-operational stage.
- Within the period of repository operation completion, full functionality of the technical means of the post-operational monitoring and functionality of the monitoring system as a whole has been demonstrated.

1.3.1 Characteristics and purpose of the post-operational monitoring

Post-operational monitoring of the environment can be characterized as a control activity, of which the purpose is to demonstrate that the repository is closed as a whole by a stabilized structure and its impact on the environment and the population will be negligible in time and in terms of safety. From the long-term perspective, it essentially concerns a gradually finishing activity and that depending on the demonstration of long-term stabilization of the situation acceptable from the safety point of view and depending on all aspects of further development of the area, locality and region.

The purpose of post-operational monitoring is:

– Documenting the development of radiation situation in the defined area after the operation has been completed in time.
– Detecting unacceptable migration of radionuclides in sufficient time in advance so that the corrective action can be taken depending on the situation and on the basis of reverse dose optimization.

The actual monitoring programme will essentially replicate the operational monitoring, possibly with an altered frequency of sample-taking. It will again be based on monitoring of drainage, ground water and surface waters. The arrangement of the sample-taking system for monitoring of drainage water should be based on operational monitoring, with the difference that the drainage water draining outside the repository area will be gravitational. It should be noted that even under normal functioning of the repository barriers, the presence of water in the drainage system of controlled drainage, which is intended to drain water from the boxes, does not have to be an emergency situation requiring investigation and intervention at that time. This will be detection of radionuclides, which are not in the radiation background, or detection of “global” radionuclides above background levels.

The scope and frequency of inspections will be progressively reduced based on the real situation and depending on possible degradation of the field technical means of monitoring. If needed it is possible to anticipate limited maintenance of the monitoring system or in case of non-standard situation occurrence also its necessary extension. After the safety stability of the area, as a result of post-operational monitoring, has been demonstrated it will be possible for the institutional control to become passive. Transition period will likely be a reduction of the monitoring activities progressing into non-systematicness and ending in its full stoppage.

1.3.2 Institutional control

The term institutional control means all activities carried out after the operation, final covering and closure of the repository (ensuring the control of access to repository and control and maintenance of the functionality of its barriers). Under our current legislation – Article 22, Section (2) of the Atomic Act [L-6] the institutional control is provided by the repository operator. Only a legal entity independent of the RAW producer, established by the Ministry of Economy of the Slovak Republic can dispose RAW – provide the operation of RAW repository, on the basis of an authorization of NRA SR and under the Article 3, Section (9) of the same Act.

Institutional control is a term which was established for the purpose of demonstrating safety of repository also for distant future. In terms of demonstrating safety it is especially important to know its duration, in other words, to conservatively estimate the time, when there could be loss of information about the existence of the repository (not taking into account measures taken currently or measures anticipated). Loss of information about the existence of the repository in the distant future could result in the implementation of activities in the area that in case the existence of the repository is known would be unpredictable, for example, various construction activities.

Estimated duration of institutional control is based on considerations of social-economic-political development in the region. Institutional control period is determined by state regulatory authorities. In majority of approaches worldwide, the institutional control period is considered for hundreds of years, usually 300 years. This approach is also applied in our legislation – in safety analyses, which are a part of Pre-operational safety analysis report approved by NRA, the institutional control period of 300 years for surface RAW repositories is considered [L-9].

Although the nature of RAW and Limits & Conditions for their disposal in repositories of VLLW type allow a shorter period of institutional control, for the recommended alternative of NRR Mochovce enlargement in its current area, the institutional control period of the area as a whole is considered for 300 years[L-40].

Demonstration of safety in intrusion scenarios is de facto based not on the duration of institutional control, but on the demonstration of the engineering barriers stability, which prevent intrusion. Demonstration of durability of existing reinforced concrete structures, or their resistance to carbonation, calculated using empirical relationships significantly exceeds the period of institutional control – see Chapter C-VI.1.1 [L-43].

In detail the activities to be carried out under institutional control shall be specified on the basis of the needs that will be relevant at the time of their implementation. It is now possible to summarize that:

- as an essential activity within the active institutional control, monitoring of environmental components, in particular ground water and drainage water will be carried out,

- pyramidal object as a “permanent marking” of the repository area storage area will be built in the repository. By means of this object it will actually be possible, if necessary, to prolong the passive institutional control.

An important part of the duties of the license holder for execution of institutional control is to keep the records on operation of the repository, the inventory of disposed RAW and all data relevant for this stage of the repository existence. The range of records and the scope of institutional control shall be determined by the authority (NRA) in the license conditions.

2 PROPOSAL OF CHECKING THE COMPLIANCE WITH SPECIFIED CONDITIONS OF SAFE OPERATION

During the construction

During the construction it is necessary to follow the technological procedure in accordance with project documentation, to carry out inspections of all performed construction activities and also inspections of technical measures taken to prevent penetration of seepage and drainage waters into the ground water and drainage into the collecting and treatment system (valid for the enlargement of NRR as well as for construction of VLLW repository).

The actual construction of the proposed activity will be implemented pursuant to the decision on building location and building permit. In this permit, the authorizing authorities shall define the conditions, the proposer and contractor must comply with. These will also predetermine the operation conditions.

During the operation

Checking the safe operation of nuclear facilities is addressed systemically. Pursuant to Article 23, Section 7 of the Atomic Act [L-6] the permit holder must carry out periodic assessments of nuclear safety. The scope and frequency of periodic assessments are specified in the regulation of NRA No. 49/2006 Coll. [L-7]. Intervals of periodic assessments of the nuclear installation are according to the aforementioned regulation specified as follows:

- the first periodic assessment as to the day on which eight years from the issuance of the permit for the operation of nuclear installation have expired,
- each further periodic assessment as to the day on which ten years from the permit to which previous periodic assessment was issued have expired.

Periodic assessment is focused on:

a) comparison of achieved state of nuclear safety in the nuclear installation with current requirements for nuclear safety and with accurate technical practice,
b) review of cumulative effects of the nuclear installation aging, the impact of changes made and considered on the nuclear installation, operational experience and technological development on nuclear safety,
c) determining justified and practical changes to the nuclear installation in order to maintain required high level of nuclear safety or increase it to the level approaching the modern nuclear installations in the world,
d) demonstration that the required level of nuclear safety is ensured until the next periodic assessment or until the end of the license validity.

The areas of periodic assessment include:

- nuclear installation project,
- current status of nuclear installation,
- qualification of installations,
- controlled aging,
- safety analyses,
- operational safety of nuclear installation,
- use of experience from other nuclear installations and research results,
- organization and administrative management,
- quality assurance system,
- operation procedures,
- human factor,
- assessment of emergency planning,
- impact of the nuclear installation operation on the environment.

During the operation of nuclear installation also all other authorities in accordance with applicable legislation, especially the regulatory authorities in the field of radiation protection and environmental protection, as well as other authorities in the field of their competence upon request must be allowed to carry out inspections. At the same time, consistent operational records, records of any emergency situations, records of accepted, possibly also produced wastes and their management must be kept.

Results of monitoring of individual areas of the operation, including the impact on the surrounding population and environment must be forwarded to the relevant administrative authorities. If it is, during the inspections, found that the actual impacts of the proposed activity assessed under the Act are worse than expected or guaranteed, the nuclear installation operator will be required to ensure effective measures to harmonize the actual impact with conditions specified in authorization for the proposed activity pursuant to special regulations.

During the repository operation, it is also necessary to provide for:

Checking and repair of technical equipment to protect RAW repository area against torrential rains:

a) Checking and cleaning of internal and external drainage gutter in the repository area,
b) Checking the technical measures for water discharges and for monitoring of the hydrosphere - drainage, ground water and surface water:

- Checking the functionality of collecting and draining system of seepage and drainage waters,
- Checking and cleaning of the measurement weirs in tributary C, Telinský stream and at the outlet of water from Čifársky pond,
- Checking and assessment of levels and other defined parameters of ground water in the repository area and in its surroundings in the direction of ground water flow.

After the operation

After the operation, inspection activities will be carried out in accordance with the project of Institutional control, which will be a part of the Project of operation completion and repository closure - see Chapter C-VI.1.3.2.

VII. METHODS USED IN THE PROCESS OF ASSESSMENT OF THE PROPOSED ACTIVITY IMPACTS ON THE ENVIRONMENT AND SOURCES OF DATA COLLECTION ON CURRENT STATE OF THE ENVIRONMENT IN THE SPECIFIC AREA

Content and fundamental systemic approach to the development of the Assessment Report is required by the Act of the National Council of the Slovak Republic No. 24/2008 Coll. on environmental impact assessment and on amendments to certain Acts [L-1]. However, the Act does not provide a uniform methodology for the impact assessment.

Method of data collection was carried out in close coordination between the elaborator and the proposer.

Basic information about the proposed activity, existing operation of RAW repository, monitoring of technological outputs and monitoring of components of the environment was provided by the proposer to the Assessment Report elaborators. The proposer provided also data from other organizations involved in the monitoring of individual environmental components.

Development of the Assessment Report in sections relating to the description of the affected area and affected municipalities - Data on settlements, its historical development and current state, number of inhabitants and their activities, cultural and historical monuments and the like were obtained from the Internet data [L-82]).

Development of the Assessment Report in sections relating to the description of the affected area and affected municipalities - Data on settlements, its historical development and current state, number of inhabitants and their activities, cultural and historical monuments and the like were obtained from the Internet data [L-105].

With regard to the obsolescence of a number of statistical data, data on the affected municipality Čifáre were confronted with field survey [L-78] and more recent information was obtained from the latest published data on this municipality [L-79].

The proposed activities and their impacts on the environment were assessed in the context of all safety technical, technological, organizational and health standards and regulations, which will have to be complied with during their implementation. At the same time, they were assessed in terms of the control system of their compliance whether during the implementation of proposed activities or after they have been put in operation. In particular, the impact of the repository existence on health of the neighbouring population in the specific area, expressed by an effective dose **E** of critical individual and group at the time was assessed on the basis of calculations using generally recognized and accepted procedures [L-104]. Other impacts on the natural components of the environment and on health of the population of the affected area as well as economic profitability of the proposed alternative and social impacts were assessed using verbal description.

VIII. DEFICIENCIES AND UNCERTAINTIES IN KNOWLEDGE, WHICH OCCURRED WHEN DEVELOPING THE ASSESSMENT REPORT

When preparing the Assessment Report, there were no major deficiencies and uncertainties that could impede a comprehensive assessment of the proposed activity impacts. Some deficiencies in knowledge can be observed in the area of information on health of the affected population that is being assessed only for larger territorial units such as districts and regions, taking into account the fact that health is not only the presence or absence of disease, which the relevant statistics were focused on, but the resultant of physical, psychological and social status of the population. One of the sources of uncertainty was also the fact that data on population, employment and housing conditions have been taken from the census documents from 2001 and relevant Internet data of this kind are also not updated regularly.

A certain degree of insufficiency was also reflected in non-quantification of the data on estimated quantities of waste generated at the time of construction and operation. With regard to the degree of the licensing process, project documentation for the proposed activity, under which it would be possible to accurately determine the quantities of waste generated during construction and reconstruction works, has not been developed. In case of waste produced during the operation of the installation, the quantity of waste is closely related to the specific composition of waste brought in. The exact dimensions of land consumption for individual buildings and installations, or land consumption required for VLLW repository construction will be specified in soon to be developed project documentation.

Assessment of uncertainties

In accordance with specified procedures, majority of uncertainties is included in the assessment as a result of natural variability and limited knowledge. Uncertainties have three primary sources:

Uncertainty of scenarios - possible future development of NRR was identified and scenarios were developed in systematic, transparent and controllable manner. The range of scenarios is comparable with scenarios of safety analyses of surface repositories in other countries.

Uncertainty of models was solved by validating models, by parallel calculations using different computing programmes and the results were compared. Model of evolution scenario has been validated by the organization NEPTUN and Company from the USA and model of intrusion scenarios by the Belgian research institute SCK•CEN. In SCK•CEN, used methodological approach was reviewed. The ground water model developed in the GoldSim was calibrated on the basis of ground water flow equation model MODFLOW in the NRR area, developed by **State Geological Institute of Dionýz Štúr** in Bratislava.

Uncertainty of data cannot be completely eliminated from the analyses particularly because of the fact that the parameter values within the considered time scale will vary. This type of uncertainty was resolved by selecting conservative values overestimating the impacts. With regard to the outcome of an evolution scenario where the potential impacts are the function of the entire inventory, it is necessary to specify difficultly detectable radionuclides in waste. The uncertainty in determining the inventory of disposed radionuclides is crucial, since the critical nuclides, according to which the impact of repository on the surrounding population in a reasonable time after its closure (300 years and more) is assessed, are long-lived difficultly detectable radionuclides, whose activities are not measured directly in disposed waste (they are often not measurable on the background of relatively high activities of other disposed radionuclides), but they are determined by a qualified estimate based on recalculation coefficients, determination of which is loaded with significant uncertainty.

IX. APPENDICES TO THE ASSESSMENT REPORT (GRAPHIC, MAP AND OTHER FIGURES DOCUMENTATION)

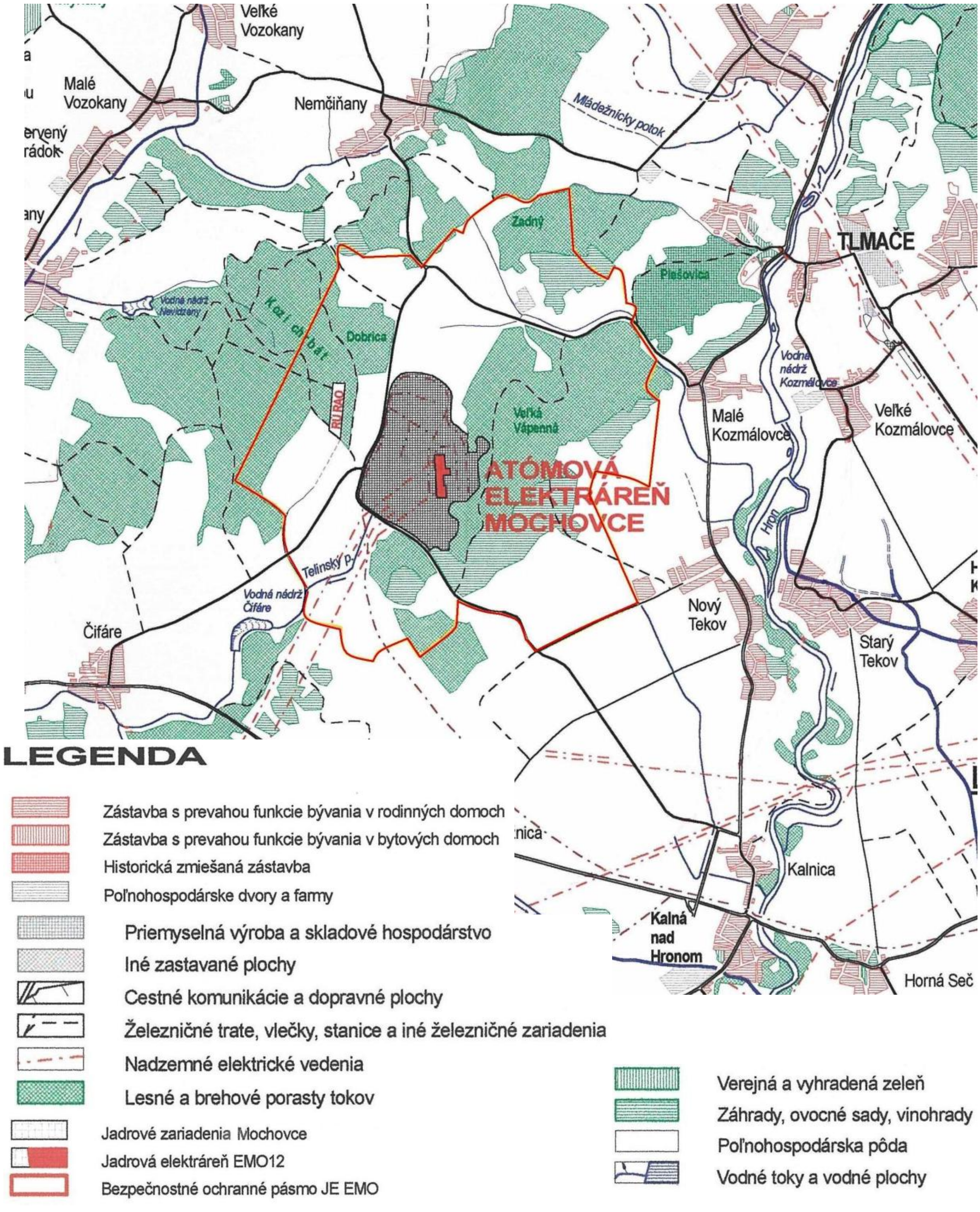


Fig. C-IX. 1 Placement of NRR and NPP EMO in the protection zone of NPP region in Mochovce

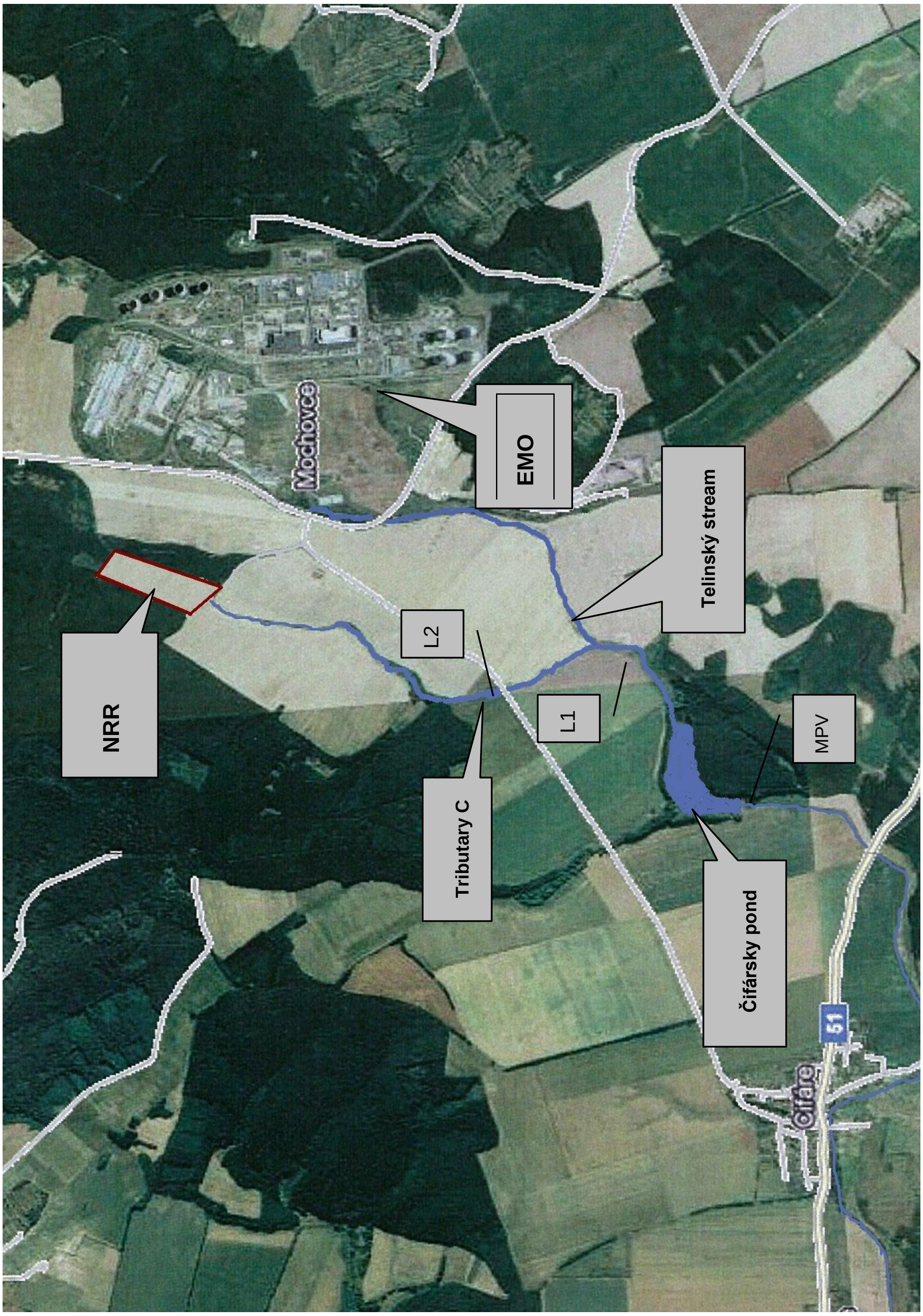


Fig. C-IX. 2 The overall situation of placing the nuclear facility at Mochovce site (according to satellite picture)

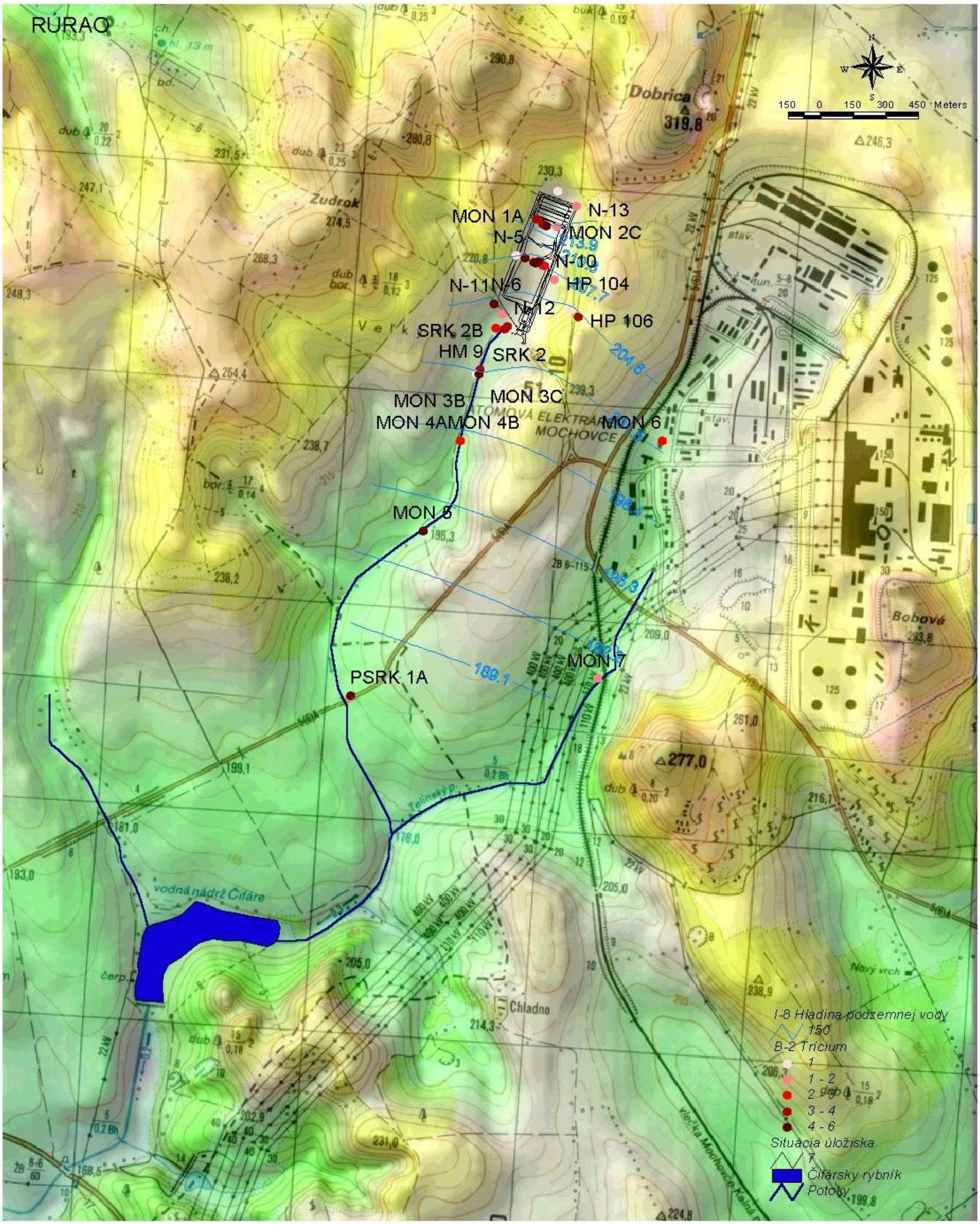


Fig. C-IX. 3 System of monitoring boreholes of underground water at NRR site

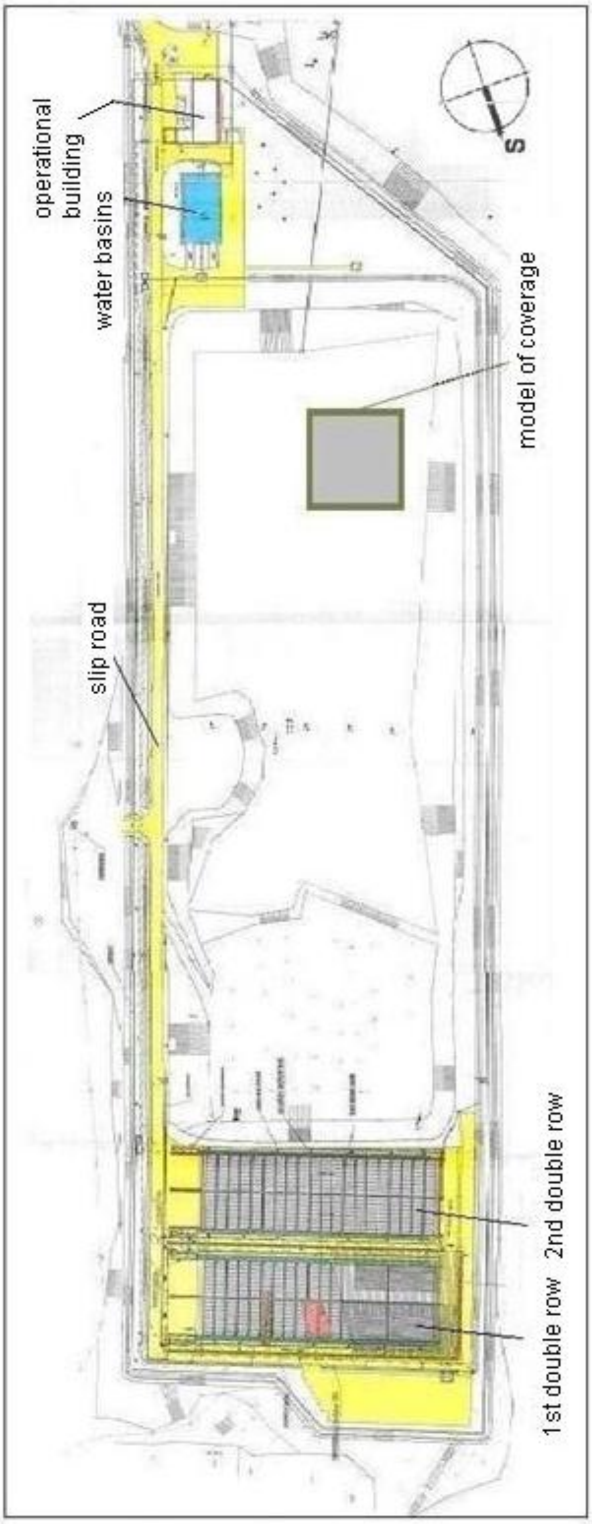


Fig. C-IX. 4 Current state of built-up area at NRR Mochovce

A. Inspectional cross-section of a cell

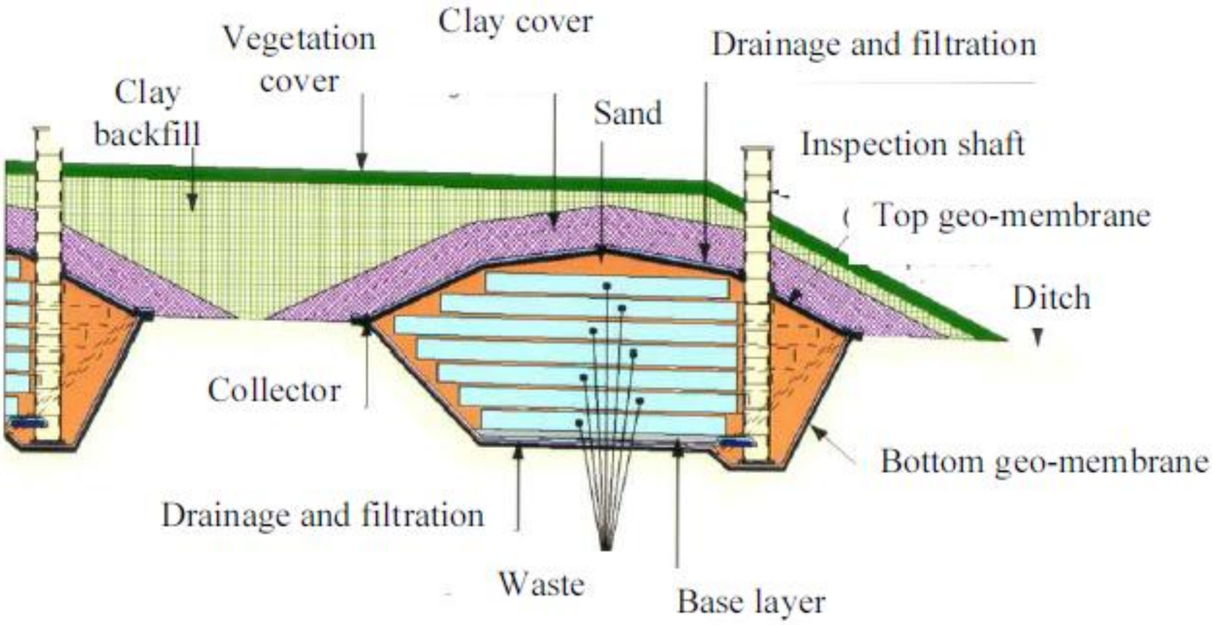


Fig. C-IX. 5 An example of VLLW disposal at Morvilliers in France [L-110]

Fig. C-IX. 6 Handling with VLLW package forms at repository in Morvilliers [L-110]

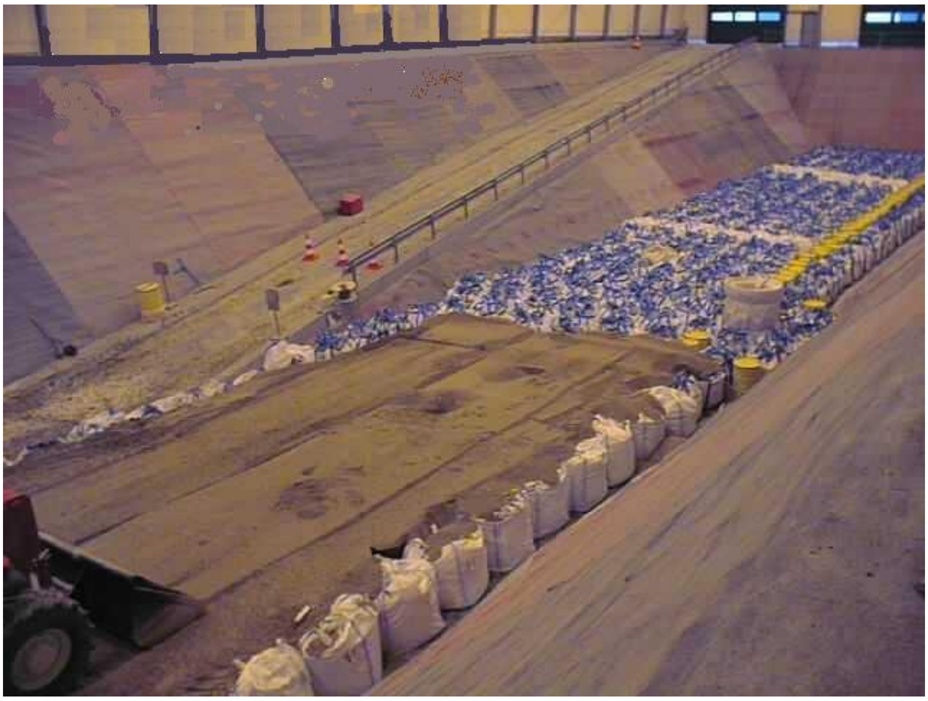


Fig. C-IX. 7 Backfilling of covering layer of soil on the first VLLW layer at repository in Morvilliers [L-110]

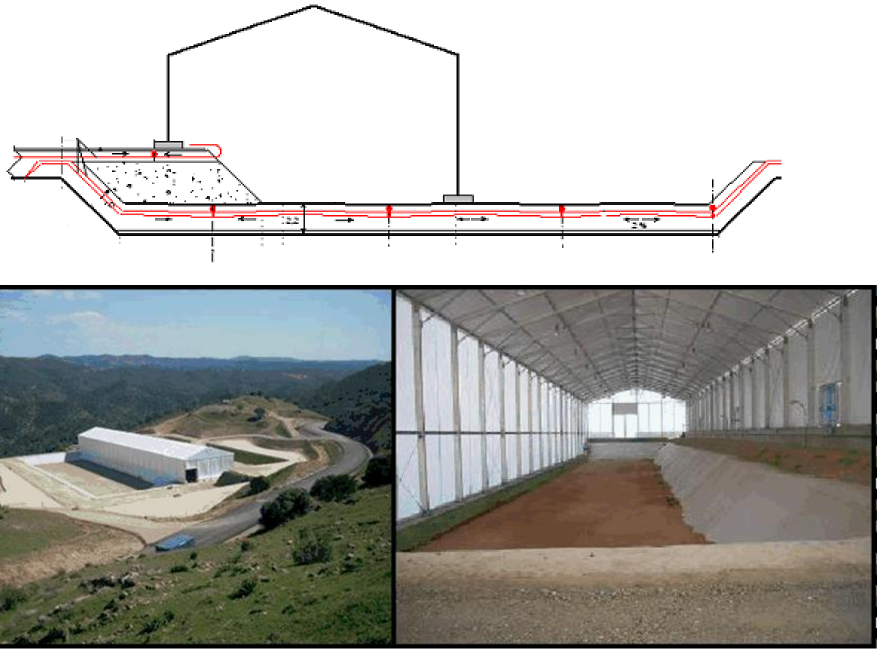


Fig. C-IX. 8 VLLW disposal – cross section (spanish approach)

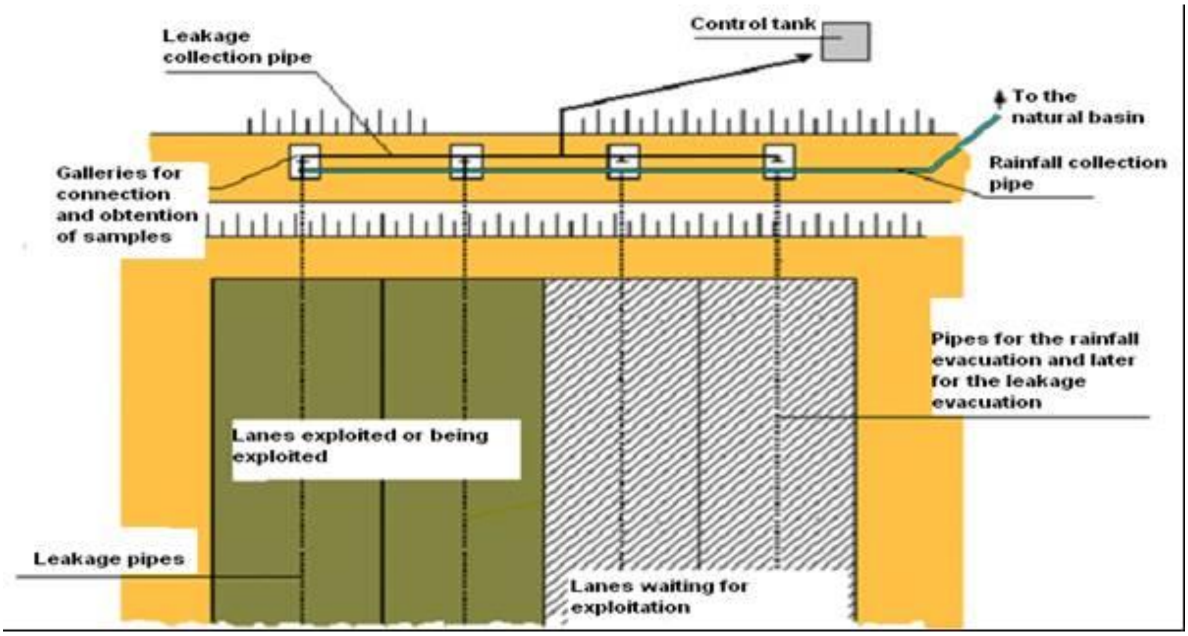
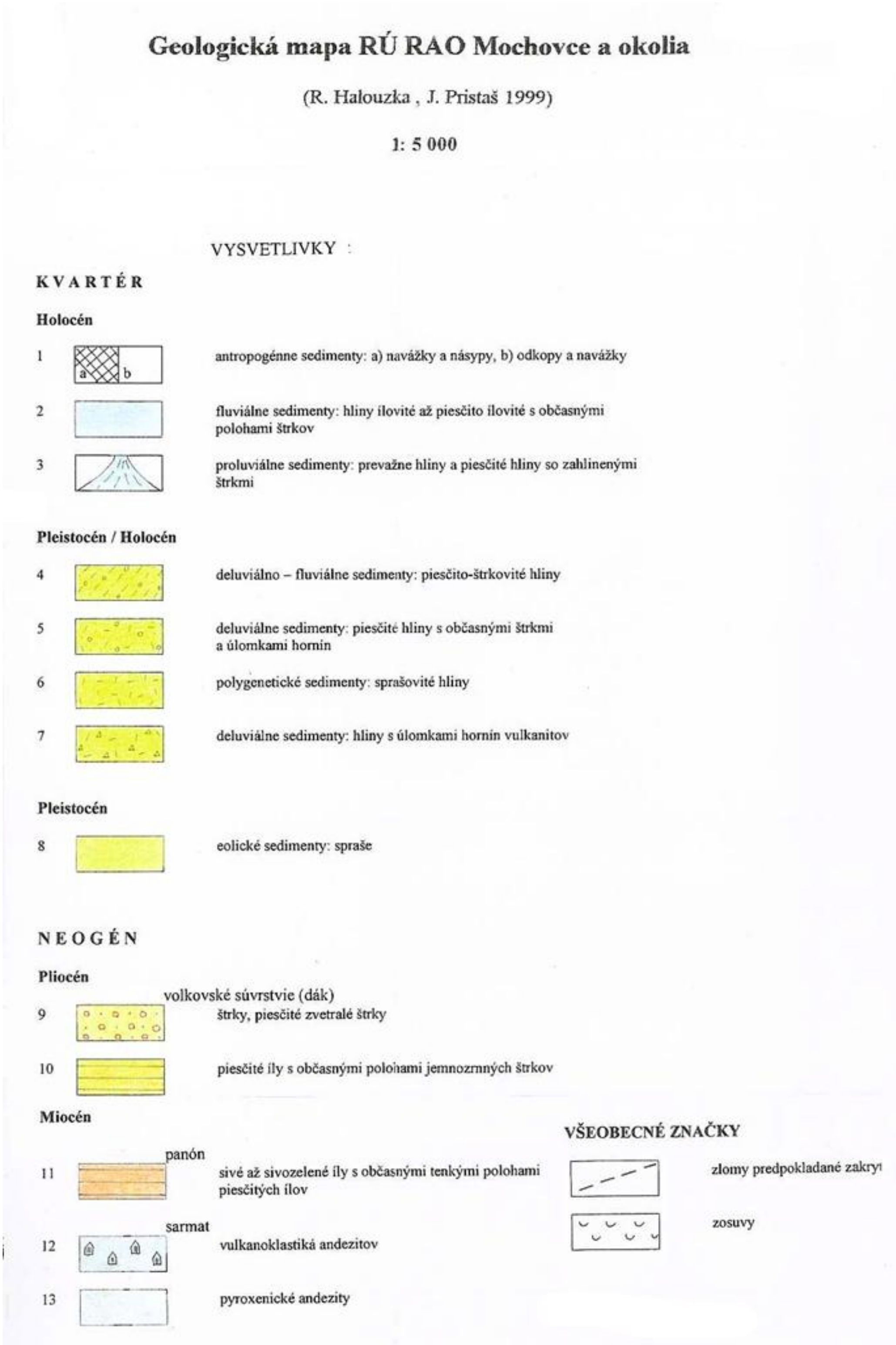


Fig. C-IX. 9 The procedure of VLLW disposal into lanes covered by the mobile roof



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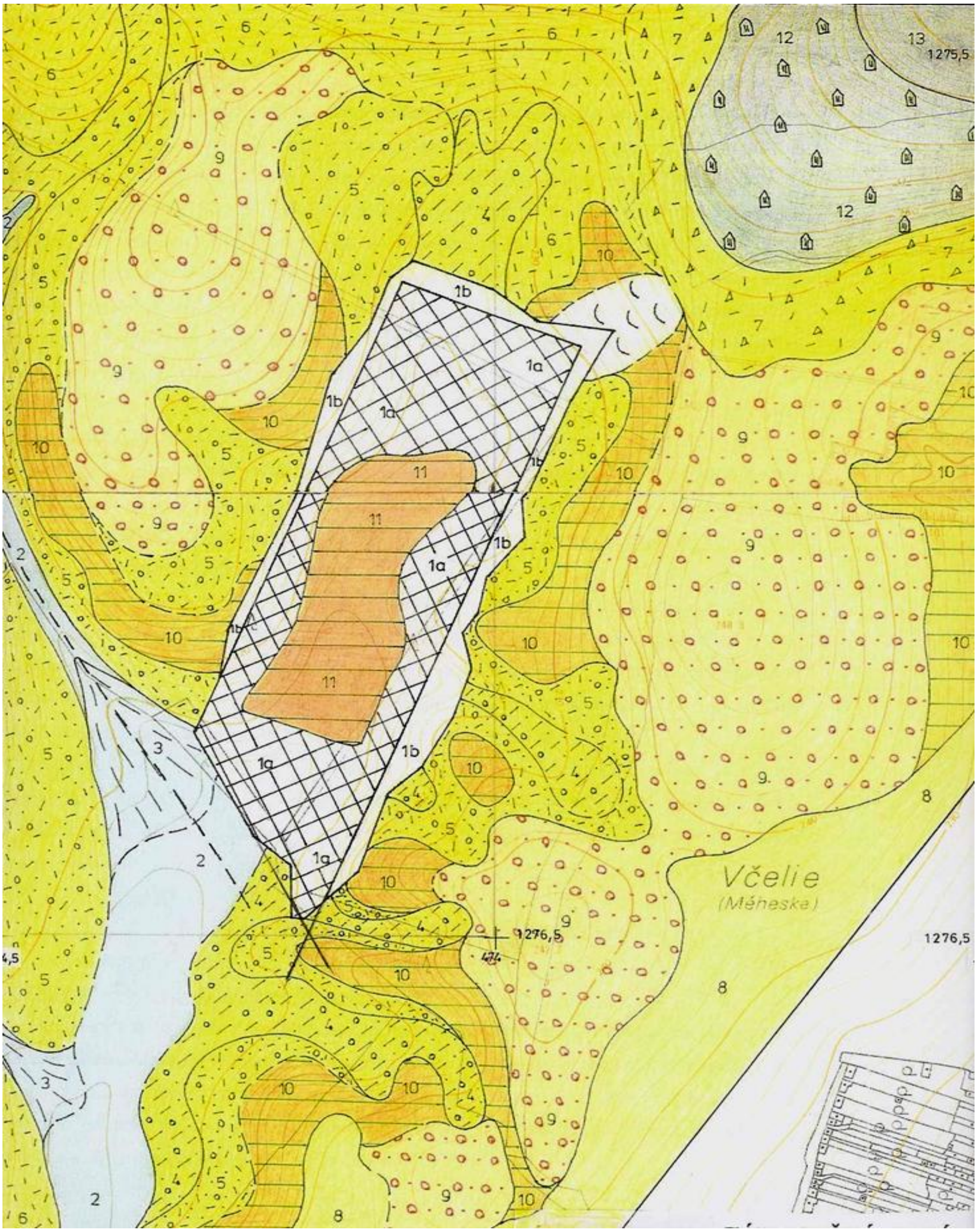


Fig. C-IX. 10 Geological map of NRR Mochovce and its surrounding

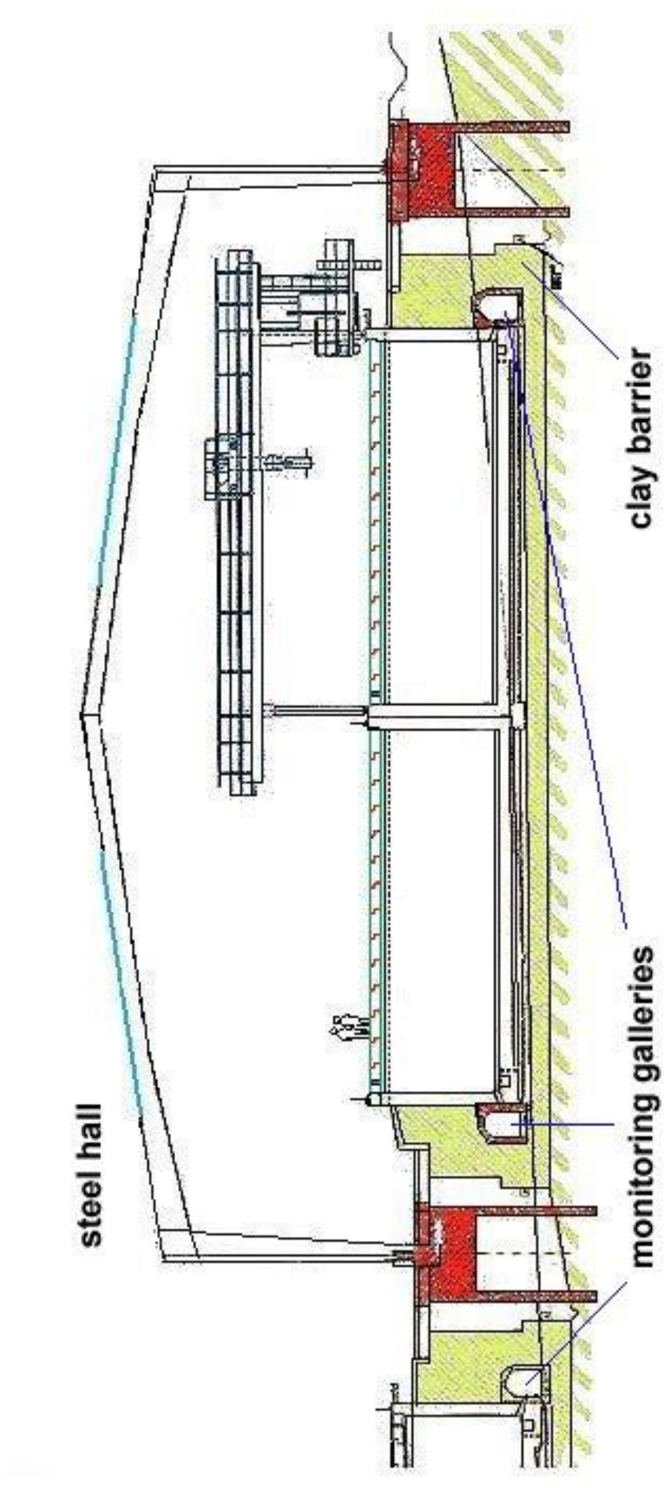


Fig. C-IX. 11 Cross-section of the first double-row at NRR Mochovce

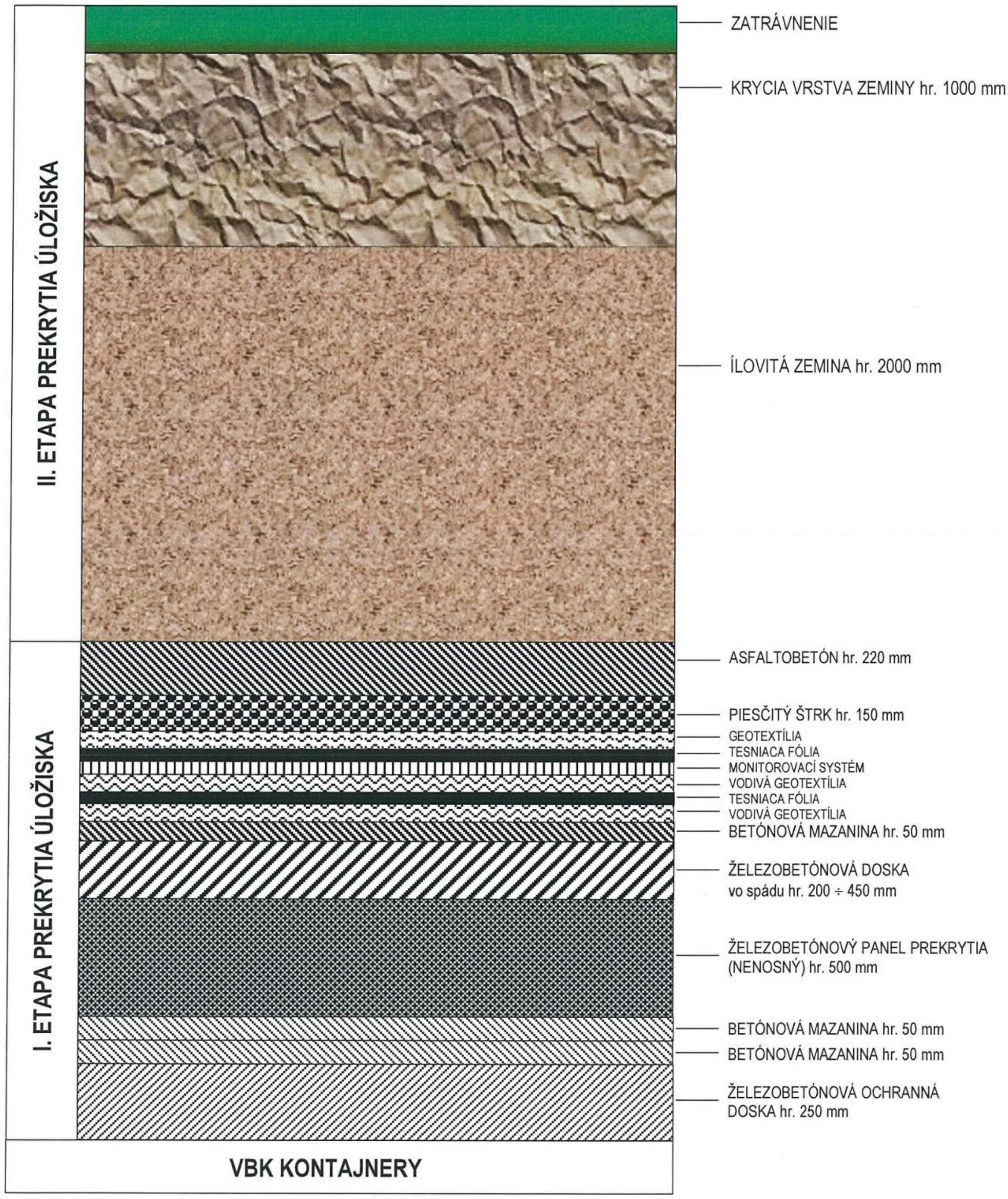


Fig. C-IX. 12 Structure of the final coverage – modified proposal from 10/2003 [L-25]

Fig. C-IX. 13 Overall view at NRR after completion of first doble-row

Fig. C-IX. 14 Reservoir Čifáre (Čifársky pond) with discharged water

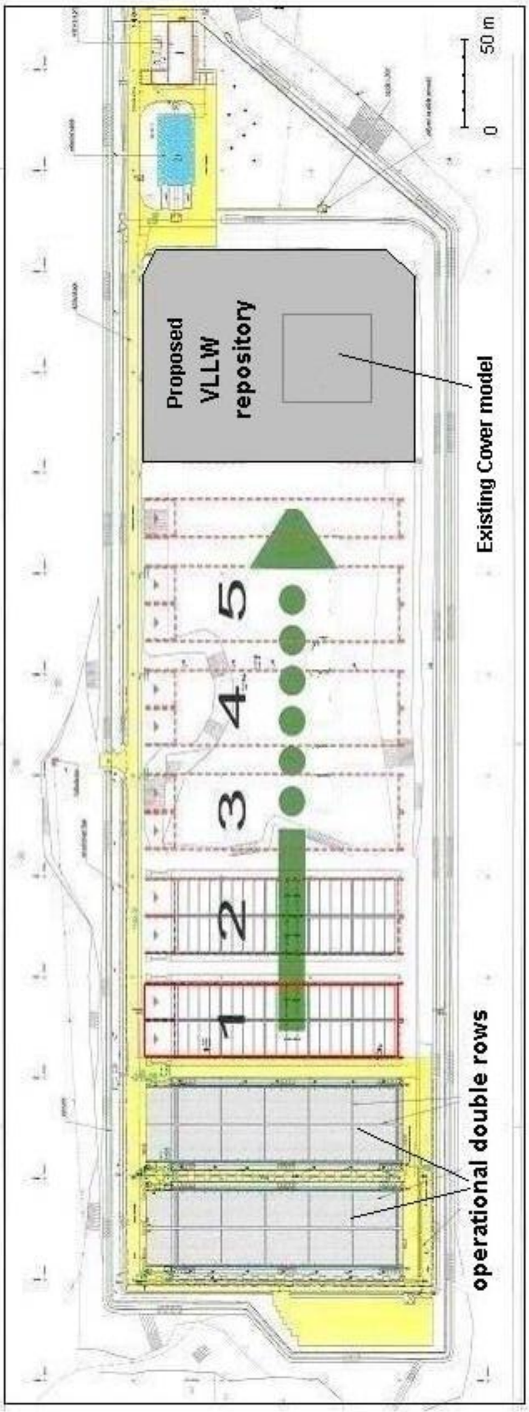


Fig. C-IX. 15 Placement of 7 and ½ double-row for LILW as an example of repository placement for VLLW at NRR - Alternative III

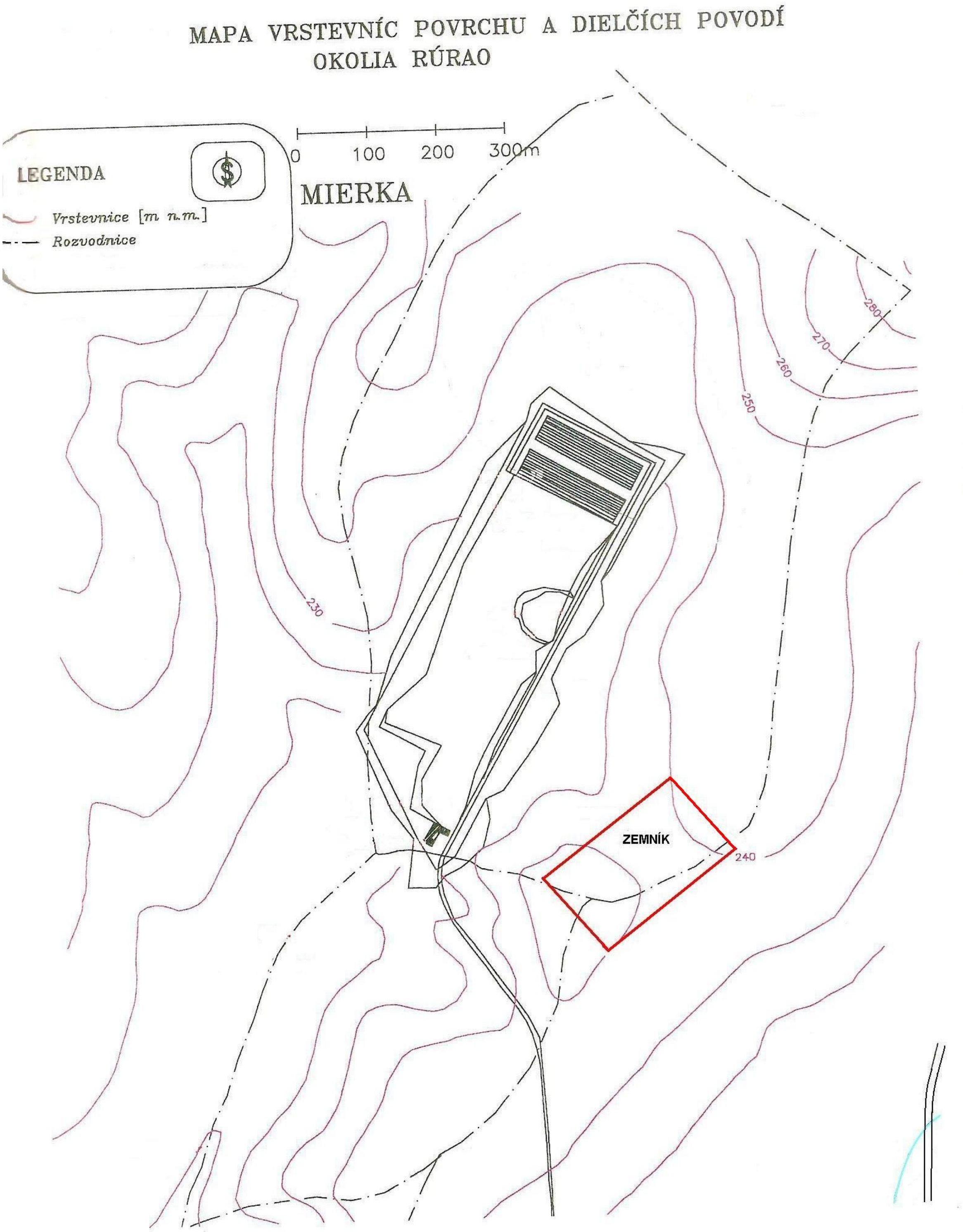


Fig. C-IX. 16 An example of placement of VLLW repository in the area of borrow pit – Altern. IV

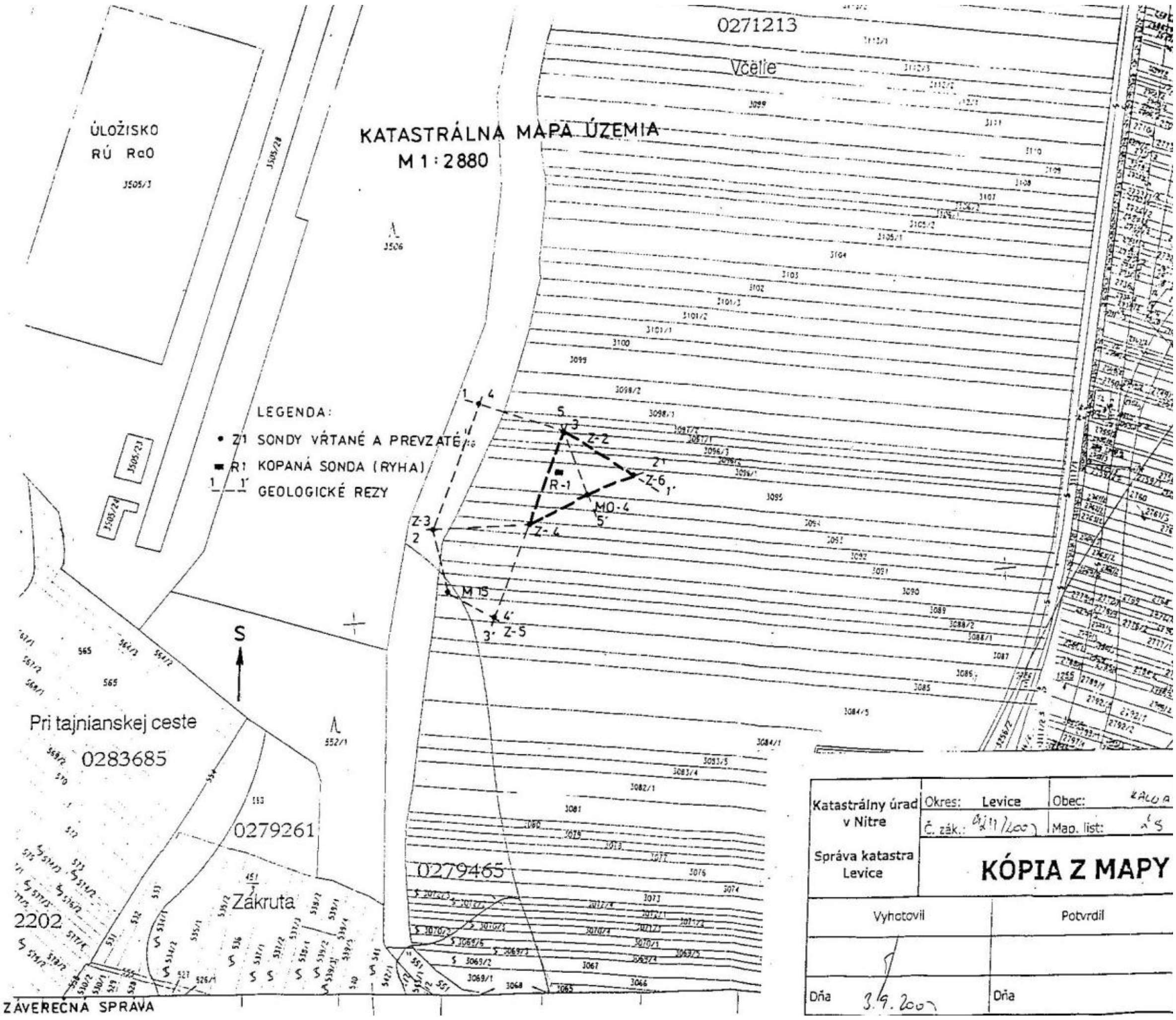
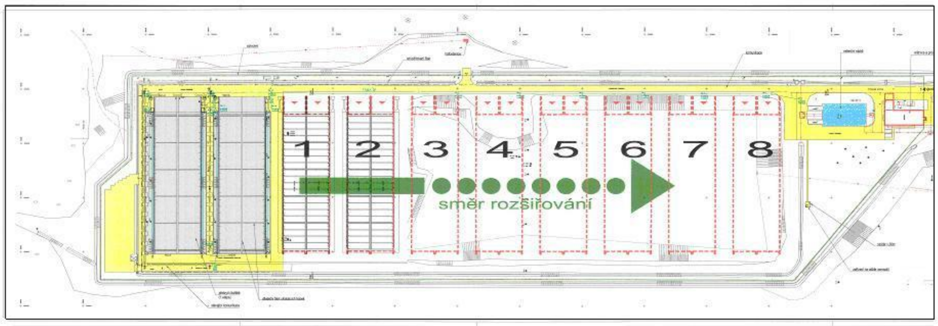


Fig. C-IX. 17 Cadastral map of area with marking of altitudes for the marking of borrow pit

a) The gradual enlargement of NRR analogically to the currently implemented two double-rows



b) Enlargement of NRR vertically on the implemented double-rows

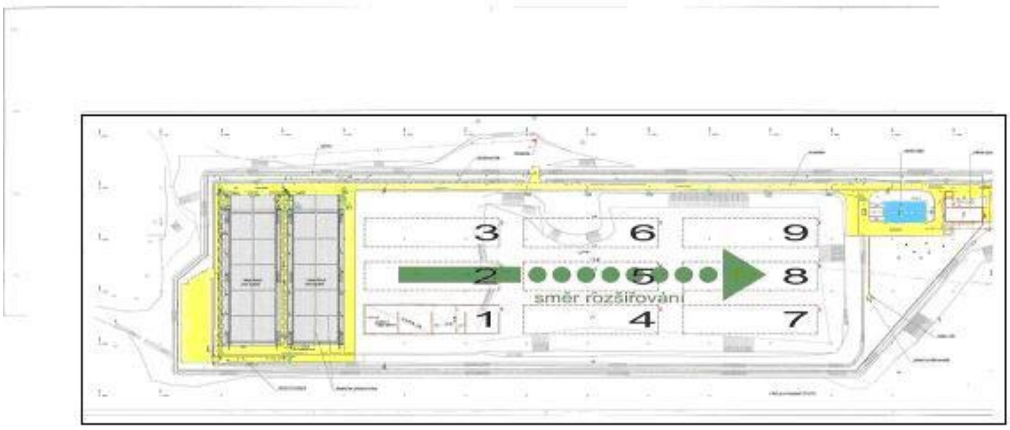
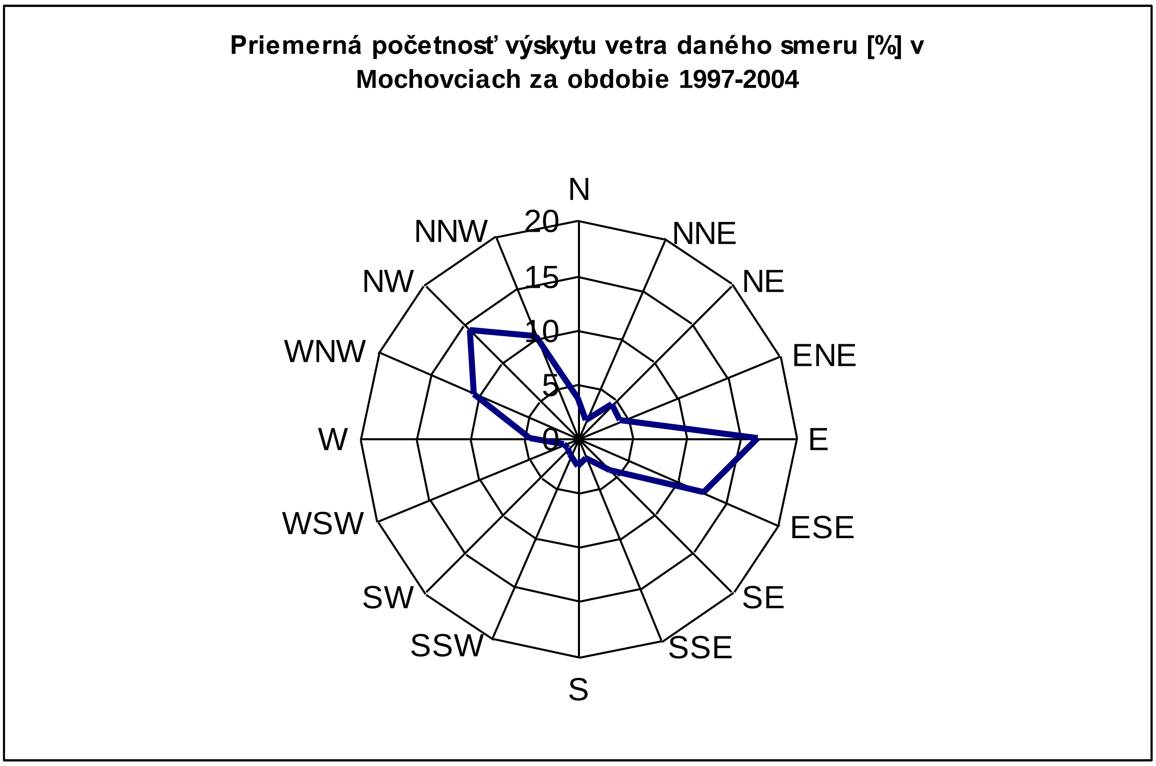


Fig. C-IX. 18 The possible alternative of the classic enlargement of NRR Mochovce [L-39]



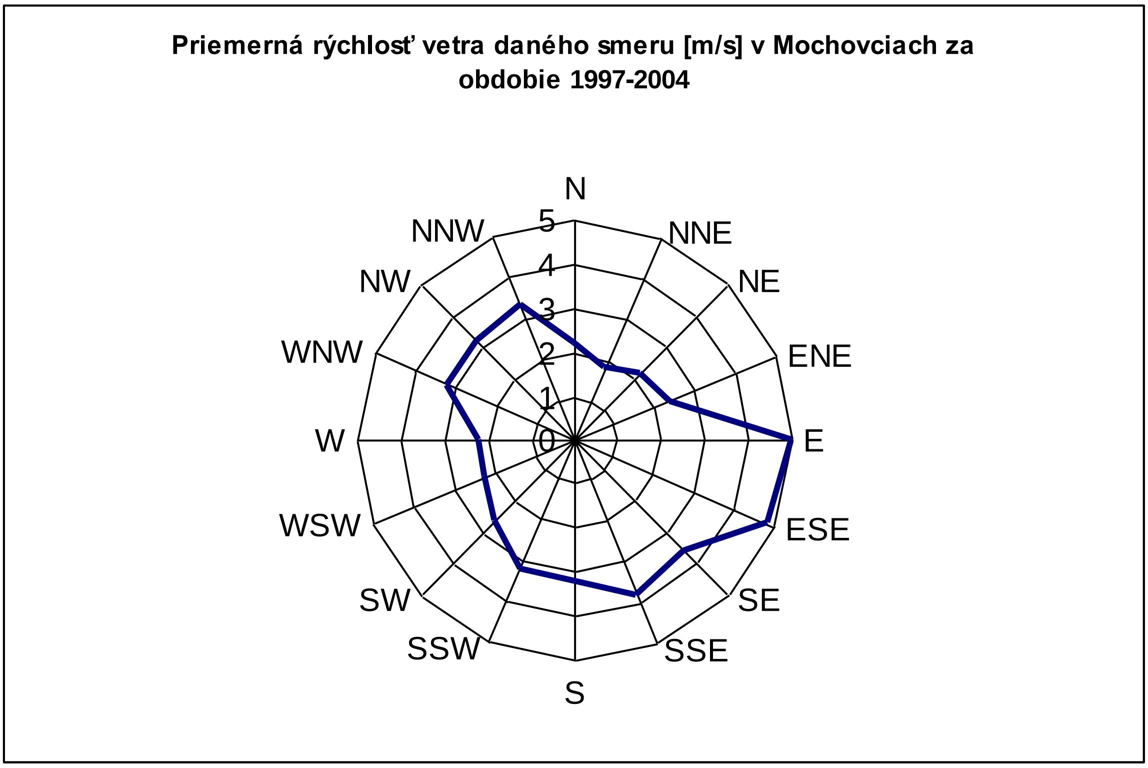


Fig. C-IX. 19 An average multitude of the wind occurrence and wind speed for Mochovce site [L-52]

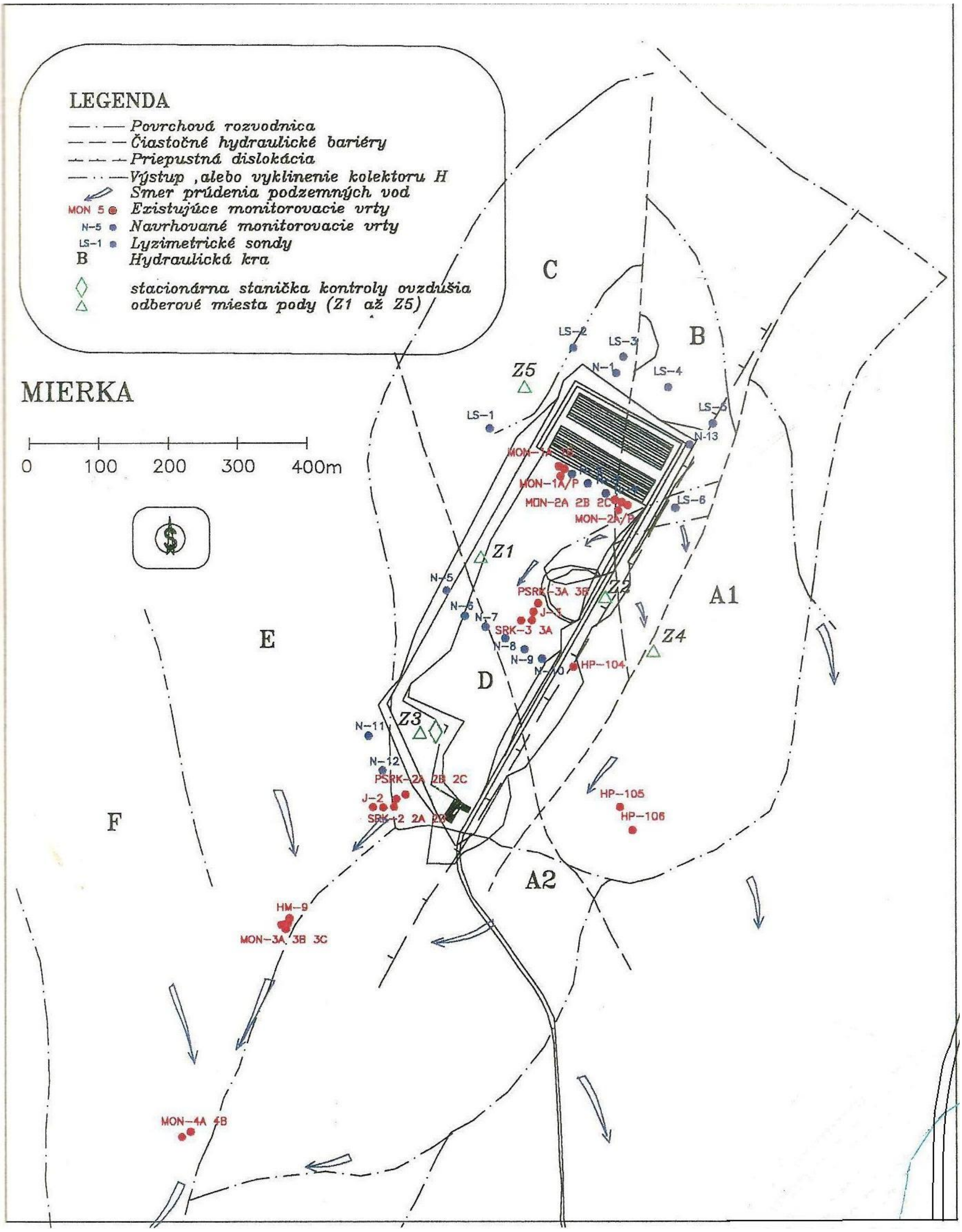


Fig. C-IX. 20 Placement of monitoring buildings at NRR Mochovce site [L-86]

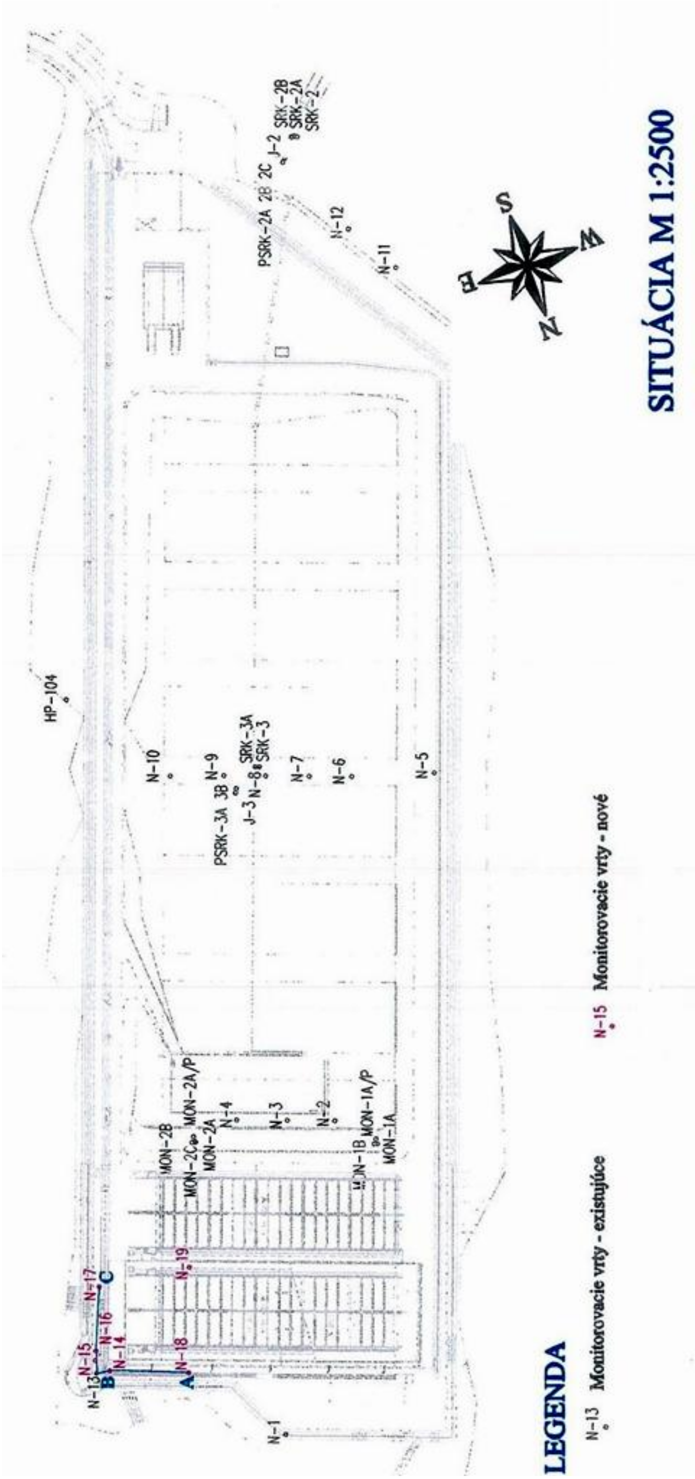


Fig. C-IX. 21 Placement of new monitoring boreholes in NRR after commissioning of NRR (in 1999)

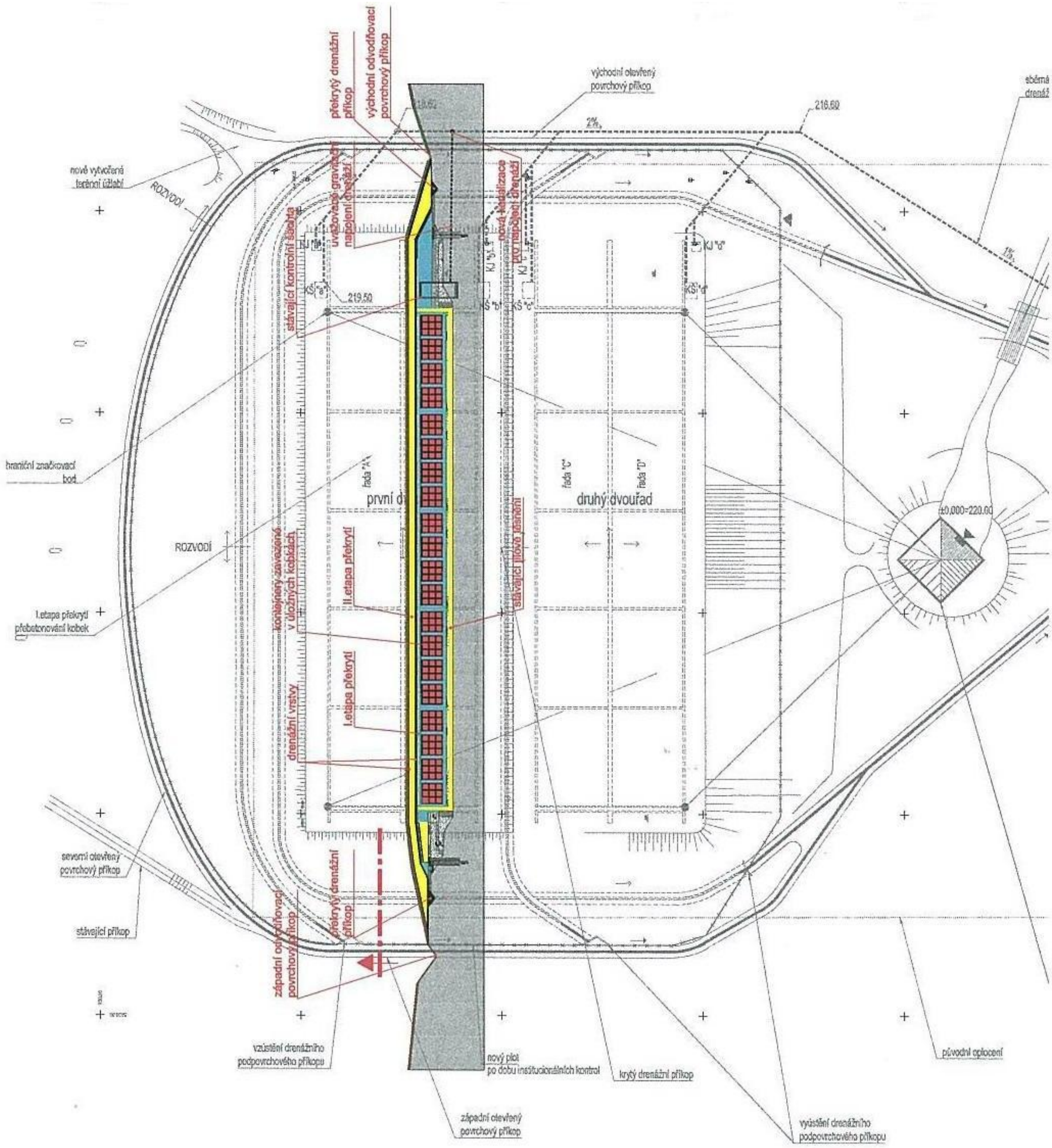


Fig. C-IX. 22 Alternative zero- plan view and cross section after repository closure

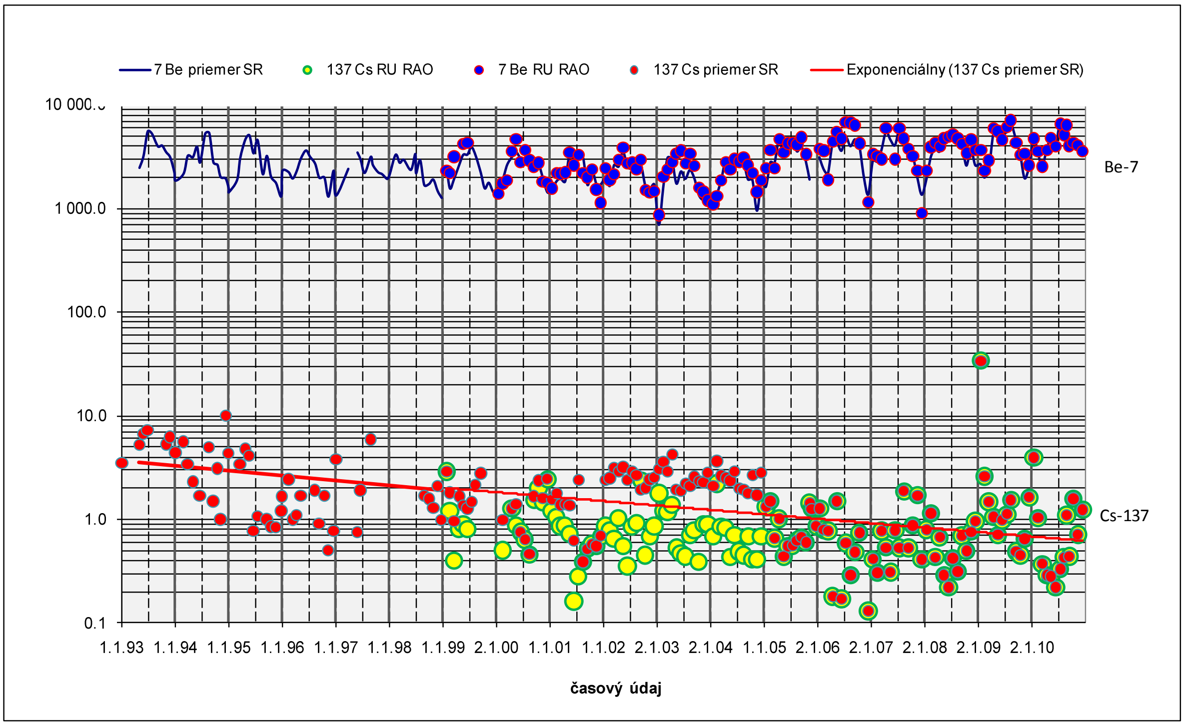


Fig. C-IX. 23 Time course of the average volume activity ^{137}Cs and ^{7}Be [μBq/m^3] in the air in the surface layer of atmosphere at NRR site in Mochovce on the area of SR [L-82]

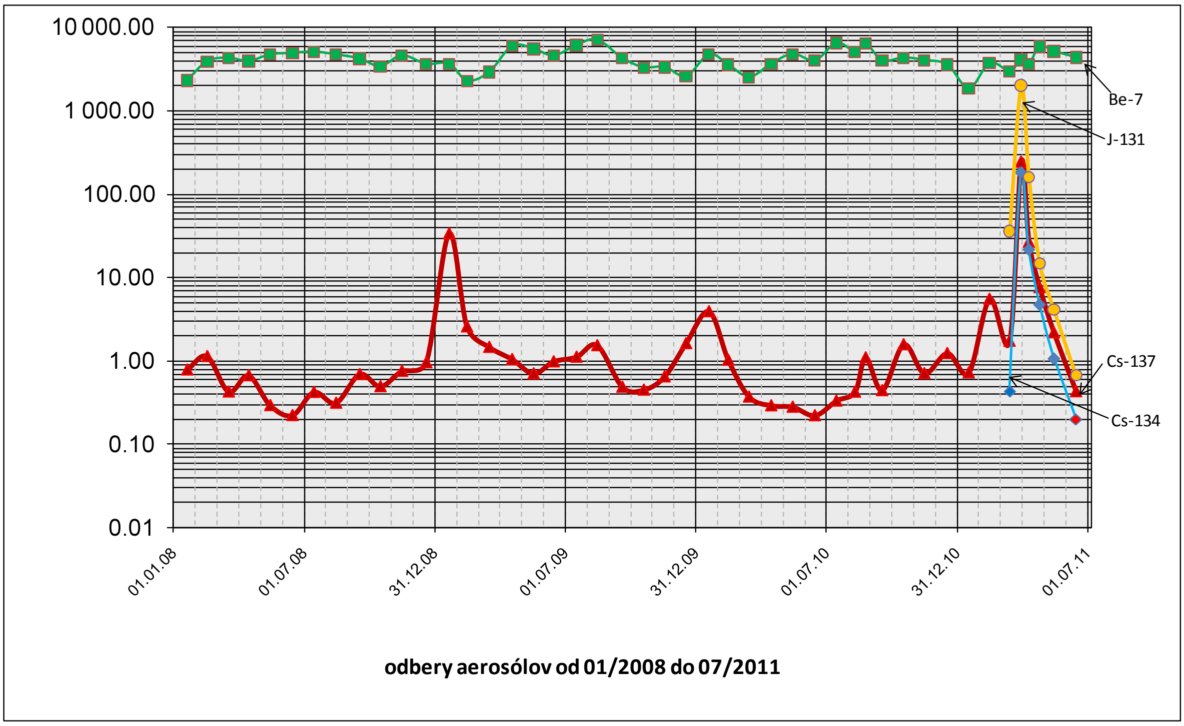


Fig. C-IX. 24 Time course of the volume activity ^{137}Cs a ^{7}Be [μBq/m3] in aerosols at NRR within 2008 - 2011 and marking of Fukushima accident impact in 2011

Fig. C-IX. 25 Model of coverage of repository in state of its completion [L-66]

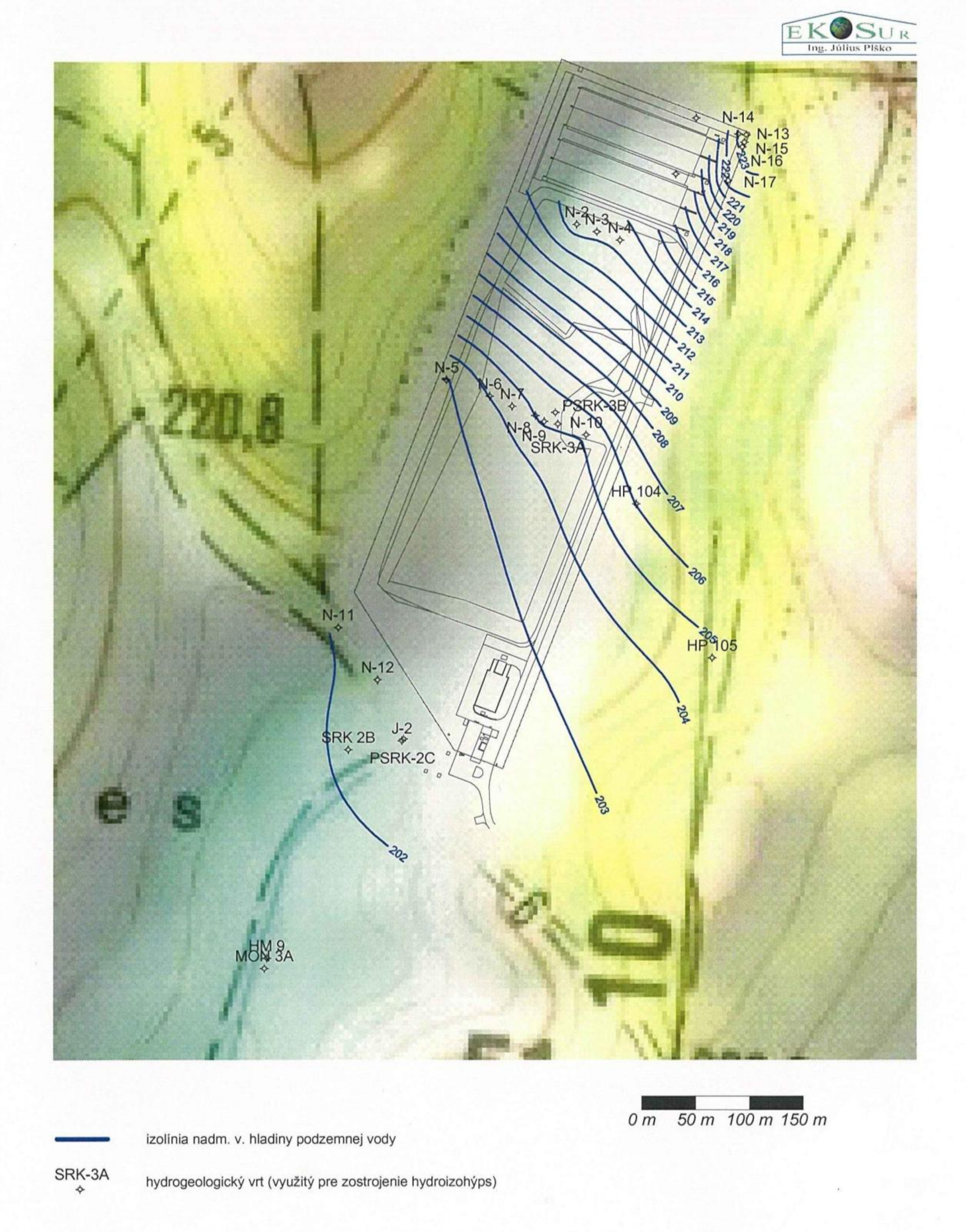


Fig. C-IX. 26 Map of hydroisohypses of H collector at NRR Mochovce, state to 21.11.2007 [L-60]

a) prior to reconstruction

b) after reconstruction

Fig. C-IX. 27 Calvinist church from 1787 at the area of former municipality Mochovce [L-105]

Fig. C-IX. 28 Hunting mension in the south of municipality Čifáre from 1911 [L-79]

Tab. C-IX. 1 Data from measurements for impact assessment of current operation of NRR Mochovce to assessment [L-82]

		Year of NRR operation															
		2001		2002		2003		2004		2005		2006		2007		2008	
Aktivity of discharged water from rainfall water basins																	
RN	**Limit [Bq]**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**	**[Bq]**	**% from the limit**
^{3}H	1.88E+10	5.28E+06	0.03	7.26E+06	0.04	1.54E+06	0.008	3.87E+06	0.02	6.43E+06	0.03	5.61E+06	0.03	3.30E+06	0.02	6.12E+06	0.03
^{137}Cs	2.28E+07	3.50E+04	0.15	5.59E+04	0.25	2.14E+04	0.094	3.01E+05	1.32	1.42E+05	0.62	9.31E+04	0.41	5.89E+04	0.26	1.28E+05	0.56
^{60}Co	2.24E+07	6.30E+04	0.28	4.96E+04	0.22	2.14E+04	0.096	2.75E+05	1.23	1.35E+05	0.60	1.05E+05	0.47	5.89E+04	0.26	1.89E+05	0.84
^{90}Sr	2.44E+08	1.17E+06	0.48	5.17E+05	0.21	2.11E+05	0.086	1.86E+05	0.08	1.49E+05	0.06	6.40E+04	0.03	7.85E+03	0.03	7.92E+05	0.32
^{239}Pu	5.56E+05	1.57E+04	2.82	1.71E+04	3.08	5.34E+03	0.960	2.10E+04	3.78	7.45E+03	1.34	1.16E+04	2.09	8.18E+04	14.70	7.92E+04	14.70
Amount of discharged water from rainfall water basins [m^3]		7 047		10 035		2 137		4 140		6 774		5 821		3 272		6 098	
Aktivity of surface water at NRR and its surrounding																	
RN	**Unit**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Σβ	Bq/l	0.08	0.63	0.06	0.74	0.08	0.21			0.09	0.62	0.11	0.33	0.08	0.21	0.08	0.33
^{3}H	Bq/l	2.00	6.00	0.15	1.07	0.54	0.93			0.62	2.20	0.81	1.63	0.95	1.30	0.95	3.00
^{60}Co	Bq/l	< 0.01		< 0.01		< 0.01		< 0.01		< 0.015	< 0.025	< 0.013	< 0.026	< 0.014	< 0.021	< 0.017	< 0.024
^{137}Cs	Bq/l	< 0.01		< 0.01		< 0.01				< 0.015	< 0.03	< 0.012	< 0.019	< 0.014	< 0.021	< 0.016	< 0.024
^{90}Sr	Bq/l	< 0.012	0.06	0.03	0.15	0.03	0.15			< 0.015	< 0.03	< 0.008	< 0.013	< 0.016	< 0.049	< 0.015	< 0.028
^{239}Pu	Bq/l					< 0.0025		< 0.002		< 0.001	< 0.003	< 0.001	< 0.008	< 0.006	< 0.023	< 0.005	< 0.059

		Year of NRR operation															
		2001		2002		2003		2004		2005		2006		2007		2008	
Surface water at NRR and its surrounding																	
RN	**unit**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Σβ	Bq/l	0.11	1.40	0.23	0.53	0.18	0.45	0.18	0.32	< 0.1		0.15	0.35	0.08	0.25	0.08	0.28
^{3}H	Bq/l	0.48	1.08	0.48	1.08	0.75	0.98	0.75	1.12	< 2.2		0.74	1.14	0.84	1.24	0.95	1.25
^{137}Cs	Bq/l	< 0.005		< 0.01		< 0.01		< 0.01		< 0.02		< 0.017	< 0.024	< 0.018	< 0.025	< 0.021	< 0.027
^{90}Sr	Bq/l	< 0.012	0.04							< 1						0.006	0.011
Aerosols in the air at NRR																	
RN	**unit**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
^{137}Cs	µBq/m3	0.15	2.45	0.45	2.38	0.39	1.78	0.41	2.21	0.44	1.44	0.13	1.5	0.31	1.87	0.29	1.14
^{7}Be	µBq/m3	1 378	4 696	1 417	3 901	1 361	3 611	1 106	3 072	1 810	4 886	1 160	8 773	903	5 960	2 330	5 120
^{90}Sr	µBq/m3	0.31	0.83	0.24	0.39	0.1	0.14	0.08	0.35	0.07	0.172	0.162	305			0.252	0.754
^{239}Pu	µBq/m3	0.02	0.04	0.01	0.02	0.01	0.1	0.01	0.03	0.002	0.019	0.0028	0.0056			0.0216	0.0293
^{241}Am	µBq/m3	0.008	0.009	0.005	0.018	0.005	0.006	0.002					0.021	0.056			0.0029
Soil at NRR site																	
RN	**unit**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
^{137}Cs	Bq/kg	< 0.4	3.29	<0.4	1.2	<0.4	1.2	0.47	3.96	0.61	3.34	0.15	0.65	0.33	11.6	< 2.61	< 5.59
^{40}K	Bq/kg	457	490			366	627	443	545	461	545	180	512	445	730	456	506
U-series	Bq/kg	25.7	30.5			18.3	30.7	37.8	48.2	24.8	36.1	10.3	52.2	2.4	36.6	21.5	30.0
Th-series	Bq/kg	25.8	30.8			31.3	40.9	39.5	50.8	35.9	52.1	14.7	44.3	22.2	58.2	27.7	36.9
^{90}Sr	Bq/kg			1.31	6.39	1.31	6.39	2.5	4.75	3.35	5.7	2.7	4.1	3.5	4.8	< 0.5	1.1
^{239}Pu	Bq/kg			0.021	0.724	0.021	0.724	0.088	0.158	0.09	0.27	0.19	0.26	0.19	0.41		
^{241}Am	Bq/kg			0.02	0.069	0.02	0.069	0.18	1.83	0.19	1.25	0.21	0.26	0.2	0.81		

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X. GENERALLY COMPREHENSIBLE FINAL SUMMARY

Submitter: JAVYS, a.s.
Tomášikova 22,
821 02 Bratislava

Proposed activity:

Enlargement of National Radwaste Repository in Mochovce for disposal of low and intermediate level waste and erection of the repository for very low level waste.

1 BASIC DATA ON THE PROPOSED ACTIVITY

JAVYS, a.s. Bratislava is submitting for assessment the Proposal for a change in using of the existing National Radwaste Repository site (NRR) in Mochovce. Within the proposed change, the following activities shall be implemented:

- Enlargement of the NRR capacity with another double-row for disposal of low and intermediate level waste (LILW) in compliance with the current concept,
- Disposal of very low level waste (VLLW) namely, by the new separated disposal structures for VLLW, or within the disposal boxes of NRR by the simpler technological procedure.

Further activities, which are not defined as a change in utilising the site, but will be implemented on NRR, are the provision of transition to the 2nd double-row before beginning of disposal in this row and completion of RAW disposal in the 1st double-row. These activities should be implemented prior to the enlargement of disposal capacities in NRR, due to the fact that it will ensure the safe continuance of RAW disposal from the operation and decommissioning of the nuclear power plants in the Slovak Republic.

The enlargement of NRR is proposed in four alternatives. Every considered version contains **classic enlargement that** is in this case represented by the construction of the third double-row of NRR for LILW disposal. The individual alternatives differ by the concept of VLLW disposal provision.

In particular, the following alternatives are proposed:

Alternative I **Enlargement of the NRR without the special VLLW treatment**, i.e. construction of third (and further) double-rows according to the actual concept and continuation in RAW disposal without distinction of RAW between LILW and VLLW.

Alternative II E**nlargement of the NRR with separated VLLW disposal in NRR repository boxes,** i.e. construction of third (and further) double-rows for LILW disposal according to the actual concept and VLLW disposal in a simpler way (e.g. without FCC) directly in the boxes of NRR.

Alternative III **Enlargement of the NRR with separated VLLW disposal in NRR area,** i.e. construction of the third double-row for LILW disposal (according to the actual concept) and construction of VLLW repository on a separate places in the NRR area outside the NRR boxes.

Alternative IV Enlargement of NRR with separate VLLW disposal in the NRR area but outside the area of NRR. In technical terms it concerns construction of VLLW repository following the same concept in the new area located near the NRR.

Table: Review of activities and characterization of alternatives.

Alternative	I	II	III	IV
[1]Volume treated RAW	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3	VLLW 68 000 m^3 LILW 50 000 m^3
[2]Required area for disposal/number of double-rows	At least 97 000 m^2 (14 double-rows)	78 200 m^2 (7,5 double-rows for LILW and about 4 double-rows for VLLW)	68 000 m^2 at the NRR areal (thereof 52 000 m^2, i.e. 7,5 double-rows for LILW and 16 000 m^2 for VLLW)	68 000 m^2 (thereof 52 000 m^2, i.e. 7,5 double-rows for LILW in the NRR areal and 16 000 m^2 for VLLW outside the NRR area)
Activity	Put in operation the second-double row	Put in operation the second-double row	Put in operation the second-double row	Put in operation the second-double row (see part A-II. 8.2.1.1)
	Completion of RAW disposal in the first double-row	Completion of RAW disposal in the first double-row	Completion of RAW disposal in the first double-row	Completion of RAW disposal in the first double-row
	Construction of the new disposal structures in line with existing RAW disposal concept (alternative does not distinguish LILW and VLLW) in the NRR area	Construction of the new disposal structures in the NRR area for LILW and within them allocation disposal boxes for disposal of VLLW in a different waste package as FCC.	Construction of the new disposal structures in the NRR area for LILW and new repository for disposal of VLLW in the current area of NRR,	Construction of the new disposal structures in the NRR area for LILW and construction of VLLW repository outside the current borders of NRR, but immediately adjacent to it

Note 1: This table contains volumes of treated waste before its disposal. The real occupied volume differs from this value, because the way to fill each repository has some constraints.

Note 2: Disposal area does not include infrastructure. After its inclusion Alternative I and IV requires about occupation of land outside existing borders of the NRR, with at least 4 ha, Alternative II area 2 ha. For Alternative III is sufficient current area of NRR.

Alternative Zero

Within the Alternative zero it is considered not to extend the NRR in Mochovce. In such case would the disposal of RAW from operation and decommissioning of NPP in the Slovak Republic continue according to the current praxis up to the backfilling of the capacity of existing double-rows of the disposal boxes at site of NRR Mochovce. The capacity of two built double-rows of disposal boxes in NRR Mochovce location provides storage room for the total of 7 200 pcs of FCC with the total volume of 22 320 m^3. From the moment of backfilling of existing disposal structures, the not yet disposed RAW should have been stored until the final process of its management was implemented.

The proposed activity is enlisted according to the appendix no. 8 of the Act no. 24/2006 Coll. on Environmental Impact Assessment as amended into the Chapter 2 Power industry item no. 10 Facility for processing, modification and disposal of low and intermediate level waste from the operation and decommissioning of NPPs and using of radionuclides, part "A" – is therefore subject to the limitless obligatory assessment.

Implementation of the proposed activity will utilise the potential of the existing site of NRR Mochovce and in compliance with the legislation will provide creation of new capacities for environmentally acceptable or economically effective disposal with RAW in the Slovak Republic.

The complex of NRR is placed in cadastral area Mochovce, municipality Kalná nad Hronom, district Levice, Nitra Self-governing Region, approximately 1.5 km north-west NPP EMO (in its protection zone). Lots on which is NRR placed, are the property of submitter and are registered as the other areas outside the built up territory of the municipality.

The whole site of NRR Mochovce was dimensioned for erection of ten double-rows for RAW disposal in FCC from operation and decommissioning of NPPs in the Slovak Republic, which are currently in operation (V-2 NPP in Bohunice site and NPP EMO12 – including 3rd and 4th Unit which are under construction – at Mochovce site), or are currently in the process of decommissioning (A-1 and V-1 NPP at Bohunice site).

1.1 The reason for implementing the proposed activity at Mochovce site

The main reason for implementation of the proposed activity is to create suitable area for safe and effective disposal of LILW and VLLW from the operation and decommissioning of all NPPs in the Slovak Republic, which are currently in operation (or eventually under construction) or is currently in the process of decommissioning.

The placement of the proposed activity at Mochovce site is justified mainly by the fact, that the site is already used for RAW disposal and that from the overall area of NRR site of 11.2 ha is currently used approximately only 20 %. The whole area is in the ownership of the state as it is for the placement of NRR required by Slovak legislation. The part of area is fencing, access and inner plant communications, draining channels, operational building, the building of repository itself or disposal boxes. The building of repository is formed currently by two double-rows of ferro-concrete boxes with the capacity of 22 320 m^3 of RAW erected in the northern part of NRR site. The connection and distribution of energy, roads, sewage and rainwater collection tanks and drainage water were designed on the capacity of 10 double-rows of similar structure as the existing two double-rows. In case that independent repository for VLLW would be erected in the southern part of the area, available space for erection of 7.5 double-rows for disposal of VLLW remains.

The need for enlargement of the existing disposal structures in NRR Mochovce is indirectly connected with the Governmental Decision of the Slovak Republic (decision no. 801/1999) on the early shutdown and decommissioning of V-1 NPP in Jaslovské Bohunice. The consequence of the immediate V-1 NPP decommissioning is, that the waste from decommissioning should be disposed earlier as it was expected and sooner as some operational RAW, for which has been the existing double rows in NRR initially erected, while the capacity of two double-rows is sufficient up to 2020.

Other more suitable alternatives as proposed continuance of RAW disposal from operation and decommissioning of NPP the Slovak republic does not have. To not enlarge NRR in Mochovce on time would be regarding the environmental impact the worst solution, because storing of liquid waste in the tanks on NPP site represent for the environment worse risk as its solidification and disposal at the repository. Moreover, such approach would negatively influence the intended process of NPP decommissioning in SR and it is in contradiction with the international obligations, which SR accepted in the area of safe management of RAW. Such solution is not in compliance with the strategy of final part of the nuclear power industry. Even the cost for this alternative would be low, due to the fact that for long-term storing of RAW it will be necessary to erect and operate suitable premises in the similar volume as for its disposal.

Safety of RAW disposal in NRR Mochovce was confirmed by the preliminary and detailed and additional engineering-geological and hydro-gelogical survey in the preparation and implementation phase of NRR erection. The repository has been operating more than 10 years and for this entire period, there was no serious violence of operational instructions. All significant technological equipment were in operable state. The values of the collective dose and individual dose of the personnel were practically void. No radiation accidents has been recorded as well as no violation of the radiation safety rules. NRR represents the operation without the environmental problems.

Based on the mentioned reasons, Ministry of Environment of SR approved the application of the claimant to enlarge disposal capacities for disposal of LILW and to erect the suitable premises for VLLW disposal at Mochovce site and have not required the development of Report on other site alternatives assessment.

NRR Mochovce is designated for disposal of the operational waste and waste from the decommissioning of NPPs in Bohunice and Mochovce and for RAW, produced in working with the sourced of ionising radiation in other than "nuclear-power" industries. The repository is not designated for disposal of nuclear spent fuel and high level wastes.

1.2 Waste stated for disposal

At NRR in Mochovce it is possible to store only solid and solidified RAW in such type of packaged form, which is approved by NRA SR. **LILW** is currently processed on nuclear facilities where were produced and the final conditioning is performed on the individual, for that purpose designated nuclear facilities(RWTC) and in Mochovce (FS KRAO). The technologies of cementation together with bituminisation of liquid waste and supercompacting of solid RAW are main methods of waste processing. By bituminisation are solidified radioactive concentrates from NPPs A-1, V-1, V-2 in Bohunice and from NPP Mochovce. In the cementation matrix are immobilised concentrates from A-1, V-1, V-2 Bohunice and NPP Mochovce, sludges and gravel from the external tanks of A-1 and the contaminated water from the cleaning of exhaust gas from RAW incineration. For compacting of sorted non-combustible waste (PVC materials, glass, glass-wool, small metallic material) from NPPs A-1, V-1, V-2 and EMO is used low pressure compacting machine. High pressure compacting machine is used for compacting of MEVA drums filled with soft compactible waste after low pressure compacting of drums with metallic waste (pipelines with thickness of wall max.6 mm). The result of high pressure compacting is pellet with height aprox. 24 cm.

The part of processing and conditioning of RAW is the packing into the suitable package forms. For LILW in the form of concrete or bitumen are for this purpose used package forms of steel drums with the volume of 200 litres, galvanized inside and outside. Such drums and other RAW of large volume are stored into fibre-concrete containers (FCC), in which are free spaces filled with cement mixture, by which it is the waste better secured tin the packaged form. Usually is into FCC inserted 6 pieces of bitumen product in 200 litre drums, or 4 drums and other empty volume is filled with pellets from high-pressure compacting. Such filled FCC grouted on the cementation facility by active cementation grout is after sealing and curing shipped to National Radwaste Repository in Mochovce.

Very low level waste (VLLW) – are the wastes, of which activity is slightly higher than the limit value for its release into environment, which contain preferably radionuclides with short-term period of half-change, or eventually low concentration of radionuclides with long-term period of half-change, and which by the disposal require lower level of insulation from the environment by the system of engineering barriers as in the case of RAW disposal of near-surface type for LILW waste disposal. In our case are VLLW preliminary limited as such, which are possible to be stored also without fibre-concrete containers usage and without the special “backfilling“ after filling of disposal structures. Its maximum specific activity for safety relevant radionuclide is usually by order 100 Bq/g, by some radionuclides it can be also one order highier. In comparison with LILW is its conditioning simple without the demands for the special technologies.

According to the requirements of submitter, the capacity after the enlargement of NRR Mochovce should respond to the overall volume of RAW, which was stated in the feasibility project of disposal capacities enlargement. The total volume of conditioned RAW from operation and decommissioning was estimated on 50 000 m^3 of LILW and 68 000 m^3 VLLW.

1.3 Basic data on the technical solution of the proposed activity

New disposal structures for LILW erected at the NRR site should be implemented the same way as the current double-rows**.** Into the design solution will be included new legislation requirements, experiences from the operation, technical progress and efficiency. The final design of new disposal structures of disposal for LILW disposal will be known based on the complex results from the BIDSF project “The design and licensing of the new area for disposal of RAW in NRR Mochovce” approximately in 2013.

The technical solution of NRR repository in Mochovce is based on so-called multi-barrier approach. The system of barriers preventing uncontrolled release of radionuclides consists of the waste form, FCC, from ferro-concrete boxes, clay bath, drainage and final closure and coverage of disposal boxes.

The object of repository itself consists of reinforced concrete boxes arranged into the double-rows. One double-row consists of ten units dilated from each other (width 37.25 m, length 123.2 m) – five in each row. Dilatation gaps between units are 50 mm wide. There are 20 boxes in one row, 4 in one dilatation unit. The axis dimension of disposal boxes are 18 x 6 m, internal dimensions are 17.4 x 5.4 m. The height of walls is variable, medium height is 5.5. The thickness of the reinforced concrete walls is 600 mm. The disposal boxes are covered by ferro-concrete panels of thickness 0.5 m. On the lengthwise walls of double-row is set crane track within the range 18 m, after which runs gantry crane with the load capacity 20 t. Operational double-row is covered by the hall, which prevents from rainfall water leakage. The steel hall has dimensions 52 x 156 m. The height of the hall is 16.75 m.

As an insulation element, separating the repository from the surrounding environment is used compacted clay of required properties. The clay sealing forms “bathtub”, in which is the repository imbedded. Compacted layer with the width 3.5 m is laid around sidelong walls of each double-row. Under the repository there is 0.6 m of gravel draining layer under which is the 1 m thick bottom of the clay bath.

LILW is disposed of into the repository in fibre-concrete containers (FCC) of cubic type with the height 1.7 m and minimum wall thickness of 115 mm. The inner volume of the container is 3.1 m^3. The total weight of the empty container together with lid and two plugs is 4240 kg. FCC after filling with RAW contains in average 12 000 kg.

Drainage system serves for draining and control of drainage waters from the repository area and its close surrounding. It consist of a system of controlled and monitored drainage.

Controlled drainage – its function is to drain waters if it gets into repository (gravel drainage layer in boxes - KD1, or between the bottom of the repository boxes and the bottom of the clay bath - KD2). Concrete galleries, enabling to control water from every repository box separately and also from the gravel drain layer under the repository, are built along every row of repository boxes for control and monitoring of such waters. The galleries are trough, lit and ventilated. They have a vault profile of 1300/1900 mm and are dilated correspondingly with dilatation of repository boxes. The galleries are in the area of long stop ways ended with monitoring of reinforced concrete shafts. The shaft consists of four floors and in it are located devices for shaft ventilation, spaces for sampling of drain waters, collection and manipulation of drain waters.

Monitored drainage – it drains the leakage waters from the outer side of the clay sealing and from the area under long and short stop way. It is built out of flexible perforated tubes laid in the gravel bed. It flows into original reinforced concrete shafts fitted with stainless steel.

For retaining and control of surface rainfall waters from the repository, before their release into drainage ditches or possibly other disposal serves ***rainfall water basins***. They are two basins independent from each other, each with a volume 490 m^3. The waters collected in basins are controlled before discharge from the repository. Following the measurement results, they are either discharged into drainage ditch or transported for further processing. The drainage ditch and artificial channel link to the “C” feeder of the Telinsky stream. These surface flows mouth into Čifársky pond, which represents virtually the only place of practical use (irrigation) of surface waters possibly affected by the repository.

Into the rainfall basins are pumped also drainage waters (controlled drainage and monitored drainage), which are after the inspection overdrawn from the relevant tanks in the monitoring gallery, or eventually in the gallery of the monitored drainage. During the operation of the double-row is water present also in gravel bed under the disposal boxes due to the regulation of the humidity of clay sealing – the amount of water is possible to regulate by means of controlled drainage of KD2. Water in the controlled drainage of KD1, which should lead water from gravel bed on the bottom of each box, is not present during the double-row, due to the fact that operational double-row is covered by the hall.

Waters in the monitored drainage are overdrawn from the controlled pit placed outside the disposal spaces in the long stop way. These waters are led into the retention basins of rainfall waters by the underground pipeline collector erected along the whole access road.

Very low level wastes - VLLW will be disposed into basic structure - cell, or module in the licensed type of the package suitable for disposal, but also for the transport. Disposal cell (module) contains several protection layers above and under the waste.

After the modification of base will be created protection layers and after filling with waste also the layer of coverage. All layers placed under the low drainage layer with the thickness 0.30 m, will be created (bottom up) in the following sequence:

- Lower drainage layer of gravel (0.30 m)
- Geotextile of lesser strength (0.7 kg/cm²) against contamination.
- Clay layer of 1 m thickness, permeability equivalent to 5 m of clay with $K < 10^{-9}$ m/s.
- Bentonite layer (geobentonite) of 10 mm thickness with $K < 10^{-11}$ m/s.
- Waterproofing sheet layer of high-density polyethylene (HDPE) of 2 mm thickness.
- Geotextile of greater strength against punching (1.6 kg/cm²) for the protection of the HDPE sheet layer.
- Gravel layer of 0.3 m thickness, for the losses drainage, with its corresponding piping network.
- Geotextile of greater strength against punching (1.6 kg/cm^2) for the protection of the HDPE sheet layer.
- Waterproofing sheet layer of HDPE (2 mm).
- Geotextile of greater strength against punching for the protection of the HDPE sheet layer.
- Gravel layer of 0.5 m thickness, for leakage drainage with its corresponding piping network.
- “Filter” Geotextile (greater strength) to avoid clogging of the gravel.
- Protective soil layer of 0.10 m thickness.

Once the disposal surface corresponding to one operational section has been prepared in the manner described above, the waste will be placed following the operational lines (sections, lanes), until the capacity of the cell has been reached. After this has happened, the cell closure will be carried out. The final cover will consist of the following layers listed from the bottom up:

- Soil regularization layer of 0.30 m minimum thickness.
- Clay layer of 0.5 m thickness.
- Waterproofing HDPE sheet layer of 2 mm thickness.
- Geotextile against punching, for the protection of the HDPE layer.
- Gravel layer of 0.3 m thickness for rainfall drainage.
- “Filter” Geotextile to avoid gravel clogging.
- Layer of selected soil of 0.6 m thickness.
- Anti-intrusion layer of coarse gravel, 0.30 m thickness.
- Vegetal soil layer of 0.3 m thickness.

To control the possible infiltrated water the two systems already described above are emplaced in the disposal cell, the infiltration water net (IWN) and the losses control net (LCN).

An adequate slope for the proper drainage of collected water will be implemented during the construction of the lower clay layer. Consequently, the perforated polyethylene piping net will then be laid out on top of the geotextile. This net will transport the collected losses to a piping collector placed in the basis of the supporting dam. This pipe will flow to a basin for taking samples and finally to a control tank placed downstream the cell.

A gravel layer of 0.30 m thickness is then placed on the piping net, which accordingly represents the same slopes than the clay layer. Together, the piping and the gravel layer act as the LCN. After that, the Infiltration water network (IWN) will be prepared. A sheet layer of HDPE with its protective geotextile will be put on top of the gravel layer mentioned above, a new net of piping similarly constructed as the LCN will be installed on top of the HDPE layer.

In order to keep rainfall water away from the disposed waste, circumferential drainage ditches will be constructed around the area occupied by the different sections of the repository that have been constructed so far.

In order to prevent from raising the water pressure from the bottom as a consequence of the potential increase of underground water level, the drainage water shall be erected.

Regarding the individual disposal structures for VLLW, the operation consists of the consolidated disposal of waste, with the aim of the best use of the disposal area and stability of the disposed waste. According to width of the accessible surface will be placement of the waste performed in circles in the lengthwise direction, called operational lanes. These will be globally covered by the light roof. This coverage shall have the width 20 m and it will stand on two rows of supports in the different height regarding the different levels of the operational cycle. The basics of coverage will lie in small concrete bases.

Waste will be transported to the entrance of VLLW repository in the packaged form on the transport vehicles and to the disposal area will be placed by means of mobile gantry crane, or by other suitable mechanism. The crane disposes the package forms on the bottom of the stabile stacking. After completion of one layer of stacking of waste will be on the upper part of waste placed solidified layer of soil with the minimum depth of 0.3 m. Immediately, after the operational lane is fully completed, the coverage will be transported to the adjacent lane and the whole process is repeated again until the cell is fully filled.

In order to continue with RAW disposal (currently is filled the first double-row of RAW on approximately 80 % of the capacity), it will be necessary to put into operation the 2 double-row, prior to the implementation of disposal capacities enlargement of LILW and repository erection for VLLW as well as prior to completion of 1st double-row disposal. In connection with the erection of the new hall above the 2nd double-row, shall be implemented reconstruction of the individual disposal structures and provision of the controlled drainage with the necessary technological equipment. Completion of RAW disposal in the 1st double-row after its filling by the FCC containers represents backfilling of free spaces between FCC containers and walls of fibre-concrete containers and implementation of the 1st part of this double-row coverage. First phase of coverage shall not be implemented complexly according to the actual conception set forth in PpBS NRR. It will be necessary when, the hall above the 1st double-row will be dismantled. The second phase of coverage and closure of the repository will be performed according to the individual project and based on the individual building permission after NRR operation completion.

2 THE ACTUAL STATE OF ENVIRONMENT OF THE RELEVANT AREA, HABITANTS AND URBAN STRUCTURE

At the Mochovce are placed two individual sites of nuclear facilities - namely:

Site of nuclear facilities of SE-EMO includes operational double-unit NPP EMO12 and Unit 3 and 4 under construction (double-unit MO34). To the double-unit EMO12 is connected nuclear facility Final processing of liquid RAW (FS KRAO), which provides the conditioning of liquid RAW from operation of NPP EMO12 by bituminisation and cementation.

Site of NRR Mochovce (approximately 1.5 km northwest from SE-EMO site), which is operated by Jadrová a vyraďovacia spoločnosť, a.s. Bratislava (JAVYS). This company is also the operator of the nuclear facility FS KRAO, which is placed at NPP SE-EMO site.

Regarding the radiological protection of the habitants in the surrounding of NPP SE-EMO, it is declared *the zone of hygienic protection* without the permanent settlement up to the distance of approximately 2 or 3 km from the area of the nuclear facility. Regarding the usage of this zone for the agricultural production there are not stated any limiting conditions, except the performance of the inspection of radiation situation and inspection of the potential contamination of the agricultural production. Settled and permanently lived-in area of the relevant villages are placed outside *the zone of hygienic protection*. On the boarder of the protection zone of the closest to it are placed the villages Nový Tekov, Malé Kozmálovce, Tlmače, Nemčiňany, Čifáre, Veľký Ďur and Kalná nad Hronom.

The NRR Mochovce site is placed in the zone of hygienic protection of NPP SE-EMO. The repository itself does not represent for the surrounding area the significant risk – calculated conservative values of the doses are lower than the values of targeting levels for the habitants protection. Based on that, NRA SR stated the extent of the endangering zone of the nuclear facility of NRR at Mochovce site as the area limited by the barrier of the guarded area, i.e. fencing of NRR Mochovce.

Boarders of the relevant area regarding the impact of NRR on the surrounding habitants were stated by the elaborators of the report in order to include the area, which is a subject of analyses of safety demonstration and deriving of acceptance criteria of the packaged forms of waste for disposal and municipality Kalná nad Hronom, due to the fact, that this municipality administrates the former area of Mochovce municipality.

The current state of environmental quality regarding the impact assessment of the nuclear facility operation on the surrounding environment is documented by monitoring of the ionising radiation level and quality of radionuclides in the individual elements of environment.

2.1 Monitoring of radiation situation in the surrounding of NRR

Currently is the impact of NRR Mochovce assessed based on the results of the monitoring of stated radionuclides activities in water, which is periodically discharged (if necessary) from the retention tanks in which is collected rainfall water from the surface of road communication and also water from the controlled and monitored drainage. Monitoring of the discharged water from the retention tanks is the part of Monitoring programme of NRR. The whole system of NRR monitoring consists of the following parts:

1. Monitoring of the underground, drainage and surface waters,
2. Monitoring of the air, soil and food webs,

3. Monitoring of the clay bath humidity,
4. Monitoring of the erosion impact on the repository area,
5. Monitoring of the ferro-concrete constructions of the repository,
6. Monitoring of the settlement of the disposal premises.

The monitoring programme of the individual parameters was specified for the individual phases of the "life cycle" of the repository as- pre-operational – operational and post-operational (period of institutional control). In general, is the monitoring programme focused on stating of properties of the construction elements of the repository and parameters of the surrounding area, which are important for the impact assessment of disposed RAW on environment in the near or far surrounding. In the individual phases, are emphasised such activities, in order to provide the objectives of the monitoring, which are characteristic for the given phase. The level of the impact assessment of disposed RAW on surrounding environment is provable finding of exceeding the activity of the characteristic radionuclides in the individual elements of environment **above the level of so-called natural radiation background.** In the individual phases of the life cycle of the repository can the individual parts of monitoring become more significant.

In pre-operational phase (survey sub-phase and sub-phase of erection and commissioning of monitoring system) with the aim to find out the necessary so-called natural radiation background. In pre-operational phase of NRR Mochovce monitoring was the attention devoted to other elements of monitoring focused on the specification of parameters of ferro-concrete containers (boxes for disposal of FCC and also FCC itself) and other engineering barriers (humidity of clay sealing, settlement of dilatation units etc.) and its confirmation with the assumptions taken into account within the project.

In the operational phase is the monitoring system in the standard operation, focused mainly on identification of relevant deviations from the project behaviour of the individual function elements in the course of repository being filled in, eventual leakages of contamination from the disposal area and from the operations by RAW disposal and for the monitoring of trends of monitoring values. The basic monitoring qualitative element is the content of defined potential radioactive contaminants in the relevant elements of hydrosphere (mainly in underground and surface waters). Also currently during the NRR Mochovce operation, it is focused on the monitoring of the hydrosphere. Water from the rainfall tanks on NRR is being monitored, which serve as collection tanks of drainage waters (monitored and controlled drainage of disposal boxes). Water from the tanks is the organised way (after the control) discharged by means of tributary C into Telinský stream, which mouths into Čifársky pond. The objective of the monitoring is the **control of meeting the stated limits of water discharge from the NRR Mochovce site.** Whereas discharged is practically rainfall water, activity of the monitored radionuclides represent nominal fragment of the limit values. Except hydrosphere is monitored also air, soil and other parts of environment. The significance of such monitoring is mostly verification, whether the operation of the near NPP (SE-EMO) does not have an impact on these parts of environment in NRR area. During the operation of NRR, the attention is paid also to other elements of monitoring with the emphasis on **settlement of disposal structures** in connection with filling of ferro-concrete boxes by the FCC containers with RAW. The measurement of settlement is performed by means of specific levelling of disposal boxes and by means of dilatometers. The results show that the current settlement of boxes proceed within the expected limits.

In post-operational phase will the monitoring and control of environment follow continuously on the operational phase of the repository existence, i.e. on functions and assessment of the results of operational monitoring system, while it shall reflect the real state on the repository in the relevant phase. It is based on the safety analyses of the approved project of operational shutdown and repository closure, part of which will be also the project of post-operational monitoring and institutional control. Post-operational monitoring of environment can be characterised as controlling activity, with the purpose to demonstrate, that closed repository is as a whole stabile structure and its impact on environment and habitants is nominal in time from the safety point of view.

Current results of monitoring of the radiation situation in the surrounding of NRR document, that operation of this nuclear facility or operation of the near NPP SE-EMO do not influence radiation situation, which does not differ from the radiation background. The correct setting and functionality of this monitoring programme is demonstrated by reliable and definite recording of radiation background disturbance as a consequence of NPP accidents (in 1986 NPP Černobyľ and in 2011 NPP Fukushima). The violation of the radiation background was definitely recorded also by the last performed test of atomic bomb in the phase of pre-operational monitoring in 1981.

3 ASSESSMENT OF THE ASSUMED ENVIRONMENTAL IMPACTS OF ACTIVITIES

In the report is performed assessment of the assumed impacts of the proposed activities on environment and on health of the surrounding habitants, which is shortly summarized in the following table-

Tab. C-X. 1 Summary of the environmental impacts assessment of the proposed activity

Description of the impact	Assessment
Habitants	
Creation of the new work positions	Enlargement of NRR will ensure work positions – on one hand (temporary) during the erection, on the other hand, long term in the period of operation.
Traffic load	Frequency of the transport in the relevant area in connection with the transport of waste to the newly erected disposal area will not change compared to the current situation. The minimum increase of traffic load in the relevant area is expected after the transport of VLLW.
Activities of habitant	Regarding the placement of the proposed activity into existing NRR site, outside the town residential area of seats and in the sufficient distance from the habitable zone, can be the impact of the proposed activity on the current habitant activities considered as acceptable.
Health state	The proposed activity does not significantly influence the environment by emissions, noise and waste production, waste waters, not suitable demands for energies, water, supplying by gas, which should have negative impact on peoples' health. Negative impacts are not expected also in the psychological or social sphere. Localisation, water economy provision, disposition solution and standard of technical and technological solution will provide all conditions of safety and health and will eliminate the risk of impact on health state and comfort of habitants. For the proposed activity was performed assessment of the health risks, based on which it can be stated that the increased risk for health of the relevant habitants has not been proved even after the consideration of the current load. Impact is assessed than as acceptable. Summary dose from the common operation of both types of the repositories in NRR site, or even the maximum by the conservative assumption of the annual drinking of the underground water or even using it from Čifársky pond, does not exceed the radiological limit 0.1 mSv/year in any case, not

Description of the impact	Assessment
	even in case of degradation of all barriers after the completion of the institutional control. Similarly, even after the potential unconscious violation of barriers would be the stated radiological limit 1 mSv met with the sufficient reserve.
Geological surroundings	
Establishment of constructions and excavation works	Assessed activity does not require any significant terrain modifications or intervention into the countryside (alternative III). Alternative II requires smaller terrain modification. Terrain modifications are required in alternativeI and IV and erection of borrow-pit for the provision of the required amount of clay soil.
Geological environment	The facility itself forms from the geological point of view foreign element in the geological construction of the area without the other impacts on the quality.
Air	
Emissions, scent substances	Repository will not be the source of emissions of the stored gas or scent substances. The repository will not change the current quality of air in the area in any phase of its life cycle.
Water	
Production of the sewage water	Sewage waste waters, in the amounts responding to consumption of portable water and for sanitary purposes produced during the erection shall be, as required, transported for liquidation to the contracted sewage tank. In the future, it is considered to erect small waste water treatment facility. System of sewage waters offtake and system of the special canalisation will not change.
Production of technological waste waters	In the current operation of NRR, the waste service waters were not produced.
Rainfall waters, surface offtake	The purpose of the rainfall basins is capturing and control of rainfall waters from the repository site prior to its discharge into dewatering channel. Waters collected in the basins are controlled before discharging from the repository. Regarding the usage of the existing site and regarding the area of erected reinforced surfaces, the current offtake conditions of the relevant area will be influenced only minimally. This impact is assessed as nominal.
Contamination of surface waters	The solution of the water economy provision of the proposed activity, by meeting of all accepted safety measures is the contamination of the surface waters practically eliminated. The potential contamination of waters can occur after the closure of the repository and potential degradation of barriers after exceeding of its lifetime in the far future, when the activity of the disposed radionuclides will be accepted regarding the impact on the surrounding habitants. In general, can this impact assessed as nominal.
Soil	
Occupation of soil	Alternative III does not require any occupation of the soil. Alternative II requires 2 ha. Alternative I and IV require permanent occupation about 4 ha of soil and terrain modifications (removal of plough land, excavation of disposal area, erection of the access roads, and oofftake of rainfall and drainage waters).
Contamination of soil	The proposed technical solution of RAW disposal will not influence the quality of the surrounding soils.
Waste	
Production of waste	The classical building waste can be produced during the building activities in connection with the transfer to the next double-row in the amounts and categories of waste adequately to the character and scope of the reconstruction and necessary building interferences. The RAW repository is designed for disposal of radioactive waste. Other “production” activities by which waste could be produced, are not expected.
Countryside	

Description of the impact	Assessment
Structure and scenery of the countryside	The activity will be implemented in the existing NRR site (alternative I-III), the scenery of the countryside will not change in comparison with the current state. Incorporation of NRR site into the natural area will solve the design of final coverage after the definite closure. Regarding the stated amount, this impact can be assessed as acceptable.
Usage of countryside	By the implementation of the proposed activities will not change the ratio between the natural elements and anthropogenic components of the environment. The functional usage of the assessed area shall not change.
Protected territory	In the relevant area are not situated any protected bird area, area of European significance, continual European system of protected areas (NATURA 2000), national parks, protected landscape areas, or protected water economy areas, which could be influenced by the proposed activity.
ÚSES (territorial system of ecological stability)and ecological stability	NRR does not influence the ecological situation in the surrounding area or its impact on the land-use system of the ecological stability has not been proved yet.
Operational risks and its possible impact on the area – possible creation of accidents	
Failure of the technological equipment	The accident during the operation connected with the radioactive substances leakage and consequent requirement of habitants protection, cannot happen at NRR.
Risk of the terrorist attack	The repository is provided by the system of physical protection, which can prevent from the terrorist attack. Attack from air by controlled crash of the transport airplane is limited by its placement and low height.
Fire, explosion	From the analysis of the risk sources inside and outside the area of NRR results, that decisive initiatory event, causing the explosion, does not exist. NRR is not listed as facility with the increased danger of fire.
Risk of the mutual influence of SE-EMO and NRR	Operation of the repository and NPP SE-EMO is independent from each other, so accident in NPP cannot endanger the basic functions of the repository and the other way around.
Floods, extreme rainfalls	The repository is erected above the level of the underground water and surface conditions of the repository site are such, that provide offtake also from the maximum rainfalls and the therefore the floods would be prevented. The area of repository is placed above the maximum water levels of streams, namely by the assessment of the historically extreme overflows.
Earthquake	NRR is placed directly on the fault zone. Earthquake regarding the probability and possible consequences is not listed between initiatory events.
Other events exceeding the framework of the design event	The buildings of NRR are designed in a way, that even the extreme meteorological conditions will not endanger the safety of its operation.

4 CONCLUSION

In the submitted report on assessment were in overall assessed impacts of the proposed activity on environment in four alternatives, including the zero alternative. Whereas on NRR will be after enlargement also stored RAW of LILW type (as it was until now), all solution alternatives contain so-called "classic enlargement of NRR", which consists of erection of next disposal boxes according to the similar concept as it was chosen for the existing two double-rows. Alternative I and alternative II differs by the concept of VLLW disposal. Alternatives III and IV consider erection of separated disposal structures of

VLLW. It differs by the fact, that **Alternative III** considers the erection of VLLW repository at the NRR site, while **Alternative IV** assumes the erection of VLLW repository at Mochovce site, but not in the NRR itself, but in the near area – “outside the fence“.

In general, it is possible to evaluate all considered alternatives as suitable for the implementation, while by the stated comparison of assessed alternatives of the proposed activity **seems as the most suitable alternative III.** In comparison with it the second alternative II requires higher costs.

NRR is placed in the sufficient distance from the built-up areas and regarding the character and the scope, there is not assumption of the negative impacts creation on the quality and comfort of life of the relevant habitants and its future generations.

Based on the above stated, we recommend to follow the proposed conditions for the implementation of the proposed activity “Enlargement of National Radwaste Repository in Mochovce for disposal of low and intermediate level waste and erection of the repository for very low level waste” the assessed alternative no. III or II.

XI. THE LIST OF SOLUTIONISTS AND ORGANIZATIONS INVOLVED IN THE DEVELOPMENT OF THE ASSESSMENT REPORT

The Intent and the Report on the assessment of the proposed activity “Enlargement of NRR in Mochovce for disposal of LILW and erection of repository for VLLW” was developed by the “Division of radiation safety, liquidation of nuclear facility and processing of RAW” in VUJE, a.s. Trnava. In development of the mentioned documents contributed as Consultant Mr. Peter Salzer from DECOM, a.s. Trnava.

Nominal list of solutionists:

Name	Organization
RNDr. Václav Hanušík, CSc. **RNDr. Jozef Morávek, CSc.** **Mgr. Zdena Kusovská**	Division of radiation safety, liquidation of of nuclear facility and processing of RAW VUJE, a.s., Okružná 5, 918 64 Trnava

XII. LIST OF ADDITIONAL ANALYTICAL REPORTS AND STUDIES THAT ARE AVAILABLE FOR THE SUBMITTER AND THE BASIS FOR THE ASSESSMENT REPORT

1 LIST OF REPORTS AND STUDIES FOR THE SUBMITTER SUBMITTED AS A BASIS FOR THE DEVELOPMENT PLAN AND ASSESSMENT REPORTS

So far, for the extension of the NRR at Mochovce and the erection of repository of VLLW were developed studies which are described below. These studies were developed within the international project, by Spanish-German consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. in 2008.

Research team who participated in the drafting of this document consisted of employees of the consortium (Biurrun, E., Haverkap, B., Sanchez, J.) which was led by Dr. Enrique Biurruna. To the preparation of input data and preliminary impact assessment of the proposed alternative solution for environment contributed the employees of the company EKOSUR Jaslovské Bohunice: Kostolanský, M., Matušek, I., Plško, J., Kučerka, M., and Fiedler, F. as external employees.

These studies are based on the need to address the problem of radioactive waste disposal with very low activities, which seriously showed in Slovakia as a consequence of V-1 NPP shutdown. It is expected, that in the course of V-1 NPP decommissioning will be to the increased extent produced RAW with very low radioactivity, due to the fact that during the whole operation of V-1 NPP was not recorded any serious extraordinary event with leakage of radioactive substance into operation premises or in the surrounding area. All campaigns have been completed without major fault of fuel assemblies sealing, what will positively influence the composition of radionuclides in RAW and in contaminated materials, which should be released into the environment, respectively which shall be disposed at repository. In these studies have been particularly stated the possibilities of VLLW disposal in the individual sites with nuclear facilities in (sites Jaslovské Bohunice and Mochovce), or eventually on different suitable places, analysed advantages or disadvantages of alternative solution of RAW disposal of VLLW type, due to the fact that assumed amount in connection with V-1 NPP decommissioning in Jaslovské Bohunice requires the new view on the conception of RAW disposal alone. It concerns the following studies:

1. Methodology of project implementation – Output from C9.1-D0. Contract: BIDSF 009 4 001. Consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. Madrid, Spain; Peine, Germany, August 2007.
2. Input data - Output C9.1-D1. Contract BIDSF 009 4 001. Consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. Madrid, Spain; Peine, Germany, March 2008.
3. Assessment of conceptual design alternatives - Output C9.1-D2. Contract BIDSF 009 4 001. Consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. Madrid, Spain; Peine, Germany, September 2008.
4. Preliminary Safety Analysis - The output of C9.1-D3 - Part 1. Contract BIDSF 009 4 001.

Consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. Madrid, Spain; Peine, Germany, November 2008.

5. Preliminary study of environmental impacts - Output C9.1-D3 - Part 2. Contract BIDSF 009 4 001. Consortium INITEC S.A.U – DBE TECHNOLOGY GmbH. Madrid, Spain; Peine, Germany, January 2009.
6. Solution of transition from the first double-row to second double-row of NRR Mochovce. Summary technical report of the project, Arch. no. EGPI-6-100512, EGP INVEST Uherský Brod, December 2010

The first four outputs of the solutions of the stated project have the character of the feasibility study of possible alternatives for disposal of VLLW (technical disposal solution) with an emphasis on assessing the suitability of the location options. Based on criteria analyses is formed the conclusion, that the optimum solution is to implement the disposal of RAW of such type in the existing site in Slovakia, where are presently disposed RAW from NPP operation and A-1 NPP decommissioning, having the character of low and intermediate level waste (LILW) – ergo in National Radwaste Repository in Mochovce (NRR).

The study referred to under No. 5 is developed in accordance with Annex No. 9 of the Act on Environmental Impact Assessment [L-1], as well as according to the statements of authors remains at the level of the feasibility study.

The last of the mentioned studies represent design solution of 2nd double-row operation, which should be implemented prior to erection of new disposal structures within the enlargement of disposal capacities of NRR Mochovce.

These materials were submitted by submitter of Intent as the basic documentation for solution and development of the Intent for the proposed activity and consequently also for the development of Assessment Report.

2 REFERENCES

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[L-2] Act of National Council no.287/2009 Coll. amending and supplementing the Act no. 24/2006 Coll. on Environmental Impact Assessment

[L-3] Act of National Council no. 355/2007 Coll. on Protection, Support and Development of Public Health (including amendments to certain acts).

[L-4] Act of National Council no. 345/2006 Coll. on basic safety requirements for protection of health of workers and habitants against ionising radiation

[L-5] Regulation of Ministry of Labour, Social Affairs and Family of the SR no. 718/2002 Coll. for Assurance of Safety and Protection of Health at work and safety of technical equipment

[L-6] Act of National Council no. 541/2004 Coll. on the Peaceful Use of Nuclear Energy, as amended.

[L-7] Regulation of NRA SR no. 49/2006 Coll., on periodic nuclear safety review

[L-8] Regulation of NRA SR no. 50/2006 Coll., by which are stated the details on requirements for nuclear safety of nuclear facilities by its placement, design, erection, commissioning, operation, decommissioning and closure of repository as well as criteria for categorization of classified equipment into safety classed.

[L-9] Decree of NRA SR no. 53/2006 Coll., by which are stated the details on requirements by radioactive waste management, RAW and nuclear spent fuel

[L-10] Decree of NRA SR no. 55/2006 Coll. on details of emergency planning in case of incident or accident.

[L-11] Decree of NRA SR no. 56/2006 Coll. on details of requirements on documentation of quality system of licence holder as well as details on quality of nuclear facilities, on details of requirements of classified equipment and details on the scope of approval.

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[L-14] T-153 – Transport of FCC by combined way. Technological PP JAVYS, a.s.

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[L-19] Act of NC SR no. 142/2000 Coll. on metrology as amended

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[L-23] Limits and Conditions of NRR operation A-02/RÚ RAO, JAVYS, a.s., June 2009

[L-24] Decision of chief sanitarian of the SR no. 9649/98-SOZO/ŠZÚ SR from 21.10.1988

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XIII. DATE AND CONFIRMATION OF THE CORRECTNESS AND COMPLETENESS OF DATA BY SIGNATURE (STAMP) OF THE AUTHORIZED REPRESENTATIVE OF ELABORATOR OF ASSESSMENT REPORT AND THE SUBMITTER

1 CONFIRMATION OF THE DATA ACCURACY BY AUTHORIZED REPRESENTATIVE´S SIGNATURE (STAMP) OF ELABORATOR OF ASSESSMENT REPORT

Name	Signature	Date and Stamp
Ing. Marián Štubňa, CSc.	.... **director** Division of radiation safety, liquidation of nuclear facility and processing of RAW VUJE, a.s., Okružná 5, 918 64 Trnava	....

2 CONFIRMATION OF THE CORRECTNESS AND COMPLETENESS OF THE DATA BY SIGNATURE (STAMP) OF THE AUTHORIZED REPRESENTATIVE OF THE SUBMITTER

Approved by		SIGNATURE	Date
Ing. Ján Horvát -	The Chairman of the Board of Directors and CEO	....	....
Ing. Miroslav Obert -	The Vice-Chairman of the Board of Director and Decommissioning and PMU Director	....	....
Ing. Milan Orešanský -	Member of the Board of Directors and Economy and Trade Division Director	....	....
JAVYS, a.s. **Tomášikova 22** **821 02 Bratislava**		**Stamp of JAVYS, a.s.**	