Intention
pursuant to the Act of National Council of the Slovak Republic No.24/2006 on the Environmental Impact Assessment

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

(brief summary)

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6. NAME

Jadrová a vyraďovacia spoločnosť, a.s. Bratislava

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2. AUTHORIZED REPRESENTATIVE OF THE SUBMITTER

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Ing. Slavomír Brudňák - Member of the Board of Directors and Direction of Safety Division

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II. BASIC DATA ON THE PROPOSED ACTIVITY

1. NAME

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

2. PURPOSE

The purpose of the prepared investment activity is to ensure change in utilization of NRR in Mochovce so that it will be prepared for disposal of radioactive wastes (RAW) inventory that is and will be in accordance with the acceptance criteria of radioactive waste packages suitable for disposal. To achieve that it will be necessary to expand the existing double-rows of repository boxes thus increasing capacity for disposal of LILW from the operation and decommissioning of the Nuclear Power Plants (NPP) in the Slovak Republic and to provide for safe and efficient disposal of VLLW.

The proposed material shall provide expert data needed for subsequent assessment of versions of proposed solution for NRR enlargement and construction of VLLW repository from the point of view of environment impact and for issue of activity permission according to special regulations.

3. USER

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

4. TYPE OF PROPOSED ACTIVITY

The proposed activity can be characterized as a **Change** in utilization of the NRR. The change of proposed activity is categorized, from the environment impact assessment's point of view, according to Annex no. 8 to the Act no. 24/2006 Coll., as amended, into part 2. Power industry, article no. 10 „Facilities for processing, treatment and **disposal of low and intermediate level wastes** from the operation and decommissioning of nuclear power plants and radionuclide utilization." Obligatory assessment from the environmental impact's point of view is prescribed for these facilities without regard to whether it concerns new facilities or changes of an existing facility and that without limitation of size of facility or change.

In relation to **the enlargement** following changes on the repository over the near years are taken into account:

- **Enlargement of NRR capacity with further disposal structures for low and intermediate wastes.**
- **Separate disposal of VLLW in the NRR area, namely either in new separated disposal structures for VLLW or within NRR disposal boxes via an easier technological procedure (e.g. without fibre reinforced concrete containers (FCC)).**
- **Change (specification) of limits and conditions – the radioactive waste (RAW) acceptance criteria for repository in relation with said activities, which will be part for safety**

documentations submitted with the application for activity permission according to special regulations.

Balance considerations setting requirements for capacity of repository spaces over time were subject of an entire range of studies. In the output from the project financed by the BIDSF C9.1 "Feasibility study of enlargement of the NRR Mochovce" is stated the entire amount of RAW disposal of which can be considered: operation and/or decommissioning of NPP A1, V1, V2, NPP12, MO34 plus an insignificant amount of (in terms of amount and activity) institutional RAW. According to the Designer's requirements, the capacity of NRR Mochovce after enlargement should be equivalent to the amount of RAW that was set in this project – Chart II.1.

Chart II. 1 The required capacity of NRR Mochovce for disposal of LILW and VLLW

LILW	VLLW
7,5 of double-row	68 000 m^3

Within the environmental impact assessment of proposed activities all designed changes on NRR are being assessed in this document jointly so that this repository (this locality) could be used for RAW disposal even in the future, after filling up of existing repository structures.

Also other activities, whose execution do not condition directly the operation of this repository or is not directly connected to RAW management from the operation or decommissioning of nuclear facilities in the Slovak Republic, will be executed in the vicinity of NRR. E.g. storage of institutional RAW, office building, information centre etc. does not belong to said activities. The environmental impact assessment process of institutional radioactive waste and orphan sources storage facility Mochovce is now under way.

5. LOCATION OF 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 Designer and are registered as other areas outside the developed area of municipality.

The benefits of use of this area for construction of new repository spaces are that this area has already been used for disposal of RAW. The criteria of selection thereof suited the legal regulations, the IAEA safety standards for placement of nuclear power plants valid as of date of placement of the repository. The safety of RAW disposal in this repository was confirmed mainly by engineering-geological and hydro-geological survey within finished work in 1996 to 1999.

The NRR is located approx. 1.5 km to the north-west from the NPP EMO (in its protection zone), which is another advantage. This lies in that the very area of NRR (as the nuclear installation) it is not necessary to create a separate protection zone. It is possible to purposefully divide the execution of the monitoring programs for both subjects in the interest of increase in efficiency and quality of monitoring of the whole area.

6. OVERVIEW SITUATION OF THE PROPOSED ACTIVITY LOCATION

The transparent situation of the location of SE-MO and the Mochovce NRR is stated in Chap.V on Fig. V.1 and Fig. V.2.

7. BRIEF DESCRIPTION OF TECHNICAL AND TECHNOLOGICAL SOLUTION

7.1. Characteristics of current status

7.1.1 Area

The NRR Mochovce is built on the area of total amount of 11.2 hectare and it consists of a complex of buildings, technical facilities serving for handling with RAW from their arrival to the repository up to the final disposal of. The part of the area is fencing, access and interplant roads, retaining ditches, operational building, the object of repository itself or 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 NNE – SSW. Only 20% of its area is being used in the present.

7.1.1. Disposal spaces

The object of repository itself consists now out of two double-rows reinforced concrete boxes constructed in the northern area of the NRR area and oriented in the direction east-west. One double-row consists of ten units dilated from each other (width 37.25 m, length 123.2 m). 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. Cover panels with the thickness of 0.5 m and length of 6 m, included always from two repository boxes into one drain trench, and are laid on internal transversal walls. At the end of each row are stop ways of the crane track. Long stop way serves for manipulation with RAW during preparation for repository, adjusting track is build at the short stop way serving for transportation of the portal frame crane within individual rows or double-rows of the repository.

Compacted clay of required properties was used as the sealing element, separating the repository from the outside environment. The clay sealing creates a “bathtub” into which is the repository set. Compacted layer with the width of 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. The width of the vertical sealing clay layer in the area of both stop ways is 1m.

The repository boxes are secured from the inner side with the hydro-insulating cover and on their bottom a gravel draining layer (granularity of 8 – 16 mm) is laid, serving also as compensation layer for container disposal. The gravel layer is covered by hardening permeable geotextile.

Due to meeting of requirements for the RAW repository system, mainly in terms of prevention of rainfall waters access into the repository, the first double-row is covered with the steel hall with dimensions 52 x 156 m. The hall’s height is 16.76 m.

In the present, the 1st double-row of repository boxes is in operation and putting into operation of the 2nd double-row is being prepared. A model of covering is build in the south part of the area, on which the parameters of material (clay soil), which will be used for execution of the 2nd phase of covering in time of definitive closing of the repository, are being long-term monitored. The current state of the area is shown in Chap. V on Fig V.3.

7.1.2. Container

The conditioned RAW are disposed of into the repository in fibre reinforced concrete containers (FCC). The containers have a cubic shape with the height 1.7 m and minimum wall thickness of 115 mm (Fig. II.1). 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. Table II.2 contains further parameters of the FCC.

Chart II. 2 Parameters of the FCC

Type, label	The 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 the FCC	28 t + additional load from the covering
manipulation-grip device	upper 4-point hanger with automatic shut-down
overall volume (1.7 x 1.7 x 1.7m)	approx. 4.9 m^3
useful volume of the FCC	approx. 3.01 m^3
weight of an empty container (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.II. 1 Cut through the fibre reinforced concrete container

The FCCs are constructed under the French license and their integrity is guaranteed by the producer for the period of 300 years. These containers are at the same time also transportation containers.

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

7.1.3. Drainage system

It serves for draining and control of drainage waters from the repository area and its close surrounding. It consists of a system of controlled and observationed drainage.

Controlled drainage – its function is to drain waters if they got into the repository (gravel drainage layer in boxes or between the bottom of repository boxes and the bottom of clay bath). Concrete galleries, enabling controlled water drain 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 ventilation enabled. 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 reinforced concrete shafts. The shaft consists of four floors and in it there are located devices for shaft ventilation, spaces for sampling of drain waters, collection and manipulation of drain waters.

Observationed drainage – it drains the seepage 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 (Fig. II.2).

Rainfall water basins

Their purpose is retaining and control of surface rainfall waters from the repository area before their release into the 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 the “C” feeder of the Telinský stream. These surface flows mouth into the Čifársky pond, which presents virtually the only place of practical use (irrigation) of surface waters that are possibly affected by the repository.

Also drain waters (controlled drainage and observationed drainage) that are pumped over after the control from respective basins in the control shaft (controlled drainage – it concerns mainly waters from gravel bed under the repository boxes) and from the control cofferdam located outside the repository spaces in the long stop way (monitored drainage), are led into the rainfall basins. These waters are led into the retaining basins via underground tube collector.

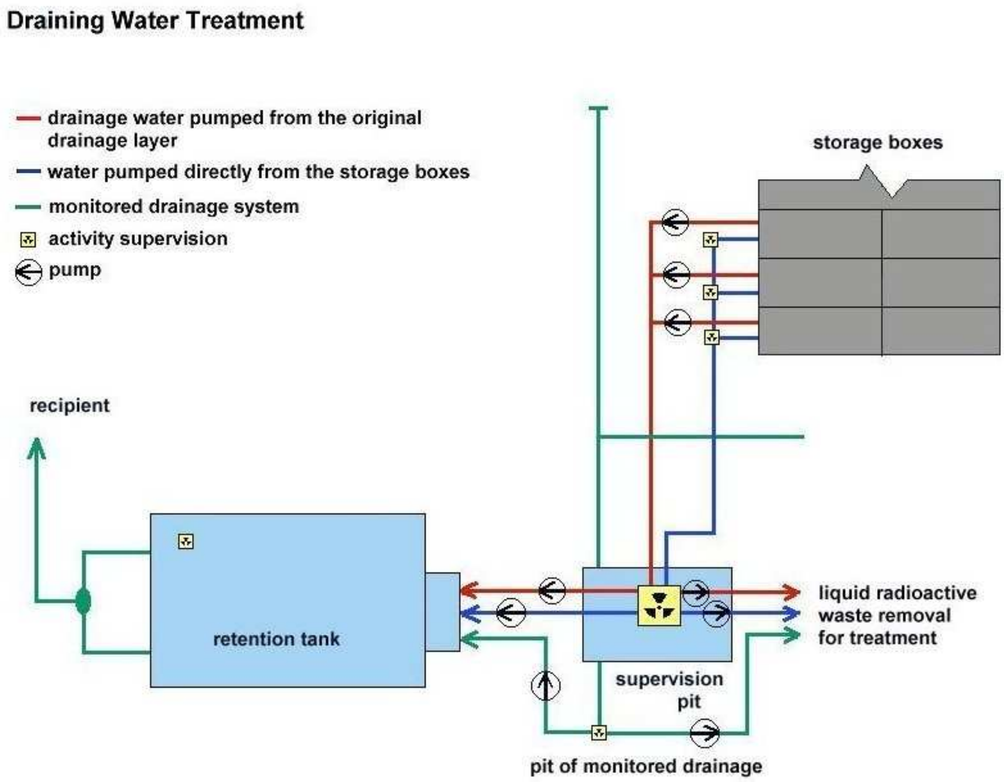

Fig.II. 2 Scheme of the drainage system and manipulation with drainage waters

7.2. Current operation – continuation of RAW disposal of in the 1st double-row and after its filling in the 2nd double-row

7.2.1. Waste packages

Wastes that are at the present day disposed of in the NRR are mostly operational wastes from the pressured water reactors of the WWER-440 type in Jaslovské Bohunice and Mochovce. Wastes from the NPP A-1 decommissioning are also disposed of. The Mochovce repository is not designed for disposal of spent nuclear fuel and high level radioactive wastes.

Low and intermediate level wastes, originating in the Slovak Republic during utilization of nuclear energy and ionizing radiation, have different activity of radionuclides and different physical and chemical form. Specific composition of radioactive wastes underlies technologies of their solidification and resulting properties of solidified form of the waste.

In term of valid limit requirements it is admissible to dispose of solid and compacted RAW only in such type of packaged forms of processed RAW in FCC that was agreed on by the repository operator and approved by the NRR.

At the present time during the operation of the repository, technologies of cementation together with bituminization of liquid wastes together with super-compaction of solid RAW are regarded as the main techniques of waste conditioning. For conditioning of RAW from the A-1 NPP also some more solidification matrixes are approved - SIAL, vitrificate and compacted ash with paraffin additive.

Radioactive concentrates from A-1 NP, V-1 and V-2 in Bohunice and from NPP Mochovce are solidified by bituminization. A soft type of bitumen A-P80, produced by Slovnaft a.s. Bratislava, is used as immobilization matrix. Dried salts from the concentrate, mixed with bitumen, are filled into 200 $dm^{3\ drums}$.

For compaction of sorted incombustible waste (PVC materials, glass, mineral wool, small metal material) from the A-1 NPP, V-1, V-2 and NPP Mochovce a low pressure compactor is being used. Trough low pressure compacting a 4-5 fold volume reduction is achieved. High pressure compactor is being use for compaction of MEVA drums filled with soft compressible waste after low pressure compacting, drums with metal wastes (tubes not more than 6 mm thick). The result of high pressure compaction is pressed material (pellet) with height of approx. 24 cm.

Chemical composition of the SIAL type matrix is similar to chemical composition of cements. SIAL is an inorganic mixture that is formed by polycondensation reactions of aluminosilicate slunks. It is suitable mainly for cold-immobilization of sludges, without exothermic reactions.

By vitrification, i.e. by immobilization into a glass matrix at temperature of 1050℃ in inert argon atmosphere, the cooling medium after storage of the A-1 NPP, so-called chrompik (mixture of chrome and potassium dichromate), is being processed.

Concentrates from NPP A-1, V-1, V-2 Bohunice and NPP Mochovce, sludges and gravels from outside basins of the NPP A-1 and the contaminated water from cleaning of burned gasses from burning of RAW are immobilized in the cement matrix. The interspaces between compacted materials, drums and freely emplaced certain types of RAW in FCC is filled with cement mortar (active and non-active).

Usually 6 pieces of bitumen product in 200 liter drums or 4 drums are inserted into the FCC and the rest empty volume is filled with pressured material from high pressure compaction. Such filled FCC, sealed in the cementation facility with active cement mortar, is (after sealing up and maturing based on criteria whose meeting is declared in its Accompanying letter) dispatched to the National repository in Mochovce.

The Accompanying letter contains all data – production parameters of the container, data about types and amounts of particular wastes emplaced into it, results of chemical control analyses, values from measures of radioactive nuclide composition of particular drums and cement mortar as well and last but not least results from monitoring of radioactive-safety characteristics. All these data are archived in written and electronic form and data about position of the disposed container and from the monitored repository will be added to them.

Long term safety of the NRR is achieved by limiting of radioactive nuclides activity in packaged form – FCC and overall inventory of radioactive nuclides in repository in [Bq]. The last version in force of limits and conditions for safe operation of NRR states these values as is shown in Tab II.3 and Tab II.4.

Tab.II. 3 Limit values of radionuclide inventory in FCC for NRR Mochovce

Radionuclide	Upper layer [Bq/VBK]	Bottom/middle layer [Bq/VBK]
^{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
Summary alpha	400 Bq/g	400 Bq/g

Tab.II. 4 Limit values of radionuclide inventory in the location 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 – inventory for given radionuclide is not limited

Meeting of these values together with meeting of other disposal acceptance criteria for wastes that have quantitative or qualitative relation with the safety analyses ensures that irradiation of individuals from the critical group of citizens does not exceed authorized values given by the state health supervision office.

7.2.2. Disposal of FCC into the boxes

The RAW will be transported in 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 data from labeling of the concrete container with RAW. The transportation vehicle with the FCC shall move to the location of disposal.

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

Disposal of containers with RAW follows the system of FCC laying 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.

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 layers than into upper layer.

The location of FCC is explicitly set by co-ordinates. The containers are disposed of upright, what is checked by the operating staff visually, eventually with the help of plumb line, before detaching of the grip device. After disposal of 30 FCC it is continued in disposal in another box in the designed order.

First packaged forms with RAW were accepted in NRR in 2000 after the supervisory body issued a permit for putting the NRR into operation in 1999. In 2001 the NRA SR issued a permit for operation of NPP NRR Mochovce. In the present the RAW are disposed into boxes of the 1st double-row on the basis of the operation permit issued by the NRA SR in 2006. Until now a total of 2168 FCC with total activity of 7.85. 10^{13} Bq was disposed in NRR Mochovce during operation in 2001 to 2009.

During the 10 years operation history all important technological devices were in the state of service availability. The values of collective dose and individual dose were practically zero. No irradiation accidents and also no violation of radiation safety rules were recorded. No radioactive substances were released neither to the atmosphere nor the hydrosphere.

The NRR carries out monitoring of the surrounding with its own technical means as well as trough the Laboratory of Radiation Control NPP SE-EMO in Levice. Selected measurements are carried out by external organizations: WERT s.r.o Trnava, PF UK Bratislava and VUJE a.s. Trnava. During the NRR operation history no values over the long-term average of the radiation background in the environment were recorded. The radiation safety during the operation history of the nuclear power installation NRR can be classified as good. No important deviation in terms of safety was found during periodic evaluation of this area. It was not necessary to adopt any remedying measures. Activities carried out in relation with the operation of NRR are carried out with high safety culture. It is possible to assert that the achieved stat in said area is satisfactory and it provides expectation of positive development for next period.

7.3. Enlargement of existing repository capacities in VLLW disposal context

Enlargement of NRR is key in this proposal and it is proposed in four versions. Individual versions of execution of said proposal were therefore, also with regard to the results of the project C9.1 after analysis of possibilities, 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 construction of third double-row of NRR for LILW disposal.

Following versions are proposed:

Version I **Classic enlargement of the NRR 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 RAW between LILW and VLLW.

Version II **Classic enlargement 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.

Version III **Classic enlargement of the NRR 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.V. 4**). Precise location and orientation of individual construction will be addressed in zoning permit drawings.

Version IV **Classic enlargement of NRR 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 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 (area of some of the NPP), which was subject of some previous proposals and was also analyzed in the project C9.1, is not considered. The reason is that this version was not recommended in the result of said project C9.1.

Very low level wastes are wastes whose activity is slightly higher than the limit value for their release into the environment, that contain preferentially radioactive nuclides with short half life, eventually also low concentration of radioactive nuclides with long half life and which require by their disposal lower level of isolation from the environment via system of engineering barriers as compared to radioactive wastes repository of surface type. In terms of categorization according to § 5 of the NRA regulation no. 52/2006 Coll., are the low level RAW a part of low and intermediate level RAW.

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 an order.

Alternative Zero

Within the Alternative zero it is considered not to extend the NRR. In the history of sequential repository filling practice there are two alternatives how sequential repository filling can be performed: as a continuation of disposal of operational waste from NPP and waste from JE A-1 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 total of 7200 pieces of FCC with total volume of 22 320 m^3.

From the moment of fulfillment of existing disposal structures, the not yet disposed RAW should have been stored until the final process of its management was implemented. The acceptable way of the management for LILW from today's point of view is the disposal in suitable repositories. 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. This solution is not in line with the Strategy of Slovak Republic for the back end on nuclear power.

7.3.1. Standard enlargement of NRR without special VLLW management (Alternative I)

Standard enlargement of NRR repository in Mochovce involves continuous (i.e.at pace that will be needed) construction of 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). The concept of disposal of according to LILW has not changed – processed RAW will be disposed into repository boxes in FCC as described in Chap. II.7.1 and II.7.2.

The standard enlargement of NRR is expected to be performed according to existing project (project of real implementation with potential application of improvements resulting from the previous practice experiences).

Alternative I of planned Intention expects building of third and further double-rows so that the current practice of RAW disposal can continue.

Part of the geologic survey will also be finding 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.

Within the enlargement project, it is also necessary to take into account the liquidation of boreholes line for potential underground water contamination monitoring if they are located in the area of new projected repository structures (double-rows). 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.

7.3.2. Standard enlargement of NRR with separated VLLW disposal in NRR disposal boxes (Alternative II)

Alternative II differs from the previous one only by the fact that VLLW would be disposed in specified boxes in existing or newly built NRR double-rows (see Chapt.Kap.II.7.1.1) in different type of container as in FCC. This way of disposal would require solve the question of the way of putting containers into boxes, drainage sedimentation and change of the solving the 1st phase of covering. From the 1st phase of covering solving point of view after the fulfillment of the boxes, it would be the best to assign whole boxes for VLLW disposal within this Alternative. Disposal economy would be solved only partially.

7.3.3. Separate VLLW disposal (identically 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 of with not changed nuclear safety (operational, short-term and long-term) and also with the fact that regarding to the lower activity of disposed waste it is possible to count with shorter period of institutional control of the relevant repository.

The VLLW repository resembles to the higher construction levels landfills. It will consist of following sections and/or systems:

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

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

- Lower requirements for engineering barriers which in practice represent:
  - Usage of less demanding and less costly packages in comparison with FCC in which the LILW are disposed,
  - Smaller thickness of isolation barrier – composite 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 or betonies,
- Shorter period of required institutional control if the VLLW repository is implemented far from the existing facility.

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

- Building for temporary waste storage,
- 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.V. 4) and within Alternative IV outside the NRR (nearby) at suitably chosen location.

Alternative III counts with the fact that new object for VLLW disposal will be built in current NRR according to the procedure specified in Chap.II.7.3.3. In regard to the fact that the space available in NRR is limited, it is necessary to optimize the space utilization by double-rows to create enough space for VLLW disposal at the southern end near the entrance – Fig.V. 4.

7.3.3.1. Current project approaches to VLLW disposal

VLLW disposal will be executed into basic structure – cell or module. For the cell there are three following construction phases:

- location preparation,
- contour dyke construction,
- protective layers construction.

Cell section is that part of the cell that, independently from its dimensions, by itself is a closed unit and complete with a leakage drainage network and a net for losses drainage.

Location preparation

Preparation works carried out on the whole surface of the disposal cell, will include these key activities:

- landscape modification, subsoil clearing and preparation for lower protective layers placement
- slopes construction of the cell walls so that the high stability and water-proof isolation is achieved.
- slope platforms construction, side ditches etc. necessary for the operation and access roads.
- lying of lower drainage layer (0.30 m of gravel) and isolation and sealing structures.
- construction of embankment with slopes (or their modification) in ratio 2H:1V on both sides, in lower part (in the direction of floor descent) of disposal cell (module) as the support of drainage layer and deposited waste.

In this particular case, in the NRR space, that is considered for the VLLW repository construction (after omitting set 7 and ½ double row for LILW) – in its southern part, the double-rows should be constructed so that it would be possible operate also the covering model for minimum 10 following years.

Protective layers

The disposal cell (module) contains several protective layers above and under the waste. In regard to the analogy, these layers are in similar repositories designed and implemented in accordance with valid legislation and standards for dangerous waste repositories.

The basic barrier against the radionuclide migration will the barrier of minimum 5 meters of clay with permeability coefficient of $K \leq 10^{-9}$ m/s. This will be reached by the combination of 1 m layer of composite clay and thinner bentonite layer.

As the water-proof isolation a foil made of polyethylene with high density (HDPE) and 2mm thick. In relation to the VLLW repository the most important are two layers of geotextile that are designated for HDPE foil protection and those located under the waste have with their own protective clay layer with thickness of 10cm.

After the soil modification, the lower protective layers and after the fulfillment with the waste also the covering layer - Fig.II. 3.

When the disposal cell is prepared according to the above mentioned procedure, the waste disposal will be started continuously in disposal rows (sections) until the disposal cell is used to capacity. Then the cell will be closed. Final covering will consist of layers that are also presented in the Fig.II. 3.

The disposal cell for VLLW will have the system for water control consisting of infiltration water, rainfall control and underground water control.

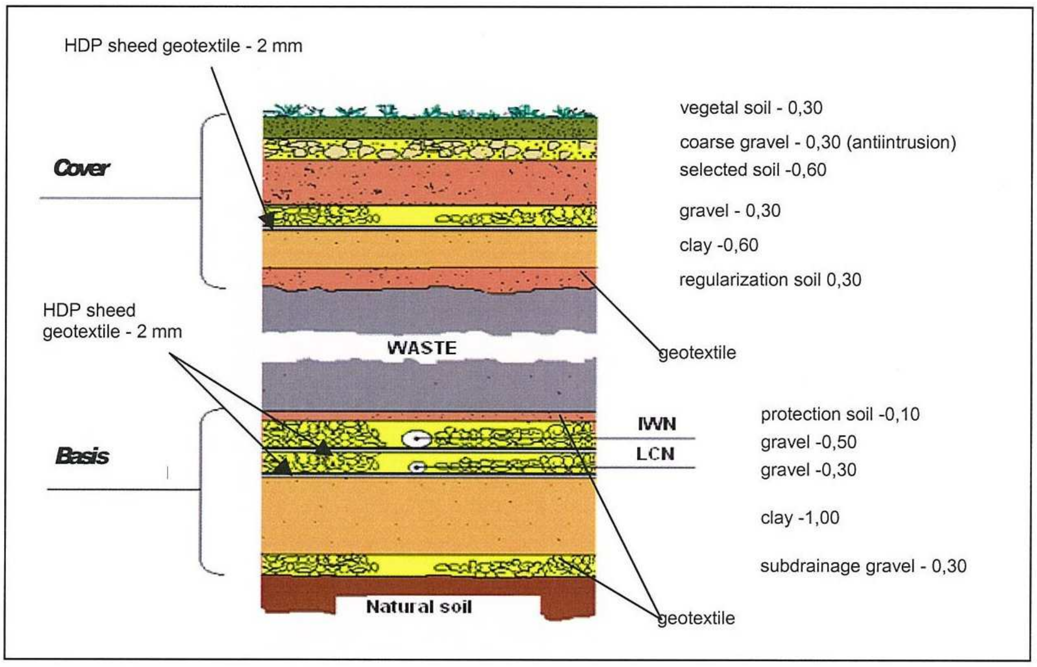

Fig.II. 3 Drawing of the basis protective layers and the cover of the VLLV repository

Infiltration water control

For the purpose of potential infiltration water control, two systems will be situated into the disposal cell, and that is Infiltration Water Network (IWN) and Losses Control Network (LCN) - see Fig.II. 4.

Rainfall water control

For securing the separation of the rainfall water from the disposed waste, there will be circuit drainage ditches built around the area with built sections. The drainage of these ditches will be directed through the contour road to the discharge location by the side pipe built on the both sides of the repository.

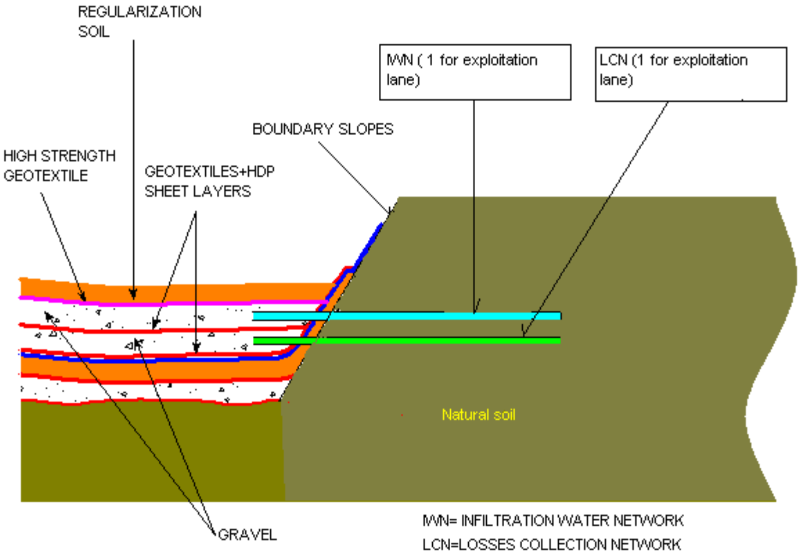

Fig.II. 4 Drawing of the Infiltration Water Network and of the Losses Collection Network

Subsurface water control

A drainage system will be implemented to prevent lifting pressures from the bottom, due to water surges or possible increase of the groundwater table. This bottom drainage layer will consist of a gravel layer of 0.3 m thickness, which contains porous piping system of PVC to evacuate possible water within this area. On top of the lower drainage layer, a geotextile layer will be placed to prevent clogging of the drainage layer by the clay layer above (Fig.II. 4).

7.3.3.2. VLLW repository operation

Regarding the individual disposal structures for VLLW, operation of each section consists of organized waste disposal in order to use the disposal space and the stability of the deposed waste most sufficiently. According to the width of the available surface, the waste disposal will be performed in lines in lengthwise direction. They will be overall covered by light roof. This shelter will stand on two rows of supports of different height in regard to different levels of operation line. The shelter foundations will lie on small concrete support plates.

After finishing one layer of waste stacking, a reinforced soil layer, minimum 0.3 m thick will be placed on the top layer of the waste. This layer will serve as a safe basis for crane and trucks used while laying the other layers.

The cross cut through the operation lane during the lying is trapezoidal, with width that can flexible and adjusted so that it can cover by the shield. As soon as the operation lane is completely full, the shield will be moved to the neighbor lane and the while procedure will be repeated until the cell is completely full. Following picture shows the cross cut of movable shield upright over the operation lane. (Fig.II. 5).

During the lying, the area, that is covered by the shield (that correspond with the operation lane), will be protected against rain but the rest of the cell will be subjected to it. This part will capture the rain water and divert it through the drainage system of seepages (IWN). For ensuring this function of IWN it is necessary to separate that part of IWN that drainages the operation lane, from the other part of the system.

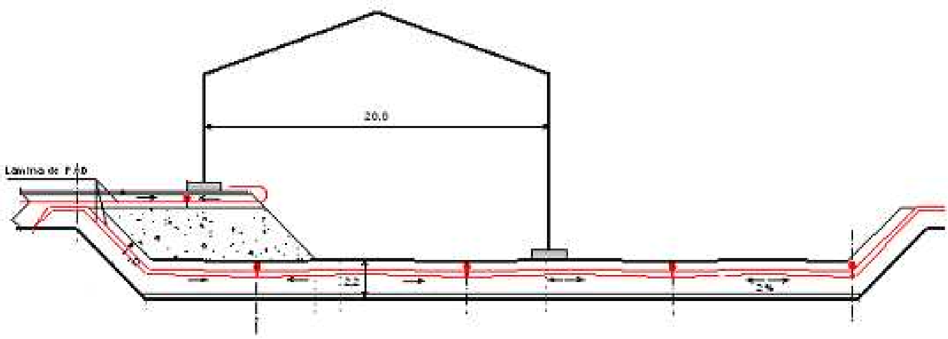

Fig.II. 5 Cross cut of the disposal cell during the disposal of showing the movable shield

8. REASONS FOR THE NEED OF ACTIVITIES IN THE CONCERNED AREA

The need to deal with the question of existing disposal structures of NRR Mochovce enlargement is related to the Government SR decision (resolution no. 801/1999) about the early shut-down and decommissioning of NPP V-1, that the waste from its decommissioning should be disposed earlier than it was originally expected and earlier than some operational RAW for which the existing two double-rows were originally constructed.

Parameters defining the NRR location were for the purpose of the need of repository long-term safety analyzed and discussed in details within the last and extensive version of the Pre-operational safety report for NRR in Mochovce from 1999. From current point of view none of the parameters value defining the location does not represent absolute neither conditionally disqualifying criterion.

Analysis of repository long-term safety showed that when following the limits derived from the inventory of radionuclides of disposed waste and other criteria of waste acceptance for disposal (technical specifications of safe operation), the existing repository will be on a long-term basis and inherently safe.

In the studies from the past, it was not considered that the new disposal capacities will be implemented somewhere outside of the current NRR location. In the study, that preceded the elaboration of this project, the attention was also paid to the VLLW disposal in the NPP location as well as in a new location. These possibilities were rejected in the end because according to the multi-criteria analyses the Alternatives that are subject of this project (Project C9.1) appeared to be the most suitable ones.

9. TOTAL COSTS

For the construction of the new LILW double-row inside the limits of the existing NRR, the Proposer estimates the overall costs in SIP for years 2011 - 2015 to be **14 840 000 €**.

The costs for VLLW repository construction inside the limits of the existing NRR were estimated in the feasibility study as **11 800 000 €**.

10. 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 inhabitants in the far future.

11. TYPE OF REQUESTED LICENSE FOR PROPOSED ACTIVITY

The Proposer will request the **License of NRA SR (Nuclear Regulatory Authority of Slovak Republic SR) for Modification of (enlargement of the usage purpose) NRR Mochovce in terms of Section 2 (u)** of the Act of the National Council of the Slovak Republic No. 541/2004 Coll. About peaceful usage of nuclear power. For the beginning of the NRR enlargement implementation, the building permit of NRA SR as the other building office will be needed and the approval for the construction location – territorial approval – on the local building office, that in this case is the municipal authority in Kalná nad Hronom (or Mutual building office Levice).

III. BASIC DATA ON THE EXPECTED IMPACTS OF THE PROPOSED ACTIVITY ON THE ENVIRONMENT

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 will differentiate by how they will solve the disposal of so-called very low level wastes (see Chapter II.7.3). The required inputs will be slightly different for each of the proposed 4 alternatives. Generally it may be said that at the implementation stage of the repository enlargement mainly the requirements for inputs will increase (suppliers, raw materials).

1. HEALTH RISKS ASSESSMENT

Potential health risks for concerned population are connected, first of all, with potential radiation exposure and secondary with related transportation or noise emissions and pollutants generated from it.

1.1. Direct impacts during operation

Activities connected with NRR enlargement or its operation itself does 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 brook could lead to annual effective individual dose of individual from critical population group on the level or around 10 μSv (which is around 1 % of the natural radiation background).

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 radiation of staff during such occasion will be significantly lower than the limits of radiation of individual from the population.

1.2. Direct impacts at the post-operational stages

Direct impacts at the stage after the repository closure are the subject matter of the analysis of the long-term repository safety. 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).
- **Intrusion scenarios –** they are based on the assumptions that after the expiration of the institutional control period (300years) 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 radionucludes is determined. In general these do not have to radionuclides which are included 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 who are being 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 in Slovakia for given type of repository are:

- effective equivalent dose 100 μSv 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 of the probability equaling to one,
- effective equivalent dose 1 mSv for an individual from a critical group of population in any year after the expiration of 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 in Chapter IV.2 are based on the assumption that into 7.5 double-rows for LILW and into the repository of VLLW in the NRR area will be disposed the radionuclide inventory according to table IV.1. This inventory was estimated for operation and decommissioning of NPP in the location of Bohunice and Mochovce (including EMO3,4). Technologies of radioactive waste processing were the same as in Chapter II.7.2.

Table IV. 1 Inventory of radionuclide activity from operation and decommissioning of NPP in Bohunice and Mochovce (including EMO3,4).

Radionuclide	LILW [Bq]	VLLW [Bq]
^{14}C	8.07E+13	2.1E+10
^{41}Ca	3.03E+10	2.6E+08
^{59}Ni	1.38E+12	1.3E+09
^{63}Ni	1.33E+14	4.4E+11
^{79}Se	7.13E+11	
^{90}Sr	8.06E+12	1.5E+09
^{93}Mo	1.80E+12	
^{93}Zr	1.69E+11	
^{94}Nb	8.74E+11	1.8E+10
^{99}Tc	7.15E+12	4.5E+07
^{107}Pd	7.31E+11	
^{126}Sn	2.37E+12	
^{129}I	6.28E+10	1.7E+08
^{135}Cs	5.14E+10	
^{137}Cs	6.26E+14	1.9E+12
^{151}Sm	3.84E+11	
^{238}Pu	1.62E+11	9.0E+08
^{239}Pu	6.52E+11	3.7E+08
^{241}Am	4.78E+11	3.8E+09

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. At the stage of construction it is the need to build the repository including clay barriers. At 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 repository will be the transportation of a large amount of RW and mentioned construction materials. From this perspective probably the most significant impact may be caused by 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 favorable scenario does represent a significant environmental risk.

Other indirect impacts in case of NRR are not known.

2. ASSESSMENT OF EXPECTED IMPACTS FROM THE PERSPECTIVE OF THEIR SIGNIFICANCE AND TIMEFRAME OF THE OPERATION

The most significant impacts will be in the next decades given by the need of relocation of a high amount of soils for creating insulation layer below the disposed radioactive waste and later for insulation layer in the cover after the end of disposal.

The time frame of radioactive waste impact is a part of the safety analysis. Typically the time dependence of concentration is prepared for individual radionuclides in various elements of the environment through which the radionuclides migrate according to the evolution scenario or according to its variations until the biosphere and to the humans. The result is a time dependency of effective dose for 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.

For illustration on Fig. III. 1 there are included results of model calculations of effective doses of safety significant radionuclides ^{129}I and ^{14}C from using the biosphere of Čifárský pond (drinking of water, plant irrigation, plant, milk, meat and fish consumption) for VLLW repository. Total dose, maximum 1.29E-6 Sv is achieved in the time of 2190 year after the repository closure. ^{14}C is a critical radionuclide (maximum 1.278E-6 Sv in 2227 year), ^{129}I - maximum 6.68E-7 Sv is achieved already in 840 year. Contributions of other radionuclides are insignificant.

Time distribution of effective dose for individual from the critical group of population for safety significant radionuclides using the biosphere of Čifárský pond in case of LILW repository is in Fig.III. 2. Total dose - maximum 1.414E-6 Sv is achieved in 7700 year after the repository closure. Critical radionuclide is ^{14}C (maximum dose of 9.56E-7 Sv in 9000 year), the second most important is ^{129}I (maximum 6.0E-7 Sv in 3000 year).

Maximum of total dose from VLLW repository is incomparably earlier than in the case of LILW repository. Total doses from LILW and VLLW repository are comparable despite the fact that expected inventory for VLLW is only a fraction (3.6 %) of expected inventory of LILW. It points out to the barrier significance such as the matrix, FCC and clay sealing in the concept of LILW disposal.

Summary dose from operation of both repositories in the NRR site (Fig.III. 3) not even its maximum of 2.2E-6 Sv in 2500 year does not exceed radiology limit of 0.1 mSv/year in any time. Probably within year 3000 after the repository closure is the greatest contribution from the VLLW repository and after thus year from the LILW 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. The waste containing long-lived radionuclides ^{129}I and ^{14}C would be better not to be stored into the VLLW type repositories.

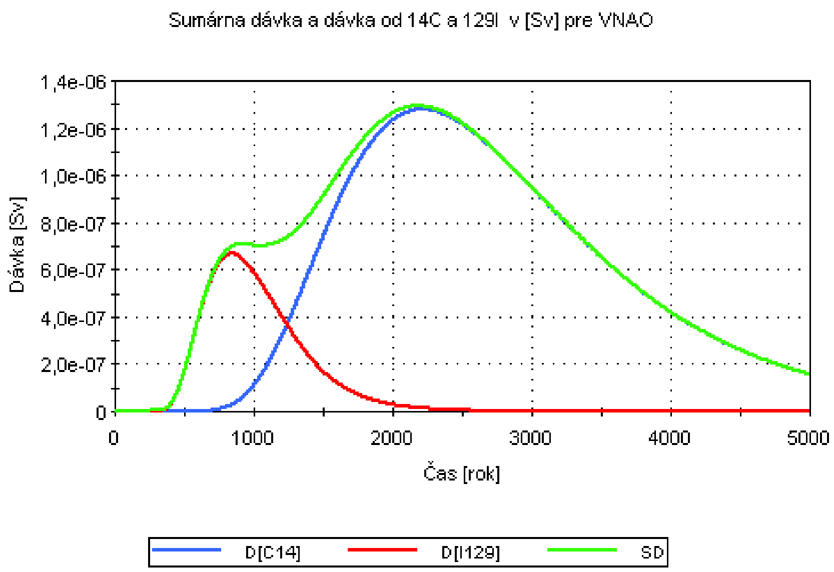

Fig. III. 1 Effective doses of safety significant radionuclides and summary dose (SD) from using biosphere of Čifársky pond for the VLLW repository

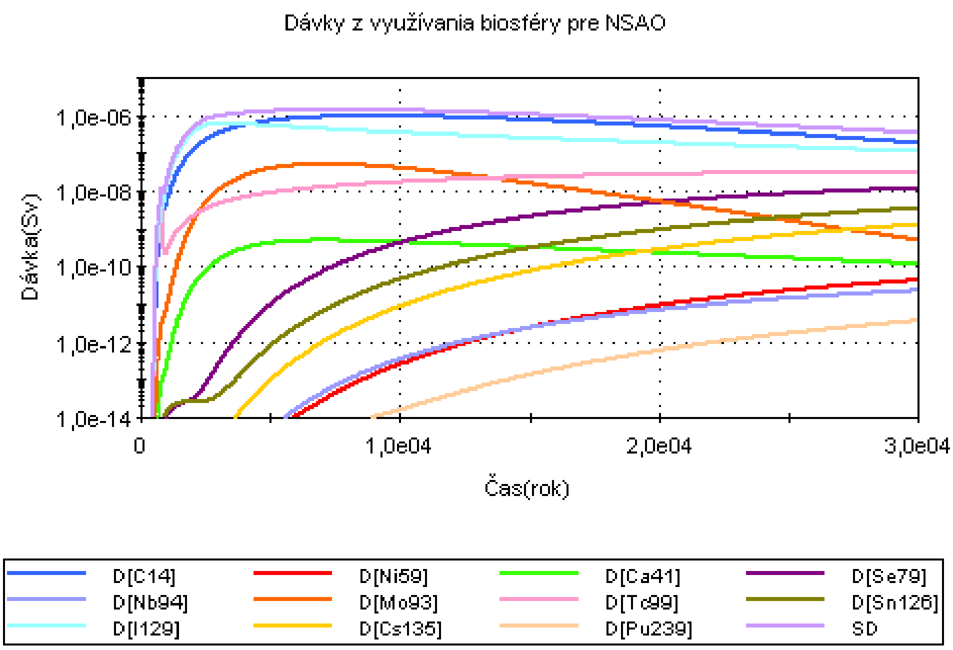

Fig.III. 2 Effective doses of safety significant radionuclides and summary dose (SD) from using biosphere of Čifársky pond for the LILW repository

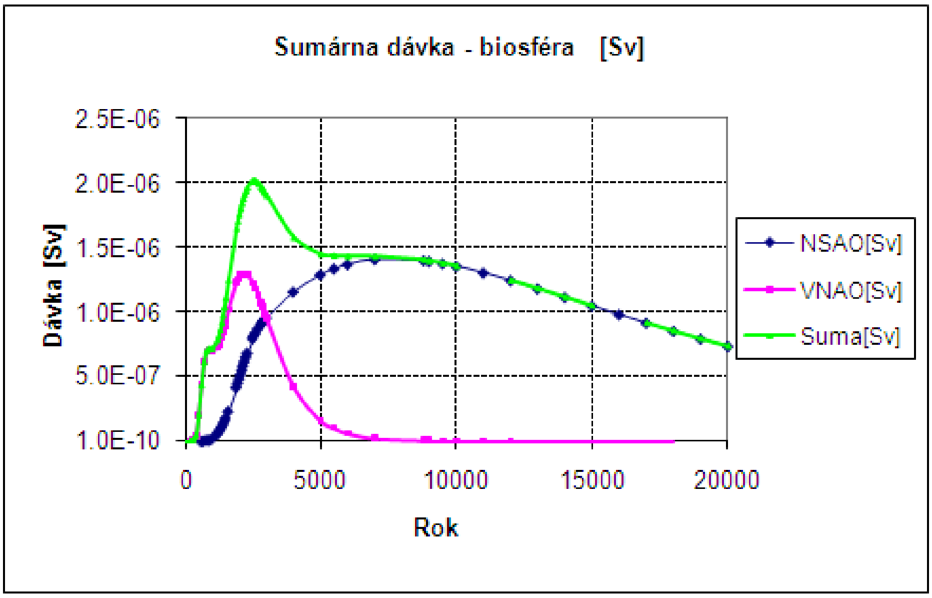

Fig.III. 3 Effective doses for VLLW, LILW repository and summary dose from both repositories in the NRR area from using the biosphere of Čifársky pond

3. EXPECTED IMPACT BEYOND THE STATE BORDERS

At the repository at present and not even after its enlargement there will be no activities done which could result into air pollution by radionuclides. Only solid and solidified waste in approved type of packaging may be disposed. As a result the repository impact on the air in the close vicinity of the repository and in the neighboring states will always be zero.

Due to the system of barriers, the repository will not produce and discharge radioactive liquid waste **during operation** and will not have impact on surface or ground water in the close vicinity and also in the neighboring states. In reality only the rainfall water and water from drainage systems will be released.

In the distant future after the repository closure and barrier degradation (see **Fig.III. 3)** it is possible to have impact on ground and surface water in the repository vicinity. Impact on surface and ground water of neighboring states is determined by the geographical position of the repository. Ground water of neighboring states due to the distance of the repository from the border shall not be affected. By the system of various flows the repository location is connected with only one neighboring state – Hungary. The repository is dewatered by Telinský brook flowing into Žitava and it flows into Nitra, Nitra flows into Váh right before its estuary to Danube near Komárno.

Radiological impacts of extended repository at the stage after the closure are evaluated in the intention for various scenarios. In compliance with the international practice it is assumed that habits and consumption of population will be the same in the future as they are now. Conservatively it is assumed that so-called critical individual lives and consumes contaminated food from the repository direct vicinity. Based on the exposure of this individual it is determined what inventory may not be disposed into the repository. In any time and not in the time when the barriers will be not functioning the exposure of critical individual may not be higher than determined by the hygienic regulations in force at present. By protecting the critical individual in the direct vicinity of the repository the protection of population also in the neighboring states is provided for.

In conclusion it may be stated on this issue that even though the NRR Mochovce as a facility designed exclusively for radioactive waste disposal of, it may be understood as facility which based on Annex 13 of Act No.24/2006 Coll. As amended is subject to statutory international assessment of their impacts on the environment exceeding the state borders, its real radiation impact exceeding the state border will be negligible. Not even the external criteria according to Annex 14 of the quoted act for determining the significantly unfavorable impacts exceeding the state border are not applicable to the NRR Mochovce operation as well as on the designed activity from the point of view of its extent, location and other impacts. None of the components and elements of the environment in the neighboring countries will be significantly aggrieved by the proposed activity, including its alternatives.

IV. COMPARISON OF ALTERNATIVES OF PROPOSED ACTIVITY AND PROPOSAL OF OPTIMAL ALTERNATIVE

The submitted intention is concerned with the enlargement of capacity of NRR in Mochovce by constructing the new disposal structures so that it enables safe and economically acceptable way of disposal of the radioactive waste originating from the operation or decommissioning of Slovak nuclear facilities. Since on NRR even after the enlargement the radioactive waste of type LILW will be stored (as now), all alternative solution contain so-called „classical enlargement of NRR", which lies in the construction of additional disposal boxes according to similar concept as was selected for the existing two double rows. Alternatives III and IV consider the construction of disposal structures for separate disposal of VLLW. Alternatives of the proposed solution including the zero alternative are described in Chapt.II.7.3.

1. COMPARISON AND SELECTION OF THE MOST SUITABLE ALTERNATIVE

1.1. Selection of evaluation criteria

In order to evaluate 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.
- **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, 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 favorable 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 evaluating 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. Costs which shall be incurred to VLLW repository construction are important classification criterion. 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, qualified personnel with the LILW repository and also another nuclear facilities 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.
- **Institutional control.** One of the advantages of VLLW repositories is that in generally 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.

Criteria of evaluating the alternatives were classified qualitatively as follows:

Suitable: This alternative is classified as optimal due to corresponding evaluation criterion.

Less suitable : This alternative is classified as less suitable compared to optimal but still suitable – neutrally overall.

Unsuitable : This alternative is not suitable (or the least suitable) due to relevant assessment criterion.

Results of evaluation obtained by the team of researchers are included in Table IV. 1.

Table IV. 1Evaluation matrix

EVALUATION CRITERIUM	ALTERNATIVES			
	I.	II.	III.	IV.
Repository safety	Suitable 3	Suitable 3	Suitable 3	Suitable 3
Availability of required area	Suitable 3	Suitable 3	Less suitable 2	Unsuitable 1
Infrastructure availability	Suitable 3	Suitable 3	Suitable 3	Less suitable 2
Availability of characterization study	Suitable 3	Suitable 3	Suitable 3	Less suitable 2
Costs	Unsuitable 1	Less suitable 2	Suitable 3	Less suitable 2
Obtaining license	Suitable 3	Less suitable 2	Less suitable 2	Less suitable 2
Institutional control	Unsuitable 1	Unsuitable 1	Less suitable 2	Suitable 3
Need to modify the area	Suitable 3	Suitable 3	Suitable 3	Less suitable 2
Additional survey	Suitable 3	Suitable 3	Suitable 3	Less suitable 2
Overall assessment	**23**	**23**	**24**	**19**

1.2. Recommended Alternative

In study C9.1 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 Intention**). It also points out to certain disadvantages of this solution – area limitation, relatively high level of ground water, existence of cover model in 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 Intention**. It also analyzes the zero alternative 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 Intention**). **Alternative II in this Intention** is only small alternation to alternative I which may bring considerable costs savings for VLLW disposal of.

If further studies show that the VLLW disposal of is suitable, then their disposal of at a separate place in the NRR area - **Alternative III** – would be the best solution. It could be a good compromise between the limits which need to be considered in individual alternatives and the requirements of freedom of solution which would be as practical and as safe as possible.

V. MAP AND OTHER GRAPHIC AND PICTURE DOCUMENTATION

Fig.V. 1 Placement of NRR and NPP EMO in the region

Fig.V. 2 Overall situation of placement of NRR in the location Mochovce

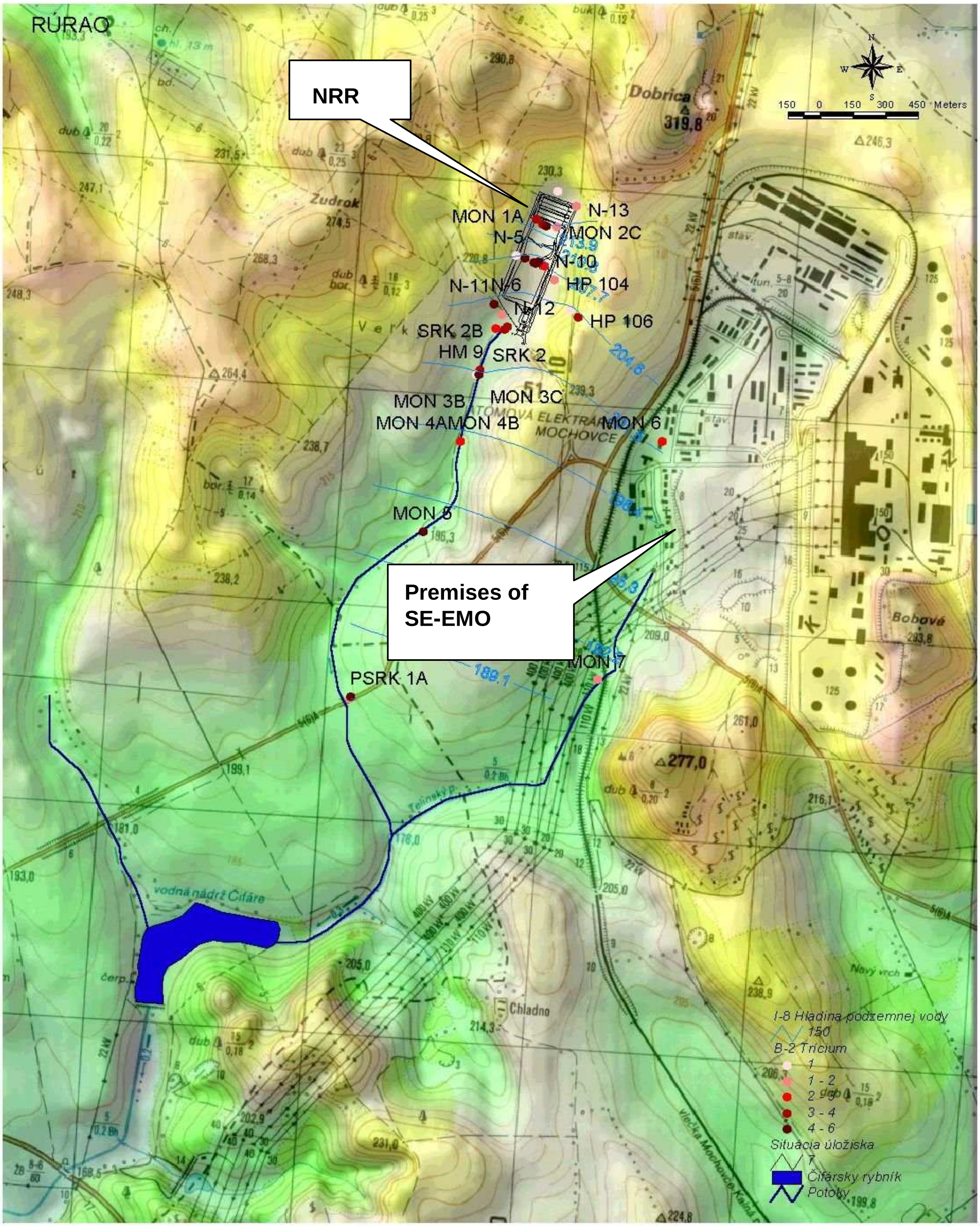

Fig.V. 3 Current status of NRR premises Mochovce

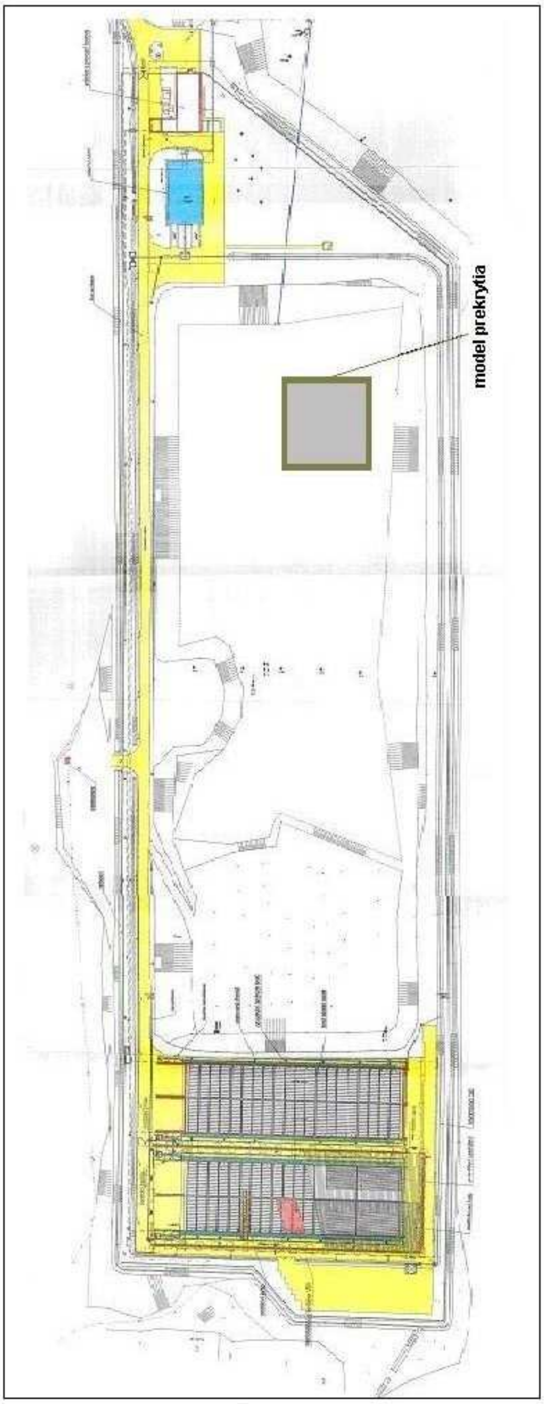

Fig.V. 4 Placement of 7 and ½ of double row for LILW and an example of placement of repository for VLLW in the premises of NRR - Alternative III