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SLOVENSKÉ ELEKTRÁRNE, a.s. "NUCLAR POWER PLANT MOCHOVCE VVER 4 X 440 MW - 3RD CONSTRUCTION

General Executive Summary

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ANNEX X

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I INTRODUCTION

This General Executive Summary reflects the overall summary of information and data included in the Environmental Impact Assessment Report (EIA) for the proposed activity:

“Nuclear Power Plant Mochovce VVER 4 x 440 MW – 3rd Construction”

that has been elaborated pursuant to National Council Act No. 24/2006 Coll. as amended and supplemented by other acts,

The activity has been assessed in compliance with Annex 8 of the EIA Act, item 2**. Energy Industry**, indent 4:

Nuclear power plants and other facilities with nuclear reactors (with the exceptions of the research facilities for production and conversion of fissile and enriched materials whose maximum thermal power does not exceed 1 kW of constant thermal power).

The location of NPP Mochovce is on Figure 1

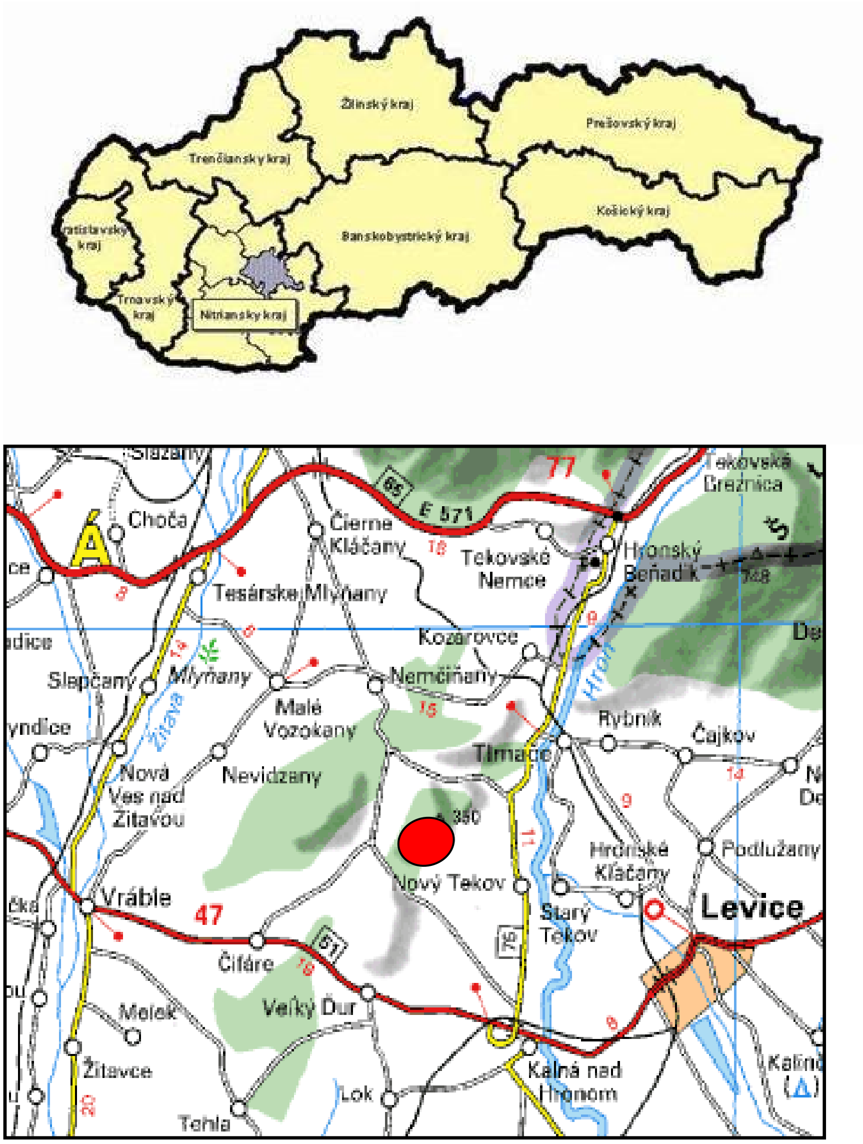


Figure 1 - General location of the site

1.0 PROGRAMMATIC FRAMEWORK

The present Report focuses on likely additional environmental effects of an existing facility, as a result of the completion and operation of Units 3 and 4.

The Environmental Impact Assessment is performed in compliance with appendix 11 of Slovak Act. No. 24/2006 “On the assessment of the effects on the environment and on the modification and enlargement of some laws”.

Key environmental aspects are discussed in this chapter: environmental management, general permitting, land use planning implying the safeguarding of the long-term harmony of the natural and cultural value of the three main components of the natural environment: land, water and air.

Land use planning methodically and comprehensively solves the functional use of land. It specifies principles of its organization and material and temporal coordination of construction and other activities that affect the development of the land

1.1 Coverage of the demand for electricity

The Slovak Republic has been an exporter of electricity for 7 years (2000 - 2006). The shutdown of two nuclear units in Bohunice (V1) has changed the situation and Slovak Republic has become an importer of electricity. The shutdown of Bohunice Nuclear Power Station V1 is a consequence of the political decision taken during the negotiation of the Preaccession Treaty with the EU. The Slovak Republic committed to shutting down two units of the Nuclear Plant V1 Bohunice, in the period 2006-2008. With the shutdown of these two units, the total capacity of NPPs has been reduced by 880 MW.

Also, based on the Directive EC 2001/80/CE (on the limitation of emissions of certain pollutants into the air from large combustion plants), several thermal units will be decommissioned in the SR. It is not economic to modify the old thermal plants with the aim of attaining the requirements of the air protection law (Act. No. 478/2002). The expected reduction of the existing installed thermal power for environmental reasons is about 242 MW.

In the document “System Adequacy Forecast” by UCTE (2007) it is indicated that the usable potential RES (Renewable Energy Sources) suitable for electricity production leaded the Government of the SR to commit to a minimal target of electricity production from RES of 19% by the year 2010. Biomass belongs among the most promising renewable resources. Even taking into account the high usage of the hydro energy potential of the SR (at present approx. 60%), there is still potential for hydro electricity production. For various reasons the possibilities for using wind energy to produce electricity in the SR are limited.

The outlook of net electricity generation from 2007 to 2020, based on forecasted development of installed capacity in the Slovak Republic, is as shown in Figure 2.

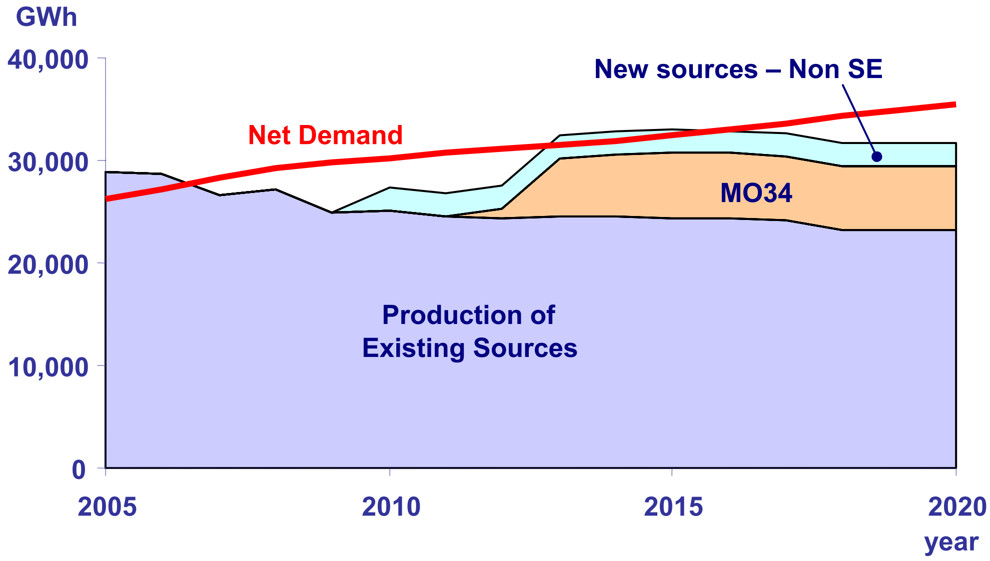


Figure 2 - Forecast for net Electricity demand and production in Slovakia

1.2 EIA law in the EU and the SR

The EIA Directive on Environmental Impact Assessment of the effects of projects on the environment (85/337/EEC) was introduced in 1985 and was amended in 1997 (97/11/ES). Member States had to transpose the amended EIA Directive into their own legislation by 14 March 1999 at the latest.

The primary purpose of the EIA Directive was to introduce general principles for the assessment of environmental effects, with a view to supplementing and coordinating development consent procedures governing public and private projects likely to have a major effect on the environment.

The history of EIA in the SR dates back to 1992, when the Environment Act was adopted (effective as of 16 February 1992). This contained very general rules for the assessment of environmental impacts of certain projects. With effect from 1 September 1994, a new legislation regulating EIA applied with the Old EIA Act, which repealed all provisions of the Environment Act regarding EIA. Act No. 127/1994 on EIA was published in April 1994 and came into force in September 1994. The Slovak Ministry of the Environment has confirmed that this Act does not apply to projects for which the licensing process began prior to its entry into force.

With effect from 1 February 2006, the EIA Act 24/2006 Coll. was adopted, fully repealing and replacing the Old EIA Act. The EIA for projects is very similar to the procedure under the Old EIA Act, but with certain deadlines being shortened. There are no major deviations from the principles regarding EIA for individual projects as set out in the Old EIA Act.

In Figures 3 and 4 are schematically illustrated respectively the main players for the EIA process for the Project.

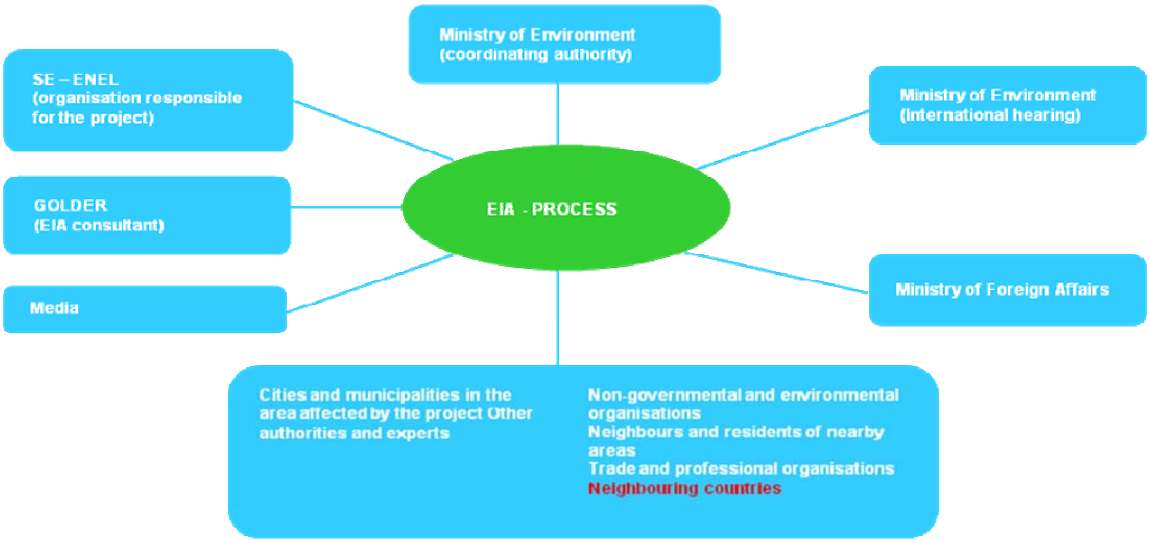


Figure 3 - Main players of Mochovce NPP EIA.

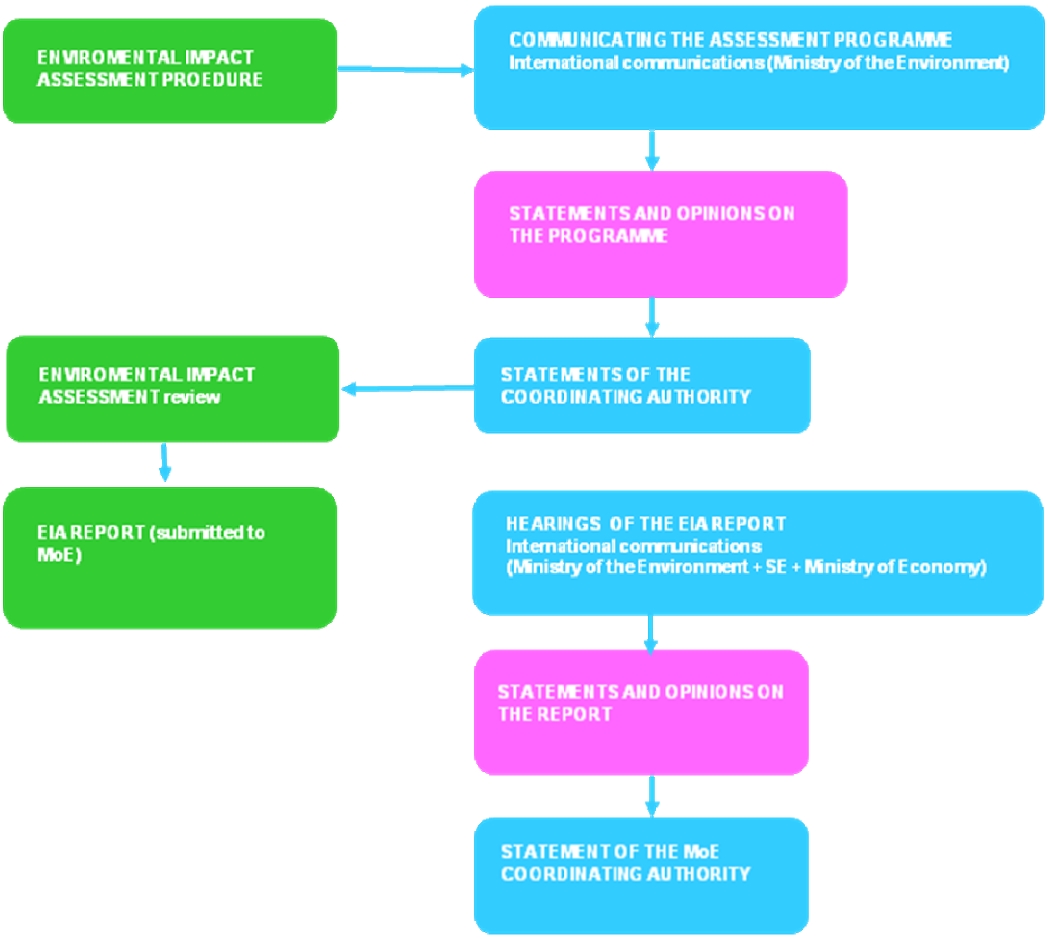


Figure 4 - Planning of the main steps of Mochovce NPP EIA process

1.3 Land use planning and Operation Permits

Land use planning methodically and comprehensively solves the functional use of land. It specifies principles of its organization and material and temporal coordination of construction and other activities that affect the development of the land.

Land use planning implies the safeguarding of the long-term harmony of the natural and cultural value of the land. In particular regarding environmental care and protection of its main components - land, water and air.

Key phases for the operation of Mochovce NPP are:

- land use procedures and land use decision; and
- operational authorization.

1.3.1 Construction Authorization

Authorizations for the launching of the construction were issued by Levice environmental office between March 1983 and November 1986 based on the various phases of the overall construction design. These permits were issued with the approval of the former Czechoslovakian atomic energy commission on the basis of an initial safety report. The issued construction license requires written approval of other state bodies.

Construction and operational authorizations for the individual stages of construction were granted with the approval of the offices of regional hygiene, occupational health and safety inspectorate, district fire protection office, the telecommunication directorate and the civil protection body.

Construction Permit No. Výst. 2010/86 for MO34 was issued by the District National Committee in Levice on the basis of the Land Planning Decisions on 12 November 1986, and it became final and conclusive on 28 January 1987. The deadline for completion of MO34 set out in the original Construction Permit has been extended as follows:

a) until 31 December 2005 by the Regional Authority in Nitra No. 97/02276-004 dated 5 May 1997; and

b) until 31 December 2011 by a Decision of the Regional Construction Authority in Nitra No. 2004/00402-007 dated 15 July 2004, becoming final and conclusive as of 3 August 2004.

Recently, the Nuclear Regulatory Authority (ÚJD SR, which, according to the Atomic Act 541/2004, is also the Building Authority for Nuclear Installations), by means of its Decision No. 246/2008 dated 14th August 2008, has set as a binding condition for the proposed activity, to complete the construction by 31st December 2013 (thus extending the validity of the Construction Permit for Completion of "Nuclar power plant mochovce VVER 4 X 440 MW - 3rd Construction").

1.3.2 Authorization for operation

According to the Slovak Atomic Act No. 541/2004 Coll., the authorization for operation shall be issued by the ÚJD (Úradu Jadrového Dozoru - Slovak Nuclear Regulatory Authority). In order to be authorised to use (operate) the facility MO34, an operational authorization would have to be issued in accordance with the relevant provisions of the Atomic Act. ÚJD shall issue authorisation for commissioning of nuclear installation within six months from submission of a complete application.

Besides the documents required by the ÚJD, there are other documents that have to be provided. The Slovak Public Healthcare Authority issues a list of "decisions" and “permits” in the field of protection against ionizing radiation, pursuant to the Public Healthcare Act. These “decisions” and “permits” are independent of the authorisations issued under the Nuclear Act, but it will be required to obtain them in addition to any authorisation issued under the Nuclear Act. The permits are issued for a period of five years, and may be extended for another period of equal length.

1.3.3 SR Public Health Authority condition for operation

According to the decision of Public Health Authority of the Slovak Republic No. 000ZPZ/6274/2006, starting from 2 November 2006 the conditions for operation of EMO12 shall observance and meet of the following limits:

- yearly limit activity of radionuclide activity in emissions;
- yearly and volume activity limits for radionuclide activity in wastewater;
- reference levels: a) investigation level for releases to atmosphere; b) interference level for release to atmosphere; c) investigation level for releases to wastewater; d) interference level for release to wastewater;

other requirements are:

- continual monitoring;
- dose loads for balancing and evaluation.

The permit is valid until 1 November 2011.

1.3.4 Terrestrial system of ecological stability

The terrestrial system of ecological stability (TSES) legally categorizes the evaluation of the state of the landscape (in particular their biotic formation). The basic TSES documents are the General, supraregional TSES for Slovakia (1992), regional TSES documentation for the former Slovak districts (1993-1995) and the National Ecological Network of Slovakia (1996).

In the Slovak Republic several methods are used for evaluation of environmental (ecological) quality of the territory and their positive and negative factors. All of these methods have markedly regional dimensions and differentiate the territory of the Slovak Republic from the point of view of various criteria. A large territorial unit plan for the Nitra region was approved in a governmental decree of the Slovak Republic issued in 1998, as a regional TSES.

1.4 International Treaties and obligations

Nuclear Third Party Liability

In Slovak Republic compensation for nuclear damage is covered by general regulations on liability for damage, except as otherwise stipulated in the act or an international agreement to which the Slovak Republic is bound.

Liability for nuclear damages is dealt with in the act 541/2004, Coll.. This act contains very detailed provisions on third party liability for nuclear damage, which largely transpose the provisions of the 1963 Vienna Convention on Civil Liability for Nuclear Damage. The Slovak Republic acceded to the Vienna Convention and the 1988 Supplementary Protocol on the Application of the Vienna Convention and the Paris Convention on 7 March 1995.

The Comprehensive Nuclear-Test-Ban Treaty (CTBT)

The Slovak Republic signed the Comprehensive Nuclear-Test-Ban Treaty on September 30, 1996 and ratified the treaty on March 3, 1998. In co-operation with the Ministry of Foreign Affairs, Ministry of Defence and the Slovak Academy of Sciences objectives, resulting mainly from the plenary sessions of the Preparatory Commission for the Treaty Organisation and from the meetings of their working groups, were provided. UJD actively contributed to the On-Site International Inspection Operational Manual.

Convention on Nuclear Safety

The Convention on Nuclear Safety was adopted on 17 June 1994 by a Diplomatic Conference convened by the International Atomic Energy Agency at its Headquarters from 14 to 17 June 1994.

The Convention was drawn up during a series of expert level meetings from 1992 to 1994 and was the result of considerable work by Governments, national nuclear safety authorities and the Agency's Secretariat. Its aim is to legally commit participating States operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which States would subscribe.

Slovakia has been the first state in the world with nuclear power plant in its territory to ratify the Convention on Nuclear Safety.

The obligations of the Parties are based to a large extent on the principles contained in the IAEA Safety Fundamentals document "The Safety of Nuclear Installations". These obligations cover for instance siting, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness.

Slovakia is also a member of the Convention on Management of Spent Nuclear Fuel and radioactive Waste.

Duties towards the European Commission under the Euratom Treaty

Under EU law, some activities pertaining to the nuclear facility have to be communicated to the Commission. According to Article 41 of the Euratom Treaty, entities have to communicate investment projects relating to new installations and also to replacements or conversions which fulfil the criteria as to type specified in Annex II of the Euratom Treaty. The investment projects to be communicated to the Commission under Article 41 are further specified in the Investment Projects Regulation. This communication has already been transmitted to the Commission for MO34 completion on July the 16th 2007.

SE received a positive standpoint from European Commission in July 2008. The standpoint covers also the recommendations that should be used during the construction from the safety point of view.

Previously, during the phase of integration of Slovak Republic in the European Union, the Slovak Government issued report, in January 2000, of its New Energy Policy Progress. In nuclear matter, relatively to completion of units 3 and 4 of Mochovce Nuclear Power Plant, in accordance with the conclusions from discussions with the European Commission and in line with Governmental Resolution No. 5 of 12 January 2000, a proposal for completion of construction of the 3rd and 4th unit of Mochovce Nuclear Power Plant was, at that date, submitted.

1.5 The coherence of the project with regional planning

The current state of the MO34 construction is:

- Civil part is complete up to 70%;
- Mechanical equipment supply is complete up to 30%;
- Electrical and I&C equipment supply is negligible.

1.5.1 Permitting

The original Construction Permit No. Výst. 2010/86 for MO34 was issued by the District National Committee in Levice on the basis of the Land Planning Decisions on 12 November 1986. This Permit has been renewed firstly on May the 5th 1997 by letter of the Regional Authority in Nitra No. 97/02276-004 and further by Decision of the Regional Construction Authority in Nitra No. 2004/00402-007 dated 15 July 2004.

Recently, the Nuclear Regulatory Authority (ÚJD SR, which, according to the Atomic Act 541/2004, is also the Building Authority for Nuclear Installations), by means of its Decision No. 246/2008 dated 14th August 2008, has set as a binding condition for the proposed activity, to complete the construction by 31st December 2013 (thus extending the validity of the Construction Permit for Completion of MO34). The authorization for the commissioning of units 3 and 4 requires completion of the EIA process for the proposed activity.

1.5.2 Safety improvements

The existing valid Construction permit, and specifically the extension granted on July the 15th 2004 with the Decision No. 2004/00402-007, requires SE to perform some safety improvements to the original Basic Design with the scope to further increase the level of nuclear safety compared to Mochovce units 1 and 2.

The required safety improvements have been included in the project and are described in the Design Framework of the present EIA Report.

2.0 DESIGN FRAMEWORK

2.1 Overview of EMO12 operational background

The Mochovce project history started off as early as the 1970s when the then Czechoslovakia started to perform geological surveys for the identification of suitable sites to construct a new atomic power plant. The future power plant had to sit on seismically stable geological formations. An essential condition was the proximity to a source of water to cool the plant and replace the evaporated water. Neither large-scale industrial enterprises nor urban agglomerations were to be located nearby. Upon taking account of all the factors, a definitive decision was taken - the site in the municipality of Mochovce was chosen to construct the nuclear power plant. This area was best to meet all the siting conditions.

The preparation work was launched in June 1981 and the proper construction of the NPP in November 1982. The original construction plan envisaged for the utility to be commissioned in the late 1980's. As compared with other installations of a similar type, the NPP Mochovce design already involved several principal improvements such as a seismically resistant attachment of technologic equipment.

Nevertheless, the original technologic process control and management system was found under the final phase of the plant construction to fail to comply with the current stage of knowledge. It had to be replaced with a new system supplied by the German company Siemens, the reliability of which had already been verified in practice. At the time of its application it represented the world's top-class and had already been successfully installed at atomic power plants in Germany.

In the early 1990's lack of funds affected the completion. The search for financial resources abroad proved the only option to ensure further progress of works. Following demanding negotiation, the Slovak Government approved in September 1995 a model for completion and funding of Units 1 and 2. Under it, the completion is implemented to the extent of the original project and with the original contractors.

However the entry by foreign and high-profile companies such as Electricité de France, Siemens or Framatome was conditional on a complex assessment of both the project and overall status of the plant equipment. The Mochovce NPP had undertaken at the time a host of examinations and opened its gates to expert missions from the most reputable institutions worldwide. Experts analysed the principle of the technical equipment and its safety functions. The result of joint efforts by Slovak and foreign experts was a nuclear safety improvement programme and its implementation even prior to the plant start up.

Unit 1 has now supplied electricity to the network since the summer of 1998 and Unit 2 was finally put into operation in late 1999.

2.2 Project description

According to the original design, Mochovce NPP consists of 4 units of VVER 440 type (Vodo Vodni Energeticeskij Reaktor) pressurized water reactors of the Russian type V 213. MO34 follow directly the EMO12 units and will use the auxiliary systems already in operation which are common for all 4 units.

EMO12 have been commercially operated since 1999 and 2000 respectively.

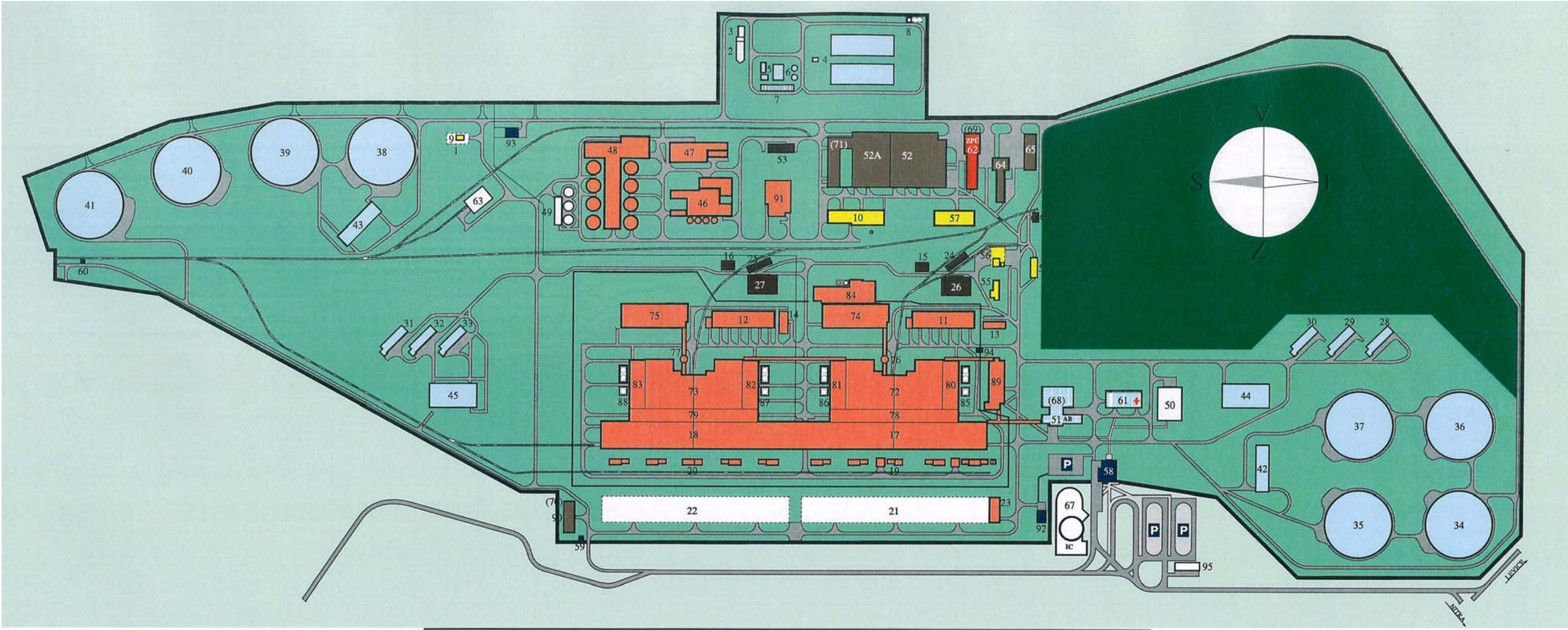
Construction works for MO34 started in 1986 with the laying the foundations of the main buildings (reactor building, longitudinal electrical building, basement of transformers, cooling towers, vent stack) and continued up to 1992. In 1992 construction works were suspended. From 1992 to 2000 maintenance and conservation of suspended equipment and components and of civil structures were carried out by the original main suppliers and constructors. From 2000 to-date the preservation and protection works have been performed on the basis of programs approved by the NRA of the SR.

The current status of the MO34 construction is:

- Civil parts are up to 70% complete;
- Machinery is up to 30%;complete ;
- Electrical and I&C equipment are up to 1% complete.

Figure 5 shows a layout of Mochovce NPP in which the following main building structures can be identified:

- 73: reactor building (72 for EMO12);
- 79: longitudinal compartment of electrical equipment (78 for EMO12);
- 17-18: turbine-generator hall;
- 38-41: cooling towers (34-37 for EMO12);
- 12: diesel generator building (11 for EMO12);
- 75: auxiliary operation building (74 for EMO12);
-
- 84: final processing of liquid radioactive waste building (for all four units).



Object	loc.	n. Name of object
320/1-01		1 Fence of regulation gas station
362/1-06		2 Storage reservoir of industrial sewerage
362/1-07		3 Oil separator on industrial sewerage
363/1-01		4 Safety reservoirs of storm sewer
366/1-01		5 Repumping station of sewage
367/1-01		6 Sewage disposal plant
367/1-02		7 Sludge bed
368/1-01		8 Associate object of waste water measuring
393/1-01		9 Regulation gas station
441/1-01		10 Auxiliary boiler house
442/1-01		11 Dieselgenerator set I (DGS)
442/1-02		12 Dieselgenerator set II
442/1-03		13 HP Compressor plant I
442/1-04		14 HP Compressor plant II
442/1-05		15 Oil management station 1st MPU (Main production unit)
442/1-06		16 Oil management station 2nd MPU
490/1-01		17 Machine room 1st MPU
490/1-02		18 Machine room 2nd MPU
510/1-01		19 Transformer ground 1st MPU
510/1-02		20 Transformer ground 2nd MPU
522/1-01		21 Outdoor distribution 100 and 400 kV 1st MPU
522/1-02		22 Outdoor distribution 100 and 400 kV 2nd MPU
529/1-01		23 Central electric survey
566/1-01		24 Petroleum DGS I and oil bottling house
566/1-02		25 Petroleum DGS II bottling house
568/1-01		26 Petroleum management of 1st MPU
568/1-02		27 Petroleum management of 2nd MPU
580/1-01		28 Cooling ventilation tower I/1
580/1-02		29 Cooling ventilation tower I/2
580/1-03		30 Cooling ventilation tower I/3
580/1-04		31 Cooling ventilation tower II/1
580/1-05		32 Cooling ventilation tower II/2
580/1-06		33 Cooling ventilation tower II/3
581/1-01		34 Cooling tower I/1
581/1-02		35 Cooling tower I/2
581/1-03		36 Cooling tower I/3
581/1-04		37 Cooling tower I/4
581/1-05		38 Cooling tower II/1
581/1-06		39 Cooling tower II/2
581/1-07		40 Cooling tower II/3
581/1-08		41 Cooling tower II/4
584/1-01		42 Central pump room of cooled water 1st MPU
584/1-02		43 Central pump room of cooled water 2nd MPU
584/1-03		44 Pump room of ITW (Important technical water) in the 1st MPU
584/1-04		45 Pump room of ITW in the 2nd MPU
590/1-01		46 Chemical water treatment (CHWT)
592/1-01		47 Store and bottling room of chemicals
593/1-01		48 Decarbonization
599/1-01		49 Sludge management of CHWT
630/1-01		50 Simulator building
631/1-01		51 Administrative building and canteen
640/1-01		52 Workroom (HND store)
641/1-01		53 Oil and combustible storehouse
642/1-01		54 Technical gas storehouse
643/1-01		55 Oxygen and nitrogen generation
643/1-02		56 Hydrogen storehouse
646/1-01		57 Outdoor store and scarp yard
650/1-01		58 Main lodge and police station
652/1-01		59 Subsidiary lodge by the secondary entry
652/1-02		60 Subsidiary lodge by the siding
653/1-01		61 Medical centre
656/1-01		62 Firehouse
700/1-01		63 Engine dock
701/1-01		64 Transport – garage, wash stand
701/1-02		65 Motor truck garage
703/1-01		66 Fuel store – petroleum pump
		67 Information bureau
780/1-01		68 Civil defence under administrative building
780/1-02		69 Civil defence under firehouse
780/1-03		70 Civil defence under metrological centre
780/1-04		71 Civil defence under workrooms and stores
800/1-01		72 Reactor building of 1st MPU
800/1-02		73 Reactor building of 2nd MPU
801/1-01		74 Auxiliary operation building of 1st MPU
801/1-02		75 Auxiliary operation building of 2nd MPU
803/1-01		76 Ventilation stack of 1st MPU
803/1-02		77 Ventilation stack of 2nd MPU
805/1-01		78 Electrical equipment rooms (EER) – lenghtwise1st MPU
805/1-02		79 EER – lenghtwise 2nd MPU
806/1-01		80 EER – crosswise 1. unit
806/1-02		81 EER – crosswise 2. unit
806/1-03		82 EER – crosswise 3. unit
806/1-04		83 EER – crosswise 4. unit
808/1-01		84 Processing and Ra waste disposal
810/1-01		85 Supercasualty charge 1. unit
810/1-02		86 Supercasualty charge 2. unit
810/1-03		87 Supercasualty charge 3. unit
810/1-04		88 Supercasualty charge 4. unit
840/1-01		89 Operational building
881/1-01		90 Metrological centre
882/1-01		91 Compressor plant
940/1-01		92 Guardhouse 1
940/1-02		93 Guardhouse 2
784/1-01		94 Small lodge
		95 INPAKO admin. building
		Railway

Figure 5 - Layout of Mochovce Nuclear Power Plant Units 1&2 and Units 3&4

2.3 Description of the process

MO34 will have two individual operational nuclear units, both containing separate nuclear and thermal parts. Both MO34 units will be directly linked to the first two operational units - EMO12. The operational auxiliary systems can be used in all four units of the complex.

The process for the production of electrical power in Mochovce NPP incorporates three principal heat transfer cycles:

1. in the first cycle, heat derived from the fuel is used to boil water to produce steam: the section of the plant that performs this function is known as the Nuclear Steam Supply System;
2. in the second cycle, the steam is used to drive turbines, which are connected to generators that produce electrical power: this section of the plant is known as the Power Conversion System;
3. in the third cycle, the remaining energy in the steam is rejected as heat: the section of the plant associated with this process is known as the Cooling Water (or Heat Rejection) System.

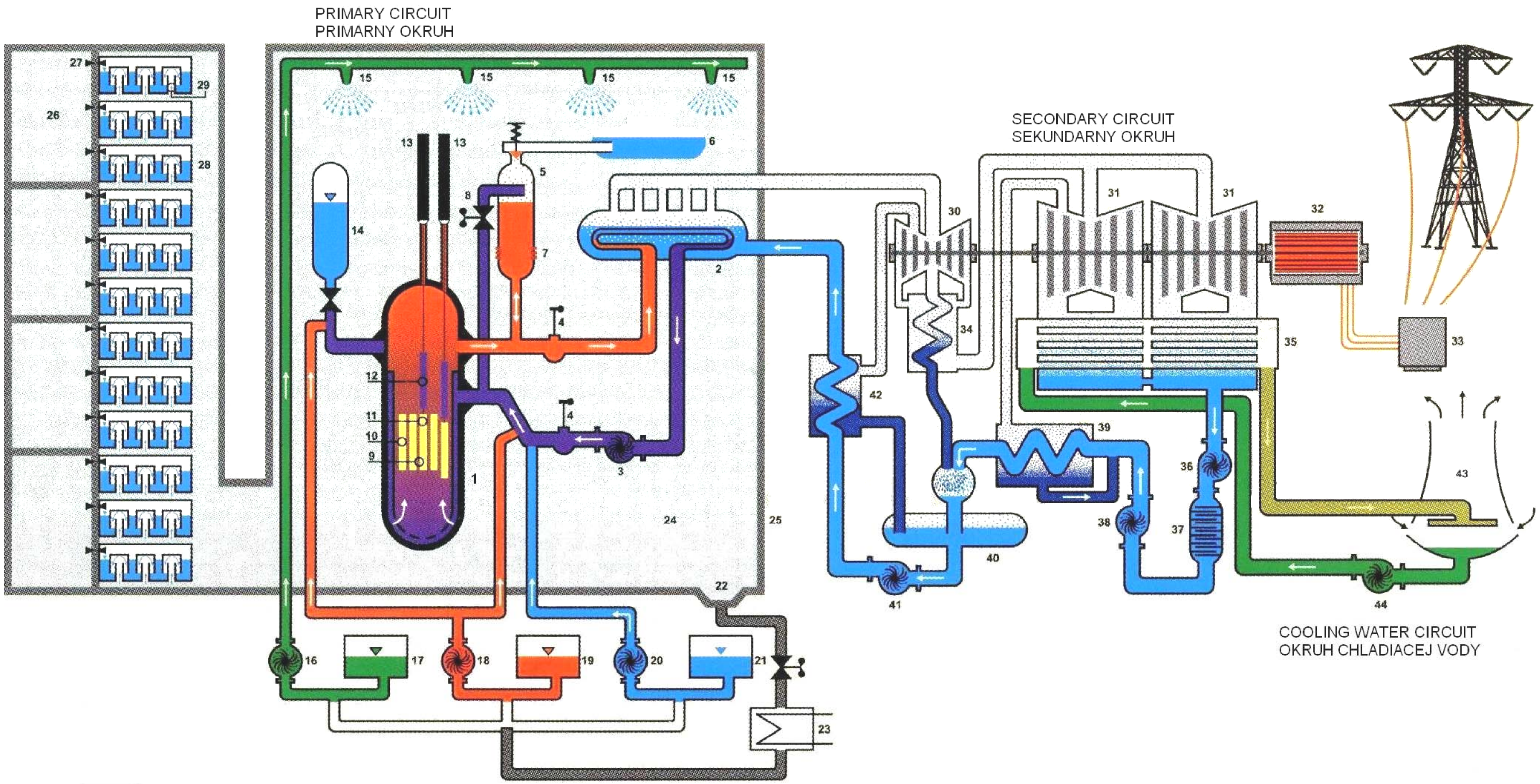
Figure 6 illustrates the general arrangement of the three heat transfer cycles for a nuclear power station based on the Russian VVER-440 Model V213 reactor unit. The two main circuits, the primary one and the secondary one, can be distinguished. Table 1 contains the basic technical data for a 440 MW unit.

The **primary circuit** of each unit is housed in the reactor building. The primary circuit is formed by the reactor and six coolant loops; each loop consists of a hot leg with an isolation valve, a steam generator (SG) and a cold leg with a reactor main circulation pump and an isolation valve (Figure 7). The reactor main circulation pumps recycle pressurized water to remove heat from the reactor core. The pressurizer establishes and maintains the reactor coolant system pressure within the operational conditions and allows compensation for reactor coolant volume changes during operation. SGs are the interface between the nuclear system (primary circuit) and the steam system (secondary circuit). Each SG is a tubular evaporator of horizontal design.

The fuel in fuel assemblies is placed in the reactor pressure vessel (RPV), where chemically treated water runs through channels in the fuel assemblies and removes the heat generated by the fission reaction. The water temperature at the exit from the reactor is about 297 °C (temperature increase through the reactor is about 29 °C).

The **secondary circuit** connects the nuclear steam supply system (NSSS) to the power conversion system. The steam generated in the six SGs is piped through 6 high pressure steam lines from the reactor building to the turbine hall. The turbine hall, shared by all four units, is oriented parallel to the reactor buildings. For each unit the hall houses two turbo-generator sets with one high-pressure and two low-pressure sections.

The exhausted steam condenses in the turbine's main condenser, which is cooled by the circulating **cooling water** system. The condensate is then sent back to the SGs..



Legend

1 - Reactor - Reaktor
2 - Steam generator - Parogenerátor
3 - Reactor coolant pump - Hlavné cirkulačné čerpadlo
4 - Main isolating valve - Hlavná uzatváracia atmatúra
5 - Pressurizer (steam section) - Kompenzátor objemu (KO) (parná časť)
6 - Pressurizer relief tank - Barbotážna nádrž
7 - Pressurizer (electric heaters) - Kompenzátor objemu (elektroohrieváky)
8 - Pressurizer injection - Vstreky KO
9 - Reactor core - Aktívna zóna
10 - Fuel assembly - Palivová kazeta
11 - Automatic control rod (ACR) (fuel section) - Automatická regulačná kazeta (ARK) (palivová časť)
12 - ACR (absorber section) - Automatická regulačná kazeta (ARK) (absorpčná časť)
13 - ACR drives - Pohony ARK
14 - Hydroaccumulators - Hydroakumulátory
15 - Spray system - Sprchový systém
16 - Spray pump - Sprchové čerpadlo
17 - Spray system tank - Zásobná nádrž sprchového systému
18 - Low-pressure (LP) emergency pump - Nízkotlakové havarijné čerpadlo
19 - LP emergency system tank - Zásobná nádrž nízkotlakového havarijného systému
20 - High-pressure (HP) emergency pump - Vysokotlakové havarijné čerpadlo
21 - HP emergency system tank - Zásobná nádrž VT havarijného systému
22 - Containment suction sump - Sanie z hermetickej zóny
23 - Spray system cooler - Chladič sprchového systému
24 - Containment - Hermetická zóna
25 - Reinforced concrete containment wall - Ochranná obálka
26 - Bubble-condenser tower air trap - Záchytná komora barbotážnej veže
27 - Check-valve - Spätná klapka
28 - Bubble-condenser tower - Barbotážna veža
29 - Bubble-condenser tower flumes - Žlaby barbotáznej veze
30 - HP stage of steam turbine - VT diel parnej turbíny
31 - LP stage of steam turbine - NT diel parnej turbíny
32 - Electrical generator - Elektrický generátor
33 - Unit transformer - Blokový transformátor
34 - Steam separator and re-heater - Separátor a priehrievač pary
35 - Condenser - Kondenzátor
36 - Condensate pump (stage 1) - Kondenzátne čerpadlo 1°
37 - Condensate treatment - Bloková úprava kondenzátu
38 - Condensate pump (stage 2) - Kondenzátne čerpadlo 2°
39 - LP regeneration - Nízkotlaková regenerácia
40 - Feedwater tank - Napájacia nádrž
41 - Main electric feedwater pump - Hlavné elektronapájacie čerpadlo
42 - HP regeneration - Vysokotlaková regenerácia
43 - Cooling tower of circulating water - Chladiaca ve ža cirkulačnej vody
44 - Circulating water pump - Čerpadlá cirkulaènej vody

Figure 6 - Principle of electrical production in a NPP (VVER type)

Table 1 - Basic technical data of 1 unit of reactor type VVER 440/213

GENERAL	
Number of operation units: 2 Type of reactor: VVER 440/V-213 (pressurised water) Reactor thermal power: 1,375 MWt	Rated unit power: 440 MWe Inherent consumption: 35 MW (8% of rated power) Unit efficiency: 29.5%
Reactor Pressure Vessel	**Steam Generator**
Inner diameter: 3,542 mm Wall thickness: 140 + 9 mm Height: 11,805 mm Weight (internals excluded): 215,150 kg Material: alloyed steel Cr-Mo-V	6 per Unit Type: PGV-213 Amount of generated steam: 450 t/h Outlet steam pressure: 4.64 MPa Outlet steam temperature: 267 °C Feedwater temperature: 158÷223 °C
Reactor Core	**Turbogenerator**
Fuel operating assemblies: 312 Number of control assemblies: 37 Total weight of fuel (UO_2) in core: 42 t Enrichment for standard type fuel (1st core as for EMO12): 3.6%, 2.4% and 1.6% depending on position in the core Advanced type of Gadolinium doped fuel radially profiled with an average enrichment of 4.87% is considered from the 2 nd campaign of MO34.	2 per Unit Type: 220 MWe Stages: 1 high pressure, 2 low pressure Rated speed: 3,000 rpm Terminal voltage: 15.75 kV
Primary Circuit	**Condenser**
Number of cooling loops: 6 Coolant flow rate: 42,600 m^3/h Nominal pressure: 12.26 MPa_{rel} Coolant temperature at the reactor outlet: 297.3 °C Coolant temperature at the reactor inlet: 267.9 °C Total volume: 250 m^3	Circulating water flow rate: 35,000 m^3/h Maximum temperature of coolant water: 33 °C
EMERGENCY SYSTEMS	
PASSIVE	**ACTIVE**
Hydroaccumulators (4x)	**High pressure system (3x)**
Total volume: 60 m^3 Volume of water: 40 m^3 Volume of nitrogen: 20 m^3	Pump flow rate: 65 m^3/h Pump discharge pressure: 13.5 MPa
Bubbler-condenser tower	**Low pressure system (3x)**
Total volume of bubbler-condenser well: 13,800 m^3 Volume of 4 gas traps: 16,140 m^3 Volume of 12 bubbler-condenser tanks: 1,380 m^3	Pump capacity: 800 m^3/h Pump discharge pressure: 0.72 MPa
	Spray system (3x)
	Pump capacity: 380-520 m^3/h

Efficiency improvements of MO34 Units

Due to higher performance reached by new components (turbogenerators and other technological parts) that will be installed in MO34 secondary circuit, for each unit, the efficiency will be increased up to 31.7%, without any change in the primary circuit.

The reactor rated thermal power (1375 MWt) being equal, the electric gross power output will be 471 MWe (corresponding to 436 MWe net power output).

The most important improvements and their environmental benefits consist of:

- New turbines of higher efficiency and other optimizations in the secondary thermal cycle (leading to a decrease of the thermal discharge to the environment as a consequence of the decrease of the thermal power dissipated in the condenser);
- New titanium tubes in condensers (leading to higher performances of the component and hence to a lower steam pressure for the inlet water to condensers);
- New natural draft cooling tower package (leading to higher thermal performances of the component and hence to a lower inlet water temperature to condensers);
- New natural cooling tower drop retainers (leading to a decrease of the water consumption).

The general reduction of the thermal discharges (about 7%) into the environment can be estimated as the percent increase of the original efficiency (29.5%).

Moreover, the increase of the NPP efficiency (the electric generated energy being equal) will allow:

- an extension of the nuclear fuel life;
- a decrease of the production of radioactive waste;
- a decrease of the radioactive discharges.

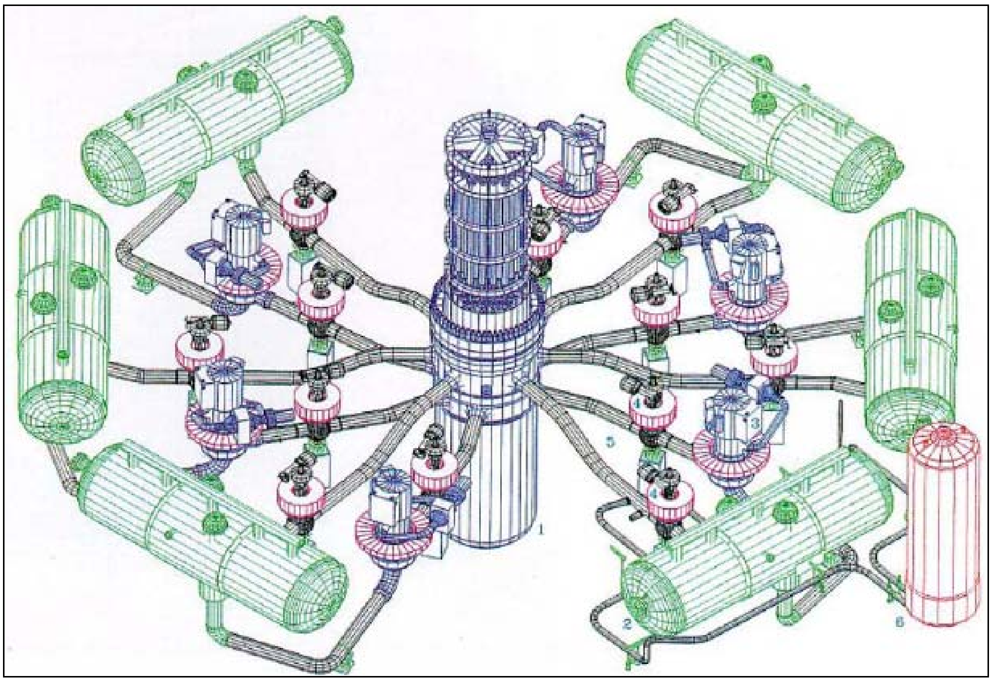


Figure 7 - Primary circuit representation with the six coolant loops

2.4 Description of the main systems

2.4.1 Nuclear Steam Supply System (NSSS)

The NSSS consists of the reactor, the reactor coolant system, and a number of auxiliary and safety systems.

Heat is generated by the process of nuclear fission with the uranium dioxide fuel. The neutron moderator for the fission process is demineralised borated water; this also acts as the primary coolant.

The fuel is placed in an assembly known as the reactor core, which is housed in the reactor vessel. The coolant water passes up through the core, removing heat from the surface of the tubes and thereby maintaining the temperature at the centre of the fuel (at full power) at approximately 1,200 °C.

Control of the nuclear chain reaction is achieved by movement of CFAs and by varying the concentration of boric acid in the reactor coolant.

In order to remove the heat from the core the reactor is equipped with a coolant system. The reactor core is housed in a steel pressure vessel with a stainless steel internal lining. Reactor coolant passes through the core, removing heat from the fuel, and then enters one of six main coolant loops (the primary circuit). The temperature of the reactor coolant is about 297 °C and, to prevent it boiling, it is maintained at a pressure of 12.26 MPa (around 125 atmospheres) by means of a pressurizer connected to one of the coolant loops.

The heated primary coolant enters the SG heat exchanging pipes. These pipes are surrounded by water which is itself heated and produces steam. In this way heat is transferred from the reactor coolant water (the primary circuit) to the power conversion system (the secondary circuit), without mixing of the two fluids. The primary coolant then returns to the core via the main coolant pumps.

The Auxiliary and Safety Systems of the NSSS are provided in order to ensure that the reactor can be safely shut down and kept shut down whenever required and to have the ability to keep the fuel elements cool, and thereby intact, under all circumstances. The Auxiliary and Safety Systems includes: Chemical and Volume Control System, RHR System, ECCS, Equipment Confinement, Auxiliary Feed-Water System and Component cooling systems.

2.4.2 Power Conversion System

The power conversion system consists of various water and steam systems and two steam turbines for each reactor unit. Demineralised water (secondary circuit water) is pumped from the turbine condensers to the SGs, where it passes over tubes containing reactor coolant water. Heat transferred through the walls of the tubes causes the secondary system water to boil, producing steam at a temperature of approximately 260 °C and pressure of about 4.6 MPa. This steam is collected in a common main steam header.

Steam from the main header passes via pipelines into the turbines, where it gives up approximately one third of its acquired energy in rotating the turbines and the connected electrical generators. The steam is then condensed in turbine condensers by passing it over tubes containing circulating water, to which it gives up the remaining two-thirds of its acquired heat energy.

2.4.3 Electrical systems

Each generator of the steam turbine generator set produces electric power at a voltage of 15.75 kV. A segregated bus bar connects each generator to a main transformer (15.75/420 kV). The generated electric power of each Unit of MO34 is transmitted through a separate single outer 400 kV line to Velký Ďur substation.

Power for internal uses of each unit is normally supplied by 2 auxiliary transformers (15.75/6.3 kV) which are connected higher voltage side to the segregated bus bar and lower voltage side to the 6.3 kV bus bars of the unit power distribution system.

If the 400 kV network fails and the switching to house load operation cannot be achieved, the power supply is taken from a 110 kV transmission auxiliary source. Two 110 kV lines connect the power plant to the Velky Ďur switchyard. For each unit there is one auxiliary transformer 110 kV/6.3 kV/6.3 kV with two secondary windings connected to the 6 kV bus bars of the unit power distribution system.

The 6 kV bus bars are interconnected so that auxiliaries of one unit can be supplied in emergency conditions from other units of the NPP.

Some of the 6 kV bus bars are dedicated to essential and safety systems. These essential bus bars can furthermore be supplied by onsite power sources composed of 3.5 MVA standby emergency diesel generators.

To assure power supply to 1st category systems (essential systems), batteries and inverters are employed.

2.4.4 Instrumentation and Control (I&C)

MO34 will use the latest commercially available digital technology. Digital electronics technology is characterized by its vastly increased functionality, improved reliability and reduced maintenance requirements.

The best practices deriving from operational experiences of Slovakian NPPs and International NPPs will be used for MO34.

The modern Human Machine Interface (HMI) will enhance operator response in any plant condition. Also expert systems shall be used to diagnose plant conditions and to advise operators.

The Safety Parameter Display System (SPDS) will be a dedicated interface for the operator, to provide all essential information for the most effective management of the plant, even in the most unlikely accident conditions.

2.4.5 Cooling Systems

In order to minimize the thermal heat dissipation to the river Hron, a closed-loop circulating water-cooling system is used, where heat exchange is performed in wet natural draft cooling towers (Main cooling system). Heated water from the condenser heat exchangers is directed to natural-draught cooling towers. There are four wet natural draft cooling towers for each of the twin reactor units. All the condensers cooling water pumps for two reactor units are located in a common pump station. The steam condenser system in the secondary circuit is cooled by the heat rejection circuit, which contains treated water. Water will be extracted from a reservoir on the river Hron at Veľké Kozmálovce, approximately 5 km from Mochovce.

Fresh water, to replace that possibly lost from the cooling water circuit by evaporation and the smaller volume of blowdown water purged from the circuit, will be taken from the reservoir on the river Hron via a pumping station to twin storage tanks, each with a volume of 6,000 m^3. From the tanks water flows under gravity via two pipelines for treatment and then is fed into the cooling water circuit.

An essential water cooling system is also present and it is used as ultimate heat sink to remove the reactor core residual heat and is cooled by wet forced draft cooling towers. There are 3 independent and 200% redundant essential water cooling systems.

2.4.6 Seismic resistance

The Mochovce plant is built to an anti-seismic design, which means that the most important buildings and process equipment are seismically resistant up to the level of the Design Basis Earthquake for the site (site design basis earthquake ZPA - Zero Period Acceleration - is equal to 0.15 g). By seismic resistance is understood the assurance of reactor coolant system integrity, including safe reactor shutdown and its continuous cool-down during and after earthquake.

2.4.7 Safety systems

To maintain a reactor in a safe shut-down condition and prevent any uncontrolled release of radioactive materials into the environment, the following critical safety functions will be fulfilled:

- sub criticality;
- core cooling;
- heat removal by the ultimate heat sink;
- reactor cooling system integrity,
- confinement integrity;
- coolant inventory.

The fulfilment of these safety functions is ensured by safety systems, which have to perform the required function even in the case of loss of off-site power and following a seismic event. In case of loss of the external electricity source, the emergency diesel generation station (containing six 3.5 MVA diesel generators, i.e. 3 per each unit) ensures the electricity supply to the safety systems.

The safety systems provide even in critical situations protection of plant personnel, and of the population around the plant, against the effects of ionizing radiation from the plant.

For this purpose, the electric equipment of safety systems is supplied by power from Category I (vital power) or Category II (essential power) sources and is seismically qualified. The safety systems have 200% back-up, i.e. each system consists of three identical independent systems of which one alone is sufficient to perform the intended safety function.

The main systems relevant for the safety of the plant in different operating conditions can be summed up as follows (Figure 8):

- High pressure and low pressure injection systems including a passive injection system (boric acid accumulators): these systems belong to the Emergency Core Cooling System (ECCS) which assures core cooling and negative reactivity injection in the case of primary circuit rupture;
- Containment Pressure Suppression System (Bubble condenser and spray system): this system performs the fundamental function of controlling the pressure after an accident in the containment, guaranteeing its integrity;
- Emergency residual heat removal system: it has to ensure the core residual heat and primary circuit accumulated heat removal during the unit cool-down at the normal, transient and accident conditions;
- SG emergency feed water system: this system supplies the steam generators with feed water in the case of low water inventory in the secondary side;
- Essential service water system: is classified as safety system. System provide persistent cooling water supply for cooling equipment which ensure NPP safety during each unit modes, including quick unit shut-down process (DSG cooling, cooling of containment equipments, in reactor hall, equipments in turbine hall). System is back-up to 200 %, i.e. including 3 equivalent
- Boron make-up and control system: it controls the inventory of coolant and it is used to maintain the optimal chemical characteristics of the reactor coolant; in particular it ensures:
    - coolant supply to reactor coolant pump seals;
    - reactor coolant system make-up to compensate non-organized leaks from reactor coolant system (RCS) and return of organized leaks into RCS;
    - correction of reactor coolant chemistry, change (increase/decrease) of H_3BO_3 concentration during normal operation and under accident situations;

- Hydrogen catalytic recombiner and burning system: this system controls the hydrogen concentration in the containment as an additional measure for severe accident management (hydrogen may be produced during an accident by the reaction of water with metals at high temperature);
- Reactor cavity flooding system: this system ensures external Reactor Pressure Vessel cool-down in case of severe accidents;
- Fire protection system.

Legend

1 Reactor
2 Steam generator
3 Reactor coolant pump
4 Main isolating valve a1 hot leg
5 Main isolating valve a1 cold leg
6 Pressurizer
7 Pressurizer relief valve tank
8 Hydroaccumulators
9 HP safety injection pump
10 LP safety injection pump
11 Spray pump
12 Boric acid solution storage tanks
13 Hydrazine hydrate tank
14 Boric acid solution storage tanks
15 Water-jet pump
16 Heat exchanger
17 Sprays
18 Containment
19 Corridor between containment and bubble-condenser tower
20 Bubble-condenser tower
21 Air traps
22 Steam entrance to the bubble-condenser channel
23 Bubble-condenser channel area
24 Bubble-condenser channel
25 Check-valve
26 Check-valve

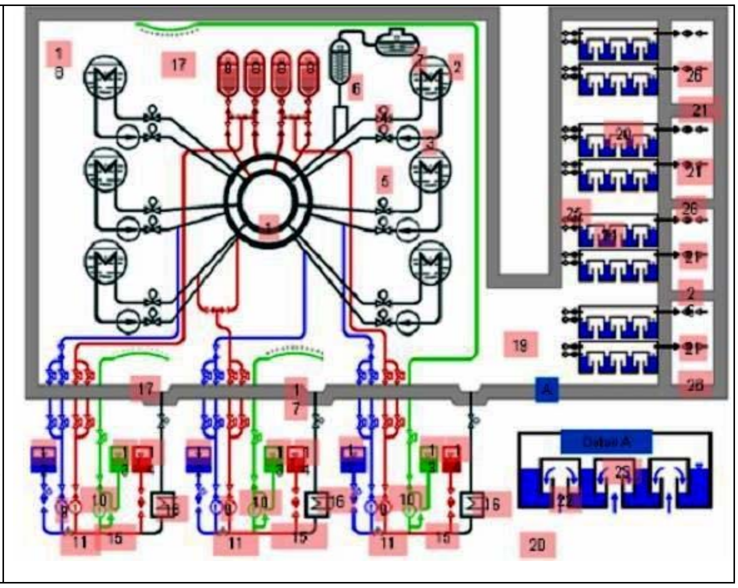


Figure 8 - Safety system scheme

The emergency reactor protections are important protections and control safety systems which assure the function of the reactor trip (*reactor trip system* and *diverse reactor trip system*).

The task of the reactor trip function is to achieve the set conditions, to automatically insert control rods in the reactor core and thus to assure the reactor trip.

The Units of Mochovce 3 & 4 are equipped with reactor limitation system. The reactor limitation system activates protection of an automatic reactor protection system to decrease the reactor thermal power depending on the achieving of set conditions.

The concept of twin reactor units allows for very efficient handling of fuel and radioactive waste. The plant safety features and the fire protection are improved as well. To maintain unit operation the auxiliary systems are installed close to the units. Additional facilities such as the nuclear auxiliary building, the diesel generator station, the compressor building, the service water and the fire fighting pump station also play a relevant role in ensuring a high level of safety of the NPP.

2.4.8 Proposed safety improvements

The safety improvements of MO34 have been conceived mainly on the basis of the IAEA document “IAEA-EBP-VVER-03, Safety issues and their ranking for VVER-440 model 213 Nuclear Power Plants”, and taking EMO12 as the starting point for their further improvement.

Two important aspects need to be pointed out when considering the MO34 safety improvements:

- the main purpose of the IAEA document was to provide “a reference for the development of plant specific safety improvements and for the evaluation of measures proposed and/or implemented”: hence, the document was mainly intended to be used as a support in the safety upgrade of operating plants;
- EMO12 is already 100% compliant with the IAEA recommendations.

For these reasons, within the framework of MO34 project, all the IAEA recommendations will be followed and exceeded, as specific design changes have been implemented for the completion of the construction works.

In particular, the most important modifications concerning nuclear safety can be summed up as below described.

- **Design measures for Severe Accident Management**: within MO34 project, not only the IAEA recommendations have been fully met, but additional measures have also been considered, as severe accidents are dealt with at the design level. In fact, specific design modifications have been identified on the basis of a large amount of analyses, in order to:
  - ensure the integrity of the RPV through external cooling;
  - avoid high-pressure core melt scenarios;
  - ensure containment integrity, through long-term cooling and management of the burnable gases in the containment atmosphere; and
  - improve the Post-Accident Monitoring System.
- **Improvements of I&C and electrical equipment**: state-of-the-art I&C will be installed in MO34. In particular, an advanced digital control system will be used, with an increase of control and monitoring capacity of the NPP. The human-machine interface will also be improved, for a more efficient monitoring and control of the plant safety status. Concerning electrical equipment, the use of solid-state technology for electric systems will improve the overall reliability of the plant: in addition, electrical interconnections between the different units and improved connections to the HV grid will reduce the impact on safety of the loss of offsite power.
- **Seismic upgrade**: following the requirements of the Slovak NRA, the MO34 design will be improved in order to achieve a higher seismic resistance of the plant. Seismic design zpa is 0.15 g.

- **<u>Design measures for the reduction of internal hazards</u>**: the MO34 design will address all the IAEA issues concerning internal hazards, including those deriving from:
  - fires;
  - internal flooding;
  - turbine missiles; and
  - high-energy pipe break.
- **<u>Improved design of safety systems and safety-related equipment</u>**: several design improvements have been considered for some safety systems (e.g., ECCS, EFWS) and for components of primary relevance for safety (e.g., Steam Generators, pressurizer safety valves, etc), as a result of the operational feedback of EMO12 and on the basis of the IAEA recommendations, in order to:
  - increase the reliability and separation of safety systems; and
  - increase the lifetime of components important for safety.

2.4.9 Measures dedicated to Severe Accident Management

The design Mochovce NPP includes systems for Severe Accident Management: these systems, such as the hydrogen catalytic recombiners and igniters and the Reactor cavity flooding system described above, ensure that accidents involving significant core damage, even if very unlikely, are safely managed, preventing significant radioactive releases to the environment.

2.4.10 Containment

MO34 is equipped with a containment system of pressure-suppression type, which relies on a large amount of cold water to condense steam released from the Reactor Coolant System as a consequence of an accident. A similar technology is widely used by other reactors, such as General Electric, Siemens and ASEA Atom (now ABB) BWR's.

The VVER-440/213 containment system is intended to prevent the escape of steam and fission products and to facilitate steam condensation, thereby reducing the pressure after the break of any single primary system pipeline, including the double-ended rupture of 500 mm inner diameter pipes.

The containment system is composed of (Figure 9, Figure 10):

- reinforced concrete accident localization structure, providing confinement function of the system;
- bubbler condenser, providing passive pressure-suppression function; and
- water droplet spray system, providing active pressure-suppression function and radioactivity removal function.

The accident localization compartments include a sealed set of interconnected compartments surrounding selected primary system components (steam generators, inlet and outlet piping, pumps, isolation valves, pressurizer and the major portion of the reactor vessel) and additional compartments containing bubbler condenser.

Compartments housing technological systems constitute a part of the reactor building.

Bubbler condenser rooms are located in an additional building (bubbler condenser tower), connected to the reactor building by a rectangular tunnel.

The reinforced concrete walls of the VVER-440/213 are approximately 1.5 m thick. All walls and roofs of the localization compartments have internal steel lining. Reinforced concrete structures, the airtight entrance doors and penetrations are designed for the 0.15 MPa overpressure.

The bubbler condenser comprises twelve levels of water filled trays. Each level contains 163 m^3 trays. The trays hold borated water with the concentration 12 g/l. Total water inventory inside the bubbler condenser amounts to 1,250 m^3. Outer surfaces of adjacent trays form vertical weirs that are capped by a downward facing trough submerged in water. The inside walls of the trays and troughs form water-filled vertical channels, approximately 50 cm long.

The reactor building spray system (RBS) provides a water spray to the reactor compartment following a LOCA or steam line break, to limit containment pressure and to minimize the release of radioactive iodine and particulates to the environment. The RBS is composed of three identical and completely independent trains, each of them with a capacity of approximately 400 m^3/h.

The efficiency of the containment system in rapidly reducing the accident pressure by combination of pressure suppression system and containment spray allows termination of releases to the environment in a very short time, as fully demonstrated by Research programs sponsored by IAEA, OECD and European Commission through Phare programs, while other containment designs have to cope with overpressurization for days and weeks after an accident. MO34 containment will be equipped with safety systems, so that the integrity of the containment will be ensured during and after an accident. In addition, the MO34 project includes several design improvements, in compliance with the most recent and demanding international safety requirements, which are specifically aimed at preserving the structural integrity of the containment even for extremely-unlikely accident scenarios ("Severe Accidents") which, nonetheless, are the most critical and challenging for the containment.

In particular, the design measures defined for MO34 will:

- avoid the uncontrolled burning of the hydrogen which is generated during a Severe Accident (by using hydrogen recombiners/igniters);
- avoid high-pressure core-melt scenarios (through a dedicated line for fast depressurization of the primary circuit);
- avoid RPV failure (through the in-vessel retention of the molten core by reactor-cavity flooding and external core cooling);

thus practically eliminating the accident sequences which could seriously jeopardize the containment structural integrity.

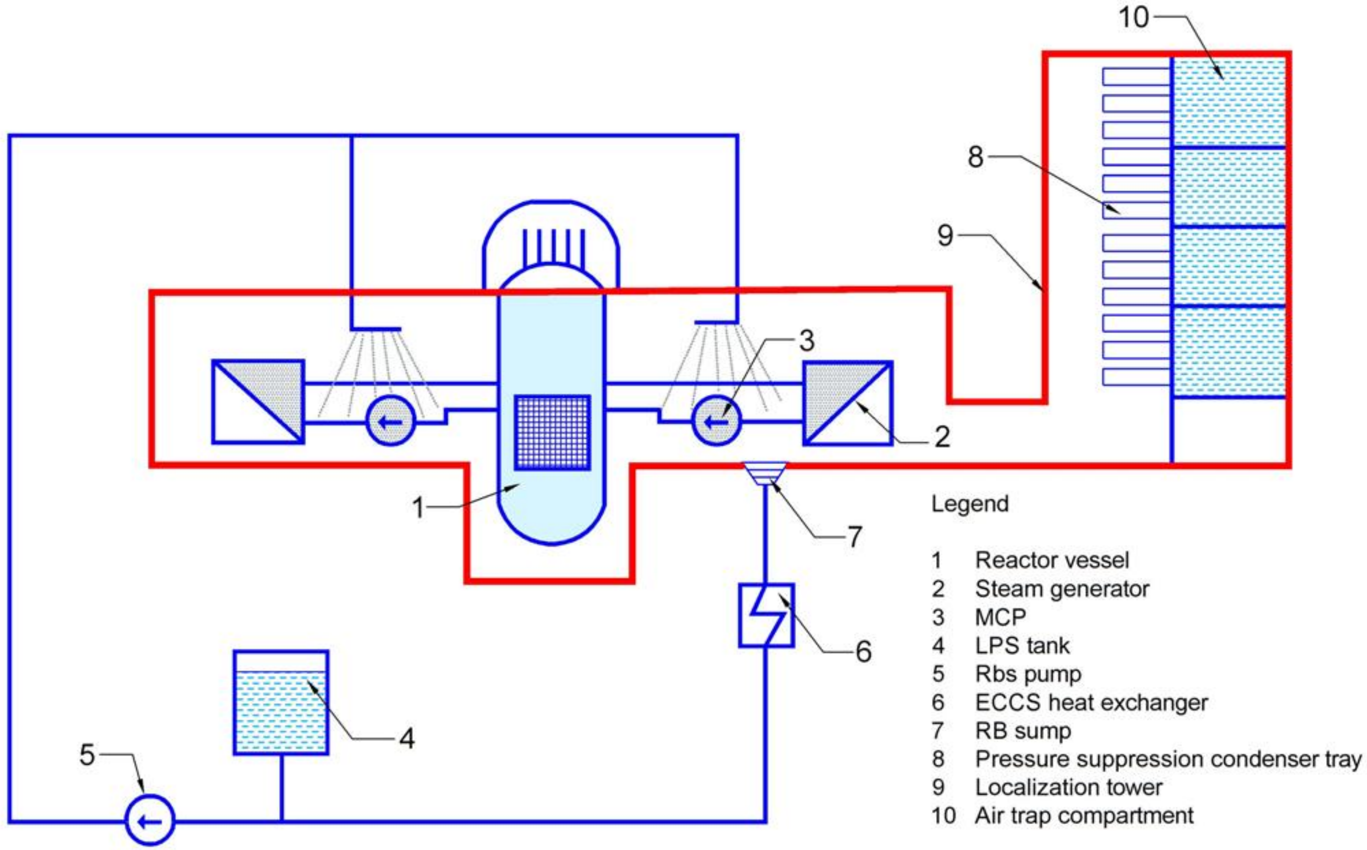


Figure 9- Schematic diagram of VVER-440/213 containment system

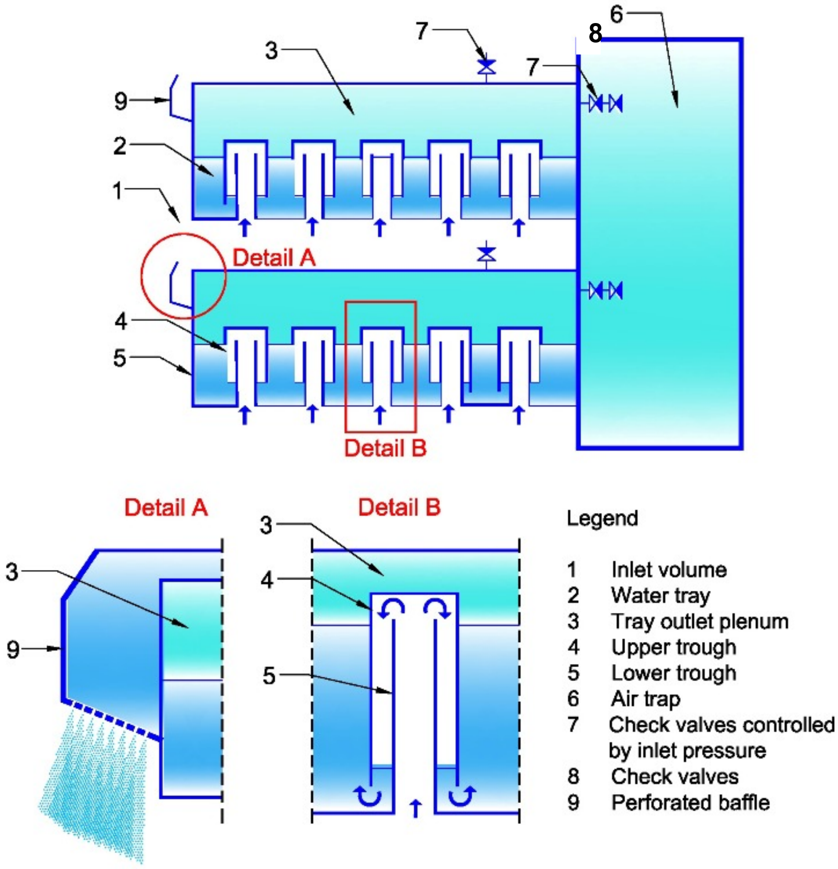


Figure 10 - Details of air trap compartment of VVER-440/213 containment system

2.5 Fuel

The fuel in form of fuel assemblies is placed in the RPV, where chemically treated water runs through channels in fuel assemblies and removes the heat generated by the fission reaction. The water exits the reactor at the temperature of about 297 °C. The used fuel is uranium dioxide (UO_2). Nuclear units operate in campaigns and periodically the reactor is shut down for refuelling.

SE nuclear reactors at NPP Bohunice, both VVER 440/213 type, started their operation with fuel of Russian fabrication and construction. For the first core of MO34 the same configuration as at Bohunice Unit 3. will be used in order to have an optimal power distribution. In accordance with original design nuclear fuel as the initial cores of Bohunice and EMO12, as well as fuel produced for the refuelling in approximately 12 month cycles, consisted of fuel assemblies with enriched uranium 1.6%, 2.4% and 3.6%. Such fuel was used in 3-4 year cycles and the maximum burn-up of discharged fuel assemblies reached approximately 40 MWday/kgU. From 1999 all units started progressively to use a radial profiled fuel with an average enrichment of 3.82% ^{235}U. From 2006 EBO V2 and EMO12 started to use second generation fuel with 3.84% ^{235}U and 4.25% of average enrichment with burnable gadolinium absorber (burnable absorber of thermal neutrons). In addition to the above types of fuel, starting with the second campaign it will be used an advanced type of Gadolinium doped fuel with an enrichment of 4.87% ^{235}U. The use of gadolinium allows to smooth the growth of energy in the reactor core from the beginning of campaign where too many neutrons are emitted to the end of the campaign where more neutrons are needed to allow the use of less fissionable products. With such a fuel it is possible to operate with a 5÷6 year cycle and the fuel burn-up should reach values of 48÷52.6 MWday/kgU.

The adoption of Gadolinium in nuclear fuel elements allows, therefore, reducing tritium production and consequently tritium discharges in wastewater streams.

In the VVER 440, Model V213, the reactor core is composed by:

- 312 Independent Fuel Assemblies (IFA);
- 37 Control Assemblies (30 Absorber Assemblies and 7 Regulation Assemblies).

The 37 Control Assemblies (or Fuel Follower) are divided in 6 groups, five with six assemblies for group and the 6th with the 7 regulation assemblies.

Figure 11 shows the layout of the first core for MO34.

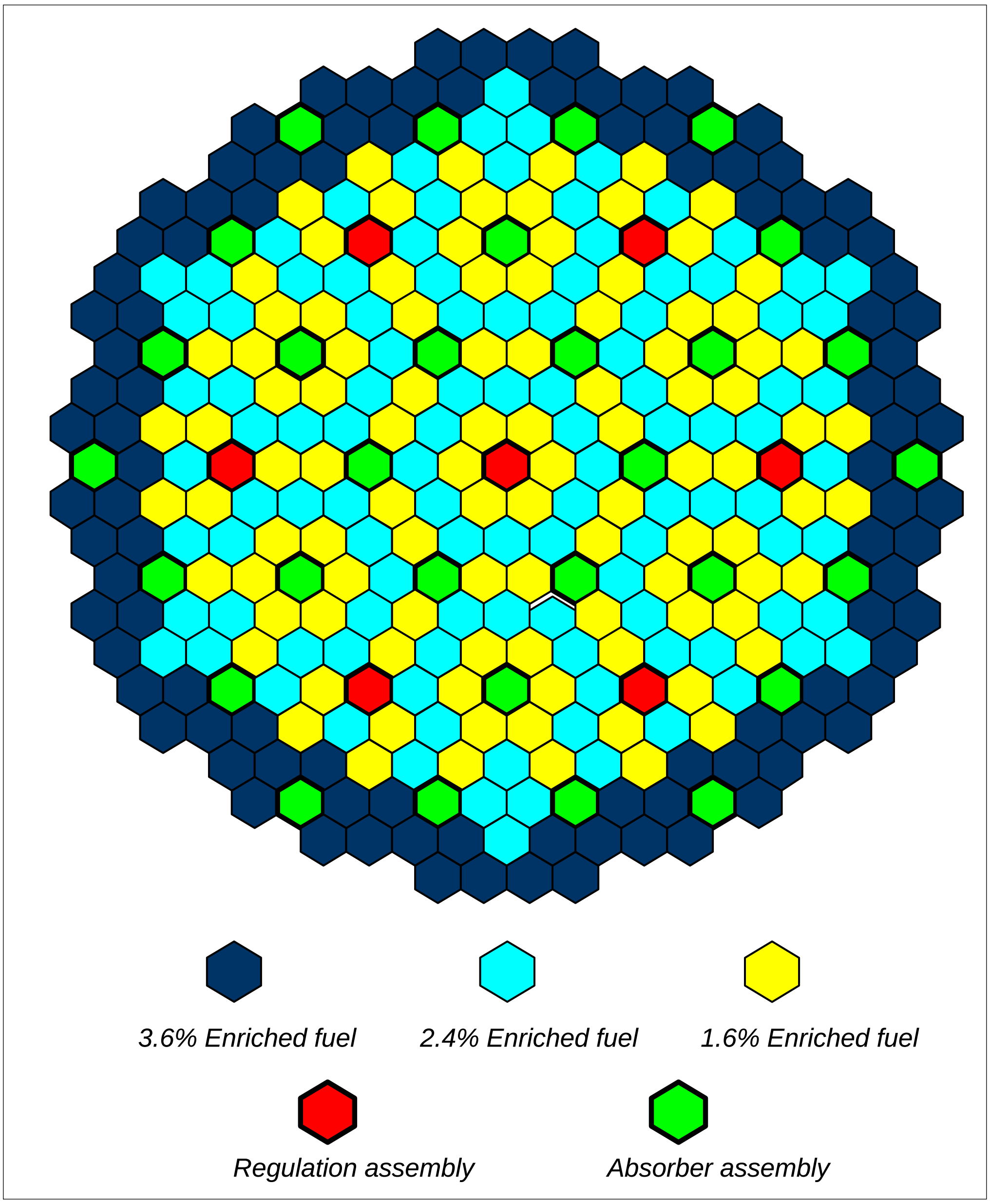


Figure 11 - Layout of the first core for MO34

Control Fuel Assembly (CFA) is composed by two parts – fuel (lower part) and absorber (upper part). Fuel part is located in the core and absorb part (contain Boron to absorb neutrons) is located over the core. To reduce the power of reactor is shift down in to the core.

Each fuel assembly is made up of 126 fuel rods and a central channel for the instrumentation. Ten spacer grids are used in order to assure the position of each rod. Inside each fuel rod there are annular pellets of enriched uranium dioxide, to produce power by fission. The space between the inner surface of the tube rod and the pellets is filled with helium to compensate for the external pressure.

Each fuel assembly is covered by a shroud, as shown in Figure 12.

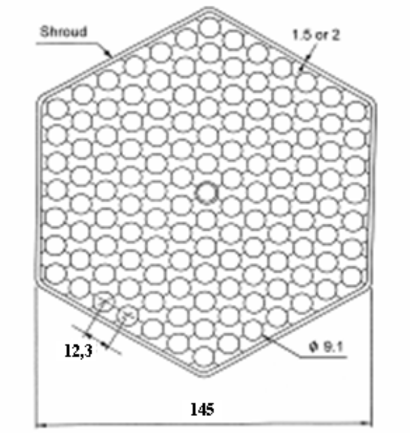


Figure 12- Fuel assembly cross section

The fuel follower of hexagonal shape is made of boron-steel.

2.5.1 Fresh fuel transport and handling

Presently a special railway train serves to transport fresh fuel. Each wagon carries eight containers, each of which holds four fuel assemblies/fuel followers. Upon arrival at the power plant the fuel is transferred into fresh fuel storage where it is checked (visually, geometrically), and either put into temporary storage racks, transport containers or into cylindrical magazines in preparation for refuelling. These magazines each hold 30 assemblies. During refuelling, the magazines are transported by crane to the receiving part of the fuel storage pool. The fresh fuel is transferred from the magazine to the core by a refuelling machine.

When the fuel is ready for discharge, it is transferred from the core to the storage pool using the refuelling machine.

2.5.2 Spent fuel management

Spent fuel treatment conception is set in accordance with Final part of nuclear power industry strategy on its long term storage (cca 50 years) and on its consequent disposal in a deep underground disposal site.

Nuclear power plants in the Slovak Republic are operated in the so-called open fuel cycle. At present it is not possible to apply the closed fuel cycle, as VVER-440 reactors operated in the Slovak Republic are not licensed for the use of MOX fuel (mixture of Uranium and Plutonium oxide). This means that the spent fuel is not reprocessed (Figure 13).

Under the assumption of the shutdown of EBO V1 and the 40 year EBO V2 operation period, EMO12 and MO34 will produce 24 698 spent fuel assemblies which correspond to approximately 2960 tonnes of spent fuel converted into the heavy metal contents. Out of that number, the EBO V1 and V2 productions will be 12 384 pieces of spent fuel assemblies and the EMO12 and MO34 productions will be 13 104 pieces of spent fuel assemblies.

The spent fuel storage in an interim storage facility is an inevitable technological stage whose aim is to reduce the amount of heat and activity produced by spent fuel assembles prior to their reprocessing or prior to their conditioning and insertion in disposal containers and the carriage to the deep underground disposal site. The Interim Spent Fuel Storage Facility in Jaslovské Bohunice is used for that purpose for the EBO V1 and V2 spent fuel and for a part of the Mochovce NPP spent fuel at present. The first spent fuel carriage from Mochovce NPP to the JAVYS Interim Spent Fuel Storage Facility was made in April 2006.

A dry storage facility construction is assumed for the spent fuel storage at Mochovce NPP, based on the principle of two-purpose transport-storage containers. The original assumed commissioning date was the year 2009. The intention to build the Mochovce NPP dry storage facility assumed spent fuel transports (approximately 2 year spent fuel production) to another site (to the JAVYS Interim Spent Fuel Storage Facility). The Mochovce NPP Interim Spent Fuel Storage Facility environmental impact assessment (EIA) process was successfully completed in 2004 resulting in a positive final position issued by the Ministry of Environment of the Slovak Republic. In 2003, however, SE, a.s., decided to make use of the free capacity in the JAVYS Interim Spent Fuel Storage Facility in Jaslovské Bohunice that will remain free after the premature shutdown of NPP V1 reactor units in 2006 and 2008 and to postpone the beginning of the construction to 2017. The capacity in question is approximately 1,500 fuel assemblies which is sufficient for about 10 years of Mochovce NPP operation (under the assumption that 75 spent fuel assemblies will be removed from the reactor core on an average yearly and the spent fuel assemblies will be stored in KZ-48 compact containers in the Interim Spent Fuel Storage Facility).

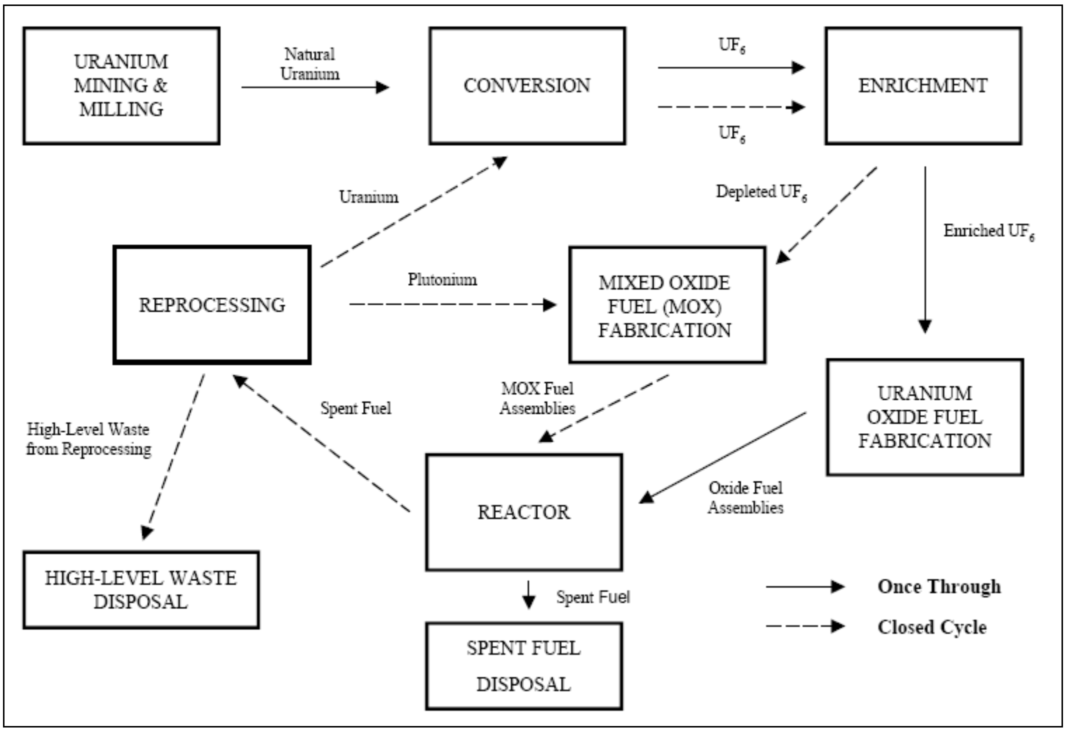


Figure 13 - Open and closed fuel cycle

2.5.3 Spent fuel storage in main reactor building hall

Yearly, after termination of planned campaign, a part of spent fuel is removed from the reactor and placed to the spent fuel pit situated in the reactor vicinity. The need for the spent fuel storage in the spent fuel pit results from the residual heat production in the fuel that continues even after its removal from the reactor core. The spent fuel stays in the spent fuel pit approximately 6 to 7 years. The Mochovce NPP spent fuel is stored in a compact storage lattice in vertical positions enabling a good cooling by the circulation of the cooling medium, i. e., the aqueous solution of boric acid with the concentration of 12 g/kg at least. The solution temperature is maintained on values up to 50 °C. The compact storage lattice capacity is 640 positions/storage places for each pit. The base of the storage lattice is formed by hexagonal absorption tubes manufactured with addition of stainless steel with up to 2% of Boron in which spent fuel assemblies and hermetic enclosures are inserted. There are positions dedicated for placement of the round hermetical capsules on the compact storage lattice edge.

Spent fuel assemblies for which a cladding damage was detected are stored in hermetic capsules. The hermetic enclosure structure ensures the following:

- a reliable isolation of gaseous fission products leaking through the damaged fuel assembly cladding;
- the residual heat removal;

- a safe transport and handling of a fuel assembly; and
- the long-term storage of the spent fuel with a damaged fuel cladding.

A further storage space for spent fuel (reserve storage lattice) is used in case of a short-term storage of fuel assemblies removed from the reactor core during revisions or repairs of internal reactor parts. The reserve storage lattice for spent fuel is manufactured with stainless steel and it is positioned above the compact lattice and its capacity is 296 fuel assemblies and 54 hermetic capsules.

The above described elements of the spent fuel storage system in the spent fuel pools are made of stainless steel. The Mochovce NPP storage pits are covered with one stainless steel liner with the thickness of 3 mm.

The heat is removed from the space when the spent fuel is stored by means of two separated cooling circuits that are equivalent as for their power outputs. Each of them alone is able to remove efficiently the heat produced by spent fuel assemblies found in the storage lattice and the maximum heat load during the operative fuel transfer from the reactor vessel to the reserve lattice.

The water warmed up by spent fuel assemblies is removed from the pit water level and from container shaft to the heat exchanger and after cooling down it is pumped by a pump back to the pit and container shaft. The maximum pit water temperature must not exceed 50 °C.

The pit, the reactor shaft and the container space are interconnected during refueling of the active core and filled completely with a boric acid solution of the concentration of 12 g H_3BO_3/kg H_2O at least, up to the highest level +21,0 m. High level of the boric acid solution ensures core subcriticality, reliable heat sink during refueling and creates adequate shielding to avoid external personnel's irradiation at the same time.

2.5.4 Anticipated Mochovce interim spent fuel storage facility

The construction of a dry storage facility (Figure 14) is assumed for NPP Mochovce based on the principle of two-purpose transport-storage containers. The assumed commissioning date is 2017. The Mochovce NPP Interim Spent Fuel Storage Facility environmental impact assessment in compliance with Act No. 127/1994 Coll., was successfully completed in 2004.

The subsequent stages are as follows: the design preparations, the technology selection, the land-use proceeding and, subsequently, the implementation.

By that time the free capacity in the JAVYS, a.s. Interim Spent Fuel Storage Facility will be used assuming the gradual spent fuel carriage from NPP Mochovce by three KZ-48 annually, alternately from Units 1 and 2.

Simplicity of operation is the major advantage of the dry interim storage facility, especially if using containers. Spent fuel is stored in dual purpose transport-storage containers.The capacity of this kind of storage facility can be modified in a simple way, because it depends on number of storage containers. Dry interim storage containers are located in a building, which primary function is to secure cooling of containers and its protection against atmospheric exposure.

Dry spent fuel storage is usually chosen where spent fuel reprocessing is not considered. The advantages of long-term dry spent fuel storage are following:

- no active systems are required (or a minimum number - e.g., the pressure monitoring system);
- low maintenance requirements;
- a simple operation and the possibility to adapt to modified Customer's requirements;
- less secondary wastes; and
- low inherent accident risk resulting for the storage principle.

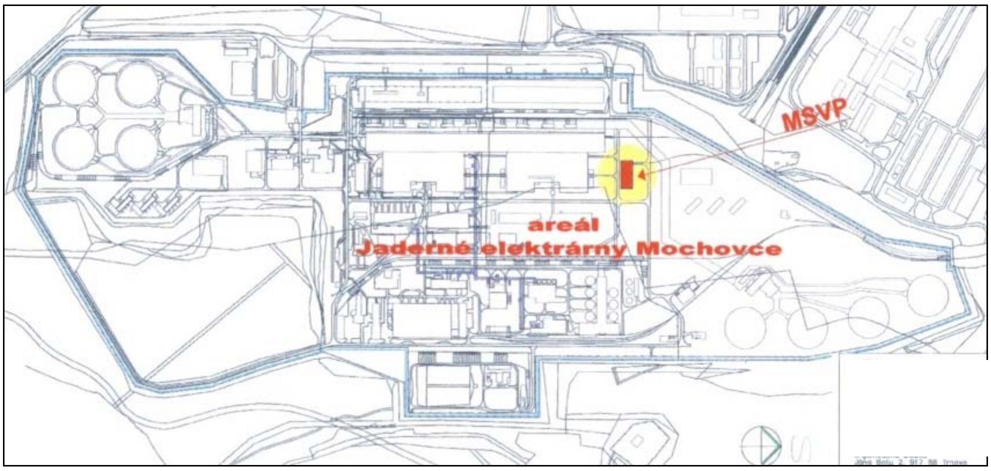


Figure 14 - Location of the anticipated Interim Spent Fuel Storage (MSVP in figure)

Civil structure

Spent fuel containers will be stored in a building whose primary function is to ensure the cooling of the containers and their protection against climatic influences. The additional biological shielding is the secondary, however not necessary, function. The interim storage facility building will be equipped with necessary handling means.

The heat that is produced by the stored spent fuel will be removed from the containers by natural ventilation. The interim storage facility building will be interconnected with other facilities on the site by roads and a railway siding. The electric power supply will be provided from the existing power plant equipment. The building will also be connected to fire water pipeline circuits on the Mochovce NPP site.

The storage facility building consists of the technical zone, receipt area and the storage space itself. The technical zone consists of the access hall, changing and sanitary rooms, electric switch room and a store room. The building will also include a storage room for transport means.

The receipt area consists of an empty container storage zone and a container preparation and inspection zone. The receipt area is sized to hold a truck with a semi-trailer or a railway wagon capable of carrying a container. The crane parking position is situated in the receipt area.

Spent fuel container

The Mochovce NPP Interim Spent Fuel Storage Facility will be built on the basis of two-purpose containers enabling both the spent fuel transport and storage. Fuel assemblies are stored in a dry inert atmosphere. The fuel assemblies must ensure the following major functions:

- a safe confinement of radioactive substances;

- the provision of the spent fuel subcriticality;
- the provision of the fuel cooling and residual heat removal;
- the provision of shielding; and
- the protection of spent fuel assemblies against external impacts and risks.

In addition to the fuel assembly cladding, the container body equipped with a double closing system also prevents radioactive substances from leaking into the environment. The subcriticality of stored spent fuel assemblies is ensured by the layout of the assemblies in the container and is calculated conservatively for the fresh fuel. The heat produced during the storage is usually removed by a passive air flow. The reference two-purpose transport-storage container for the dry interim spent fuel storage facility consists of the following parts:

- the metallic monolithic container body providing the biological shielding and structural integrity of assemblies during:
  - the whole storage period;
  - the on-site transport;
  - potential transport to the reprocessing plant or to the spent fuel disposal site;
- the storage basket (receiver) where fuel assemblies are placed in the defined position;
- the closing system (consisting of two screwed-on lids) including doubled seals;
- the container leakage monitoring system.

Neutron absorbers made of plastics are also inserted in the container body and lids.

Monitoring system

The storage rooms will be monitored for gamma and neutron radiation. The monitoring system will be equipped with lamp and acoustic alarm signals that will be activated in case of exceeding the permissible levels for normal operation. The storage containers will be equipped with the tightness monitoring system that ensures the internal space tightness inspection and early indication of possible loss of tightness.

Auxiliary systems

Container Repair and Maintenance System

During the normal operation of the interim storage facility, maintenance actions will only be taken to a limited extent. They will especially consist in visual inspections and filling the helium receiver of the pressure monitoring system, or in the removal of deposited dust from the surface of containers. After some storage period it may be necessary to restore the container coatings.

The visual inspections can also be ensured by means of cameras installed in the storage hall and on the crane. The filling of the pressure monitoring system receiver with helium can be performed in the preparatory zone of the receipt area.

It will be possible to remove the secondary upper lid leakage in the Interim Spent Fuel Storage Facility. Activities for which it is necessary to open the primary container lid will be performed outside the interim storage facility building (in the Reactor Hall).

Ventilation system

The task of the interim storage facility building ventilation system is to remove the residual heat produced by spent fuel assemblies in containers and to ensure that the maximum design values will not be exceeded. The ventilation is ensured by the natural air flow and circulation (a passive system). The air enters through shutters at the bottom part of the perimeter wall and gets out through holes in the ceiling structure of the interim storage facility.

Drainage system

The function of the drainage system is to lead the potential liquid radioactive waste to the collection tank. Following the dosimetrical control, the waste will be either discharged to the sewer system or carried and processed by the liquid radioactive waste processing system.

Fire protection System

The dry interim storage facility will make use of the NPP Mochovce site fire protection system.

On-Site container handling

After the termination of the storage in the spent fuel pool, the spent nuclear fuel will be carried to the Interim Spent Fuel Storage Facility. All handling actions related to spent fuel preparations for the placement in the Interim Spent Fuel Storage Facility will be taken in the NPP Mochovce Reactor Building. Spent fuel assemblies will be inserted in containers in the transport container shaft. They will be carried in the containers to the Interim Spent Fuel Storage Facility and stored there in the containers. The spent fuel is inserted in containers in the water environment whose parameters are identical to those of the cooling water in the spent fuel pit. The following actions will be taken after the spent fuel is inserted in the containers and the containers are closed and transferred to the service point:

- the cooling medium will be pumped out from the containers,

- the containers will be dried out, and
- the container tightness test will be performed.

Those actions are aimed to fill the container and prepare it for the carriage to the Interim Spent Fuel Storage Facility.

Both the insertion and removal of the fuel to and from the containers will only be performed by means of the refuelling machine at the spent fuel pit in the Reactor Building of the relevant reactor unit. The container decontamination will also be performed in those rooms.

The containers will be carried from the Reactor Building to the Interim Spent Fuel Storage Facility by a truck with a semi-trailer or by a railway wagon in the horizontal position. The container will be lifted by a crane from the transport means in the receipt area and placed in the vertical position to the preparatory zone. After the required inspections and handling are performed, the container will be transported to its storage position in the storage space and connected to the system monitoring the gas pressure in the container (container tightness inspection).

2.5.5 Deep underground geological disposal site for spent fuel

The spent fuel disposal, following the relevant preparations (the transfer to the storage container, welding up, etc.), in a disposal site built in deep underground geological formations of appropriate properties (or the carriage abroad, if enabled by legislative and economic conditions) will be the final phase of the spent fuel management in the open cycle.

The deep underground geological disposal principle consists in, after a storage period, placing the spent fuel and high-activity radioactive waste in an engineering construction in a big depth in a stable geological environment in order to ensure a permanent isolation of stored materials from the environment without any intention to retrieve the materials in the future. In principle, it is possible to design the disposal site so that the stored waste is retrievable prior to the closing of the disposal site or for some time after the closing.

A system of multiple engineering and natural barriers (the multi-barrier principle) in the deep underground geological disposal site ensures the isolation of wastes from the biosphere and a high degree of safety.

Regarding the research-development activities related to the deep underground disposal in the Slovak Republic, the following objectives can be highlighted:

1) a detailed geological exploration of sites with crystalline rock and clay environments that were identified during preceding programme stages based on results obtained by means of light geological methods, but also deep bores;

2) the draft concept of the deep underground disposal respecting the spent fuel and radioactive waste parameters after the storage, rock environment properties in the given sites, the long-term safety of the disposal site after the termination of its operation and closing based on a combination of storage container properties, engineering barriers and geological environment and the minimalisation of impacts on the environment;

3) safety analyses for the draft concept of the deep underground disposal;

4) the reduction in number of exploration sites and the selection of candidate site and stand-by sites.

The development programme for deep geological disposal was launched 1996. It came from federal programme that has been modified for condition within Slovak territory. Programme was financially covered by SE, .a.s. and coordinator was DECOM Slovakia Ltd. The Programme was stopped in 2001. It is expected that the main responsibility will be taken by a new established state agency for disposal of RW.

2.6 Resources consumption at the installation

2.6.1 Land

Further development of the Mochovce NPP, units MO34, has a minimal demand for new land usage. The majority of the construction (70%) is already built and used by the existing site for operational areas of EMO12. The existing auxiliary operations will also be utilized i.e. water mains etc. A minimal amount of land will be required for the construction of the required independent electrical network for connection to the Veľký Ďur distribution plant.

2.6.2 Water

Surface water

Water for the operation of Mochovce NPP is extracted from the dam at Veľké Kozmálovce on the Hron River approximately 5 km from the site (Decision of the district authorities in Banská Bystrica, No. 1094/2/177/405.1/93-M from 6.7.1993).

The volume of extracted water is given based on the water needs of the circulating cooling system of the condensers and depends on the season and external climate conditions. Operation of all four units at Mochovce NPP would require the consumption of water from the dam in Veľké Kozmálovce in the average volume of $Q_{\varnothing}$ = 1.5 m^3/s, to the maximum volume of Q_{max} = 1.8 m^3/s.

Bigger parts of solids from the withdrawal structure are collected from the extracted water, first through a coarse 3 to 5 cm hack at the inlet of the piping, and then refined, through a 16 mm hack at the entrance of the pumping station. This second set of hacks is cleaned by an automatic device and the impurities are gathered into a 3.2 m^3 tank. Water deprived of mechanical impurities is pumped from the pumping station to two reservoir tanks, each with a volume of 6.000 m^3 at the Mochovce NPP.

A total volume of supplemented water consists of the water loss due to evaporation from the cooling towers in the range of 0.85 m^3/s to 1.33 m^3/s depending on the external air temperature and humidity. A further part of the water in the range of blow-down from 0.18 m^3/s to 0.36 m^3/s is supplemented for the purpose of keeping the chemical regime in the cooling circuit. The water is discharged into the industrial drainage system, and then to the waste piping of EMO.

Consumption of surface water in 2004 - 2008

The volume of consumed surface water in 2004-2008 is given in Table 2. In 2008, the total amount of surface water extracted was 20,626,000 m^3 from the source at Veľké Kozmálovce, which is in conformity with the yearly limits permitted by the water authorities valid for 4 units to the amount of 47,304,000 m^3/year. Once Units 3 and 4 are in operation, extraction of surface water will be doubled.

Table 2 - Volume of consumed surface water in relation to the production of electrical energy

Year	Water consumption [m^3]	Production of electric energy [MWh]	Specific water consumption [m^3/MWh]
2004	17,615,583	5,482,865	3.21
2005	19,313,417	6,239,944	3.09
2006	18,949,001	6,320,254	2.99
2007	19,994,286	6,828,737	2.93
2008	20,626,000	6,890,967	2.99

The quality of extracted surface water depends on the water reservoir at Veľké Kozmálovce, which serves for the supply of utility water to the Mochovce NPP.

A deterioration in the quality of water from the water reservoir V. Kozmálovce leads to a higher consumption due to worsening of the parameters of treated water. The deterioration of water quality is caused by sediments in the water reservoir. Their amount is estimated to be about 50% of the volume of the reservoir.

It resulted from the analysis of water consumption for operation of all four units that the permitted average consumption of 1.5 m^3/s - representing the amount of 47,304,000 m^3 per year, as stated in the valid licence, will not be exceeded.

The volume of water in V. Kozmalovce water reservoir will be sufficient for water needs of four units in operation. It is necessary, however, to monitor sedimentation in the reservoir.

Groundwater

Groundwater is extracted from two wells, HMG-1 and HMG-1/A, owned by SE in Červený Hrádok approximately 8 km away from Mochovce NPP. The maximum permitted take-off is 18 l/s for HMG-1 and 15 l/s for HMG-1/A. After treatment, the groundwater is used for drinking.

Groundwater is extracted on the basis of a decision issued by the Western Slovak Regional State Commission in Bratislava No. PLVH-4/1746, 1747/1984-8 of 29 April 1985.

Up to 2005 groundwater was mostly taken from the two wells in Červený Hrádok, and the remaining part from a substitute source in Kalná nad Hronom (Table 3). Since 2006, it has been supplied only from the drinking water source in Červený Hrádok. The supply of drinking water from the substitute sources was stopped in June 2005 following the decision of NPP management.

In 2008, the volume of pumped groundwater from the source at Červený Hrádok was 126,606 m^3, out of which 116,750 m^3 being effectively supplied to Mochovce NPP.

Currently the well at Červený Hrádok provides sufficient drinking water for the Mochovce NPP.

Table 3 - Volume of consumption of drinking water from the different sources in the period 2004-2008

Year	Volume of consumed drinking water [m^3]		
	Wells	Substitute source	Total
2004	353,940	47,167	401,107
2005	178,760	22,305	201,065
2006	96,183	=	96,183
2007	83,478	=	83,478
2008	91,378	=	91,378

The volume of extracted groundwater had a decreasing trend in 2005-2007. In 2008, the volume of extracted ground water slightly increased. However, no measures beyond common activities need to be taken.

2.7 Release of airborne effluents in normal conditions

One of the sources of gaseous discharges is the primary coolant decontamination system. The primary coolant becomes contaminated during the operation of the reactor through activation of the impurities present in the coolant and through fission products that may enter the coolant from a failed fuel element. The primary coolant decontamination system is designed to keep the activity level in the primary coolant system within specified limits.

The system operates at primary coolant system pressure. In addition, it also removes corrosion products that are present in the coolant. Part of the coolant is taken from the disconnectable section of each circulation loop, cooled in the heat exchangers and returned to the primary coolant system. In this process, non condensable radioactive gases are gathered and sent to the radioactive gas purification system.

The radioactive gas purification system removes radioactive gases. In the blow-down system, these gases are diluted with Nitrogen, removed from the primary circuit, and directed into the special gas cleaning system.

For releasing (discharging) gaseous and liquid radioactive substances into the ambient of the NPP, limits are determined. The purpose of these limits is to ensure that the discharge of radioactive products (whether liquid or gaseous) into the ambient of the NPP under normal conditions as well as abnormal operation does not cause the value of effective exposure of 0.250 mSv/year of individual citizens to be exceeded in the whole region due to the operation of the NPP.

2.7.1 Permit to release gaseous radioactive substances into the environment

The permit to release gaseous substances into the environment in the manner of their discharge in pollutants through a ventilation stack under normal conditions is given by a permit of the Office of Public Health Care of the Slovak Republic No 000ZPZ/6274/2006 of 2 November 2006.

This decision set the conditions for operation of EMO12 (Table 4) including the yearly limit of emitted activity of noble gases ($4.1\cdot10^{15}$ Bq), iodine radioisotope ^{131}I in total gaseous and aerosol forms ($6.7\cdot10^{10}$ Bq) and radionuclide mixtures (except ^{131}I) in aerosol with half-life greater than 8 days ($1.7\cdot10^{11}$ Bq).

In addition, it sets reference investigation levels for releases to atmosphere for radionuclides of noble gases ($1.1\cdot10^{13}$ Bq/day), iodine radioisotope ^{131}I in gaseous form ($1.8\cdot10^{8}$ Bq/day) and radionuclide mixtures in aerosol ($0.5\cdot10^{9}$ Bq/day) and also intervention levels for release to the atmosphere for radionuclides of noble gases ($5.5\cdot10^{13}$ Bq/day), iodine radioisotope 131I in gaseous form ($9.0\cdot10^{8}$ Bq/day) and radionuclide mixtures in aerosol ($2.5\cdot10^{9}$ Bq/day).

The decision also sets the requirement for continual monitoring of total bulk activity of noble gas radionuclides, total bulk activity of aerosol and bulk activity of iodine radioisotopes ^{131}I in gaseous form, in gas emissions; dose loads for balancing and evaluation of gaseous emissions, and the reporting requirements to the Office of Public Health Care of the Slovak Republic.

The decision is valid until the 1st of November 2011.

Table 4 - Yearly limits, reference investigation levels and intervention levels for releasing radioactive substances into the environment under normal conditions for EMO12

	Yearly limits	Reference investigation levels	Intervention levels
Radionuclide of noble gases	$4.1\cdot10^{15}$ Bq	$1.1\cdot10^{13}$ Bq/day	$5.5\cdot10^{13}$ Bq/day
Iodine radioisotope ^{131}I	$6.7\cdot10^{10}$ Bq	$1.8\cdot10^{8}$ Bq/day	$9.0\cdot10^{8}$ Bq/day
Radionuclide mixtures	$1.7\cdot10^{11}$ Bq	$0.5\cdot10^{9}$ Bq/day	$2.5\cdot10^{9}$ Bq/day

In 2008, for gaseous discharges, the percentage of using of the annual limit for noble gases was 0.037 %, for iodine ^{131}I 0.00027 %, and for aerosols 0.0049 % of the permitted annual limit for EMO 12.

2.7.2 Technical aspects

Gaseous radioactive substances from the hermetic zone and from some selected areas of the controlled zone are conducted through the ventilation system to the ventilation stack (one shared by both units, MO34). Exhaust gases are conducted through a system of filters.

Should there be aerosol or iodine in the hermetic areas there is a circulation filter system installed to reduce the volume of aerosol in order to protect the surroundings of Mochovce NPP against aerosol and iodine isotopes.

The ventilation systems are supplemented with a system of technical measures so they will function even if the environmental parameters are exceeded (in particular temperature and temperature load of the ventilation system, when heat extraction is provided by an independent system).

During normal operation the ventilation system is constantly monitored and the results of measurements of individual qualitative and quantitative parameters are recorded by an information system.

Ventilation of areas of the **hermetic zone** is provided by an independent air-conditioning system, which works independently of the regime of the operation of the NPP and the reactor. Air tight zones of the areas in the block are boxes, areas and rooms in the reactor to which the worst possible accident can not spread. Air tight areas are ventilated based on the presence (periodic, permanent) or absence of service staff. The ventilation system is for areas with an absence of service staff and periodic presence of service staff under pressure with a moderate circulation of air to areas with a potentially higher activity. Areas with permanent presence of the attendance staff do not have a guaranteed value of pressure difference compared to its surroundings.

The outflow system creates pressure in the ventilated areas by the flow of air from one area to another in the direction of cumulative activity. Filters are fitted to clean the air, including aerosol filters and also iodine filters. The ventilated air from the controlled zone is discharged to the atmosphere through an air-conditioning stack.

The safety system includes a ventilation system of the all active operations of the NPP.

The ventilation systems of active operations of Mochovce NPP (including the FSKRAO-LRAWTF) are led into a ventilation stack. At the end of the ventilation stack it is present a final quality control of the discharged air to the environment with continual measurements taken of 10% of air flown. In addition to the continual measurement the system is fitted with an air sampler for periodic analysis.

The effectiveness of the filtration ranges from min. 99.97% (for standard oily mist) to 99.5% for iodine filters (for methyl iodide).

All of the calculated values of individual and collective doses during normal conditions are under the limits pursuant to the Atomic Energy Act and the Act No. 355/2007 Coll. on Prevention, Protection and Promotion of Public Health and the Decree of the Government No 345/2006 on Basic Safety Requirements for Health Protection of Workers and population from Ionizing Radiation.

2.7.3 Radioactive discharges to atmosphere from other installations

The only installation at Mochovce NPP which emits to the atmosphere are the NPP itself with the ventilation system from units 1 and 2, and from the final processing of the liquid radioactive waste – FSKARAO (LRAWTF). This facility does not have its own air emissions. The ventilation system of the LRAWTF is connected to the ventilation system of Units 1 and 2 of the NPP. The pathway from the LRAWTF to the ventilation system of the NPP is monitored independently.

The safety report for the LRAWTF evaluated the impact on the critical group of inhabitants and concluded that the "systems provide a sufficient guarantee of negligible impact on the environment".

2.7.4 Monitoring of discharges

The main source of radioactive emissions to the atmosphere during operation are technological equipment for the treatment and degasification of cooling water from the primary circuit, which can reach the working environment through various ways through the air-conditioning system and the ventilation stack. Radioactive substances discharged to the atmosphere is made up of gas, aerosol and iodine. Total flow volume of discharge is approximately 5.10^5 m^3/hour.

Table 5 shows data obtained from measurements by instruments located in the ventilation stack and from laboratory analyses.

Table 5 - Balance of radioactive substances discharged to the atmosphere

Year	Noble gases		I-131		Aerosols	
	Annual limit [GBq]	4.1E+06	Annual limit [MBq]	6.7E+04	Annual limit [MBq]	1.7E+05
	Exhaust [GBq]	% of the annual limit	Exhaust [MBq]	% of the annual limit	Exhaust [MBq]	% of the annual limit
1998	7,890	0.192	77.25	1.2E-01	13.62	0.0080
1999	12,507	0.305	108.57	1.6E-01	24.13	0.0142
2000	14,412	0.352	56.53	8.4E-02	10.92	0.0064
2001	12,712	0.310	14.65	2.2E-02	17.77	0.0105
2002	11,419	0.279	14.93	2.2E-02	8.18	0.0048
2003	10,805	0.264	1.93	2.9E-03	12.52	0.0074
2004	3,145	0.077	2.18	3.2E-03	8.12	0.0048
2005	4,566	0.111	0.38	5.6E-04	20.53	0.0121
2006	3,061	0.075	0.43	6.4E-04	19.23	0.0113
2007	2,691	0.066	10.18	1.5E-02	10.28	0.0061
2008	1,517	0.037	0,18	2,7E-04	8.39	0.0049

2.8 Release of liquid effluents in normal operation

Discharge receptors of waste water coming from Mochovce NPP are:

- the Hron River, for waste water of EMO, and rainfall water collected in Mochovce NPP;
- the Telinsky Stream for water coming from the operational premises of MO34 (facilities of the construction site) and the de-sludged water from the Čifáre sludge bed after the drinking water treatment;
- the Širočina Stream from sludge lagoons after washing sand filters.

The main waste water source discharged to river Hron is represented by industrial wastewater (cooling water) from EMO12. The industrial wastewater can be divided into:

- waste water without radionuclides comprising cooling tower blow-downs and water coming from the regeneration of the installation for demineralised water production; and
- waste water with presence of low activity radionuclides, constituted by condensation of vapour coming from radioactive liquid treatment.

Waste water is led away by three types of drainage system (sewage, rain, and industrial special) into a common waste piping (Ø 1,000 mm, made of steel, along the full length covered by concrete) about 6,0 km long, by gravity force into the Hron River.

In 2008, a total amount of 4,812,820 m^3 water from the operation of EMO12, out of which 91,378 m^3 of sewage water, and the remaining 4,721,442 m^3 of industrial waste water (Table 6).

Table 6 - Discharged waste water into the Hron River from Mochovce NPP between 2004 and 2008

	2004	2005	2006	2007	2008
Discharged industrial wastewater [m^3]	4,285,390	4,969,195	4,762,647	4,367,000	4,721,442
Treated sewage wastewater [m^3]	363,466	157,609	96,000	83,000	91,378
Total discharged wastewater [m^3]	**4,648,856**	**5,126,804**	**4,858,647**	**4,450,000**	**4,812,820**
Permitted annual value [m^3] (*) for EMO12	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**

(*) The permitted annual value for four units of Mochovce NPP is 12,000,000 m^3/year.

The volume of waste water discharged to the Telinské Stream from the Čifáre settling tank was 141,000 m^3 in 2008. The limit value set in the decision of Regional Environmental Authority /REA/ Nitra No. 2004/00408, from 22.7.2004 is 252,288 m^3.

The last group of wastewater related to the operation of the NPP is wastewater from drinking water treatment at Červený Hrádok. The volume of waste water discharged to the Širočina Stream was 810 m^3 in 2008. The limit value set in the decision of Nitra No.2003/015778, from 19.9.2003 is 10,000 m^3.

2.8.1 Permit to discharge liquid radioactive substances into the environment

The permit to discharge liquid radioactive substances from the installation under normal conditions is established by the permit of the Office of Public Health Care of the Slovak Republic No. 000ZPZ/6274/2006 of 2 November 2006.

This decision set the conditions for operation of EMO12 (Table 7) including the yearly limit of radionuclide activity in emissions for Tritium (1.2×10^{13} Bq) and for fission and activation/corrosion products (1.1×10^{9} Bq).

In addition, it sets limits for volume activities of liquid outlets releases to hydrosphere for Tritium (1.0×10^{5} Bq/l) and for fission and activation/corrosion products (40·Bq/l).

The decision is valid until the 1st of November 2011.

Table 7 – Yearly limits and volume activities limits for discharging radioactive liquids under normal conditions for EMO12

	Yearly limits	Volume activities limit
Tritium	1.2×10^{13} Bq	1.0×10^{5} Bq/l
Activation/corrosion products	1.1×10^{9} Bq	40 Bq/l

In 2008, for liquid radioactive discharges, the percentage of using the yearly limit for tritium was 65.47 %, and for other radionuclides (corrosive and fission products, transuranium) was 1.26 % of the permitted annual limit for EMO12.

2.8.2 Radioactive liquid effluents

Starting from the operational experience gained at EMO12, the amount of wastes deriving from the treatment of liquid radioactive substances, which can be expected during the assumed 40-year period of MO34, is reported in Table 8.

Table 8 - Assumed amount of wastes deriving from liquid radioactive treatment during the MO34 operation period

Waste type	Amount [m^3]
Radioactive concentrate	9,025
Low-activity sorbents	122
Medium-activity sorbents	204
Radioactive oils	9.5
Sludges	400
Sediments	8.5

From the radioprotection point of view, the conditionally active water containing tritium that is released into the environment after a dilution is the most significant low-activity liquid waste. Tritium is produced in the reactor core coolant and is a very low-energy β-emitter having a long transition half-life (12.34 years). The radioactive hydrogen isotope cannot be removed from the coolant using common purification processes. That results in the increase in its activity in the coolant.

The limit tritium concentration is based on the limit volumetric activity value in the primary circuit water 3.7×10^{9} Bq/m^3. Within the waste water purification system, all waste water originating from MRB, ASB and impure condensate tanks are collected in the subsystem of waste water collection tanks. The water is purified and mechanical, chemical and radioactive impurities are removed so that the water can be reused for internal needs of reactor units or discharged to the waste water sewer.

The mechanical purification is performed in the waste water purification subsystem. The waste water and impure condensate are deactivated in the evaporator subsystem by means of distillation. The impure condensate is thickened to the concentration of 40 g H_3BO_3/l in the evaporator and the concentrate is further purified in the boric acid regeneration system. The waste water is thickened in two evaporator stages to the concentration of 400 g/l (a piece of design data, the real value is 150 to 200 g/l) and the concentrate is pumped by means of the handling tank to a temporary liquid radioactive waste storeroom. The vapour condensate is drained to the condensate evaporator subsystem for purification and it is stored in purified concentrate monitoring tanks after the purification.

The waste water purity below the volumetric activity limit of 4.0×10^4 Bq/m^3 is achieved by the purification by means of sedimentation, distillation, filtration and ion exchange units, and by combination of those processes. The purified water (purified concentrate) collected in the monitoring tanks is radiochemically controlled. If the volumetric activity limit value is exceeded, the water is returned from the monitoring tanks back to the purification process for further purification. If the volumetric activity limit value is not exceeded, a major part of the water (approximately 133,000 m^3/year) is pumped from the monitoring tanks to the pure condensate tanks, a small part of the purified condensate with a satisfactory β volumetric activity (up to 4.0×10^4 Bq/m^3 without tritium) is discharged to the industrial sewer system in order to maintain the concentration in the primary circuit water.

The tritium volumetric activity in the water does not exceed 3.7×10^9 Bq/m^3. The assumed amount of water discharged from both EMO12 reactor units equals approximately to 3,200 m^3/year. Before the purified condensate is discharged to the industrial sewer system, the water containing tritium is diluted already in the Mochovce NPP by means of the cooling water so that the resulting water conforms to requirements specified by Decree No. 345/2006 Coll., on protection, support and development of he public health as last amended. Following the dilution, 192,000 m^3 of water containing tritium with the total activity of 1.2×10^8 Bq/m^3 are discharged from the nuclear power plant annually. The volumetric activity of 4.0×10^4 Bq/m^3, i. e., the value determined by the efficiency of purification processes, is the decisive criterion for the water discharged from TCCP and for the discharged regeneration water from steam generator blow-down purification plants.

The tritium volumetric activity values in the water discharged from the monitoring tanks (radioactive media purification stations) exceed the activity values of other β and γ radionuclides in all the waters discharged from the power plant by approximately 5 orders. The tritium water is discharged from the monitoring tanks in an organized manner by batches and after the preceding radiochemical control. Two monitoring tanks are assumed for NPP Mochovce to be discharged weekly.

The tritium water must be diluted 30 times by means of the following:

- cooling towers blow-down;

- waste water from the chemical water treatment plant containing also regeneration solutions;
- water from the waste water purification plant containing water originating from the Operational Building;
- water from the liquid organic waste purification plant;
- cooling water originating from the compressor plant;
- neutralised regeneration solutions originating from the steam generator blow-down treatment stations.

As for the optimisation of releases, it is important to ensure the automatic control of tritium water dilution. Limit values of summary activities specified for releases from operated VVER V213 reactor power plants into the environment are given in Table 9.

Table 9 - Annual releases and limit values for summary activities of tritium, corrosion and fission products in waste water in some operated power plants

Release type	Unit	EBO V2 (2005)	EMO12 (2004)
Tritium water ^3H	Bq/year	7.207×10^{12}	9.83×10^{12}
Corrosion and fission products	Bq/year	4.03×10^{7}	3.78×10^{6}
Annual limit value for tritium water releases	TBq/year	43.7	12
Annual activity limit value for corrosion and fission products in waste water	GBq/year	38	1.1

Based on the design, the levels of low-activity and conditionally active releases assumed for four Mochovce NPP reactor units are reported in Table 10.

Table 10 - Assumed annual average levels of low-activity and conditionally active releases for four Mochovce NPP reactors units

Source	Amount [m^3/year]	β volumetric activity without tritium [Bq/m^3]	Tritium volumetric activity [Bq/m^3]
Operational building	75,000	3.7×10^{3}	0
TCCP	22,000	5.5×10^{4}	0
Regeneration solutions from the steam generator blow-down treatment plant	6,000	5.5×10^{4}	0
Tritium water	6,400	5.5×10^{4}	3.7×10^{9}

V Tab. 11 sú uvedené hodnoty aktivity kvapalných výpustí počas desiatich rokov prevádzky EMO12

Table 11 - Activity of the radioactive liquid effluents discharged to river Hron during the last 11 years (1998 – 2008)

Year	Tritium		Activated/corrosive and fission products		Amount of the discharged water
	Annual limit 1,2E+04 GBq		Annual limit 1,1E+03 MBq		
	Discharge [GBq]	% of the annual limit	Discharge [MBq]	Discharge [GBq]	% of the annual limit
1998	1095	9.1	29.17	2.7	24751
1999	5772	48.1	50.63	4.6	47272
2000	10484	87.4	57.93	5.3	53321
2001	9248	77.1	72.41	6.6	48637
2002	9130	76.1	49.36	4.5	46620
2003	10714	89.3	40.88	3.7	52532
2004	9826	81.9	37.84	3.4	43830
2005	8959	74.7	59.58	5.4	40360
2006	10230	853	32.75	3.0	22220
2007	7458	62.2	13.01	1.18	21280
2008	7856	65.5	13.88	1.26	16800

2.9 Production of radioactive solid waste in normal conditions

The design basis related to the solid radioactive waste production and storage at 2x440 MW assumes values of 230 to 330 m^3/year.

The following approximate division of that amount by waste type is assumed by the design:

- 65% of compactable waste;
- 25% of non-compactable waste;
- 10% of HVAC filters.

Solid radioactive waste can be further divided into dry and wet wastes. Dry solid radioactive waste represents a mixture of different materials combined to a various extent (wood, paper, fabric, plastics, metal, building materials, thermal insulation, inserts from HVAC filters, etc.). High-activity in-core parts (non-fuel sections of control assemblies, thermocouples, etc.) form a specific part of dry solid radioactive waste. Wet solid radioactive waste is produced during the liquid radioactive waste treatment process; it includes saturated ionexes, sludges and crystallised salts.

Based on experience gained during the operation of EBO V2, as well as of EMO12, the amounts that can be really expected during the assumed 40-year period of MO34 operation are reported in Table 12.

Table 12 - Assumed amounts of solid radioactive waste to be produced during the whole MO34 reactor unit's operation period

Waste type	Amount (kg)
Solid radioactive waste intended for sorting(*)	170,000
Combustible radioactive waste	252,000
Compactable non-metallic radioactive waste	56,600
Compactable metallic radioactive waste	79,920
Wet rags	6,900
Total of solid radioactive waste	565,420

Note: Solid radioactive waste intended for sorting consists of combustible, compactable and non-compactable radioactive waste, the amount data relates to the state prior to sorting.

The assumed amounts of conditionally non-active waste, inserts from HVAC filters and the waste that will be allowed to be released into the environment due to its below-limit activity values is shown in Table 13.

Table 13 - Assumed amounts of solid radioactive waste produced during the 40 year period of MO34 reactor reduction plan units operation

Waste type	Amount
Conditionally non-active waste	232,500 kg
HVAC filter inserts	4,930(*) pieces
Radioactive waste released into the environment	237,500 kg

(*) Assumed amount taking into account the solid radioactive waste production

2.10 Environmental management system certification

In 2005 SE-MO34 completed, introduced and passed the Environmental Management System certification. The subject of MO34 certification is the maintenance of accepted property and preparation of units 3 and 4 completion.

The goal of introducing and applying EMS in SE-MO34 is to show the endeavour of continual improvement in relation to the reduction of impacts of activities performed in SE-MO34 on the environment by managing activities that result in such impacts.

There was a work group created to deal with the issue of EMS implementation preparation proceeding in line with the approved action plan.

In September 2005 there was a certification EMS audit performed at MO34. The certificate was issued on 4 October 2005.

In 2006, the concept of EMS certification in SE, a.s. changed, specifying that SE, a.s. would be certified as a whole. Recertification audit was held in SE, a.s. in June 2007. The certificate was issued on 30 Jule 2007. In line with the concept of periodical oversight and recertification audits SE, a.s. are audited each year by an accredited certification company.

Certificate pursuant ISO 14001:2004 is shown in the following Figure 15.

BUREAU VERITAS
Certification

BUREAU VERITAS 1828

Certification
Awarded to

Slovenské elektrárne, a.s.
Hraničná 12, Bratislava
Slovak Republic
and
Nuclear power plant Bohunice; Nuclear power plant Mochovce; Blocks 3 and 4 of nuclear power plant Mochovce; Power plant Nováky; Power plant Vojany; Hydroelectric power plant Trenčín;

Bureau Veritas Certification certifies that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the environmental standards detailed below

Standards

ISO 14001:2004

Scope of supply

MANAGEMENT CONTROL AND SUPPORT OF ELECTRICITY AND HEATING POWER PLANTS. SALE OF ELECTRICITY. PRODUCTION AND SUPPLY OF ELECTRICITY AND HEAT BY NUCLEAR POWER PLANT BOHUNICE. PRODUCTION AND SUPPLY OF ELECTRICITY BY NUCLEAR POWER PLANT MOCHOVCE. MAINTENANCE OF HANDLED PROPERTY AND PREPARATION OF FINISHING THE CONSTRUCTION OF BLOCKS 3 AND 4 OF NUCLEAR POWER PLANT MOCHOVCE. PRODUCTION AND SUPPLY OF ELECTRICITY, HEAT AND PRODUCTS BY THERMAL POWER PLANT VOJANY AFTER COMBUSTION. PRODUCTION AND SUPPLY OF ELECTRICITY, HEAT AND PRODUCTS BY THERMAL POWER PLANT NOVÁKY AFTER COMBUSTION. PRODUCTION AND SUPPLY OF ELECTRICITY BY HYDROELECTRIC POWER PLANTS.

Original Approval: 26.07.2007
Subject to the continued satisfactory operation of the organisation's Management System, this certificate is valid until: **22.06.2010**
To check this certificate validity please call +421 2 5341 4165
Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organisation

Date: 30.07.2007

Certificate Number: **219432**

ANAB ACCREDITED

ISSUING OFFICE ADDRESS: Bureau Veritas Certification Slovakia s.r.o., Plynárenská 7/B, 821 09 Bratislava, Slovak Republic

Figure 15 - SE, a.s. ISO 14001/2004 certificate

3.0 ENVIRONMENTAL FRAMEWORK

3.1 Location

Units 3 and 4 of Mochovce NPP are located in Central Europe in the southeastern region of Slovakia on the western boundary of the district of Levice, close to the operating EMO12 NPP. The MO34 site lies on the southwestern edge of the Kozmálovské vŕšky (hills) in the Hronskej pahorkatina (uplands). The elevation of the terrain is between 200 and 250 m above sea level. The coordinates of the center of the Mochovce NPP protection zone are:

- longitude 18° 27´ 35´´;
- latitude 48° 15´ 35´´.

From the point of view of the terrestrial and administrative arrangement of Slovakia the MO34 site lies in the eastern part of the Nitra region in the northwestern corner of the district of Levice, close to the boundary with the Nitra and Zlaté Moravce region, approximately 12 km from the municipality of Levice, which is the largest town in a 20 km radius of the NPP. Other municipalities are Tlmače which is 7 km away, Zlaté Moravce 14 km away, Nitra 27 km away and the outskirts of Slovakia's capital city of Bratislava are approximately 90 km to the west of MO34, i.e. 120 km by public roads. Budapest and Vienna are the closest cities with over 1 million inhabitants in a 200 km radius of MO34. The outskirts of Budapest are approximately 85 km to the southeast of MO34 and the outskirts of Vienna are about 145 km to the southwest. Other large agglomerations with more than 1 million inhabitants are Varšava to the north, Záhreb to the south, Kyjev to the east, and Prague to the west.

Slovakia shares its borders with five other countries: Hungary, Austria, the Czech Republic, Poland and the Ukraine. The approximate distance of the MO34 site from the individual state borders is included in the Table 14.

Table 14 - Distance from MO34 to individual state borders

Country	Distance from MO34 to state border
Hungary	37 km
Austria	110 km
Czech Republic	85 km
Poland	130 km
Ukraine	270 km

The closest state boundary is the border with Hungary. The Ipeľ River forms a natural boundary with Hungary in a 50 km radius of the site with the exception of the boundary between the municipalities of Šahy and Ipeľský Sokolec. The closest NPP is in Jaslovské Bohunice which lies approximately 64 km from MO34.

3.2 Reasons for location at given place

Mochovce NPP was designed and its construction has been launched and realized as a four-unit NPP with common civil structures and technological components to be shared by all the four units. That means that the site of Mochovce NPP has been conceived to host four units and all the environmental evaluations (which were necessary to obtain the siting and construction permits) have been carried out always taking into account the likely impacts and the needs of four units.

From the point of view of water needs, waste production, atmospheric releases and liquid discharges, electric grid, land use, infrastructures, roads, railway and all the external services, the Mochovce site is fully capable of bearing Units 3 and 4.

Moreover, due to the advanced stage of completion of Units 3 and 4, Mochovce site represents a one off opportunity to cover in a short time the significant gap between demand and supply of electric energy on the Slovak network.

Assessment of anticipated area development if the proposed activity was not undertaken

The site location for the construction of the four units at Mochovce was determined based on a land use decision and the subsequent construction permit.

Mochovce NPP was designed and its construction has been launched and realized as a four-unit NPP with common technological components.

The area is not expected to develop in a way other than how it will be with Units 3 and 4, due to the presence of Units 1 and 2 that prevent the area from developing in any other way.

3.3 Date of beginning and termination of construction and operation of proposed activity

Construction works for MO34 started in 1986 with the laying of the foundations of the main buildings (reactor building, longitudinal electrical building, basement of transformers, cooling towers, vent stack) and continued up to 1992. In 1992 construction works were suspended due to insufficient funds. At that time the civil parts were up to 70% complete and the machinery parts up to 30% complete. The basic technological equipment like the reactor vessel, the steam generators, the pressurizer, the safety systems and the main parts of the turbines were delivered to the site and partially installed.

From 1992 to 2000 maintenance and conservation of suspended equipment and components and of the civil structures were carried out by the original main suppliers and constructors. From 2000 to-date the preservation and protection works have been performed on the basis of programs following technical guidelines of the IAEA and approved by the Nuclear Regulatory Authority (ÚJD) of the Slovak Republic.

Expected time schedule to launch and complete construction and operation of proposed activity is as follow:

Beginning of construction:	1986
End of construction:	February 2012 (Unit 3) – July 2012 (Unit 4)
Beginning of commissioning:	October 2012 (Unit 3) – July 2013 (Unit 4)
End of operations:	February 2053 (Unit 3) – October 2053 (Unit 4)

3.4 Definition of Boundaries of Area of Concern

The concerned area of the project includes the following regions that can reasonably be expected to be directly or indirectly affected by the project, or which may be relevant to the assessment of cumulative effects and the effects from future operation of the facility. In the scope of assessment has been suggested following three areas:

- *Site Study Area*: this area, centred on the plant site with a radius of about 3 km, includes facilities, buildings and infrastructure at the Mochovce site, including the licensed buffer zones (Protection zone) for the site on the land. This zone, where it is forbidden to reside permanently, has been set by Decree of Region Health Officer No. H-IV-2370/79 from 15.10.1979;
- *Local Study Area*: this area is defined as that area existing outside the site study area boundary, where there is a potential for impacts in the unlikely events of abnormal operating conditions. The Local Study Area has a radius of 10 km centred on the Mochovce site;
- *Regional Study Area*: this area is defined as that conservative area within which there is the potential for cumulative and social-economic effects and it approximately corresponds with a 50 km radius area around the site, limited to National borders. The size and configuration of the applied study areas varies by environmental component. Each is described, including the rationale for its determination, in the appropriate subsections.

Even if some of environmental effects of the project, including malfunctions or accidents and some cumulative environmental effects are likely to involve the Local Study Area or the Regional Study Area, the main additional environmental effects that may occur during operational phase are likely to be observed within the Site Study Area (Protection zone).

3.5 Characteristics of Current Environmental Conditions in the Area of Concern

3.5.1 Air

Until 1999, there were performed measurements of regional air pollution and quality of rainfall waters by the Meteorological Observatory of the Slovak Hydro-Meteorological Institute being a part of Slovak regional stations national network in evaluated zone of the Mochovce power plant. Between 2000 and 2002, there were performed no measurements in the Meteorological Observatory of the Slovak Hydro-Meteorological Institute.

The imission situation of the region can be assessed on a base of results of measurements performed at the regional station of the Slovak Hydro-Meteorological Institute in Topoľníky, which is located in plain landscape of the Danubian Lowland. Results measured at this station were comparable with results measured at the Mochovce station during previous years.

In 2002, measured concentrations of basic polluters represented less than 20% of the critical level value (15 µg/Nm^3) for SO_2 as S and 31% of the critical level value (9 µg/Nm^3) for NO_2 as N, that are usually recommended for agricultural vegetables.

The average yearly levels of polluters measured at the Topoľníky station didn't exceed even permitted limit values according to the Public Notice No 705/2002 Coll.

Regional concentration level for sulphur dioxide in Topoľníky was 2.92 µg/Nm^3 SO_2 as S, which corresponds to 5.84 µg/Nm^3 SO_2. In accordance with the Public Notice No 705/2002 Coll., this is lower value than the Lower Limit for vegetation limit value assessment. In other words, the air quality shall be assessed in the regime 3 under the Lower Limit of the pollution of 8 µg/Nm^3 SO_2.

Following the emission limits under the Lower Limit of the assessment can be considered as fixed, while it is well possible to replace the direct measurement in zones out of agglomerations by model calculations, expertise estimations and indicative measurements.

There are more sources of basic polluters emissions in the Mochovce NPP surroundings interest zone, that take a part on several actual as well as potential, either local or regional, problems (rainfalls acidification, air quality decline, soils acidification etc.).

In frame of 79 districts of SR, the Levice district involving the essential part of the Mochovce NPP surroundings occupies the 43rd position for basic harmful substances production, the 33rd position for SO_2, the 43rd position for NO_2, the 33rd position for solid combustibles and the 38th position for CO production.

In terms of releases of non-radiological chemical substances, the Power Plant, as an NPP, is not a significant emitter to conventional air pollutants including NO_x, SO_x, CO_2 and particulate.

Avoided CO_2 and conventional air pollutants

It has to be highlighted that the Project has a beneficial effect on the terrestrial environment compared to alternative electrical generating plants that result in SO_x, NO_x and other emissions.

As it is well known, electricity produced by NPPs leads to the avoidance of CO_2 emissions into the atmosphere; this is a very useful contribution to the fulfilment of requirements listed in the Kyoto Protocol on reduction of greenhouse gas emissions.

With reference to year 2005, the energy produced by EMO12 was 6,240 GWh, and taking into account the average specific CO_2 emission factor (for efficient coal thermal plants) of approximately 800 kg/MWh, the avoided emission was equal to 5,000,000 t of CO_2.The same reduction will be achieved with the future operation of MO34.

3.5.2 Water Conditions

Surface water

Mochovce nuclear power plant is located in the Podunajská pahorkatina (Podunajské Hills) on the southwest margin of Štiavnické vrchy (Štiavnica Hills) in the upper reaches of Telinský Stream at an altitude of 242 m a.s.l.

The western part of the locality is included in the basin of the Nitra River, while the eastern part falls in to the Hron River basin. Telínský Stream, which passes through the protection zone of Mochovce nuclear power station, is part of the basin of the Žitava River.

The Velké Kozmálovice reservoir is formed by a dam situated 73.500 km from source of River Hron. The reservoir has been filled intensively by sediments from the time when the water construction was put into operation (1988). The total volume of the reservoir dropped by approximately 39% as a consequence of the sedimentation of fine grained material.

The operational levels in the reservoir oscillate in the range 171.50-175.00 m a.s.l. Permitted discharge of the minimum residual flow into the channel of Hron under the dam is $Q_{min} = 6.6\ m^3/s$ and into the channel of Perec $Q_{min} = 0.2\ m^3/s$.

Slovenský vodohospodársky podnik ensures the supply of the surface water from Veľké Kozmálovce for the Mochovce NPP. The principal task of the Velké kozmálovce waterworks is to supply surface water in the quantity of 1.8 m^3/s, and annual volume of 47,304,000 m^3 (in accordance with the valid decision No.10924/2/177/405.1/93-M from 9th of July1993) with the security of 99%. According to the valid manipulation order, approved by KÚ ŽP in Nitra No. 2007/00509 from 20th of July 2007, the supply of water to the NPP is a priority of the administrator of the Veľké Kozmálovce waterworks.

Surface water and groundwater pollution level

Surface waters quality in the area is potentially affected by discharges of polluted or insufficiently cleaned municipal water, as well as by the washing of agrochemical substances from surrounding fields. Groundwater quality is mainly affected by the river Nitra. Among other things it contains chemical elements and compounds such as iron (Fe), manganese (Mn), mercury (Hg), ammonia (NH4)+X, chlorides and hydrogen sulphide (H_2S).

Groundwater influenced by the river Hron is potentially contaminated by iron, manganese, aluminium, ammonia and humic substances.

The groundwater in the neovulcanites and their surroundings is relatively clean.

Results of the monitoring of water discharged from the RAW facility to Telinsky stream in 2006 are included in the following tables 15 and 16.

Table 15 shows a comparison of the qualitative indicators with the limit concentrations. The limit values of indicators in water discharged from surface water outflow which were set in the water authority's decision were not exceeded.

Table 15 - Comparison of qualitative indicators with limits for water discharge from the RAW facility

Indicator	Measured values		Permitted limit concentration
	min.	Max.	
pH	7.8	8.1	-
Conductivity [µS/cm]	160	250	-
tritium [Bq/l]	0.81	1.63	4,690
^{60}Co [Bg/l]	0.013	0.026	5.6
^{137}Cs [Bg/l]	0.012	0.019	5.7
$^{239+240}Pu$ [Bg/l]	<0.001	<0.008	0.139
^{90}Sr [Bg/l]	0.008	0.013	61.0
Total beta [Bq/l)]	0.11	0.33	-

(Source: Slovenské elektrárne, a.s.)

Table 16 - Percentage valuation of total activity of individual radionuclides in water from surface outflow at the RAW facility to LaP

Radionuclide	LaP [Bq]	Discharged activity [Bq]	LaP Filling [(%]
^{3}H	$1.88 \cdot 10^{10}$	$5.61 \cdot 10^{6}$	0.03
^{137}Cs	$2.28 \cdot 10^{7}$	$9.31 \cdot 10^{4}$	
^{60}Co	$2.24 \cdot 10^{7}$	$1.05 \cdot 10^{5}$	
^{90}Sr	$2.44 \cdot 10^{8}$	$6.40 \cdot 10^{4}$	0.03
^{239}Pu	$5.56 \cdot 10^{5}$	$1.16 \cdot 10^{4}$	2.10

(Source: Slovenské elektrárne, a.s.)

In groundwater, surface water and drainage water the activity of individual radionuclides ranges as follows:

^{3}H	< 2.2 [Bq/l]
total beta activity	< 1 [Bq/l]
^{137}Cs	< 0,026 [Bq/l]
^{60}Co	< 0,024 [Bq/l]
^{90}Sr	< 1 [Bq/l]
^{239}Pu	< 0,01 [Bq/l]

Liquid effluents coming from operation of Mochovce NPP are in compliance with Regulatory Limits.

3.6 Public attitude surveys

The main sources of information regarding the public level of knowledge and the perception of nuclear power, particularly for Mochovce NPP, are represented by:

- *Country Nuclear Power Profile*, by IAEA 2002;
- *Perception of NPP Mochovce by inhabitants of I and II Protective zone*, by Department of Geography and Regional Development of the University of Constantine Philosopher in Nitra, 2004;
- *Attitudes and perception of the company SE, a.s. by the population inhabitants of Slovakia*, survey conducted by GfK, 2004 and 2007;
- *Eurobarometer; and*
- *Public poll performed by Markant Agency for JAVYS, a.s.*

The above mentioned documents provide information at various levels, starting from a single opinion on the use of nuclear energy to a poll on the perception of Mochovce NPP by inhabitants of protective zones, and even a poll on the perception of nuclear energy and NPPs in the whole SR.

Perception of Mochovce NPP by inhabitants of the Protective zone I and II

In 2004, the Department of Geography and Regional Development of the University of Constantine Philosopher in Nitra carried out a survey of the perception of Mochovce NPP by inhabitants of Protective zone I and II.

The survey focused on:

- Level of knowledge of Mochovce NPP;
- Level of knowledge of the SE's monthly "SE, a.s., News Mochovce ";
- Perception of threat;
- Opinion on completion of MO34;
- Opinion on the future of NPPs in the SR;
- Opinion on usage of nuclear power; and
- Level of knowledge of environmental impacts.

The survey was divided into 3 phases. The first one was a preliminary phase which included preparation of a questionnaire in close cooperation with the Mochovce NPP Infocentrum and a tour of Mochovce NPP with the aim of obtaining feedback on the effectiveness of the given information.

The second phase of the survey involved 32 settlements municipalities, including the towns of Levice and Vrable (table 17). In this survey 10% of the working inhabitants were questioned (1,149 totally in villages, altogether 1,149 people, 250 in the towns of Vráble and Levice, and 121 in Tlmače) so that the total of 1,770 people expressed an opinion in response to 25 questions related to Mochovce NPP.

Evaluation of the received information received (statistical and graphical) was the scope of the final phase of the survey.

Table 17 - Facts on survey on perception of Mochovce NPP by inhabitants of the I and II Protective zone

Number of municipalities/villages	*Number of inhabitants*	*Area in km^2*	*Number of respondents*
32	74,800	450.6	1770

Figure 16 shows the positive opinion of respondents concerning the completion of Mochovce NPP.

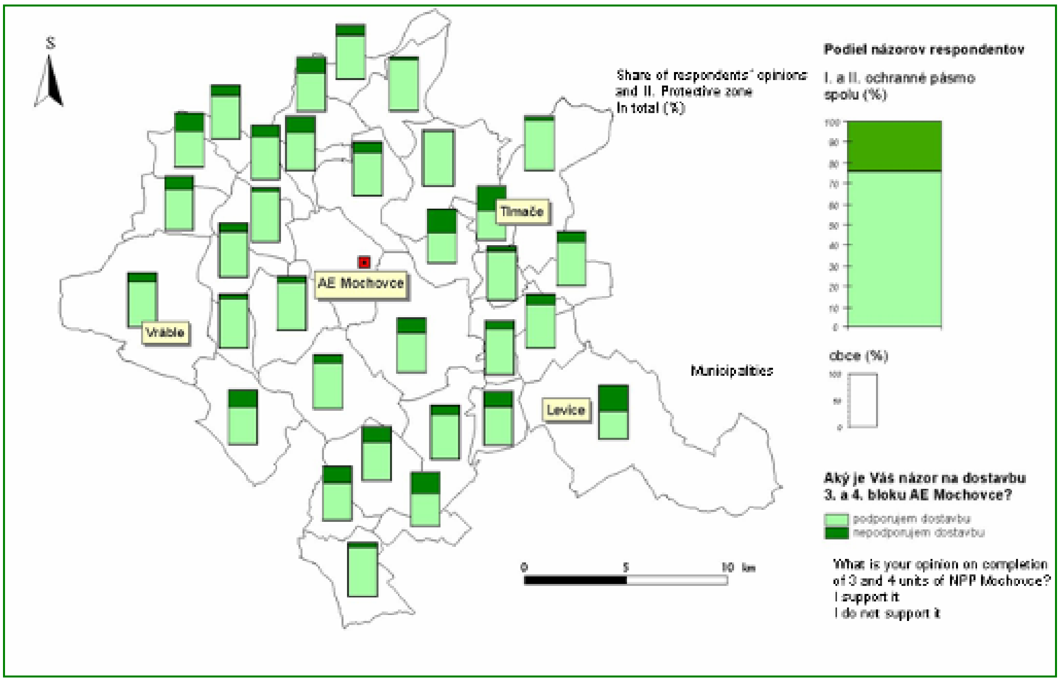


Figure 16 - Results of the survey on the opinion on completion of Mochovce NPP

Attitudes to and perception of the company SE, a.s. by inhabitants of the Slovak Republic

In 2004, GfK Agency group, specialized in market and consumer research, carried out a survey on attitudes and perception concerning the company of SE, a.s. by inhabitants of the SR.

The poll focused on:

- implications of nuclear energy;
- opinions on pros and cons of nuclear energy;
- opinion on the extent of a threat from the NPPs in the SR;
- perception of nuclear energy as a source of electricity generation energy production;
- opinions on the share amount of the electricity energy generated in produced by means of NPPs;
- respondents' opinions on the protests against nuclear energy;
- opinions of the respondents on the safety of the Mochovce NPP safety;
- information about completion of the remaining parts of Mochovce NPP; and
- opinions about completion of the remaining parts of Mochovce NPP.

The sample was made up of 1,000 persons in with the age intervals of 19÷69 (adults) and 14÷19 (students).

Figures 17 and 18 illustrate some responses to specific issues in the polls.

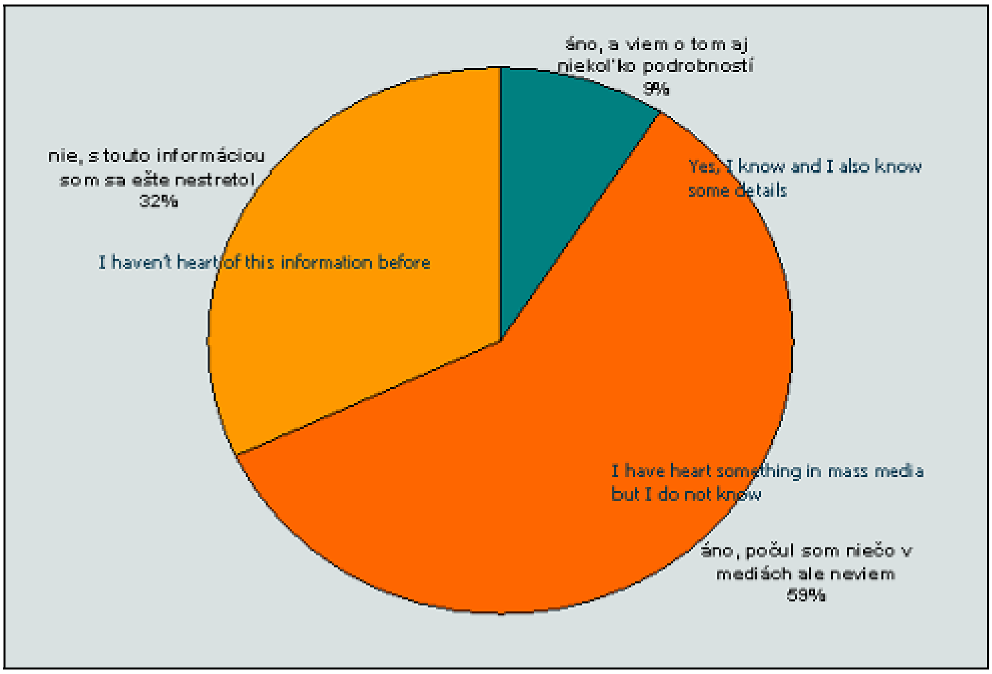


Figure 17- Information about completion of the remaining parts of Mochovce NPP

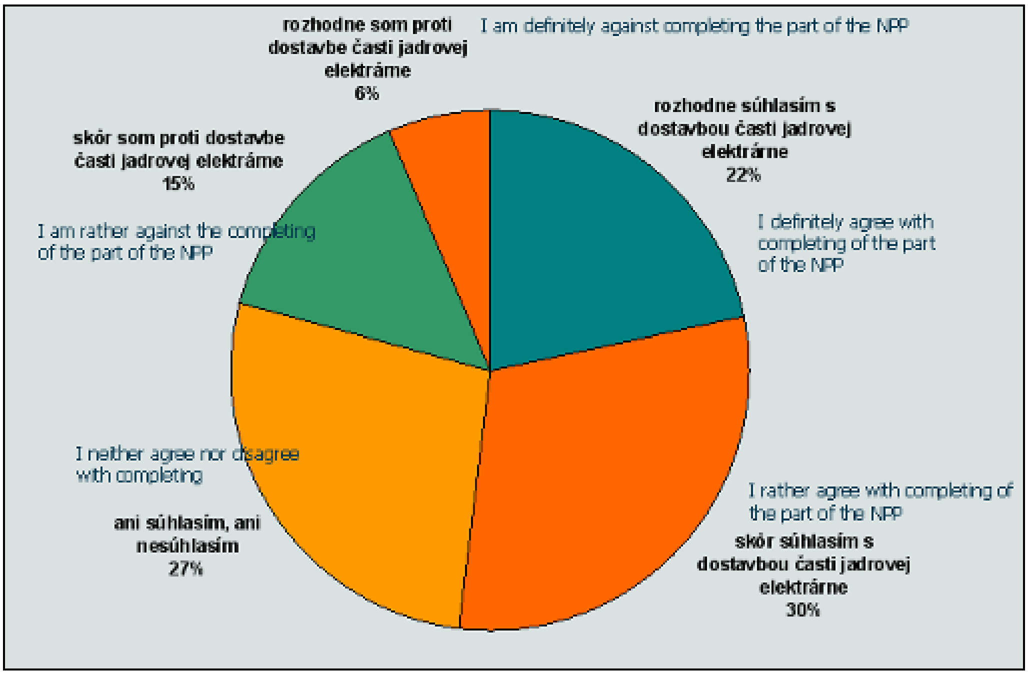


Figure 18 - Opinions about completion of the remaining parts of Mochovce NPP

Another further survey on “Acceptability of Nuclear Power by the Public of the Slovak Republic and Brand Awareness of Slovenské Elektrárne” was carried out by GfK Agency group ion the spring of April 2007. The main survey objective was to find out about opinions and attitudes of the Slovak population about nuclear energy and nuclear power plants in Slovakia, and compare the selected findings with the results of the 2004 survey.

Compared with the year 2004, the 2007 survey shows that:

- associations connected with a specific accident and disaster decreased by more than a half, mainly among the adult population, however, the feeling of potential threat and danger has considerably increased;
- the rational aspects of nuclear power production have increased slightly;
- environmental fears have decreased;
- general awareness of completion of the remaining units of the Mochovce Nuclear Power Plant has increased slightly; despite the fact, that general awareness of the population near Mochovce NPP regarding the completion of MO34 is almost 100%, almost two thirds do not know any other details, in 2007; and
- completion of MO34 has generally strong support of the public – almost 90% in the plant's 10-km area, almost 70% in Slovakia.

Figure 19 shows population opinions on MO34 completion (GFK, 2007 survey).

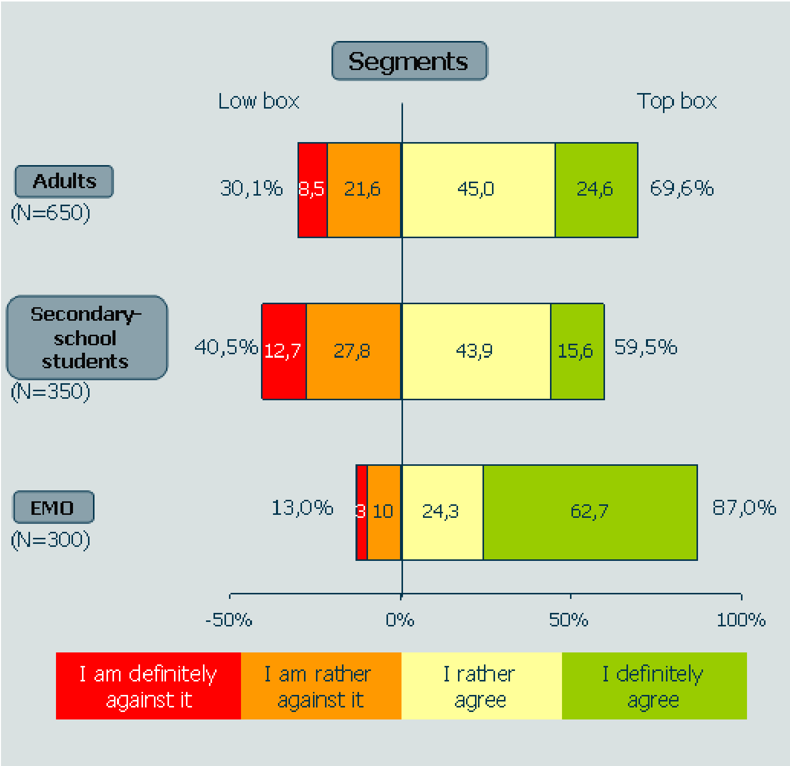


Figure 19 - Opinions on Completion of the Remaining Parts of the Mochovce Nuclear Power Plant (2007 survey)

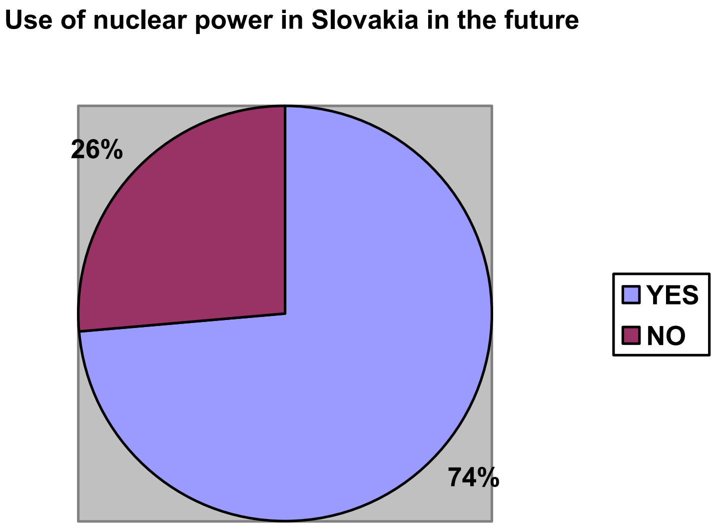


Figure 20 - Opinion on the future use of nuclear power in Slovakia (survey by Markant, 2008)

3.7 Monitoring of Radioactivity in the Environment

In accordance with the Radiation Monitoring Plan in the vicinity of Mochovce site EMO/2/NA-052.01-02, the NPP controls its radiological impacts on the environment and on inhabitants. Monitoring activities are aimed at documenting that radiological impacts, for example exposure of inhabitants and concentration of isotopes from emissions are below the limits presented in the Annex No. 3 to the Decree of the Government No 345/2006 on Basic Safety Requirements for Health Protection of Workers and population from Ionizing Radiation (and L&P laid down by ÚJD) and that the impacts are as low as reasonably achievable – ALARA.

Samples of air, soil, water, and food chain (feed, milk, agricultural products, etc.) in the area with the radius of 20 km around the plant are regularly measured and assessed by the SE ERML (Environmental Radiation Monitoring Laboratory, in Levice). All radioactive potential impact of emissions and effluents to the atmosphere as well as to all hydrosphere components (surface water, potable water, continuous bottom sediments, etc.) on the power plant vicinity are monitored.

SE, a.s. presents annually complete reports on Monitoring of Radioactivity in the SE– EMO Environment. In the reports, analysis of data is based on the pre-operation (the section related to the statistic processing of results) and operation period from the past years. In fact, the measurements of samples were done even prior to commissioning of power plant so that to acquire referential values to be compared with values measured during operation and after the end of the plant's life-time.

Detailed results from the monitoring program of the radioactivity in the environment are provided in Annex IV "Report of monitoring of radioactivity in the SE-EMO environment (years 2005 till 2008)".

Monitoring results demonstrate that impacts of EMO12 during standard operation are close to zero in spite of a high sensitivity of the equipment applied and it can be supposed that the contribute from MO34 will follows this trend. The way of operating the systems of gaseous and liquid emissions treatment and their permitting ensure the emissions maintained ALARA principle and demonstrate that the radiological impacts of the plant operation on the environment and on exposure of inhabitants were not only below the limits specified, but they were practically undetectable.

Tritium and ^{90}Sr values measured in surface waters (river Hron) comply with the Mochovce NPP project values and with the legal requirements (the Decree of the government of SR No. 296/2005, by which the indicators of permissible pollution level of surface waters – tritium - are set forth) too. Results from monitoring of the air, soils, agricultural products, from thermoluminiscent dosimeters or ionization chambers did not reveal impacts of Mochovce NPP operation on the background values of radionuclides in the Mochovce NPP environment (consisting of terrestrial radionuclides - ^{238}U, ^{232}Th, ^{40}K, ^{7}Be and anthropogenic radionuclides - ^{137}Cs, ^{134}Cs, ^{90}Sr produced during nuclear tests in the air and during the Chernobyl disaster) either.

The assessment of primary effects of radiation on non human biota is screened from consideration for two reasons:

1) monitoring shows very low or non detectable radioactivity level in non human biota (see Annex IV);
2) Slovak law does not require forced standard for the exposure of non human biota.

Around Mochovce NPP 15 SDS are located and a station is present in the locality of RR RAW (Republic Radioactive Waste Repository in Mochovce – Managed by JAVYS). The stations take off aerosol particles permanently by their absorption in the filter. Moreover, they contain a polyethylene tank for fallout collection (wet and dry together) and there are located cartridges equipped with TLD (Thermoluminescent Dosimeters) at arms installed at the stations. The environmental radiation monitoring covers an area of about 15 km from the power plant.

There are 24 monitoring stations of TDS located in the vicinity of Mochovce NPP which monitor a dose rate of gamma radiation, volume activity of aerosols and radioactive iodine.

The Environmental Radiation Monitoring Laboratory (ERML) determines volume activity of individual radionuclides by gamma-spectrometry in surface and drinking waters, ERML determines also ^{3}H and ^{90}Sr activity as well as total alpha activity and total beta activity.

ERML takes off sedimentary deposits from the river Hron quarterly from three locations situated in Tlmače (upstream the dam V. Kozmálovce), the discharge tube downstream the dams N. Tekov and at Kalná nad Hronom.

3.8 Impacts on population and potential transboundary impacts

3.8.1 Radiation doses to members of the public

In the following it will be estimated the radiological impact on surrounding population (in terms of doses) in normal operational states and in anticipated operational occurrences taking into account the simultaneous operation of the four units. In the simulation, discharge values and meteorological data from 2006, 2007 and 2008 have been used.

The assessment of the radiological impact was done by the deterministic code RDEMO©.

To estimate the emissions of radionuclides into the atmosphere and hydrosphere in the full configuration (EMO12 and MO34), as well as the radiological situation in the environment around the power plant and the expected effects on inhabitants, an evaluation based on observations at the two reference units (EMO12) was used.

The assessment is reported in the “Assessment of the Radiological Impact of the Radioactive Discharges from Operation of 4 Reactors NPP Mochovce – 1st revision” (SE Report B0120/Spec/2007/6-1; Annex III).

Simulation was performed, much conservatively, for an area with a 60 km radius around Mochovce NPP, in the Slovak Republic territory, in which there are approximately 1.2 million inhabitants.

3.8.2 Radiation doses deriving from normal operation

The analysis of doses to the surrounding population was made on the basis of the radioactive discharges into the atmosphere and hydrosphere during 2006, 2007 and 2008 from operation of EMO12. These discharge data are of the same order of magnitude of data from the last operational years with regard to discharged activity and radio nuclide composition.

RAS discharges from operation of units 3 and 4 are assumed to be on the same level. Balance data of discharged activity for individual radio nuclides were extrapolated by doubling the value of current discharges from operation of NPP Mochovce units 1 and 2 (due to increased amount of reactors from two to four) and then used in the calculation. For example, the list of radio nuclides and their activities, has been obtained doubling the RAS discharges of EMO12 in 2008.

Evaluation of radiological impact of RAS discharges during normal operation of four reactors installed in NPP Mochovce is based on assumption that limits for RAS discharges from operation of four reactors will be twice as high as limits for RAS discharges from the two already operating units 1 and 2 of NPP Mochovce. All other input data for the code RDEMO© are identical for two and four reactors.

Calculations by code RDEMO© show that regions with the highest annual IED (Individual Effective Dose), and 50 (70)-year commitments CED (Collective Effective Dose), are located in ESE direction and NW from the NPP area along the flow direction of the river Hron and in direction of predominating winds.

Moreover results show that annual IED and CED commitments are highest in sectors along the river Hron (significant impact of liquid radioactive discharges). Critical zone with permanent residence with the highest annual IED is in ESE direction in 3-5 km distance – zone No. 64 where it is located the village of Nový Tekov.

The maximum annual effective dose for inhabitants calculated by the model during normal operation of 4 reactors is 0.215 µSv/year for 2006. The result of this calculation is 0.259 µSv/year for 2007 and 0.295 µSv/year for 2008.

The CED commitment (for 50/70 years) for the whole region (1,200,000 inhabitants) is 10.7 man×mSv for 2006, 16.7 man×mSv for 2007 and 18.7 man×mSv for 2008.

3.8.3 Radiation doses deriving from anticipated operational occurrences

Annual balance limit values for RAS discharges for four reactors installed in the nuclear power plant Mochovce were assumed as double values compared with currently valid limit values for operation of NPP Mochovce units 1 and 2.

Calculations performed by the code RDEMO© show that regions with the highest values of individual effective doses (IED) and 50(70)-year commitments of CED are found in SE and NW direction from the NPP area in direction of predominating winds and of the river Hron.

Zone with calculated maximal IED in the whole region is a permanently uninhabitated zone located in WNW direction at 0 – 1 km distance.

Permanently habitated (critical) zone with the highest value of annual IED is in ESE direction at 3 – 5 km distance – zone No. 64 with the village Nový Tekov.

Results show that annual IED is predominantly contributed to by atmosphere (93.0%) rather than hydrosphere (7.0%). The highest annual IED reaches 4.47 µSv for year. As for normal operation, the calculated value is negligible compared with legislative requirements (Decree of the Government of SR No. 345/2006 Coll.) for maximum annual effective dose to inhabitants from critical group (250 µSv/year).

The CED commitment (for 50/70 years) for the whole region (1,200,000 inhabitants) is 465.3 man×mSv.

3.8.4 Conclusions

In conclusion, the calculated results show that the radiological impact of radioactive discharges during normal operation and under anticipated operational occurrences of 4 reactors is negligible, much below the siting design limit for nuclear installations.

It is expected that, when the new units will be in operation, the annual discharges of MO34 will be comparable with EMO12 discharges. The same is valid for the inhabitant doses (there is linear dependency between released activity and inhabitant doses).

It is clear that in 2006, 95% (98% for years 2007 and 2008) of the (negligible) dose from the NPP releases will be due to Tritium discharge into the river Hron. For this reason, the model RDEMO© conservatively overestimates real dose situation because it predicts that all water which was drunk by inhabitants during the year is taken from river Hron.

It can be useful to remark that the Tritium calculated dose itself is much less than normal variations of the natural background. For example, the calculated Tritium dose is lower than the variations (decrease) of natural dose rate from terrestrial natural sources (at 1 m above ground) after 10 mm of rain. In other words, these variations have an effect on individual dose greater than Tritium contribution dose (NUREG Report 1501/August 1994 on parts regarding the variability of background radioactivity).

Conservative estimation of the transboundary impact due to released Tritium (for four units operation) trough the river Hron, can be perfomed. This can be estimated taking into account an additional dilution in river Danube at the confluence of river Hron with Danube river. Average flow rate of Danube in Bratislava is 2000 m^3/s. For the evaluation, it has been assumed the same flow rate in Štúrovo, while the average Hron flow rate (during Tritium release) in year 2008 was 28 m^3/s. So the additional dilution factor for Tritium concentration in Danube is 0,014. The corresponding very conservatively calculated doses for inhabitants of a critical group living in Hungary, close to the confluence of rivers Hron and Danube, from Tritium releases into river Hron in 2006 was 3.0 nanoSv, in 2007 was 3.6 nanoSv and in 2008 it was 4.0 nanoSv.

Dose to an individual from the critical group obtained from discharges of other radionuclides are order of magnitude lower in comparision to Tritium dose. A similar conclusion can be assumed about the transboundary radiological impact of radionuclides other than Tritium, discharged into river Hron. In fact, these radionuclides are predominantly attached to sediment particles and as there are no dams (obstacle for sediments downstream) constructed on river Danube, no catchment of these sediments is assumed. Similarly, dose from these sediments is orders of magnitude lower for the inhabitants of a critical group living in Hungary, close to the confluence of rivers Hron and Danube.

Transboundary impact from airborne releases in Hungary (the same place as in previous paragraph) has been calculated by the code RDEMO as 2,9E-10 Sv/y, which gives really a negligible contribution to dose rate during everyday's life (compared to natural background, etc.).

Thus, assuming the most conservative results of calculation (year 2008), the total dose rate for an inhabitant in Hungary living at the confluence of rivers

Hron and Danube is calculated as 4.3 nanoSv/y, These values, not measureable by instruments, are, in comparison with dose limits or doses from natural background, very low, and practically equal to zero from a radiation protection point of view.

As far as concerns the transboundary impact of discharges in Austria, there is no impact to inhabitants from NPP EMO water discharges into river Hron. Concerning the impact from airborne discharges in Austria, the dose evaluation at a distance between the source of release and the country border (100 km), is at the limit of validity of any radiological assessment models. In fact, the evaluated dose is in the order of tens of pico Sv due to the modest releases and to the huge dilution of pollutants (at that distance), From the results of RDEMO, an approximation of calculated individual dose from NPP EMO discharges gives dose about 1.E-11 Sv/y for an inhabitant living at the Austrian border close to Bratislava. Again, the value is practically equal to zero from a radiation protection point of view.

Anyway, on the basis of the constant SE care about the environment, Mochovce NPP could focus its environmental sampling programme on levels of Tritium in the groundwater and in river Hron. The much conservatively model for Tritium dose calculation should be refined too. Then, there would be the need to perform a dedicated assessment to the dose calculation model in order to gain a more precise confirmation that the increased contribution due to Tritium discharge in surface water does not contribute significantly to the increase of annual radiation dose for the critical group of exposed population.

Moreover, due to the use of new Gadolinium fuel, Tritium production in reactors should be decreased by about 27% in comparison with the current situation. Consequently, this will also result in a decrease of Tritium doses to critical group.

No long term build up of radioactivity in environment is likely because of the small amount of radioactivity routinely released by the power plant. Further, the extensive environmental radiation monitoring program would provide early detection of any unexpected build up. Early detection would allow mitigation measures to be put in place.

It may be noted that the scientific literature on ecological risk from long-term exposure to low-level ionizing radiation suggests that no observable effects have been found, even in the most sensitive species of organisms, at dose rates less than 1 mGy per day. By limiting the exposure of humans to a maximum dose of 0.250 mSv per year (with actual doses incurred being substantially smaller), it is therefore clear that adequate protection will be ensured for local flora and fauna.

Table 18 - Predicted doses to members of the public during operations compared with natural background and regulatory limit

Natural background (UNSCEAR, 2000)	Regulatory Limit (*)	Max annual effective dose for inhabitants				
		Normal operation State			Anticipated operational occurrences	
μSv/year	μSv/year	Year	μSv/year	Regulatory limit (%)	μSv/year	Regulatory limit (%)
2400	250	2006	0.215	0.09	4.47	1.79
		2007	0.259	0.10		
		2008	0,295	0.12		

(*) Slovak Ordinance of the Government No 345/2006

3.8.5 Radiological consequences during design basis accident conditions

Common design and realization of safety measures for NPP EMO12 gave assumptions to elaborate safety analysis for both units and for that reason preoperational safety analyses report (POSAR) was written for NPP EMO12. The chapter “safety analyses” in POSAR include radiological consequences which have been actualized by each change of fuel type. POSAR actualization and radiological consequences during design basis accident conditions is chronology described below.

Preliminary safety analyses report for NPP EMO34 is elaborated in accordance with law No. 541/2004, regulation No. 50/2006 and safety guideline No. BNS I.11.1/2008.

The results of the analyses for DBA are assessed in terms of the fulfilment of safety functions which are derived from the three safety objectives (Safe shutdown and long-term sub-criticality, Residual heat removal, Limitation of radioactive leakages and graded according to the expected frequencies of occurrence of the postulated event sequences. The initial and boundary conditions for the analyses and the grading of the derived safety functions are determined by the risk involved, i.e. the greater the probability of occurrence of an event, the tighter the acceptance criteria; therefore the allowable consequences are more restrictive for the sequences calculated as less frequent. Fulfilment of the safety objectives is assured by the integrity of unharmed barriers to protect the public against the consequences of radioactive substances release.

These barriers are as follows:

1) the chemical and physical structure of nuclear fuel,
2) the fuel cladding,
3) the reactor coolant pressure boundary,
4) the reactor hermetic zone building (hermetic zone).

The mathematical models used in the consequence assessment bear some resemblance to those used to assess the impact of normal operations, since they reflect the same atmospheric phenomena and environmental processes leading to radiological exposure. The main difference is that, for an accidental release, the accident event itself and the resulting dispersion processes are simulated through time, whereas in normal operations environmental concentrations are assumed to achieve steady-state conditions.

Compliance with the dose targets has to be verified at 2 kilometres from the NPP, since an evaluation of dose commitment (within one year) at shorter distances from the plant is not significant. In fact, an “exclusion area” around the Mochovce Nuclear Power Plant (in an area of radius ranging from 2 to 3 kilometres) has been established in 1979 by a Decree of the Regional Health Office No. H-IV-2370/79, in which no permanent residence is allowed.

Following limits had been approved by the District Health State Authority in Levice (representative of the National Health State Authority of the Slovak Republic):

Mandatory limits	*Effective dose [mSv]*	*Dose to thyroid [mSv]*
	≤50	≤500

New limits for radiological consequence, shown in the following table, have been defined based on Governmental Decree 345/2006 and on the subsequent standpoint OOZPŽ/8155/2006 issued in 2007 by UVZ for EMO12.

Mandatory limits	*Effective dose [mSv]*	*Dose to thyroid [mSv]*
	≤50	≤250

Calculated dose shall be below the limits for postulated accidents and they have to be verified around the Mochovce NPP within a radius ranging from 2 to 3 kilometers ("exclusion area").

MO34 radiological consequences during design basis accident conditions

Dispersion of the released plume is evaluated using a Gaussian plume model, through the code RTARC©.In the elaboration of the MO34 Preliminary Safety Analysis Report, radiological consequences were calculated in 2008 by VÚJE for the typical following DBA scenarios:

- double-ended guillotine Loss-Of-Coolant Accident (LOCA 2 x 500 mm), with the pipe break location in the non-isolable part of the cold leg of one of the main circulation loops, i.e., between the main isolating valve and the reactor-pressure-vessel nozzle (maximum DBA);
- rupture of a steam-generator cold collector primary lid, with a coolant leakage into secondary circuit (bounding scenario for primary-to-secondary leakage scenarios).

In all the scenarios, highly-conservative assumptions have been adopted:

for thermal-hydraulic analyses of the accident (performed with the codes RELAP5 and MELCOR), including:

- selection of the most adverse position of pipe rupture;
- adoption of the single-failure criterion for the system with the worst consequences on the evolution of the accident;
- no credit to hermetic zone spray to wash-down fission products;
- use of a hermetic zone leak-rate about three times larger than the value measured for EMO12 and expected for MO34;

- assumption of direct releases from the hermetic zone to the environment without consideration of retention of radioactive material in structures surrounding the hermetic zone.
- for the second scenario, 100% of the primary coolant released to environment before the leak is isolated.

for radiological analyses calculating the off-site consequences of the accident (performed with the RTARC© code), including:

- highest admissible specific radioactivity of primary coolant;
- radioactive inventory of fuel gap at the end of fuel cycle;
- worst meteorological conditions;
- no sheltering taken into account in dose calculations.

The fuel radioactive source term has been taken from the analyses performed for EMO12, i.e., Gd fuel of II generation (specific data will be used for the analyses to be included in the Final Safety Analysis Report).

On the basis of the assumptions discussed above, it can be clearly expected that the radiological consequences presented hereinafter are significantly higher than the actual consequences of a DBA.

Table 19 shows the comparison of maximal calculated doses for LOCAs, on the border of protection zone (2 kilometers), with acceptance criteria.

Table 19 - Spectrum of postulated piping break – Comparison of calculated doses and acceptance criteria

MO34	*Effective dose [mSv]*		*Dose to thyroid [mSv]*	
	2 km	*3 km*	*2 km*	*3 km*
Large break LOCAs	0.39	0.25	0.46	0.29
Mandatory limits	≤50		≤250	

The significant reduction of the radiological consequences of a LOCA with respect to the analyses performed for EMO12, is based on a more realistic estimate of the fuel damage occurring during a LOCA accident. In fact, instead of assuming a damage of 100% of fuel assemblies and release of 100% of fuel gap inventory (as done in previous analyses) of more precise evaluation of the extent of the fuel damage has been possible by using the code TRANSURANUS. The TRANSURANUS code (developed at the EC Joint Research Center, Institute for Transuranium Elements, Karlsruhe, Germany) has been successfully employed in several international programs (e.g., EU PHARE, EXTRA) involving also other countries of Eastern Europe (e.g. Czech Republic, Hungary).

Through statistical thermo-mechanical calculations, by using the TRANSURANUS code, it is possible to achieve a conservative but more realistic estimation of the number of fuel elements for which failure cladding can be expected, thus, reducing the excessive margin of conservativeness adopted previously for the radioactive source term.

Table 20 shows the comparison of maximal calculated doses for the second DBA Scenario, on the border of protection zone, with acceptance criteria.

Table 20 - Leaks from primary to the secondary side of the steam generator – Comparison of calculated doses and acceptance criteria

MO34	*Effective dose [mSv]*		*Dose to thyroid [mSv]*	
	2 km	*3 km*	*2 km*	*3 km*
Leaks from primary to secondary side of SG	2.92	2.10	18.5	13.3
Mandatory limits	≤50		≤250	

Conclusions

Considered accidents have been chosen as the most representative scenarios and performed calculations have been carried out with very conservative assumptions.

All the analyses confirm that, even with these conservative assumptions, a large margin exists with respect to the dose targets; indeed, the calculated values are more than one order or magnitude lower than the dose target defined for MO34 project.

3.9 Impacts on air - Radiological parameters

Human health (including members of the public and workers) has been selected as the VEC for radiological parameters of Atmospheric Environment.

The effects of interactions on VECs occur in the Local Study area.

Regarding radioactive aerosol, considering that Units 3 and 4 will have approximately the same level of emission of EMO12 and also on the basis of air monitoring program measures, the anticipated impacts can be considered negligible.

The extent of the effects of these interactions on VECs is detected through the radio-ecological detailed monitoring plan.

Considering that exposure for workers of MO34 will be similar to exposure measured for workers of EMO12, the figures of occupational exposure reported in the Design Framework, show that the expiated collective dose and the maximal individual dose for workers contractors is low compared with WANO Performance Indicator.

The extent of the effects of these interactions on VECs is detected through the radio-ecological detailed monitoring plan and through the organizational and operational measures for prevention, elimination, minimization and compensation of environmental and health impacts.

Likely environmental effects

For radiological parameters, a minor adverse effect is identified for radiological parameters for human health workers.

Table 21- Atmospheric Environment - Significance of likely adverse effects

Valued ecosystem component	Adverse effect	Magnitude (of effect)	Geographic Extent (of effect)	Timing and Duration (of effect)	Frequency (of conditions causing effect)	Degree of Reversibility (of effect)	Significance of adverse effect
				Likely Adverse Effect			
				Non radiological parameters			
Local atmosphere / Human health	Effects on air quality due to predicted ambient concentration of conventional emission	*low*	*moderate*	*moderate*	*moderate*	*low*	*no adverse effect*
				Radiological parameters			
Human health workers	*Doses to workers* On average, workers doses are much below the regulatory limits of 20 mSv/year and 100 mSv over a five year period	*moderate*	*low*	*moderate*	*high*	*moderate*	*minor adverse effect*

3.10 Impacts on water conditions – radiological parameters

Project-environment interactions with Radioactivity in surface water and in the aquatic environment, included groundwater, were identified for projects activities during operation phase.

The extent of the effects of radioactivity in surface water and in the aquatic environment, included groundwater is detected through the radio-ecological detailed monitoring plan.

The effects of interactions with VECs (Human health and member of the public) occur in the Regional Study area.

The extent of the effects of these interactions on VECs is detected through the radio-ecological detailed monitoring plan.

As rightly estimated, it is expected that when the new units will be in operation, the annual discharges of MO34 will be comparable with EMO12 discharge.

It is clear that 95% of the (negligible) dose from releases from the NPP will be due to tritium discharge to river Hron.

It can be useful to remark that the tritium calculated dose itself is much less than normal variations of the natural background. For example, the calculated tritium dose is lower than the variations (decrease) of natural dose rate (at 1 m above ground) after 10 mm of rain. In other words, these variations have an effect on individual dose greater than tritium contribution dose (NUREG Report 1501/August 1994 on parts regarding the variability of background radioactivity).

Anyway, on the basis of the constant SE care about the environment, Mochovce NPP could focus its environmental sampling programme on levels of tritium in the groundwater and in river Hron. Since the model RDEMO© conservatively overestimates real dose situation, the much conservatively model for tritium dose calculation should be refined too.

Moreover, due to the use of new gadolinium fuel, tritium production in reactors should be decreased by about 27% in comparison with the current situation. This will also result in decrease of tritium doses to critical group.

Likely Environmental Effects

For non radiological parameters, no long-term build up of pollutants in the environment is likely because of the limited amount of water based releases.

For radiological parameters, a minor advers effect has been identified for *Human health and member of the public.*

The significance of the likely effects is evaluated in Table 22.

Table 22 - Hydrology and groundwater- Significance of likely adverse effects

Likely Adverse Effect							
Valued ecosystem component	**Adverse effect**	**Magnitude** (of effect)	**Geographic Extent** (of effect)	**Timing and Duration** (of effect)	**Frequency** (of conditions causing effect)	**Degree of Reversibility** (of effect)	**Significance of adverse effect**
Non radiological parameters							
Hydrology, Hydrogeology and Aquatic biota	*Chemical and physical effect*	*low*	*moderate*	*moderate*	*high*	*low*	*no adverse effect*
Radiological parameters							
Human health and member of the public	*Doses to member of the public* maximum annual effective dose for inhabitants calculated by model for normal operation of 4 reactors (0.215 μSv/year) is negligible compared with maximum annual effective dose to inhabitants from critical group (250 μSv/year).	*low*	*low*	*moderate*	*high*	*moderate*	*minor adverse effect*

3.11 Other Impacts

No long-term build up of pollutants in the soil is likely because of the absence of measurable effects coming from the contribution of the proposed activity on the terrestrial environment up to 10 km from the Mochovce NPP.

In consideration that civil parts of NPP are completed up to 70%, the commission and operation of units 3 and 4 of Mochovce NPP have no likely effects on the landscape.

The likely effects deriving from the commission and operation of Units 3 and 4 of Mochovce NPP are reasonable compared with likely impact coming from operation of Units 1 and 2.The results of the environment impact assessment have highlighted that the significance of the identified likely adverse effects is minor.

The present Report highlights that positive effects to economic conditions are likely as a result of the project. The positive effects and their significance are summarized below:

- creation of new employment opportunities and maintenance of existing jobs within the study areas, resulting in improved employment stability;
- increase of the population associated with, or directly dependent on, MO34 related employment.

Increased employment associated with MO34 will serve to maintain income levels, which are a major determinant of an individual's or family's quality of life. Mochovce NPP will remain one of the single largest employers in the region. These effects will contribute to economic activity growth trough process expenditure and pay rolls.

- Creation of new business activity and increased number of industrial, commercial and institutional business/operations associated with, or directly dependent on, Mochovce NPP related expenditures.

Increased business activity associated with MO34 will contribute to growth and development in the local and regional economic base.

- Increased community stability trough existent of a long term power plant with employment opportunities.

Increased population associated with MO34 will contribute to the maintenance of the social structure and stability of communities across the region.

3.12 Likely impacts on environment and health - Conclusions

Mochovce is an operating NPP with two units in operation since 1998 and 2000 and two units in a partially completed state. The project involves the commission and operation of units 3 and 4 and the operations of all 4 units to generate electricity for distribution to the Slovak Republic grid.

This Report provides the results of an assessment of the likely effects on the environment due to the commission and operation of units 3 and 4 and the continued operations of all 4 units for approximately 40 years.

It is noted that Mochovce is an existing facility on a well established site with an existing Protection Zone (approximately 3 km). As a result of more than 9 years of operations, extensive measures have been incorporated to ensure that the effects of the project are monitored and mitigated using practical technology. In carrying out the environmental assessment existing safety and environmental protection systems and programs were taken into account along with planned enhancement and environmental programs.

For non radiological parameters, no residual adverse effects were identified in the operations phase for Atmospheric Environment, Geology and Seismicity, Hydrology, Hydrogeology and Aquatic Environment.

For non radiological parameters, a minor adverse effect was identified in the operations phase for the radiation exposure to workers and members of the public. The predicted doses are well below regulatory limits. For example the predicted dose to members of the public as a result of the project is less than 0.1% of Slovak and international standards (a summary of these results is provided in Table 23).

The EIA Report also considered the effects of accidental conditions that might be expected and found that existing and planned safety measures are sufficient to mitigate any adverse effect.

Taking into account the findings of the present EIA Report, including the identified mitigation measures, the project is not likely to have any significant adverse effect on the environment. Indeed, the project will result in a number of positive effects through reducing greenhouse gases emissions (if compared to conventional power plants) and providing a safe supply of electricity and economic benefits to the immediate and surrounding communities.

Table 23 Summary of residual adverse/beneficial effects of the Project and their significance

Residual adverse effect	Significance
Atmospheric Environment	
Non radiological parameters	
Change in local climate due to predict increased of the amount of heat discharged to atmosphere	No adverse effect
Radiological parameters	
Increase in the average individual radiation doses to workers and to members of the public as a result of the Completion of MO34	Minor adverse effect (not significant)
Hydrology and Groundwater including Aquatic Environment	
Non radiological parameters	
Chemical and physical effect	No adverse effect
Radiological parameters	
Increase in the average individual radiation doses to workers and to members of the public as a result of the Completion of MO34 Increase of background tritium concentration in surface water and groundwater	Minor adverse effect (not significant)
Socio-economic Condition	
Beneficial effect: increase economic activity trough process expenditures and pay-roll. Beneficial effect: increase community stability through existence of a long term power plant with employment opportunities	Beneficial effect

4.0 PROPOSED MEASURES FOR PREVENTION, ELIMINATION, MINIMIZATION AND COMPENSATION OF ENVIRONMENTAL AND HEALTH IMPACTS

4.1 Physical-planning measures

The radiation dose targets for an individual of the population due to radioactive releases from the NPP during normal/abnormal operation for siting of the nuclear facility, shall not exceed the maximum dose allowed by Slovakian regulatory body (Ordinance of the Government No 345/2006), which is 0.25 mSv/year.

The exclusion area (Protection Zone) for Mochovce NPP was determined by Decree of Region Health Officer No. H-IV-2370/79 from 15.10.1979; it is a zone in which permanent residence is prohibited. The average distance of exclusion area boundary to Mochovce NPP is about 3 km (Figure 21).

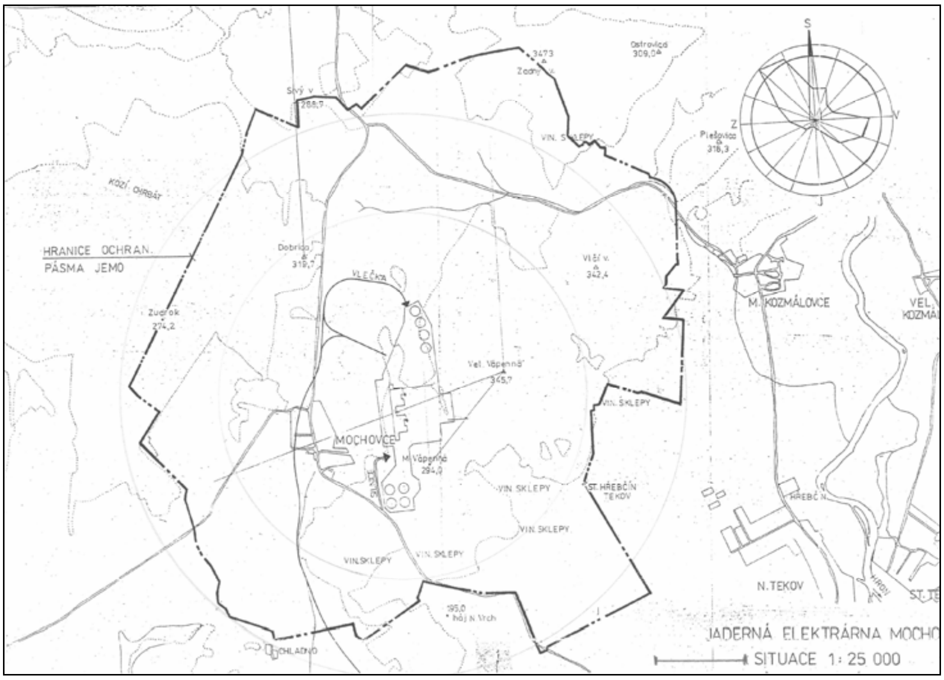


Figure 21 - Exclusion Area Border (Protection Zone) of Mochovce NPP

This radiation dose target is stated in compliance with Decree of the Slovak Government No 345/2006 on Basic Requirements for Radiation Protection of Public and Workers against Ionization Radiation and on the decision of the Slovak regulatory body valid for Mochovce NPP site. The use of dose constraint (250 μSv/year) is fully according with ICRP recommendations and the objectives of European Community Directive 96/29.

4.2 Measures in case of accidents – Emergency Plan

The design, project execution and operation of nuclear power plants ensures that the likelihood of an accident resulting in significant radiation exposures to workers and members of the public is very small. Nevertheless, it is still necessary to prepare suitable emergency procedures, means and equipment – an integral part of emergency response for all levels of accidents. The existence of a proper emergency plan is a standard practice – it is a prerequisite for licensing process resulting in granting a licence for operation of the nuclear installation.

The legal requirements on emergency preparedness come from Act No.541/2004 Coll. on Peaceful Utilization of Nuclear Energy, Act No. 355/2007 Coll., Act No. 444/2006 Coll. on Civil Protection of Population and Ministerial Order No. 345/2006 Coll.

The UJD Decree No. 55/2006 on Details in Emergency Planning in Case of Accident describes the main principles and details for emergency planning and preparedness of operators, as well as of state and municipal authorities located outside the plant (off-site authorities).

In accordance with the above acts, the operating organization, regulatory bodies and public authorities shall cooperate to prepare emergency plans.

The major tasks of emergency planning and preparedness are as follow:

- to decrease the risk of accident or emergency, or to reduce their consequences;
- to prevent serious direct health damage (death, etc.); and
- to decrease the probability of possible later health damage (e.g. cancer) as far as it is reasonably achievable.

Emergency preparedness is a complex of activities aimed at fulfilling all measures necessary to protect employees and other persons, if risk of accident or release of radioactive materials is possible. It includes establishment of emergency plans, training system, correct procedures and exercises for individuals, authorities and organizations to perform activities which have to be fulfilled according to On-site Emergency Plan (OEP) and Off-site Emergency plans – Plans for Population Protection in the threatened area. Accordingly, preparation and precise activities of EMO personnel shall be ensured if it comes to significant emissions of radioactive materials into the working environment and surroundings and it is necessary to take measures to protect human health in the area of the nuclear facility, as well as health of inhabitants in the surroundings of the nuclear facility.

Plant Manager is responsible for maintaining emergency preparedness in accordance with the requirements stated in legislation.

4.2.1 Off-Site Emergency Plan

The National Emergency Plan in case of Nuclear or Radiation Accident describes activities, links of individual units of national emergency response organization. It provides a balance of forces, sources and means necessary for an effective response.

It specifies the links to IAEA and cooperation with neighbouring countries in accordance with bilateral and international agreements.

The “Plan of Population Protection in case of Radiation Accident in Nuclear Power Facilities” (JEZ) is the document based on which the off-site emergency response is managed. The plans were prepared by Emergency Control Departments of County Councils in Nitra and Banská Bystrica in accordance with the Act No. 541/2004 Coll. on Peaceful Utilization of Nuclear Energy, UJD Decree No. 55/2006 on Details in Emergency Planning in Case of Accident, Act No. 444/2006 Coll. on Civil Protection of Population and Ministerial Order No. 345/2006 Coll.

It defines the organizations involved in regional emergency preparedness and defines duties of the individual subjects.

The Government of the Slovak Republic is responsible for the national emergency planning and preparedness. The relevant ministries are responsible for coordination of preparedness and potential activation of the Integrated Emergency System of the Slovak Republic.

Off-site Emergency Response Organization is provided at two levels:

- National level - the Safety Committee of SR and the Central Emergency Headquarters of SR are the control and coordination bodies for events during which population and environment are in a danger. They provide uniform preparedness and efficient realization of measures for protection as well as actions during a radiation event considering both the public and economy in the territory of the Slovak Republic. The Safety Committee is established by the Government of the Slovak Republic.

- Regional level - emergency commissions are established at district and municipal councils. They are coordinated by the emergency commissions of county councils in Nitra and Banská Bystrica. The commissions are responsible for ”planning measures according to the relevant region”. Plans of Public Protection are approved by the Ministry of the Interior of the Slovak Republic and assessed by the Nuclear Regulatory Authority (UJD).

4.2.2 Protective Measures

Priorities of protection during an emergency are defined as follows:

1) Protection of the plant personnel and persons legally moving on NPP territory;
2) Protection of reactor unit, avert core melting and mitigation of the consequences;
3) Protection of population living in the plant surroundings;
4) Protection of environment.

The following measures are implemented to protect the priorities in case of an emergency:

- monitoring of personnel and other persons´ movements at the site;
- notification of ERO members and officials of public service, self-government and regulatory bodies;
- warning of personnel and other persons at site;
- gathering and sheltering of personnel and persons that are at site, including use of protective aids;
- iodine profylaxation;
- evacuation of persons from the plant;
- warning and notification of population in 5, 10, 20 km Planned Protective Zones;
- recommendations of protective measures for population prepared by ERO at NPP that are subsequently reviewed by the relevant emergency commissions.

5.0 PROPOSED MONITORING AND POST-DESIGN ANALYSIS

5.1 Proposed monitoring from the beginning of construction, during the construction, during operation and after termination of operation of proposed activity

Monitoring is controlled by the regulation *"Programme of radiation monitoring in the vicinity of Mochovce NPP (QA-07-01)"* that describes the radiation monitoring around NPP Mochovce in a radius of 20 km from the plant.

A teledosimetry system (TDS), equipped with 40 monitoring stations, monitors the dose rate of gamma radiation, the volume activity of aerosol, the volume activity of radioactive Iodine and supplementary data on the state of the environment.

The monitoring system has been set up for the whole site of Mochovce, hence, once in operation, Units 3 and 4 will be covered as well.

5.2 Proposed checking of compliance with defined conditions

In order to assist in determining if the environmental and cumulative effects of the Project are as predicted in the EIA Report and to confirm whether the impact mitigation measures are effective and thus determine if new mitigation strategies are required, a follow-up and monitoring program is proposed.

Purpose of the follow-up and monitoring Program

The follow-up program would incorporate current Mochovce monitoring programs and other environmental studies, as appropriate.

Accordingly, the follow-up program should achieve the following three goals:

- *Confirm assumptions in the analysis of the EIA Report;*
- *Verify the predictions and assessment of the environmental effects; and*
- *Verify the effectiveness of implemented mitigation measures.*

New mitigation measures would be justified if either the implemented mitigation measures were found to be ineffective, or if the actual environmental effects were greater than predicted in the EIA Report. This process would help ensure continual improvement in the environmental performance of Mochovce NPP.

The plan for the follow-up program was developed in two steps. First, each of the likely effects of the Project identified in this Report was reviewed to determine how the predicted effect could be confirmed. The focus of the review was to identify which components of the environment might be incorporated into the follow-up and monitoring program. Secondly, each of the mitigation measures was reviewed to determine how its effectiveness could be monitored.

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