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Draft Safety Analysis Report for the Vrbina Krško LILW Repository

Chapter 2 General description of the repository

DOCUMENT HISTORY

Revision:	Date of (previous) revision:	Brief description of changes from the previous version:	Notes:
1	May 2017	Amendment of the document following review	
2	January 2018	Amendment awaiting opinion of an approved nuclear and radiation safety expert	
3	November 2018	amendment following SNSA review	
4	February 2019	amendment following SNSA review	
5	March 2019	Supplementing of application	

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TERMS AND ABBREVIATIONS

Vrbina road – (Decree on the DPN for the LILW repository). Explanation: The road section is partially a public thoroughfare, JP 693631 – Sanitary landfill, and partially an uncategorised public road.

osnVP
Draft Safety Analysis Report

SA.2 – investment scenario with cooperation of Croatia (disposal of all waste from Krško NPP and Slovenian institutional waste)

SA.3 – basic investment scenario (disposal of Slovenian part of waste from Krško NPP and Slovenian institutional waste)

SSC
structures, systems and components

2 GENERAL DESCRIPTION OF REPOSITORY

2.1 INTRODUCTION

Slovenia uses nuclear and radiation technologies in many commercial and other fields. Slovenia's use of nuclear and radiation technologies gives rise to radioactive waste, which must be handled safely at all stages of the management of radioactive materials, from the time it is generated to the time it is disposed of.

The Environmental Protection Act (ZVO-1) [1] defines radioactive waste as waste which, owing to certain radioactive properties under the regulations on ionising radiation protection, is categorised as radioactive waste. Radioactive waste can be substances in gaseous, liquid or solid form, and objects or equipment that are waste products of radiation practices or intervention measures and for which no further use is anticipated, but that contain radioactive substances or are radioactively contaminated beyond clearance levels. A more detailed classification of radioactive waste with regard to the level and type of radioactivity and aggregate state is contained in the ZVISJV[2] and in the Rules on Radioactive Waste and Spent Fuel Management (JV7) [3] adopted pursuant to that act.

Under JV7, radioactive waste in solid form is classified, in accordance with the level and type of radioactivity, into the categories of transitional radioactive waste, very low-level radioactive waste (VLLW), low- and intermediate-level radioactive waste (LILW), high-level radioactive waste (HLW), and radioactive waste containing naturally occurring radionuclides.

In terms of quantity, LILW accounts for the bulk of the radioactive waste generated in the course of nuclear and radiation practices in Slovenia; country has therefore taken the decision to seek out a site for and to construct a repository for LILW generated within its borders. The project investor is the Slovenian government and the contractor (agent) is the Agency for Radwaste Management (ARAO), with its headquarters in Ljubljana. The following types of radioactive waste will be disposed at the repository:

- operational LILW from Krško NPP
- LILW from Krško NPP decommissioning
- LILW stored at the central storage facility (CSRAO)
- LILW from CSRAO decommissioning
- LILW from TRIGA decommissioning
- LILW from conditioning for disposal and
- LILW from the operation and decommissioning of the repository

All the above types of waste will have to meet the acceptance criteria for disposal at the planned LILW repository in order to be deposited at that facility. Data on the waste types are summarised in the Inventory report.[4] The acceptance criteria are set out in the special report Acceptance criteria for radioactive waste at the LILW repository.[5]

The DPN [6] also defined the concept of LILW disposal in waste disposal silos constructed from the surface, and placed in poorly permeable silt in a saturated zone below the water table. This concept combines the properties of surface repositories (surface disposal) and those of underground repositories (siting of disposal units in poorly permeable water-saturated

geological formations). The safety analyses demonstrated that the combination of the site and the disposal concept was a favourable one, with negligible impact on human beings and the environment. The concept of the Vrbina Krško LILW repository is based on a multi-barrier system and a system in which individual repository components perform multiple safety functions.

A similar concept of LILW disposal in disposal silos has been used in several countries to date, e.g. Korea, Sweden and Finland. A similar disposal concept and geological conditions at the radioactive waste disposal site are found in Japan.

The Swedish operational LILW waste repository is located in the direct vicinity of the Forsmark nuclear power plant. It is built on a magma substrate at a depth of approximately 60 m below the sea surface, and is located underwater. The repository started operations in 1988. The intermediate level radioactive waste is placed in concrete containers which are then placed into the disposal silo. After three layers of containers are placed, voids are filled with backfilling grout. The thickness of the silo wall is approx. 1 m. The gap between the outer wall of the silo and the rock is also approx. 1 m and is filled with bentonite. The closed silo will be covered with a layer of concrete, and the remaining voids will be filled with sand.

The Olkiluoto repository is located in Finland, in the vicinity of a nuclear power plant of the same name. It is situated on a tonalite and gneiss geological formation at a depth of 60 – 100 m. Two disposal silos were built in the first phase, which are designed to hold 8400 m^3 of operational waste. The repository started operations in 1992. Access is provided via an access ramp and a shaft. According to statements on the cessation of operations and the decommissioning of the nuclear power plant, a further three silos are scheduled to be built at Olkiluoto in 2040. Part of the decommissioned low-level radioactive waste will be placed in the transport tunnels. The waste is placed into the silos in concrete containers that can hold 16 200-litre casks or a corresponding volume of other types of LILW. The silos are equipped with guides that determine the placement pattern. The voids between the walls of the containers are filled simultaneously with the placement of the containers. After the cessation of operations, the empty underground spaces will be filled with the appropriate grade of granulated primary rock and isolated by section using cement barriers.

The Rokkasho repository in Japan is designed to accept waste in 200-litre casks directly into the disposal cells, which are built in an excavated section below the surface level. The repository is comparable to the Slovenian concept, since like the repository in Vrbina it is located in a geological area (tufa and sandstone) with comparable water permeability to that of the silt at the Vrbina location. The Takahoko formation in which the waste is deposited at the Rokkasho repository in Japan has a hydraulic conductivity of water of an order of magnitude of 10^{-7} m/s,[7] while at the Vrbina – Krško location the hydraulic conductivity of the silt in which the waste will be deposited is estimated at from 10^{-6} to 10^{-7} m/s.[8] In both cases, the sediments were deposited during the Miocene epoch. Upon closure, the Rokkasho repository will be covered so that it will not differ morphologically from the environment and will be saturated with water from natural watercourses.

A comparison of the costs of construction and operation of the repository with the costs in other countries was carried out in the study Comparison of costs of LILW disposal around the world.[9] The document gives a comparison of the costs of construction and operation of

surface and underground LILW repositories. A list of the repositories studied in the comparison is given in Table 2-1.

Table 2-1: List of repositories used for comparison of costs of construction and operation[9]

Country	**Repository – abbreviation**	**Disposal capacity (m^3)**	**Start year**	**Total cost of disposal (EUR million)**	**Disposal costs in EUR/m^3**
Belgium	Dessel	70 500	planned	1 428	20 260
Czech Republic	Dukovany – CZ (Du)	55 000	1994	95.5	1 740
France	Centre de L'Aube	1 000 000	1992	3 081	3 080
South Africa	Vaalputs	142 390	1986	355.9	2 500
Hungary	Bataapati	27 000	2008	253.6	9 390
Romania	DFDSMA	122 000	planned	452	3 700
Spain	El Cabril	230 000	1993	2 901	12 610
Slovenia	Vrbina – SI SA.3 Vrbina – SI SA.2	12 157 24 314	planned	494.5 532.3	32 840 19 450

The Vrbina Krško LILW repository project is currently in the environmental consent acquisition phase, which requires the drafting of an environmental impact assessment (EIA). The Draft Safety Analysis Report is also an integral part of the environmental impact assessment, in accordance with the opinion on the proposed content and scope of the EIA issued by the Slovenian Nuclear Safety Administration (SNSA) in December 2011. The content of the safety analysis report is defined in the SNSA PG 1.03 Guidelines (Content of the safety analysis report for the LILW repository).[10]

LILW from Krško NPP (LILW from the operation and decommissioning of Krško NPP, along with other LILW, such as equipment that has been replaced or removed, etc.) is expected to be disposed of at the Vrbina repository. This will either constitute half of all the waste from Krško NPP or, if an agreement is reached with Croatia on the joint disposal of LILW from Krško NPP, all such waste, in accordance with the relevant international treaty. In addition to the aforementioned, other Slovenian institutional waste, LILW from the CSRAO in Brinje, LILW from the decommissioning of CSRAO and the TRIGA reactor, and LILW generated through the operation and closure of the repository will be deposited in the repository. Krško NPP shall condition all the LILW for disposal to meet the acceptance criteria.

Development of the LILW disposal concept in place at the Vrbina Krško site began with identification of the site as the most suitable for the construction of the LILW repository.[11] The development of the concept can then be traced through the material for the acquisition of guidelines[12] and the Conceptual Design[13] to the Preliminary Design.[14] The disposal concept also accords with international guidelines for the construction of near-surface LILW repositories.[15]

The basic LILW disposal concept in place at the Vrbina site involves the disposal of suitably conditioned and packaged radioactive waste in disposal units located below the level of the groundwater at the site itself. Disposal shall be carried out from the surface. In accordance with the IAEA recommendations, the repository is recognised as being of a near-surface type. During the planning process, a multi-functional or multi-barrier approach was taken, with the final barrier being the geology of the site.

The repository will be equipped only with those technological systems and devices that are necessary, from the technical point of view, for the disposal of preconditioned disposal containers. Under the Preliminary Design[12] and the optimisation study[16], all LILW that meets the acceptance criteria[17] for disposal at the planned LILW repository will be conditioned for disposal at Krško NPP. The conditioning of all LILW for disposal at Krško NPP, which will also be responsible for transporting the containers prepared for disposal to the repository, is also laid down in ReNPRRO16–25[18] and permitted under Article 95 of the ZVISJV[2], which allows the operator of a nuclear facility to store and process radioactive waste and spent fuel for the requirements of the provider of the compulsory national public utility service of radioactive waste management if it obtains the relevant licence from the authority responsible for nuclear safety. Disposal containers shall be used to prepare waste for disposal, as these enable relatively easy transport and handling. The optimised design of the repository also enables expansion of the repository in terms of disposal capacity, as well as in terms of the capacity of technological systems and devices.[18]

After the containers have been transported to the repository, a (non-invasive) check is once again made to ensure that they comply with the acceptance criteria. Containers that have been accepted are then deposited in disposal units. A cross-section of the silo is shown in Figure 2-1.

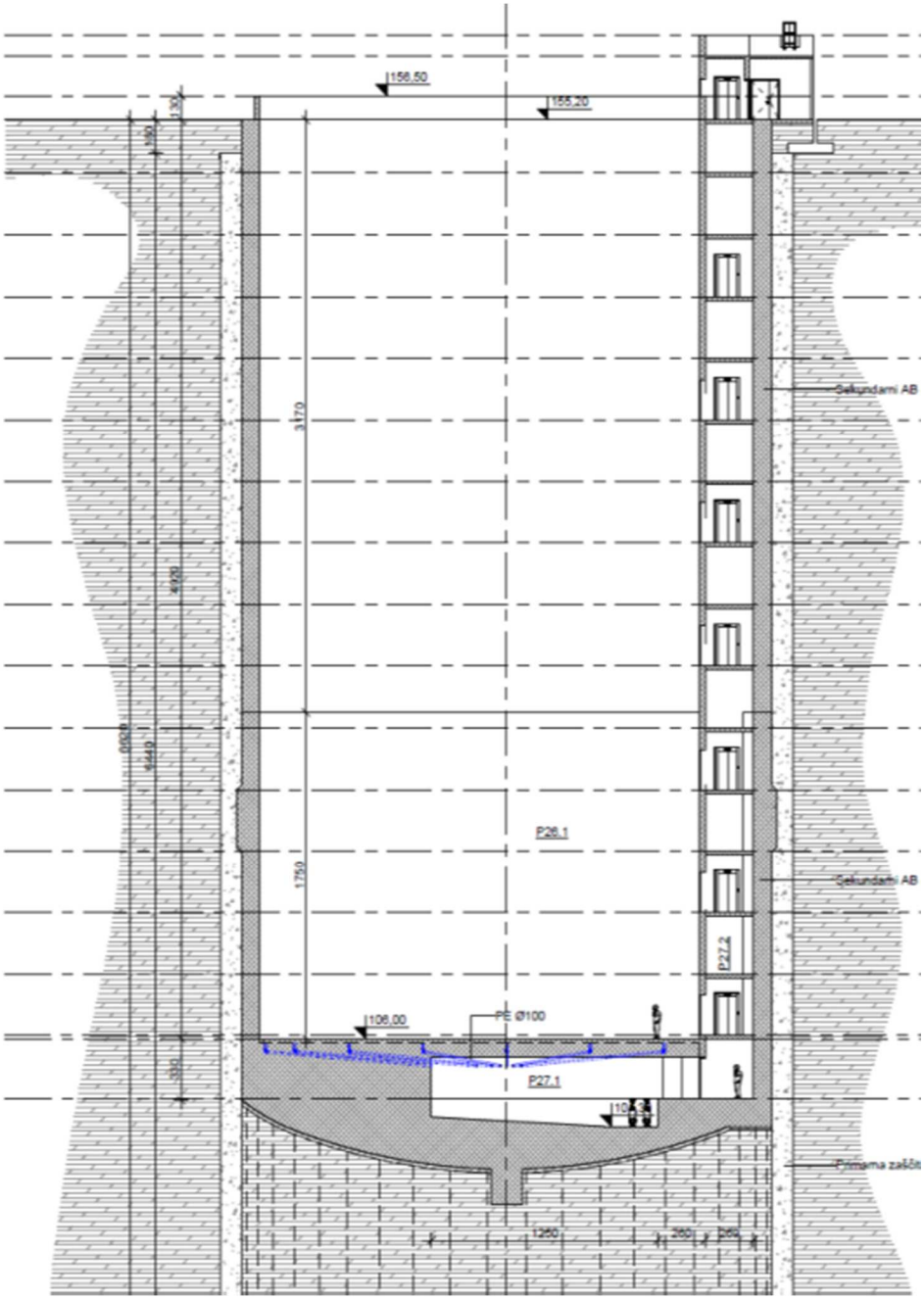

Figure 2: Schematic presentation of disposal silo (taken from IDZ, Rev. C)

Sekundarni AB	Secondary RC
Primarna zaščita	Primary protection

In order to protect the repository against probable maximum flood (PMF), all of the repository structures are built on a single flood protection plateau. Waste in concrete containers (final packages) will be placed into the silo using a gantry crane. The gaps between the final packages and the silo will be filled in using a suitable material (backfilling grout). A drainage system will also operate as part of the disposal system, which will collect any water that sinks into the silo during operation. The water will then be drained in a controlled manner, thereby keeping the silo dry during operation. When the silo reaches full capacity, it will be sealed. The sealing concept for a full silo is shown in Figure 2-2.

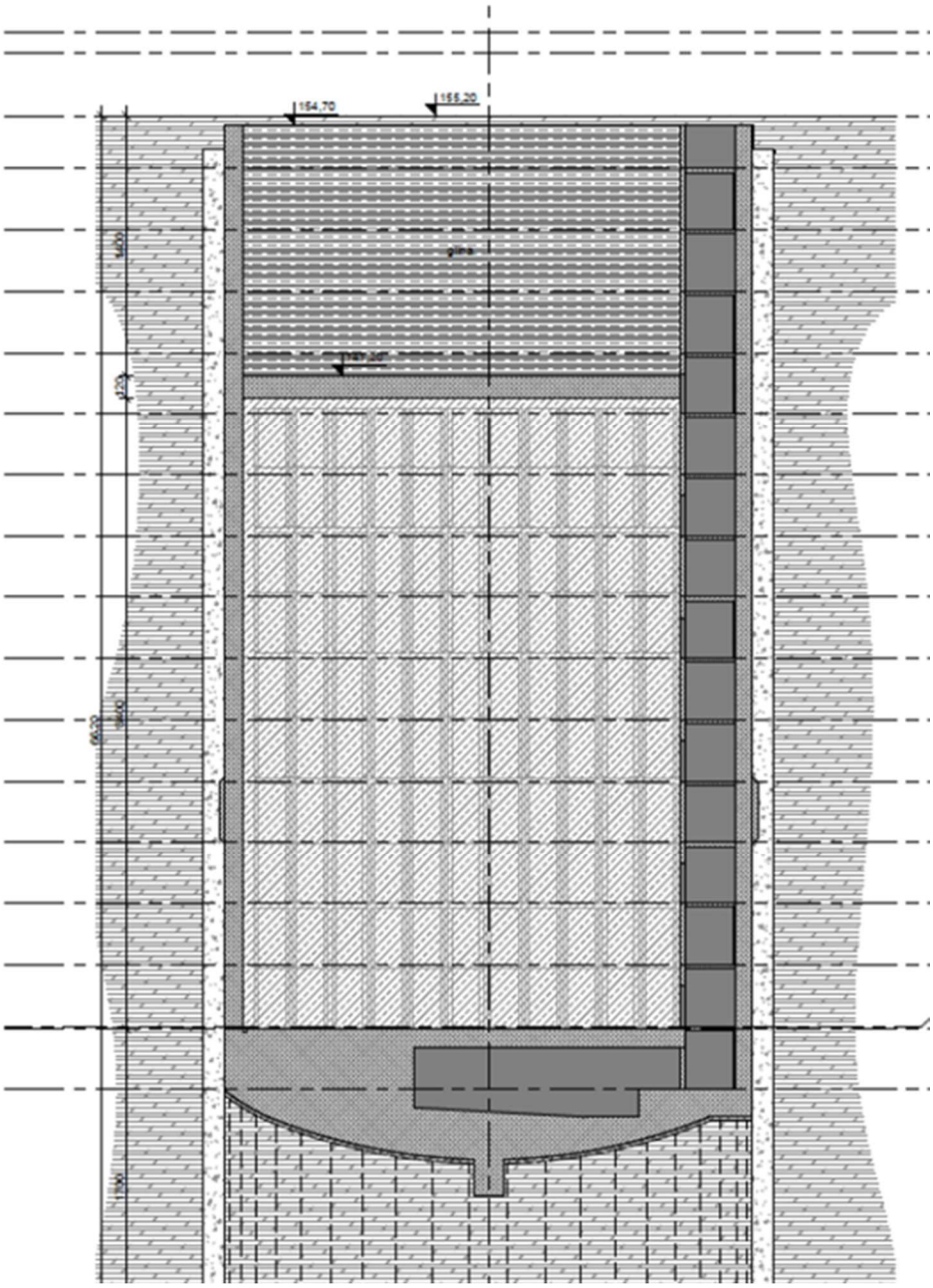

Figure 2-1: Silo sealing concept after cessation of operation (IDZ, Rev. C)

The silo must be sealed in such a way that it is as far away as possible from the water table at the site, thereby preventing or retarding the spread of potential radionuclide contamination. This will be achieved using a combination of barriers (concrete and clay). The silo will be covered with a concrete slab above which an impermeable clay barrier will be installed. The impermeable barrier will reach practically to the surface and will be covered with humus and seeded with grass on the surface.

The drainage system is also expected to be sealed after the silo is sealed. As far as possible, the sealed silo must constitute a monolithic structure with an adequate ratio between

impermeability to water (physical barrier) and permeability to the gases that will be created at the repository,[19] and the ability to contain radionuclides (chemical barrier). All artificial barriers must be designed in such a way as to perform the safety functions laid down in the System Description and Safety Functions Report, Rev. 2 [20] and the functional analysis.[21]

2.2 APPLICABLE REGULATIONS AND STANDARDS

List of regulations and standards applying to the content of the safety analysis report:

- Practical Guidelines PG 1.03 – Content of the safety analysis report for the low- and intermediate-level radioactive waste repository, 2102
- Resolution on Nuclear and Radiation Safety in the Republic of Slovenia 2013 – 2023 (Official Gazette of the RS 56/2013)
- Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016 – 2025 (Official Gazette of the RS 31/2016)
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation
- Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the regulation of status and other legal relations regarding investment in and the exploitation and decommissioning of Krško nuclear power plant (BHRNEK) (Official Gazette of the RS 23/2003)
- Ionising Radiation Protection and Nuclear Safety Act (ZVISJV) (Official Gazette of the RS 102/2004, 60/2011, 74/2015)
- Act Ratifying the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (MKVIGRO) Official Gazette of the RS [Mednarodne pogodbe], 3/1999
- Environmental Protection Act (ZVO-1) (Official Gazette of the RS 39/2006 [official consolidated text], 49/06 – ZMetD, 66/06 [CC Dec.], 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/2008, 108/2009, 108/09 – ZPNačrt-A, 48/2012, 57/2012, 92/2013, 56/2015, 102/2015 and 30/2016)
- Fire Safety Act (Official Gazette of the RS 3/2007, 9/2011, 83/2012)
- Health and Safety at Work Act (ZVZD-1, Official Gazette of the RS 43/2011)
- Private Protection and Organisation of Security Services Act (Official Gazette of the RS 17/2011)
- Rules on radiation and nuclear safety factors (**JV5**, Official Gazette of the RS 74/2016)
- Rules on radioactive waste and spent fuel management (**JV7**, Official Gazette of the RS 49/2006)
- Rules on operational safety of radiation and nuclear facilities (**JV9**, Official Gazette of the RS 85/2009, 9/2010 – corr., 87/2011)
- Rules on the monitoring of radioactivity (**JV10**, Official Gazette of the RS 27/2018)
- Rules on the obligations applying to entities conducting radiation practices and holders of ionising radiation sources (SV8) Official Gazette of the RS 13/2004
- Rules on the use of radioactive sources and on practices involving radiation (**JV2/SV2**, Official Gazette of the RS 27/2006)
- Rules on the conditions and methodology for assessing doses in the ionising radiation protection of workers and the public (**SV5**, Official Gazette of the RS 47/2008)
- Rules on the obligations of entity performing a radiation practice and the holder of a

source of ionising radiation (**SV8**, Official Gazette of the RS 43/2018)
- Rules on radiation safety measures in controlled and monitored areas (**SV8A**, Official Gazette of the RS 47/2018)
- Rules on the physical protection of nuclear facilities and nuclear and radioactive materials, and the transport of nuclear materials (Official Gazette of the RS 17/2013)
- Decree on radiation activities (**UV1**, Official Gazette of the RS 19/2018)
- Decree on dose limits, radioactive contamination and intervention levels (**UV2**, Official Gazette of the RS 18/2018)
- Decree on areas of restricted land use occasioned by a nuclear facility and the construction conditions applying to these areas (**UV3**, Official Gazette of the RS, Nos 36/2004, 103/2006, 92/2014)
- Decree on the safeguarding of nuclear materials (**UV6**, Official Gazette of the RS 34/2018)
- Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško (Official Gazette of the RS 114/2009)
- Decree on the detailed plan of national importance for the area of the Brežice hydroelectric plant (Official Gazette of the RS 50/2012 and 69/2013)
- Decree on activities affecting the environment that require an environmental impact assessment (Official Gazette of the RS 51/2014, 57/2015)
- Decree on Waste (Official Gazette of the RS 37/2015 and 69/2015)

The guidelines and recommendations that are not part of Slovenian law but are examples of good practice used around the world in the area of LILW management and disposal are listed below. The guidelines and recommendations are applied in such manner that they do not conflict with the regulations and standards applicable in the Republic of Slovenia.

- The 2007 Recommendations of the International Commission on Radiological Protection, Publication 103, Elsevier. ICRP, 2007
- Near Surface Disposal Facilities for Radioactive Waste, No. SSG-29. IAEA, 2014
- Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1. Vienna: IAEA, 2006
- Disposal of Radioactive Waste, No. SSR-5. IAEA, 2011
- Safety Case and Safety Assessment for the Disposal of Radioactive Waste, SSG-23. IAEA, 2012
- WENRA, “Radioactive Waste Disposal Facilities Safety Reference Levels”, 2014
- Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste, GSG-3. Vienna: IAEA, 2013
- Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4. IAEA
- IAEA, Safety Assessment Methodologies for Near Surface Disposal Facilities, Results of a Coordinated Research Project, Volume 1: Review and Enhancement of Safety Assessment Approaches and Tools, IAEA – ISAM. 2004
- IAEA, “IAEA safety glossary : terminology used in nuclear safety and radiation protection”, 2007

Other regulations and standards to which the individual chapters of the Draft Safety Analysis Report refer are listed at the end of the individual chapters.

2.3 DETAILS ON THE APPLICANT SUBMITTING THE SAFETY ANALYSIS REPORT

Details on the applicant submitting the Safety Analysis Report:

Applicant:	**Republic of Slovenia**
	Gregorčičeva 20-25
	1000 Ljubljana
	by authorisation of
	ARAO, Ljubljana
	Celovška cesta 182
	1000 Ljubljana
Responsible person:	Director Sandi Viršek, MSc

ARAO, Ljubljana was established as a public utility company by decree in 1991, with the basic mission of ensuring conditions for the disposal of radioactive waste in Slovenia. In 1996 it was transformed by government decree from a public utility company into a public commercial institution, and its scope of activities was formally expanded to include research and development in the area of long-term management of radioactive waste and spent fuel, keeping records of RW and SF, management of the radioactive waste storage facility in Brinje, organisation and performance of RW transport, development and implementation of rehabilitation projects, cooperation with international organisations and participation in international projects relating to radioactive waste, information provision and communication in the area of radioactive waste management and various other duties.

Via a new decree in 1999, ARAO, Ljubljana also became the provider of the public utility service of management of radioactive waste from small generators. The method of the provision of the public utility service of radioactive waste management is set out in the Decree on the method, subject of and conditions for the provision of the public utility service of radioactive waste management (Official Gazette of the RS 32/99 and 41/04 – ZVO-1). Pursuant to the decree from 2009 and the ZVISJV-D, which was adopted on 2 October 2015, the ARAO carries out:

- the compulsory national public utility service of RW management (Article 95 ZVISJV):
    - acceptance, collection, transport, conditioning and pre-disposal storage, preparations for construction of the repository, construction of the repository and

disposal of radioactive waste and non-waste spent fuel, i.e. spent fuel from energy producing nuclear facilities,
- pre-disposal conditioning of radioactive waste and spent fuel, preparations for construction of the repository, construction of the repository and disposal of radioactive waste and spent fuel from energy producing nuclear facilities,
- management, long-term monitoring and maintenance of radioactive waste and spent fuel repositories,
- long-term monitoring and maintenance of repositories of mining and hydro-metallurgical tailings generated during the extraction and exploitation of nuclear mineral raw materials,
- compiling of expert bases for national strategic documents (Article 98 ZVISJV), including cooperation in the compiling of expert bases for the decommissioning and radioactive waste and spent fuel management programme,
- investment planning and management of national infrastructure facilities required for the provision of public utility services (Article 99 ZVISJV) and
- education, notification and provision of information in connection with RW.

ARAO carries out duties on behalf of and for the account of the Republic of Slovenia relating to spatial planning and infrastructure development and the drafting of investment and project documentation for construction.

2.4 BASIC TECHNICAL CHARACTERISTICS OF THE REPOSITORY

The LILW repository is a nuclear facility at which all activities will be carried out that are directly linked to the disposal of radioactive waste.
The wider area of the repository, which is at the same time also the area of the DPN, comprises:
- the entrance to the repository,
- vacant surfaces of the repository, and
- areas for connection to utilities infrastructure.

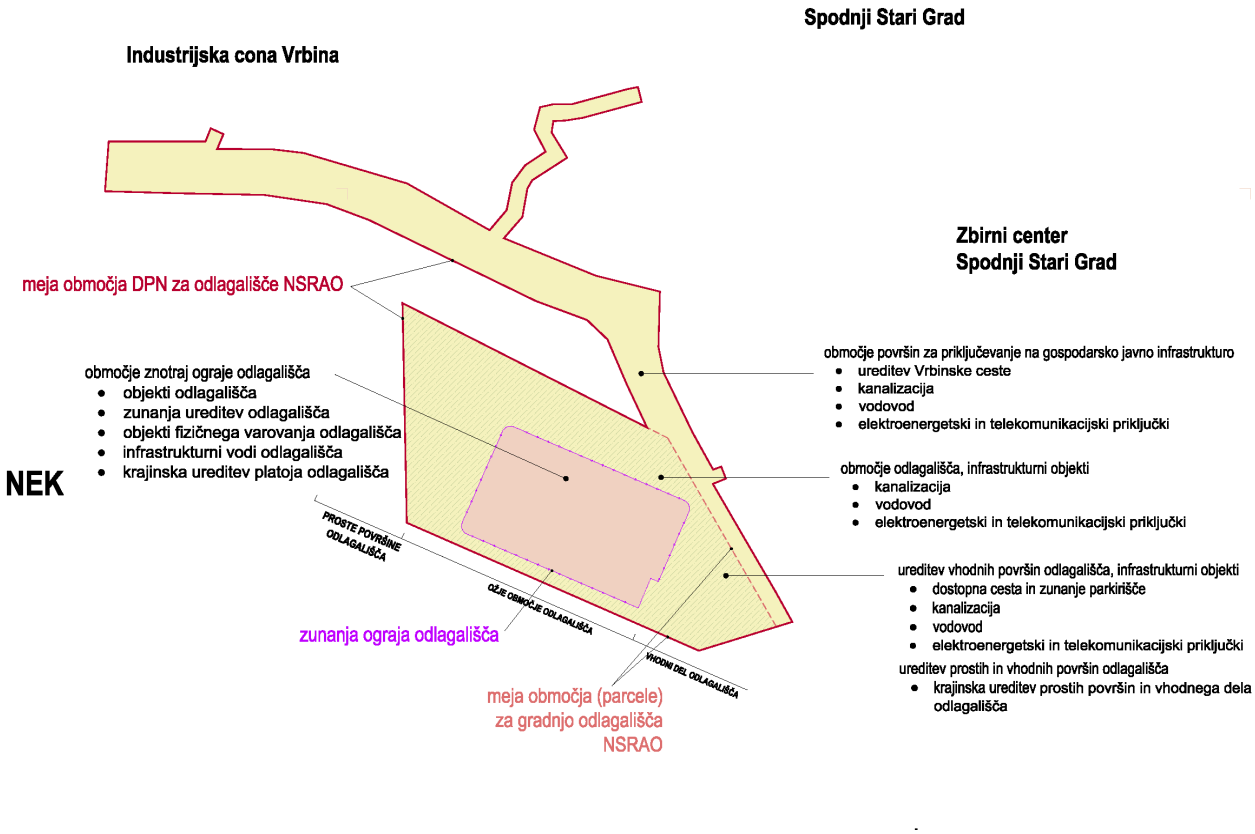

Figure 2-3: Overview of areas with planned works

Industrijska cona Vrbina	Vrbina Industrial Zone
Spodnji Stari Grad	Spodnji Stari Grad
meja območja DPN za odlagališče NSRAO	boundary of the DPN area for the LILW repository
Zbirni center Spodnji Stari Grad	Spodnji Stari Grad Collection Centre
območje znotraj ograje odlagališče	area inside repository fence
• objekti odlagališča • zunanja ureditev odlagališča • objekti fizičnega varovanja odlagališča • infrastrukturni vodi odlagališča • krajinska ureditev platoja odlagališča	• repository facilities • exterior arrangement of repository • facilities for physical security of repository • infrastructure lines at the repository • landscaping of repository plateau
PROSTE POVRŠINE ODLAGALIŠČA	VACANT SURFACES OF REPOSITORY
OŽJE OBMOČJE ODLAGALIŠČA	CORE AREA OF REPOSITORY
VHODNI DEL ODLAGALIŠČA	ENTRANCE TO REPOSITORY
zunanja ograja odlagališča	outer perimeter fence of repository
meja območja (parcele) za gradnjo odlagališča NSRAO	boundary of the area (lots) for the construction of the LILW repository
območje površin za priključevanje na gospodarsko javno infrastrukturo	area of surfaces for connection to public utilities infrastructure
• ureditev Vrbinske ceste • kanalizacija • vodovod • elektroenergetski in telekomunikacijski priključki	• arrangement of Vrbina road • sewerage system • water supply system • electricity and telecommunications connections
območje odlagališča, infrastrukturni objekti	area of repository, infrastructure facilities
• kanalizacija • vodovod • elektroenergetski in telekomunikacijski priključki	• sewerage system • water supply system • electricity and telecommunications connections
ureditev vhodnih površin odlagališča, infrastrukturni objekti	arrangement of entry areas of repository, infrastructure facilities
• dostopna cesta in zunanje parkirišče • kanalizacija	• access road and external parking area • sewerage system

• vodovod • elektroenergetski in telekomunikacijski priključki	• water supply system • electricity and telecommunications connections
ureditev prostih in vhodnih površin odlagališča	arrangement of repository vacant and entrance areas
• krajinska ureditev prostih površin in vhodnega dela odlagališča	• landscaping of vacant areas and entrance section of repository

The structures at the LILW repository are designed to meet the technological conditions and requirements with their dimensions, capacities and selection of finishing work. At the same time, special attention was devoted in the spatial arrangement of the structures and in their architectural design to their appropriate harmonisation and adaptation to the surrounding environment.

It is anticipated that the structures will provide appropriate conditions for the healthy, safe and comfortable use, stay and work of all users of the facilities and other persons, while fulfilling all the essential requirements for buildings (mechanical resistance and stability, fire safety, hygienic and health protection and environmental protection, safety in use, noise protection, energy saving and heat conservation). All of the aforementioned requirements will also be taken into account in the subsequent design phases.

In terms of architectural design, and especially the design of their exteriors, the repository facilities are divided into two groups:

(a) Structures of small volume and longitudinal layout, with a varied programme:
- administration and service building and
- technological facility (phase 1).

(b) Structures of larger dimension, the same volume and without any exterior openings:
- the hall for back up storage capacities in the technological facility (phase 2) and
- the hall above the silo.

The facilities within the individual groups are designed using the same design principles and elements and the use of the same materials is planned.

In general, the structures are designed large-scale, with clearly articulated facade surfaces.

1. **Technological facility** (TF) – planned to be constructed in two phases:

TF Phase 1, premises clusters:

a. control point with accompanying premises,
b. storage of secondary RW and measurement room,
c. service, energy and technical areas serving the technological facility during Phase 1, and
d. common areas and utility rooms.

TF Phase 2, premises clusters:

e. reserve storage capacities with hot workshop and secondary LILW storage area,

f. ventilation control room and measurement room for the operational requirements during Phase 2.

The technological facility (TF) is intended for the temporary storage and repair of any damaged waste containers, basic laboratory research, control of technological processes, and the remaining necessary technological and service functions of the repository as well as functions for the provision of nuclear and radiation safety. The facility is designed from a functional, structural and design standpoint to be able to be constructed in two phases.

The technological facility contains a control point for entry to and exit from the (radiologically) controlled area. The facility is located in the central part of the repository. The majority of the facility is single-storey, with a two-part floor plan and two stories. The eastern part of the facility (Phase 1) is lower, height 5.20 m, while the western part of the facility (Phase 2) is 9.20 m high with a clear height of 8.00 m, for reserve storage capacities. The first phase of construction of the TF includes a storage room for secondary radioactive waste and a measurement room. In the event of any damaged containers, during the construction of TF Phase 1 they will be stored in the hall above the silo. The radiologically controlled area during Phase 1 of the construction of the TF could be planned to include the hall above the silo and the silo.

2. **Disposal facility**
   disposal silo.

3. **Hall above the silo** (i.e. the Hall)

The hall above the silo is located in the central part of the flood protection plateau (at an elevation of +155.20 m), in the radiologically controlled area, and covers the entire footprint of the silo along with the handling areas. The hall protects the silo and the gantry crane against weather impacts during the placing of containers.

4. **Administrative and service building** (ASB), premises clusters:
   a. reception
   b. administrative area
   c. kitchenette
   d. common areas (communications, service and technical areas)
   e. areas for physical security installations
   f. areas for collection of municipal waste
   g. workshop
   h. quick access storage facility
   i. electrical switchboard
   j. water supply and fire protection areas
   k. storage facility for geological samples (core samples)

The majority of the ASB is single-storey. The southern part of the facility is two-storey (G+1), while the part between axes M and O has a basement (B+G).

Under the Conceptual Design, the administrative part of the facility contains the premises and systems serving repository management activities, and the related service and administrative

activities, as well as activities to control the entry of items, persons (personnel and visitors) and vehicles (RW-carrying and other vehicles) and to exercise surveillance of the repository.

The service part of the administrative facility is intended for power supply, fire water supply, collection of municipal waste, storage of equipment and geological samples (core samples) and a workshop. This part of the facility contains all of the infrastructure, power supply and service areas that are important for the safe and undisturbed operation of the repository, but are not directly connected to the undisturbed operation of the technological facility itself (those areas are located directly within the technological facility).

5. **Devices for monitoring and radiological monitoring** of emissions and the environment:
    a. control pool (CP).

The control pool is designed to collect water from the disposal silo and the hall above the silo, and from the technological facility. The pool will be excavated, and located on the eastern side of the hall above the silo. The structural design of the control pool is in compliance with technical requirements.

The pool is rectangular in shape. The dimensions of the internal footprint of the pool are 5.5 m x 10.0 m, with a clear height of 3.7 m. The pool is fully covered by a reinforced concrete slab, in which openings are planned for a submersible pump, and openings for access and maintenance and for ventilation. The load-bearing structure is composed of 40 cm reinforced-concrete exterior walls, a 40 cm thick top slab and a 50 cm thick bottom slab. In order to ensure water-tightness and to protect the concrete surfaces against the corrosive effects of the collected water, the interior of the pool will be covered with a sealing liner that is resistant to chemical influences.

Detailed descriptions of the repository and its systems are given in chapters 5 and 6 of the Safety Analysis Report.

2.4.1 DISPOSAL CAPACITY

990 disposal containers (design quantity, scenario SA.3) and the construction of a single silo are planned for the disposal of half the LILW (operational waste and waste from the decommissioning of the Krško NPP) and the disposal of LILW from other Slovenian generators (medicine, industry, research activities). The disposal of the entire quantity of waste from the Krško NPP (operational waste and waste from the decommissioning of the Krško NPP) will require the construction of two disposal silos (scenario SA.2). Data on the waste types are summarised in the Inventory report.[4] The acceptance criteria are set out in the special report Acceptance criteria for radioactive waste at the LILW repository.[5] Below we provide a summary of the planned disposed quantities of waste and the types of waste to be deposited.

The disposal capacity of the repository totals 990 disposal containers or 12,157 m^3 (990 containers x 12.28 m^3 gross volume per container) in the case of the realisation of scenario SA.3., or 1880 disposal containers (24 314 m^3) in the case of the realisation of scenario SA.2.
The following types of LILW will have to be disposed at the LILW repository:

- LILW from Krško NPP
  - operational LILW from Krško NPP
  - waste from the decommissioning of Krško NPP
  - other LILW from Krško NPP (replaced/discarded equipment, etc.)
- LILW from the central LILW storage facility in Brinje (CSRAO; medical and industrial waste and waste from research activities), LILW from the decommissioning of the CSRAO and the TRIGA reactor
- LILW generated at Krško NPP during conditioning of LILW for disposal and during decommissioning
- devices for conditioning of LILW for disposal
- LILW generated during the operation and decommissioning of the repository

In accordance with the Conceptual Design Rev. C [13], the waste will be placed into standard N2 containers, which will meet the requirements for IP-2 packages. The individual disposal containers will be labelled with the following data:

- unique identification of the package in both eye-readable and digital form
- package weight
- radioactive waste category
- type of radioactive waste
- maximum measured dose rate on the package surface

The containers must be filled with solid waste of sufficient density that the total weight of the container does not exceed 40 t. The proportion of voids may not exceed 10%. The content of organic substances in disposed radioactive waste will be prescribed at the lowest practically achievable level. All disposed waste will be appropriately conditioned so that it is fire-resistant and does not contain flammable substances.
The waste-filled containers will also have to be conditioned so that they meet the following criteria, which are presented in detail in Chapter 11 of this Draft Safety Analysis Report.
Radiological properties:

- content of emitters and specific activity
- surface dose rate and dose rates at reference distances from the package surface
- specific surface contamination
- degradation effects of radiation

Chemical properties:

- leachability
- free liquid content
- corrosiveness
- corrosion resistance
- presence of chelating and other complex compounds
- toxin content
- gas formation and gas content
- explosive properties
- chemical stability

Mechanical properties:

- structural strength

Thermal properties:

- flammability;
- combustibility

Biological properties:

- content of organic substances

Physical properties:

- permeability and porosity
- homogeneity
- density
- presence of voids

Labelling and packaging:

- method of labelling packages
- types of containers and packaging method

2.4.2 LAYOUT AND PLACEMENT OF FACILITIES

Figure 2-4 shows the layout of the LILW repository and the placement of the facilities.

The entrance part of the repository includes a gated entry from Vrbina road (uncategorised public road which is an extension of public thoroughfare JP 693631 – Sanitary landfill), a car park for employees and visitors, and green and other open spaces.
The narrow area of the repository is set aside for administrative and service activities, waste takeover and disposal, and the provision of physical security for the repository. The core area of the repository is equipped with a security fence and is physically secured. The facilities in the narrow area of the repository are constructed on a single flood control plateau at an elevation of 155.20 m above sea level.
The administrative and service section of the narrow area of the repository contains an administrative and service building from which the repository will be operated and managed and associated administrative and service activities performed, along with activities to control access to and physically secure the repository, energy-related activities, fire water supply, the collection of municipal waste, the storage of spare parts and geological samples (core samples), and a workshop. The core of the narrow repository area comprises the technological facility and the disposal silo with hall. The construction of the technological facility is planned in two phases. In the first phase a control point will be built with accompanying premises and service, energy, technical, common and auxiliary areas for the needs of the TF. An area for reserve storage capacities with a ventilation control room and a measurement room will be built in the second phase. During the first phase of construction of the TF, reserve storage

capacities will be provided in the hall above the silo. The technological facility (TF) in both Phase 1 and Phase 2 is intended for the temporary storage and repair of any damaged waste containers, measurements, monitoring of technological procedures, and other required technological and service functions of the repository, as well as functions for ensuring nuclear and radiation safety. The vacant areas of the repository are planted with trees, thereby creating a green barrier of indigenous trees between the repository and the surrounding area.

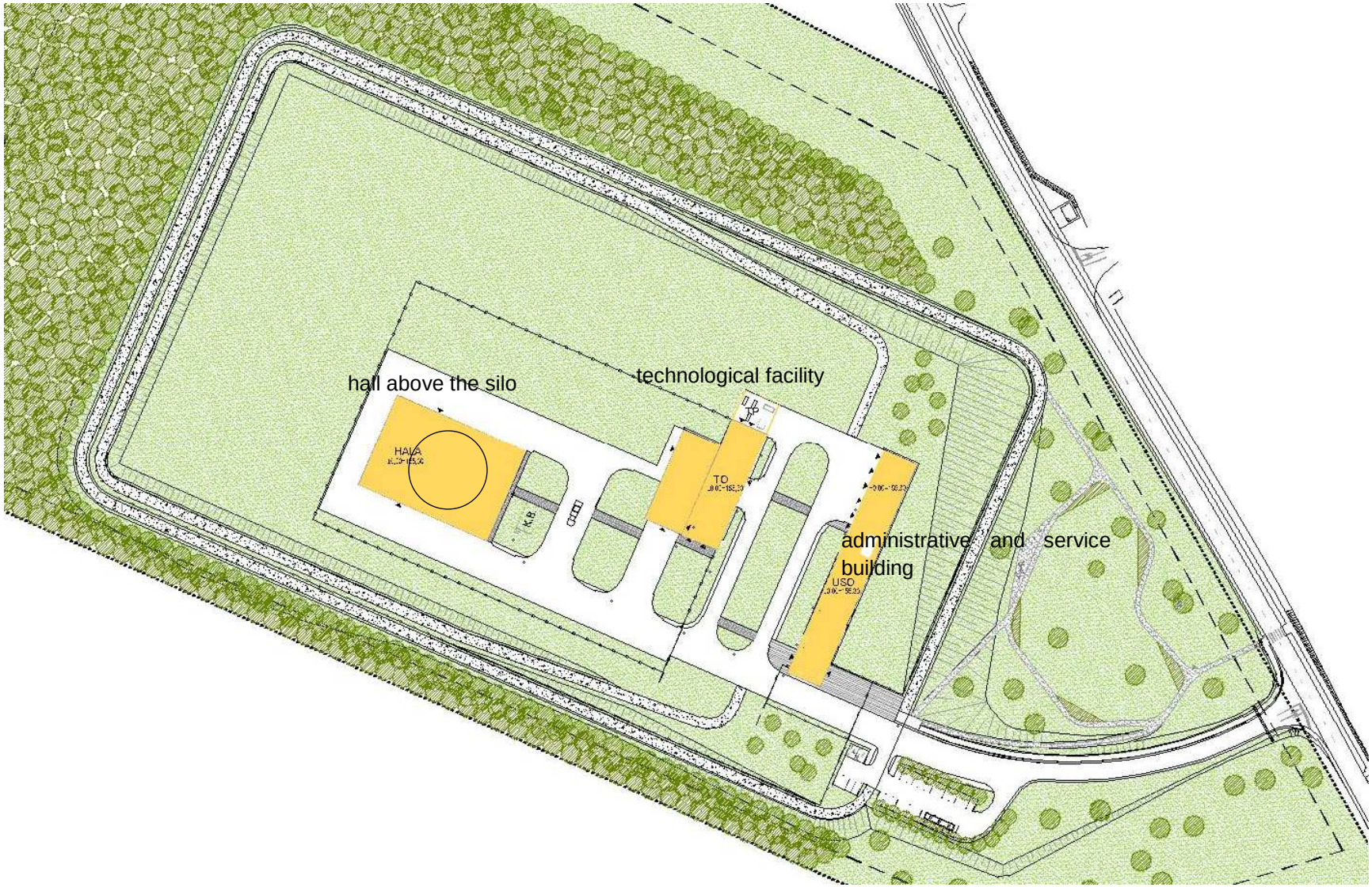

Figure 2-4: Graphical presentation of the layout of the repository and the placement of facilities (single disposal unit variant)

The repository is connected to Vrbina road via a road junction. The infrastructure connections partially run along Vrbina road.
The surfaces in the disposal area and the majority of the areas in the TF are planned such that they can be considered controlled radiation areas (CRA).
The controlled area is restricted and secured with a fence or construction elements (TF). The contamination of the exterior surfaces (CRA) and interior surfaces (hall above the silo and TF) is not expected. Only local and temporary contamination of surfaces can occur, in the event of exceptional design-basis events or in the event of the conducting of work with sources of radiation in the TF that will be installed in the TF in the second phase. Since the surfaces in the planned CRA will not be contaminated, and any contamination will be removed immediately, while at the same time the radiation load (dose rate) will be low in the majority of the CRA, during the period of operation of the repository the majority of the planned CRA will be able to be transformed into a radiologically monitored area (RMA). Only the area of the silo and the hall will be organised as a CRA. In such case, access to the CRA in the hall and the silo will be provided via an auxiliary control point in the hall.

The structures, systems and components planned at the repository are listed below.

Structures

1. Technological facility:
The TF is planned to be built in two phases.

TF Phase 1, premises:
a. control point with accompanying premises
b. storage of secondary radioactive waste and measurement room
c. service, power supply and technical areas serving the technological facility during Phase 1
d. common areas and utility rooms

TF Phase 2:
e. reserve storage capacities with hot workshop and a secondary LILW storage area
f. ventilation control room and measurement room for the operational requirements during Phase 2.

2. Disposal facility:
a. Disposal silo
b. Hall (above the silo)

3. Administrative and service building, premises clusters:
a. reception
b. administrative area
c. kitchenette
d. common areas (communications, service and technical areas)
e. areas for physical security installations
f. areas for collection of municipal waste

g. workshop
h. quick access storage facility
i. electrical switchboard
j. water supply and fire protection areas
k. storage facility for geological samples (core samples)

4. Facilities for monitoring and radiological monitoring of emissions and the environment:
a. Control pool
b. Boreholes

5. Physical security facilities:
a. Outer perimeter fence
b. Inner fence

6. Exterior and landscaping arrangements:
a. Solid surfaces:
    i. Road connection
    ii. Repository roads
    iii. Car parks
    iv. Plateaus
b. Green areas

7. Infrastructure lines and connections:
a. Municipal sewage system
b. Surface runoff drainage system
c. Water supply connection
d. Electrical and
e. TC connection

Systems and devices

Mechanical/technical systems and devices:
Systems
1. System for collection of wastewater in the area of the disposal silo (R)
2. System for collection of wastewater in the controlled area of the TF (R)
3. Water supply system
4. Sewage system
5. Heating
6. Cooling
7. Ventilation (partly R)
8. External hydrant network
9. Internal hydrant network
Note: (R) denotes systems with potentially radioactive media.

Devices

1. Devices for carrying out transit
a. Gantry crane above the silo with container gripper and winch for auxiliary lifting
b. Personnel lift in the silo access shaft
c. Forklift
d. Personnel lift in the ASB

Electrical systems and devices
1. Power supply
2. Reserve power supply
3. Lightning arresters
4. Grounding
5. Lighting
6. Exterior lighting
7. Security lighting
8. Process management and monitoring
9. Radiation monitoring
10. Fire alarm system
11. Safety/access monitoring
12. Paging
13. Telecommunications

Note: All electrical systems and devices partly run through the controlled radiation area of the repository and will potentially be contaminated. These parts of the systems will be subject to decommissioning.

Detailed descriptions of the design of the systems and components are given in chapters 5 and 6 of the Draft Safety Analysis Report.

2.5 DISTRIBUTION OF REPOSITORY EQUIPMENT AND PLACEMENT IN THE ENVIRONMENT

2.5.1 TECHNICAL SCHEMATICS OF THE MAIN SYSTEMS AND EQUIPMENT

The technical schematics of the main systems and equipment are an integral part of the design documentation (IDZ) [13], Technological plan, Disposal technology. The following schematics are presented: technological schematic of the repository, schematic of system for collection of wastewater and schematic of system for collection of wastewater in the area of the disposal silo.

The schematics are given in section 2.8 Appendixes.

2.5.2 PHYSICAL AND GEOGRAPHICAL LOCATION OF THE REPOSITORY

The Vrbina site lies on the alluvial plain along the Sava River in the vicinity of the existing Krško NPP, approximately 400 m to the south-west of the village of Spodnji Stari Grad. The closest point of the site is located 300 m from the bank of the Sava. The site relief is flat with various local small depressions, the remains of the former course of the Sava. The wider area is used for agriculture and is officially designated as prime agricultural land. The site contains fields, and there is a commercial orchard located in the direct vicinity.

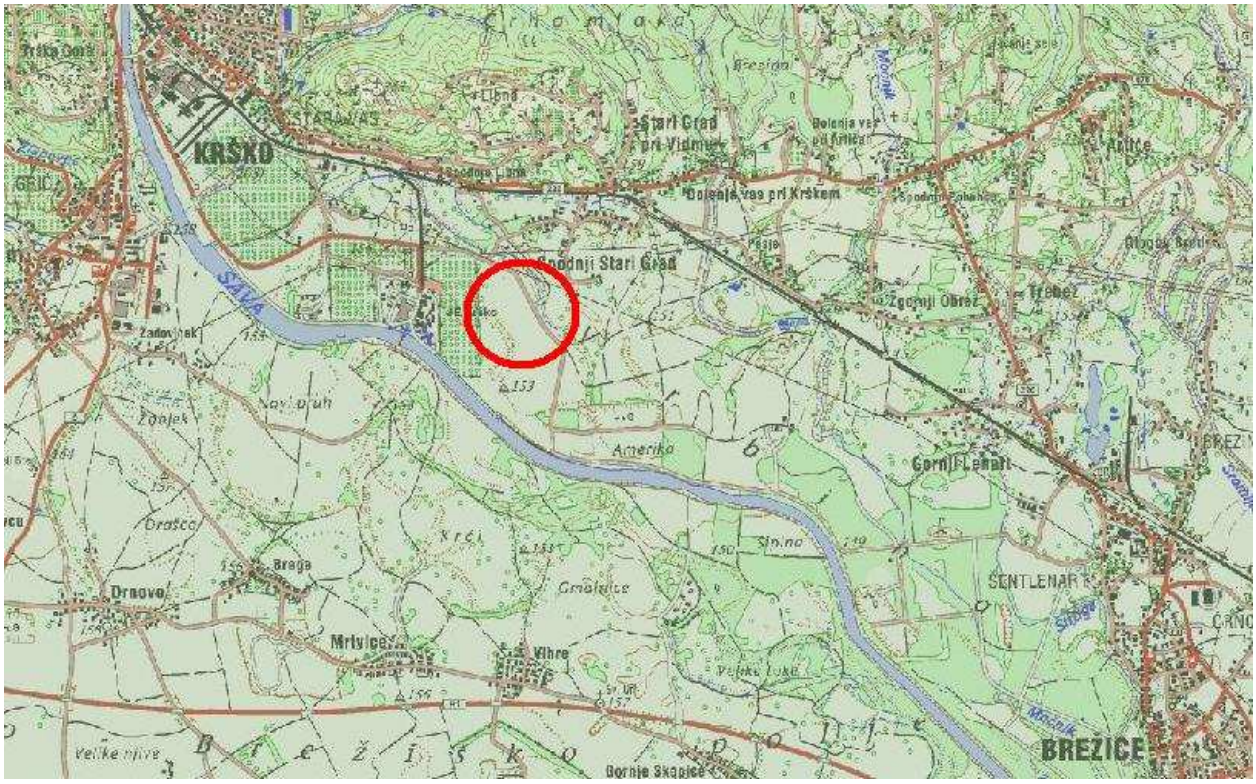

Figure 2-5: The Vrbina site (source: Environment Atlas, September 2015)

The narrower area of the site contains no particular natural features, protected areas or areas important to biodiversity, nor are there any cultural heritage units or protected archaeological sites listed in the area. The Spodnji Stari Grad waste management centre is located near the site.

The repository site is presented in more detail in Chapter 4 of the Draft Safety Analysis Report.

2.5.3 CONNECTION TO THE ELECTRICITY SUPPLY NETWORK AND OTHER INFRASTRUCTURE, ACCESS POINTS

The infrastructure connections are discussed in detail in the design documentation (IDZ).[13]

The main connections to the repository equipment and infrastructure are: connection to the public sewage system, which includes the construction of a pumping station and a pressurised sewage system, connections to the electricity and water supply networks, telecommunications connection and connection to the public road.

Infrastructure lines and connections at the repository:
Electricity (transformer station next to technological facility)
Wastewater sewage system:

- municipal water (shaft outside of fence, at the repository entrance) and industrial water (collected at point of occurrence)

Municipal and industrial water that is suitable for discharge into the sewage system is discharged into the sewage system to its end point at the Vipap treatment centre, while contaminated and polluted water is sent for processing.

- surface runoff water (shaft outside of fence, at the repository entrance)

Surface runoff water is led into an infiltration field at the south-east side of the repository.
The water supply system and the external hydrant network on the plateau (water gauging shaft on outside of fence),
telecommunications (TC) lines (TC enclosure in administrative and service building).

Traffic infrastructure will be installed in the form of an access road to the repository, which connects to the uncategorised public road which is an extension of public thoroughfare JP 693631 – Sanitary landfill.

2.5.4 OVERALL PLAN OF THE REPOSITORY

The repository, which is surrounded by a security fence, includes a surface intended for administrative and service activities and acceptance of waste, and a surface for waste disposal.

The main above-ground structures at the repository are: the administrative and service building, the technological facility and the hall above the underground silo. They are laid out in order along the repository's main transport axes, which are determined by the access route to the repository.

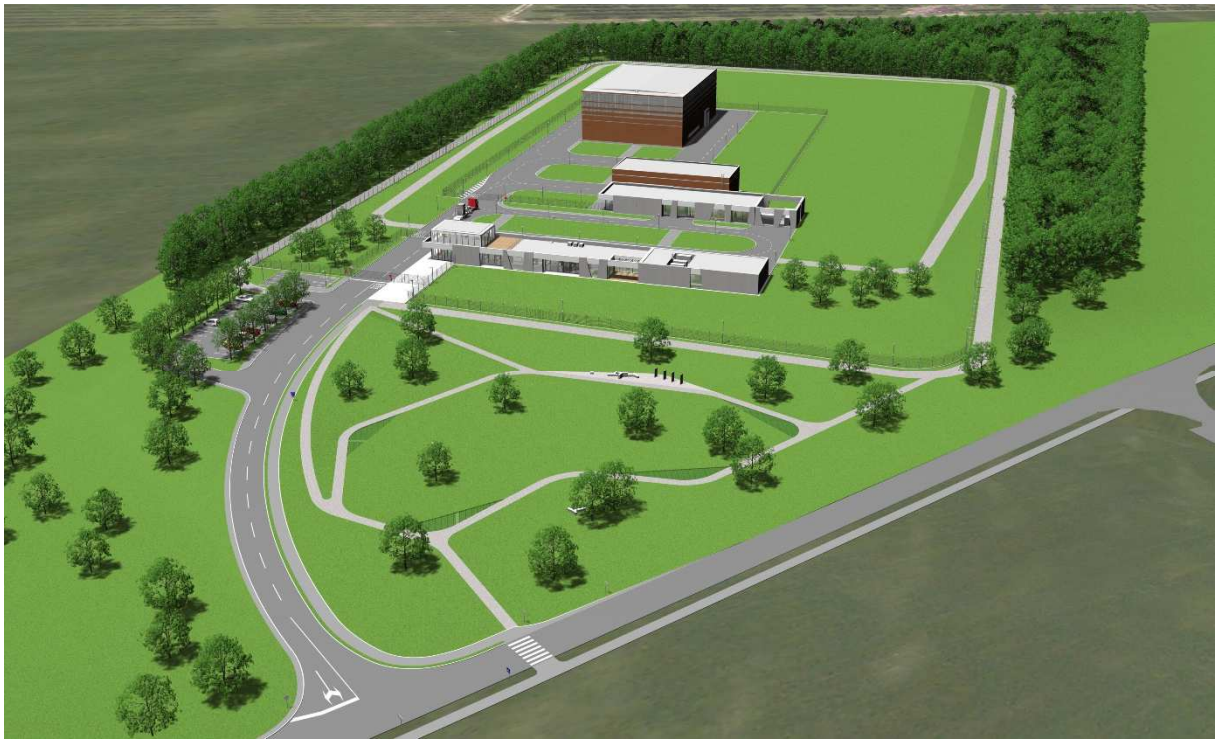

Figure 2-6: Visualisation of the repository

In the design of the surfaces and the placement of the facilities, attention was paid to the architectural and landscape-architecture design, with the intention of creating a uniform complex.

Inside the fenced secure area is a fenced area with the disposal silo and the hall above it, where the controlled radiation area will be determined depending on the level of exposure to ionising radiation. The design solutions allow the technological facility to be included in the controlled area.

The envisaged spatial arrangement ensures adequate conditions for the safe operation of the repository (safe evacuation of people, necessary distances between facilities, i.e. adequate fire breaks between structures, transport and working areas for intervention vehicles, sources for adequate supply of fire water, areas for vehicles to move and turn).

Outside the repository fence are a car park for employees and visitors, green areas and an access road.

Trees will be planted to establish a wooded area by the repository, primarily on the NE and NW sides of the repository. On the south-eastern side the planting will be arranged in clusters and spread out with the aim of making the repository open to the surrounding environment.

2.5.5 DESCRIPTION OF THE MAIN SYSTEMS AND COMPONENTS, THEIR PURPOSES AND INTERACTION, MAIN CONNECTIONS AND SEPARATION BETWEEN COMPONENTS AND SYSTEMS

The systems and components are set out in point 2.4.2.

The description of the systems (SSC) is given in more detail in Chapter 6.

Processes at the repository that are derived from SSC and are nuclear safety related:

- safety/access monitoring
- radiation monitoring
- system for collection of wastewater in the area of the disposal silo
- gantry crane (placing of containers)
- system for collection of wastewater in the controlled area of the TF
- fire protection system

2.5.5.1 LILW repository connection to the electrical grid, electrical installations and equipment

The electric power transmission system includes network electrical installations for lighting (interior, exterior, security), lightning conductors and grounding, fire alarm system, information system (PA), management and supervision (of processes, access, radiation, safety monitoring), and a reserve power supply.

In the event of a power outage, important electrical equipment will be supplied power from a UPS with 15 min of autonomy. During that time a diesel generator will be started which will take over the task of supplying power to that equipment, and the remaining loads required for the normal operation of the repository.

For security purposes, the entire repository will be lit along the outer perimeter fence with lights mounted in fixtures at a height of ca 7-9 m. This part of the repository lighting will be covered in a separate plan under physical security at the repository. The interior roads inside the fences will be lit with lights mounted on poles approximately 6-9 m high at the edges of the roads.

Management and monitoring of all technological processes will be carried out from the control room in the technological facility. The processes will be monitored visually using cameras. All work areas and stations will be equipped with audio connections. Next to the control room there will be a server area and equipment for management and monitoring of processes, and an area for power supply equipment.

2.5.5.2 Telecommunications link and communication systems

In order to connect the LILW repository to the telecommunications system for management, business informatics, information systems, and relay of measurements and statuses, it will be necessary to provide high-quality, reliable and upgradable telecommunications connections. The repository's telecommunications connections will support broadband communication. If necessary, the telecommunications network will also be able to be connected to international traffic flows via neighbouring countries, taking into account the recommendations for protection of computer and information technology.

A paging system is planned to be installed throughout the entire complex at the Vrbina repository for notification of staff in the event of an accident, general notification of staff and in the event of evacuation.

2.5.5.3 Mechanical installations and equipment

Machine technology systems comprise: drainage of water from the area of the disposal silo, collection of wastewater in the controlled part of the repository, water main, sewerage, heating, cooling, ventilation, the hydrant network (exterior and interior).

Machine technology devices are devices for carrying out internal transport, the gantry crane above the silo with the container gripper and winch for auxiliary lifting, a personnel lift in the access shaft of the silo and a forklift.

The heating requirement of the administration and service building and technological facility will be serviced by using reversible heat pumps. Electricity will be used to power the reversible heat pumps. The reversible heat pumps will run on air and be able to operate at up to -20°C.

In summer the cooling requirement of the administration and service building and technological facility will be serviced by using reversible heat pumps switched to the operational cooling regime.

The disposal silo and temporary hall above the silo will be passively ventilated during the period of filling the silo. Where necessary, ventilation or the local induction of air can be provided by portable devices that can be used in poorly ventilated structures.

The access shaft of the silo will be actively ventilated. The air intakes for the negative pressure ventilation system will be located in the lower part of the silo. The exhaust will be located on the facade of the hall and will be radiologically controlled.

The planned controlled area in the technological facility will be actively ventilated. Exhaust will be controlled from the decontamination area, which is a part of the control point. In the event of exceeding the permitted emissions, the spaces will be ventilated using dampers isolated from the surrounding area. By providing differential pressure (low and high pressure), air will be moved from the area with lower potential to the area of higher potential for contamination. In work areas where there is a higher potential for contamination (Phase 2 of technological facility), local suction will be provided as necessary. Exhaust from the local ventilation device will be conducted via a local HEPA filter to the air outlet from the technological facility.

2.5.5.3.1 Water supply system

In order to supply the necessary quantities of fire water pursuant to the fire safety study, a fire water tank is planned in the basement of the service part of the administrative and service building. The tank will be filled from the water supply system.

Exterior and interior hydrant networks are planned in order to provide the necessary level of fire safety of the facilities. The hydrant network will be connected to the fire water tank via a positive pressure firefighting system. The exterior hydrant network, which is designed as a closed loop around the facilities, will be serviced via this device. The interior hydrant network will be connected to the exterior hydrant network.

2.5.5.4 Discharging of wastewater

For collection of industrial wastewater, a collection tank will be installed beneath the bottom of the disposal silo, a sanitary tank next to the technological facility, and a floor drain sump (Phase 2 of the technological facility) and a control pool next to the hall above the silo.

Wastewater, which could potentially be contaminated, is generated during the use of the decontamination sinks and showers in the (controlled) part of the technological facility. A sanitary tank for this wastewater is planned to be installed next to the technological facility.

The toilet in the decontamination area in the technological facility is a chemical (dry) toilet, and the only one within the planned controlled area. During periods of major works (filling voids) in the silo, a temporary chemical toilet will be provided due to the distance from the technological facility.

In the event that water from the collection tank below the silo does not exceed the limit values for clearance, it will be pumped directly into the municipal sewage system, and into the control pool only in the exceptional circumstance that the water flows do not allow for appropriate sampling. The control pool is designed to collect contaminated water from the collection tank below the silo, and in the event of emergencies also from the sanitary tank next to the technological facility, and water that is removed from the floors of the hall and from the floor drain sump in Phase 2 of the technological facility. This wastewater can be discharged into the sewage system after prior sampling and harmonisation with the requirements of the administrative authority in the area of nuclear safety and the operators of the sewage system and the wastewater treatment plant.

In the event that the wastewater satisfies the clearance criteria, it shall be discharged pursuant to the Decree on the emission of substances and heat in the discharge of waste water into waters and public sewage system [22] or pursuant to the Decree on the discharge and treatment of municipal waste water and surface runoff water in the Municipality of Krško [23] and the Technical rules on the discharge and treatment of municipal waste water and surface runoff water in the Municipality of Krško.[24]

It is estimated that the quantity of industrial wastewater will not exceed 1000 m^3 per year, i.e. 3 m^3 per day. In the event that it does not exceed the prescribed limits for other pollution and contamination, it can be treated as municipal wastewater.

If the wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste. The collected contaminated wastewater will be sent for treatment (e.g. to the Krško NPP), or (preferentially) suitable treatment capacities will be installed at the repository.

2.5.6 PHYSICAL SECURITY OF THE REPOSITORY

The repository will have a security fence that marks the boundary of the controlled area with respect to physical security of nuclear facilities. Physical security of the repository is covered in Chapter 10. A Physical Security Study has been made as part of the Conceptual Design.[13]

In accordance with Article 3 of the FV1 Rules on physical protection of nuclear materials, nuclear facilities and radiation facilities,[25] the LILW repository is classified as a Category III nuclear facility. The repository will be secured right from the start of construction.

All of the facilities at the repository except for the access road with car park, will be surrounded by a security fence. Within the fenced area there will be an additional fenced area that will be

a controlled radiation area (CRA). During the period of operation of the repository, control of access, monitoring the situation at the repository via video cameras and other functions of physical security will be performed from the control centre in the reception of the ASB. The repository will also be linked to a security and control centre (SCC). This centre will be at a remote location and will be provided by the outside security contractor.

2.6 REPOSITORY PHASES

The repository phases include facility siting, project planning, construction, operation (trial operation, regular operation, standby phase), closure of the repository, preparation of the repository for long-term surveillance and maintenance, long-term surveillance and maintenance (active long-term surveillance, passive long-term surveillance) and unlimited use of the site.

1. Site selection and facility siting

The site selection was carried out in accordance with the Programme for the preparation of the national site development plan for an LILW repository.[26] The location of the LILW repository was adopted through the adoption of the Decree on the detailed plan of national importance for an LILW repository.[27]

2. Project planning

Project planning includes drafting of documentation for obtaining administrative permits, the obtaining of administrative permits and the drafting of the implementation documents.

3. Construction

The construction of the repository will proceed in accordance with the planned timetable for construction of the LILW repository.

The decision on whether to build the first phase or both phases of the technological facility will be taken before commencement of construction.

The repository is planned to be built in three years.

4. Operation

4.1. Trial operation

Two years of trial operation are planned.

4.2. Regular operation

Regular operation will begin after the successful completion of the trial operation period and the obtaining of a use permit. According to the plan for cessation of operations, the repository will enter into preparation for cessation of operations and then into the standby phase. The repository is planned to re-start operations in 2050.

Preparation for acceptance and disposal of LILW

Acceptance and disposal of LILW

Non-disposal works in the area of the silo (installation of drainage system along the silo wall, filling voids and pouring levelling layers).

4.3 Standby phase

Preparation for standby phase

Standby phase

After the disposal of all LILW generated to that point, the repository will enter the standby phase.

Preparation for re-start of operations

The preparation for re-start of operations is planned for 2049.

5. Closure of the repository

After the adoption of the decision on the final closure of the repository after the decommissioning of the Krško NPP, the closing of the repository will be initiated.

5.1 Decommissioning

Decommissioning is provisionally planned for 2061. It will be carried out only for the technological facilities. After decommissioning, which does not also necessarily include dismantling, the facility will cease to be a nuclear facility and can be transferred into unlimited use.

The facilities will be removed in such a way that remains will be preserved (the columns to both entrance portals to the hall, etc.), which will mark the location.

5.2 Filling shafts and covers

5.3 Closure of disposal facilities

The closure of the disposal silo is planned for 2062.

6. Preparation of the repository for long-term monitoring

The operator identifies and monitors the effectiveness of the measures that bring the repository to a state appropriate for the repository to be transferred to long-term monitoring. This period is projected to last 3 years.

7. Long-term monitoring (after closure of the repository)

Long-term monitoring will last 300 years.

7.1 Active long-term monitoring and maintenance

Active long-term monitoring begins when all preparatory activities are performed for the transfer to monitoring and when the competent authority or the monitoring provider takes over the repository for long-term monitoring. In the period of active long-term monitoring the provider ensures in particular:

- performance of measurements and observations
- maintaining physical protection of the facility (fence)
- all repairs and maintenance of control, measuring and service elements of the repository

The length of the active long-term monitoring period will be determined on the basis of a safety analysis. For the purpose of the drafting of the SSA [28] and the additional safety analyses, it was assumed that the active long-term monitoring period would last for 100 years after the closure of the repository.

Based on the development and drafting of the repository documents, it was determined on the basis of the safety analyses that active monitoring would last 50 years.

7.2 Passive long-term monitoring

After the end of active long-term monitoring, the repository will pass into the phase of passive long-term monitoring. The above-ground facilities of the repository will be removed or assigned to unlimited use. It is assumed that the earth-filled plateau of the repository will continue to remain at the site in the phase of passive long-term monitoring. The plateau can also be removed.

Passive long-term monitoring of the repository is a form of monitoring that comprises principally:

- the storage of information on the repository
- maintenance of ownership of the repository land
- the presence of warning geodetic signage at the repository

The length of the active long-term monitoring period will be determined on the basis of a safety analysis. For the purpose of the drafting of the SSA [28] and the additional safety analyses, it was assumed that the passive long-term monitoring period would last for 200 years after the end of the active long-term monitoring period.

Based on the further drafting of the documents for the LILW repository, it was determined on the basis of the safety analyses that passive long-term monitoring would last 250 years after the end of the active monitoring period.

8. Unlimited use of the repository site

At the end of the passive long-term monitoring period, the repository site will pass into unrestricted use.

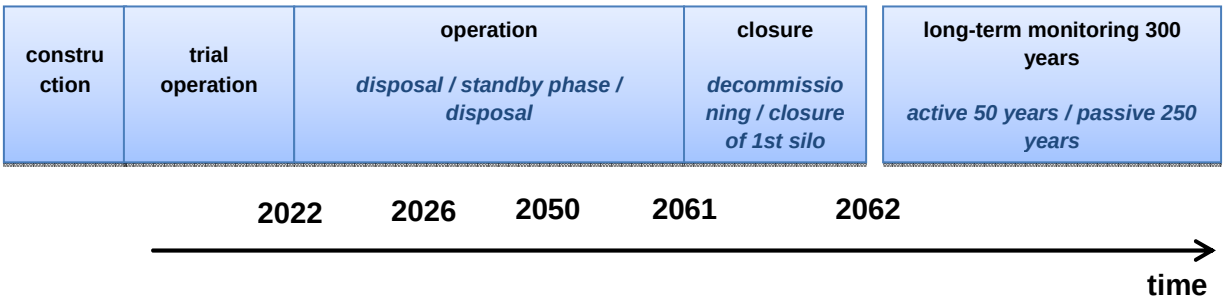

Figure 2-7: Main repository periods and planned timetable

Note: In the event of the construction of the 2nd silo, it is planned to be built during the repository's standby phase.

2.7 REFERENCE DOCUMENTS

Table 2-2: Primary supporting documents (reports and technical documentation) and documents cited in the Draft Safety Analysis Report (other documents are listed under the references section in the individual chapters):

TITLE (REPORTS, TECHNICAL DOCUMENTS)	DOCUMENT NUMBER	AUTHOR
Conceptual design (IDZ), Rev. C	NSRAO2-IDZ-001	IBE d.d., January 2016
Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste in Slovenia (Varnostna analiza in priprava meril za sprejemljivost odpadkov za odlagališče odpadkov nizke in srednje radioaktivnosti v Sloveniji)	document packet	EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO) 2012 – 2016
Environmental Impact Assessment	NSRAO2-PVO-001	ERICo d.o.o. and HSE Invest d.o.o.

Table 2-3: Reference documents used for the Draft Safety Analysis Report

TITLE OF REFERENCE DOCUMENT	DOCUMENT NUMBER	AUTHOR
Characteristics of the Area of the Repository Site	NSRAO2-POR-001	ARAO
Decommissioning Programme	NSRAO2-POR-003	ARAO
Training	NSRAO2-POR-004	ARAO
Document and Records Storage	NSRAO2-POR-006	ARAO
Actions in Case of Emergency	NSRAO2-POR-007	ARAO
Long-term Post-Closure Monitoring and Maintenance Plan	NSRAO2-POR-008	ARAO

RW Management Programme	NSRAO2-POR-009	IBE d.d.
Formats and Lists of Procedures and Instructions	NSRAO2-POR-010	ARAO
Reporting to Administrative Authorities	NSRAO2-POR-011	ARAO
RW Acceptance Criteria for the LILW Repository	NSRAO2-POR-014	ARAO
Design Basis	NSRAO2-POR-013	ARAO
Construction of the Repository	NSRAO2-POR-018	IBE d.d.
Trial Operation	NSRAO2-POR-019	IBE d.d.
Operation	NSRAO2-POR-020	IBE d.d.
Standby Phase	NSRAO2-POR-021	IBE d.d.
Closure of the Repository	NSRAO2-POR-022	IBE d.d.
Maintenance, Monitoring, Inspections and Testing	NSRAO2-POR-023	IBE d.d.
Monitoring of Changes	NSRAO2-POR-024	IBE d.d.
Monitoring of Operating Experiences and Operating Indicators	NSRAO2-POR-025	IBE d.d.
Monitoring of the Ageing Process	NSRAO2-POR-026	IBE d.d.
Operational Limits and Conditions	NSRAO2-POR-027	IBE d.d.
Operational Monitoring	NSRAO2-POR-028	IBE d.d.
Description of SSC	NSRAO2-POR-034	IBE d.d.
Repository Monitoring Programme	NSRAO2-POR-037	IBE d.d.

Other reference documents will be compiled subsequently for purposes of drafting the Safety Analysis Report.

2.8 APPENDIXES

2.8.1 GRAPHICAL APPENDIX 2-1

Technological schematic of the repository site (activities at the repository)

2.8.2 GRAPHICAL APPENDIX 2-2

Schematic of wastewater collection

2.8.3 GRAPHICAL APPENDIX 2-3

Schematic of collection of wastewater in the area of the disposal unit (silo)

2.9 REFERENCES

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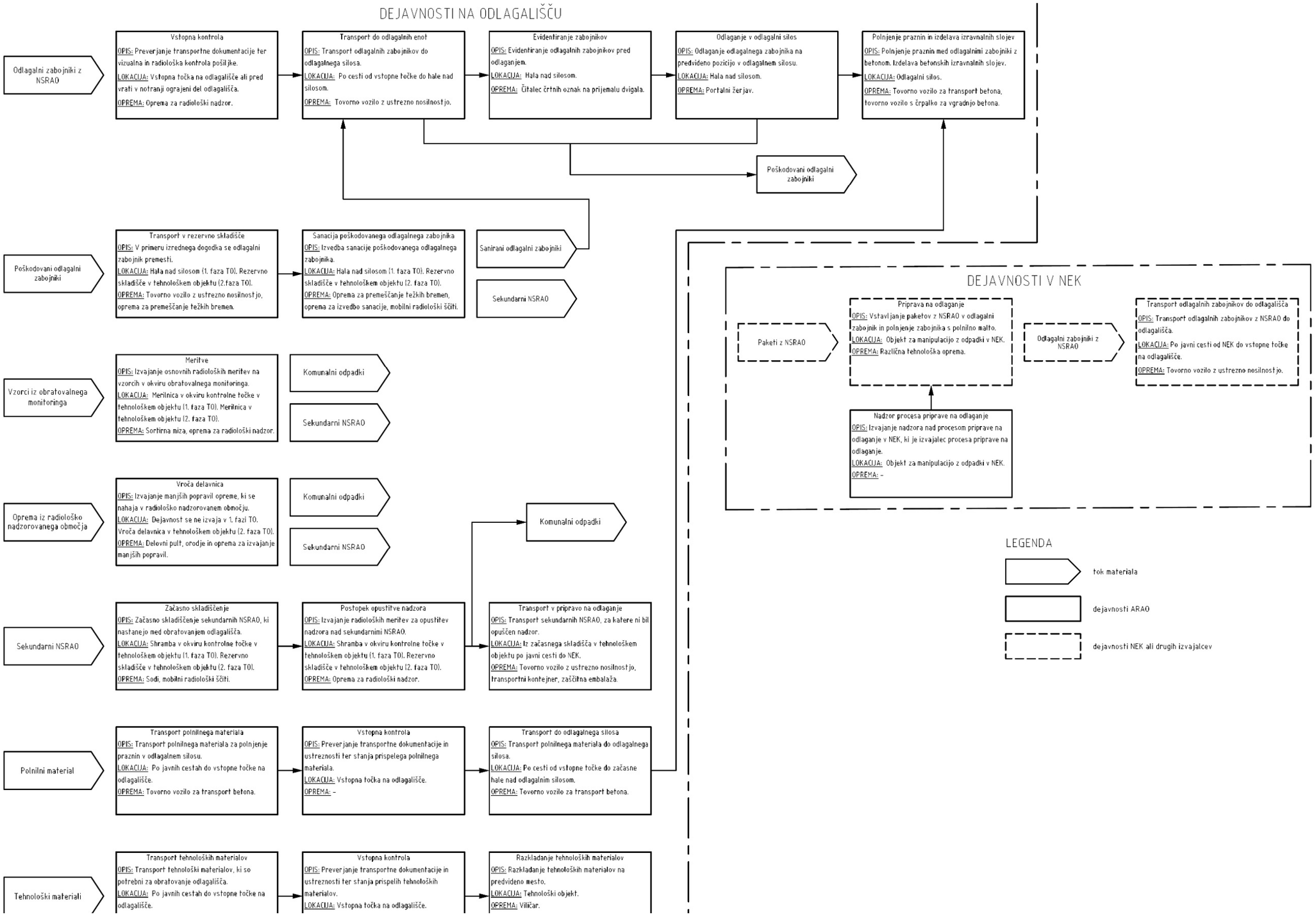
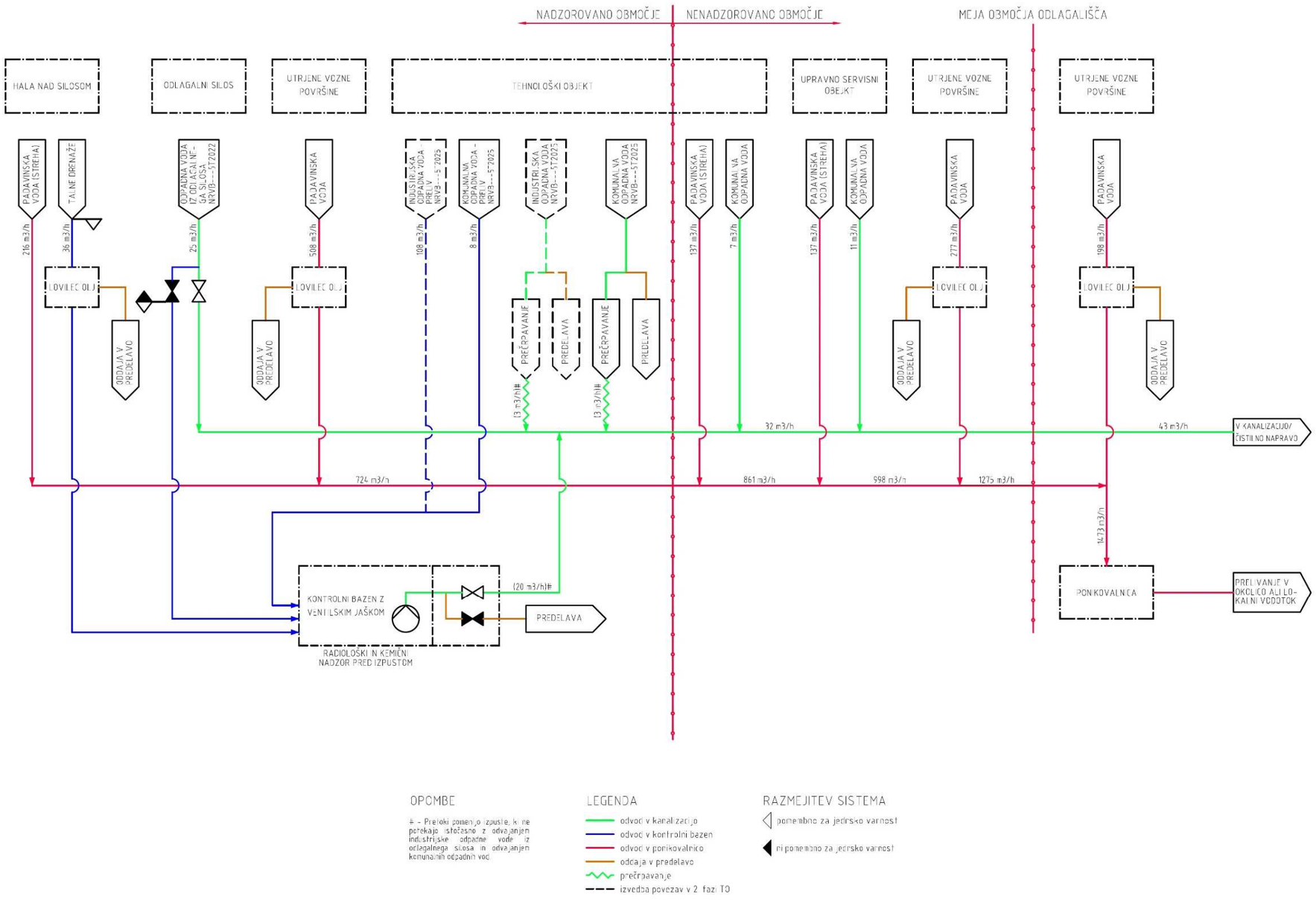


Graphical appendix 2-1: **Technological schematic of the repository site**

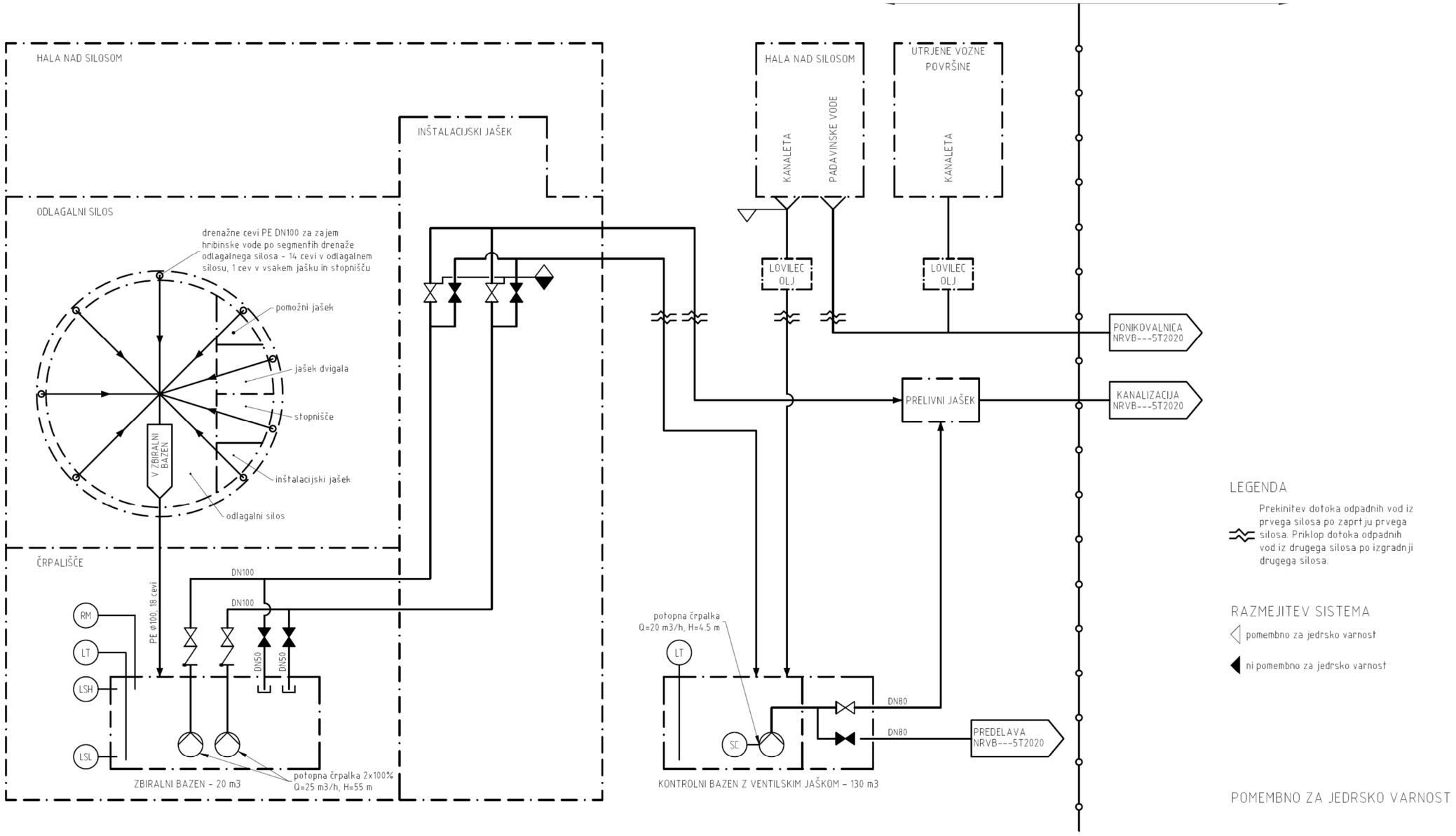
DEJAVNOSTI NA ODLAGALIŠČU	ACTIVITIES ON THE REPOSITORY SITE
Odlagalni zabojniki z NSRAO	Disposal containers filled with LILW
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije ter vizualna in radiološka kontrola pošiljke.	DESCRIPTION: Verification of transport documents, and visual and radiological control of the shipment.
LOKACIJA: Vstopna točka na odlagališče ali pred vrati v notranji ograjeni del odlagališča.	LOCATION/SITE: Entry point to the repository or in front of the doors to the internal fenced part of the repository
OPREMA: Oprema za radiološki nadzor.	EQUIPMENT: Equipment for radiological control (monitoring)
Transport do odlagalnih enot	Transportation to the disposal units
OPIS: Transport odlagalnih zabojnikov do odlagalnega silosa.	DESCRIPTION: Transportation of disposal containers to the disposal silo.
LOKACIJA: PO cesti od vstopne točke do hale nad silosom.	LOCATION/SITE: By road from the entry point to the hall above the silo
OPREMA: Tovorno vozilo z ustrezno nosilnostjo.	EQUIPMENT: Freight vehicle with the required load capacity
Evidentiranje zabojnikov	Keeping records of disposal containers
OPIS: Evidentiranje odlagalnih zabojnikov pred odlaganjem.	DESCRIPTION: Keeping records of disposal containers before disposal.
LOKACIJA: Hala nad silosom.	LOCATION/SITE: Hall above the silo
OPREMA: Čitalec črtnih oznak na prijemalu dvigala.	EQUIPMENT: Barcode reader on the lift gripper
Odlaganje v odlagalni silos	Disposal in the disposal silo
OPIS: Odlaganje odlagalnega zabojnika na predvideno pozicijo v odlagalnem silosu.	DESCRIPTION: Disposal of the disposal container to the envisaged position in the disposal silo.
LOKACIJA: Hala nad silosom.	LOCATION/SITE: Hall above the silo
OPREMA: Portalni žerjav.	EQUIPMENT: Portal crane
Polnjenje praznin in izdelava izravnalnih slojev	Filling the gaps between the containers and pouring the levelling layers
OPIS: Polnjenje praznin med odlagalnimi zabojniki z betonom. Izdelava betonskih izravnalnih slojev.	DESCRIPTION: Filling the gaps between the disposal containers with concrete. Making concrete levelling layers.
LOKACIJA: Odlagalni silos.	LOCATION/SITE: Disposal silo
OPREMA: Tovorno vozilo za transport betona, tovorno vozilo s črpalko za vgradnjo betona.	EQUIPMENT: Freight vehicle for the transportation of concrete, freight vehicle with a pump for the installation of concrete
Poškodovani odlagalni zabojniki	Damaged disposal containers
Transport v rezervno skladišče	Transportation to the reserve (backup) storage facility
OPIS: V primeru izrednega dogodka se odlagalni zabojnik premesti.	DESCRIPTION: In the event of extraordinary circumstances the disposal container is relocated.
LOKACIJA: Hala nad silosom (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Hall above the silo (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF)
OPREMA: Tovorno vozilo z ustrezno nosilnostjo, oprema za premeščanje težkih bremen.	EQUIPMENT: Freight vehicle with the required load capacity, equipment for the relocation of heavy loads
Sanacija poškodovanega zabojnika	Repair of the damaged container
OPIS: Izvedba sanacije poškodovanega odlagalnega zabojnika.	DESCRIPTION: Repair of the damaged disposal container.
LOKACIJA: Hala nad silosom (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Hall above the silo (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF)
OPREMA: Oprema za premeščanje težkih bremen, oprema za izvedbo sanacije, mobilni radiološki ščiti.	EQUIPMENT: Equipment for the relocation of heavy loads, repair equipment, mobile radiological shields
Sanirani odlagalni zabojniki	Repaired disposal containers
Sekundarni NSRAO	Secondary LILW
Vzorci iz obratovalnega monitoringa	Samples from operational monitoring
Meritve	Measurements
Opis: Izvajanje osnovnih radioloških meritev na vzorcih v okviru obratovalnega monitoringa.	Description: Performance of basic radiological measurements in samples within the scope of operational monitoring.
LOKACIJA: Merilnica v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Merilnica v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Measurement room within the scope of the control point in the technological facility (1st phase of the technological facility - TF) Measurement room in the technological facility (2nd phase of the TF)
OPREMA: Sortirna miza, oprema za radiološki nadzor	EQUIPMENT: Sorting table, equipment for radiological control
Komunalni odpadki	Municipal waste
Oprema iz radiološko nadzorovanega območja	Equipment from the radiologically controlled area
Vroča delavnica	Hot workshop
OPIS: Izvajanje manjših popravil opreme, ki se nahaja v radiološko nadzorovanem območju	DESCRIPTION: Minor repairs to equipment located in the radiologically controlled area.
LOKACIJA: Dejavnost se ne izvaja v 1. fazi TO. Vroča delavnica v tehnološkem objektu (2. faza TO)	LOCATION/SITE: The activity/service is not carried out in the 1st phase of the TF. Hot workshop in the technological facility (2nd phase of the TF)
OPREMA: Delovni pult, orodje in oprema za izvajanje manjših popravil.	EQUIPMENT: Workbench, tools and equipment for performing minor repairs
Sekundarni NSRAO	Secondary LILW
Začasno skladiščenje	Temporary storage
OPIS: Začasno skladiščenje sekundarnih NSRAO, ki nastanejo med obratovanjem odlagališča.	DESCRIPTION: Temporary storage of secondary LILW which are generated during the operation of the repository.
LOKACIJA: Shramba v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Storage within the scope of the control point in the technological facility (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF).
OPREMA: Sodi, mobilni radiološki ščiti.	EQUIPMENT: Barrels, mobile radiological shields

Postopek opustitve nadzora	Control omission process
OPIS: Izvajanje radioloških meritev za opustitev nadzora nad sekundarnimi NSRAO.	DESCRIPTION: Radiological measurements for the omission of control of secondary LILW.
LOKACIJA: Shramba v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Storage within the scope of the control point in the technological facility (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF).
OPREMA: Oprema za radiološki nadzor.	EQUIPMENT: Equipment for radiological control (monitoring)
Transport v pripravo na odlaganje	Transportation to preparation for disposal
OPIS: Transport sekundarnih NSRAO, za katere ni bil opuščen nadzor.	DESCRIPTION: Transportation of secondary LILW for which control was not omitted.
LOKACIJA: Iz začasnega skladišča v tehnološkem objektu po javni cesti do NEK.	LOCATION/SITE: From a temporary storage facility in the technological facility by public road to Krško NPP
OPREMA: Tovorno vozilo z ustrezno nosilnostjo, transportni kontejner, zaščitna embalaža.	EQUIPMENT: Freight vehicle with the required load capacity, transport container, protective packaging
Polnilni material	Backfill material
Transport polnilnega materiala	Transportation of backfill material
OPIS: Transport polnilnega materiala za polnjenje praznin v odlagalnem silosu.	DESCRIPTION: Transportation of backfill material for filling voids in the disposal silo.
LOKACIJA: Po javnih cestah do vstopne točke na odlagališče.	LOCATION/SITE: By public road to the entry point to the repository
OPREMA: Tovorno vozilo za transport betona.	EQUIPMENT: Freight vehicle for the transportation of concrete
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije in ustreznosti ter stanja prispelega materiala.	DESCRIPTION: Verification of transport documentation, fitness for continuation and state/condition of the arrived material.
LOKACIJA: Vstopna točka na odlagališče.	LOCATION/SITE: Access point to the repository
OPREMA: -	EQUIPMENT: -
Transport do odlagalnega silosa	Transportation to the disposal silo
OPIS: Transport polnilnega materiala do odlagalnega silosa.	DESCRIPTION: Transportation of the backfill material to the disposal silo.
LOKACIJA: Po cesti od vstopne točke do začasne hale nad odlagalnim silosom.	LOCATION/SITE: By road from the entry point to the temporary hall above the disposal silo.
OPREMA: Tovorno vozilo za transport betona.	EQUIPMENT: Freight vehicle for the transportation of concrete
Tehnološki materiali	Technological materials
Transport tehnoloških materialov	Transportation of technological materials
OPIS: Transport tehnoloških materialov, ki so potrebni za obratovanje odlagališča.	DESCRIPTION: Transportation of technological materials required for the operation of the repository.
LOKACIJA: Po javnih cestah do vstopne točke na odlagališče.	LOCATION/SITE: By public road to the entry point to the repository
OPREMA: Osebna ali tovorna dostavna vozila.	EQUIPMENT: Passenger (cars) or freight vehicles
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije in ustreznosti ter stanja prispelih tehnoloških materialov.	DESCRIPTION: Verification of transport documentation, fitness for continuation and state/condition of the arrived technological materials.
LOKACIJA: Vstopna točka na odlagališče.	LOCATION/SITE: Access point to the repository
OPREMA: -	EQUIPMENT: -
Razkladanje tehnoloških materialov	Unloading of technological materials
OPIS: Razkladanje tehnoloških materialov na predvideno mesto.	DESCRIPTION: Unloading of technological materials to the planned location.
LOKACIJA: Tehnološki objekt.	LOCATION/SITE: Technological facility
OPREMA: Viličar.	EQUIPMENT: Forklift
DEJAVNOSTI V NEK	ACTIVITIES AT Krško NPP
Paketi z NSRAO	LILW packages
Priprava na odlaganje	Preparation for disposal
OPIS: Vstavljanje paketov z NSRAO v odlagalni zabojnik in polnjenje zabojnika s polnilno malto.	DESCRIPTION: Insertion of LILW packages into the disposal container and the filling of the container with backfill mortar.
LOKACIJA: Objekt za manipulacijo z odpadki v NEK.	LOCATION/SITE: Facility for the handling of waste at Krško NPP
OPREMA: Različna tehnološka oprema.	EQUIPMENT: Various technological equipment.
Odlagalni zabojniki z NSRAO	Disposal containers filled with LILW
Transport odlagalnih zabojnikov do odlagališča	Transportation of disposal containers to the repository
OPIS: Transport odlagalnih zabojnikov z NSRAO do odlagališča.	DESCRIPTION: Transportation of the disposal containers filled with LILW to the repository.
LOKACIJA: Po javni cesti od NEK do vstopne točke na odlagališče.	LOCATION/SITE: By public road from Krško NPP to the entry point to the repository.
OPREMA: Tovorno vozilo z ustrezno nosilnostjo.	EQUIPMENT: Freight vehicle with the required load capacity
Nadzor procesa priprave na odlaganje	Control of the process of preparing for disposal
OPIS: Izvajanje nadzora nad procesom priprave na odlaganje v NEK, ki je izvajalec procesa priprave na odlaganje.	DESCRIPTION: Control of the process of preparing for disposal at NPP, which is the provider responsible for preparation for disposal.
LEGENDA	KEY
tok materiala	flow of material
dejavnosti ARAO	ARAO activities
dejavnosti NEK ali drugih izvajalcev	activities of Krško NPP or other providers



Graphical appendix 2-2: **Schematic of wastewater collection**

NADZOROVANO OBMOČJE	CONTROLLED AREA
NENADZOROVANO OBMOČJE	NON-CONTROLLED AREA
MEJA OBMOČJA ODLAGALIŠČA	BOUNDARY OF REPOSITORY SITE
HALA NAD SILOSOM	HALL ABOVE THE SILO
ODLAGALNI SILOS	DISPOSAL SILO
UTRJENE VOZNE POVRŠINE	SOLID DRIVING SURFACES
TEHNOLOŠKI OBJEKT	TECHNOLOGICAL FACILITY
UPRAVNO-SERVISNI OBJEKT	ADMINISTRATION AND SERVICE BUILDING
PADAVINSKA VODA (STREHA)	PRECIPITATION WATER (ROOF)
TALNE DRENAŽE	FLOOR DRAINAGE
ODPADNA VODA IZ ODLAGALNEGA SILOSA	WASTEWATER FROM THE DISPOSAL SILO
PADAVINSKA VODA	PRECIPITATION WATER
INDUSTRIJSKA ODPADNA VODA	INDUSTRIAL WASTEWATER
KOMUNALNA ODPADNA VODA	MUNICIPAL WASTEWATER
LOVILEC OLJ	OIL TRAP (SEPARATOR)
ODDAJA V PREDELAVO	SUBMISSION FOR PROCESSING
PREČRPAVANJE	RE-PUMPING
PREDELAVA	PROCESSING
V KANALIZACIJO/ČISTILNO NAPRAVO	INTO THE SEWERAGE SYSTEM/TREATMENT PLANT
KONTROLNI BAZEN Z VENTILSKIM JAŠKOM	CONTROL POOL WITH A VENTILATION SHAFT
RADIOLOŠKI IN KEMIČNI NADZOR PRED IZPUSTOM	RADIOLOGICAL AND CHEMICAL MONITORING BEFORE DISCHARGE
PONIKOVALNICA	SINK HOLE
PRELIVANJE V OKOLICO ALI LOKALNI VODOTOK	DISCHARGE INTO THE SURROUNDING AREA OR LOCAL WATERCOURSE
OPOMBE	NOTES
# - Pretoki pomenijo izpuste, ki ne potekajo istočasno z odvajanjem industrijske odpadne vode iz odlagalnega silosa in odvajanjem komunalnih odpadnih vod.	# - Flows mean discharges that do not take place simultaneously with the discharge of industrial wastewater from the disposal silo and the discharge of municipal wastewater.
LEGENDA	KEY
odvod v kanalizacijo	drainage into the sewerage system
odvod v kontrolni bazen	drainage into the control pool
odvod v ponikovalnico	drainage into the sink hole
oddaja v predelavo	submission for processing
prečrpavanje	re-pumping
izvedba povezav v 2. fazi TO	construction of links in Phase II of the TF
RAZMEJITEV SISTEMA	SYSTEM SEPARATION
pomembno za jedrsko varnost	related to nuclear safety
ni pomembno za jedrsko varnost	not related to nuclear safety



Graphical appendix 2-3: **Schematic of collection of wastewater in the area of the disposal unit (silo)**

HALA NAD SILOSOM	HALL ABOVE THE SILO
INŠTALACIJSKI JAŠEK	INSTALLATION SHAFT
KANALETA	DRAIN
PADAVINSKE VODE	PRECIPITATION WATER
UTRJENE VOZNE POVRŠINE	SOLID DRIVING SURFACES
ODLAGALNI SILOS	DISPOSAL SILO
drenažne cevi PE DN100 za zajem hribinske vode po segmentih drenaže odlagalnega silosa – 14 cevi v odlagalnem silosu, 1 cev v vsakem jašku in stopnišču	drainage pipes PE DN100 for the collection of underground water by segment for disposal silo drainage – 14 pipes in the disposal silo, one pipe in each floor drain sump and staircase
pomožni jašek	auxiliary shaft
jašek dvigala	lift shaft
stopnišče	staircase
inštalacijski jašek	installation shaft
odlagalni silos	disposal silo
V ZBIRALNI BAZEN	INTO COLLECTION TANK
LOVILEC OLJ	OIL TRAP (SEPARATOR)
PONIKOVALNICA	SINK HOLE
PRELIVNI JAŠEK	OVERFLOW SHAFT
KANALIZACIJA	SEWERAGE SYSTEM
ČRPALIŠČE	PUMPING STATION
ZBIRALNI BAZEN – 20 m^3	COLLECTION TANK - 20 m^3
potopna črpalka 2x 100% Q= 25 m^3/h, H = 55 m	submersible pump 2 x 100% Q= 25 m^3/h, H = 55 m
potopna črpalka Q= 20 m^3/h, H = 4,5 m	submersible pump Q= 20 m^3/h, H = 4.5 m
PREDELAVA	PROCESSING
KONTROLNI BAZEN Z VENTILSKIM JAŠKOM – 130 m^3	CONTROL POOL WITH A VENTILATION SHAFT - 130 m^3
LEGENDA	KEY
Prekinitev dotoka odpadnih vod iz prvega silosa po zaprtju prvega silosa. Priklop dotoka odpadnih vod iz drugega silosa po izgradnji drugega silosa.	Disconnection of the inflow of wastewater from the first silo after the closure of the first silo. Connection of the inflow of wastewater from the second silo after the construction of the second silo.
RAZMEJITEV SISTEMA	SYSTEM SEPARATION
pomembno za jedrsko varnost	related to nuclear safety
ni pomembno za jedrsko varnost	not related to nuclear safety