REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

Seventh Slovenian Report under the

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

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All Slovenian Reports under the Joint Convention and other information can be found on the website of the Slovenian Nuclear Safety Administration at www.ursjv.gov.si.

PREFACE

The National Report on fulfilment of the obligations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management has been prepared in fulfilment of Slovenia's obligations as a Contracting Party to this Convention.

This report was prepared by the Slovenian Nuclear Safety Administration. Contributions to the report were made by the company NEK d.o.o., the Jožef Stefan Institute, the Agency for Radwaste Management, the public company Žirovski Vrh Mine d.o.o., the Ministry of Infrastructure, the Institute of Oncology Ljubljana – Department of Nuclear Medicine, the Ljubljana University Medical Centre – Department of Nuclear Medicine, and the Slovenian Radiation Protection Administration. It constitutes an updated document with basically the same structure as previous national reports under the Joint Convention. The issues raised at the sixth review meeting and future plans are addressed in Section K of the report.

The report was approved by the Expert Council for Radiation and Nuclear Safety and adopted by the Government of the Republic of Slovenia.

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LIST OF ABBREVIATIONS

ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
ALARA	As Low As Reasonably Achievable
ARAO	Agency for Radwaste Management
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CRDM	Control Rod Driving Mechanisms
CSF	Central Storage for Radioactive Waste
DSRS	Disused Sealed Radioactive Sources
DRPI	Digital Rod Position Indication
EU	European Union
EPRI	Electric Power Research Institute
ERDO-WG	European Repository Development Organisation – Working Group
FA	Fuel Assemblies
HLW	High Level Waste
HERCA	Heads of Radiation Protection Authorities
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IGD-TP	Implementing Geological Disposal of Radioactive Waste Technology Platform
JSI	Jožef Stefan Institute
INPO	Institute for Nuclear Power Operation
LILW	Low and Intermediate Level Waste
MKSID	On-Line Communication System in the Event of a Nuclear or Radiological Emergency
NPP	Nuclear Power Plant
OECD/NEA	Organisation for Economic Co-operation and Development/ Nuclear Energy Agency
OSART	Operational Safety Review Team
PHARE	Central and Eastern European Countries Assistance for Economic Restructuring
PWR	Pressurised Water Reactor
RS	Republic of Slovenia
RW	Radioactive Waste
RTD	Resistance Temperature Detector
SF	Spent Fuel
SFDS	Spent Fuel Dry Storage
SFRY	Socialist Federal Republic of Yugoslavia
SNSA	Slovenian Nuclear Safety Administration
SRPA	Slovenian Radiation Protection Administration
SSC	Systems, Structures and Components
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TLD	Thermoluminiscent Dosimeter
TRIGA	Training Research Isotope General Atomic
TTC	Tube-Type Container
USA	United States of America
US NRC	United States Nuclear Regulatory Commission
WAC	Waste Acceptance Criteria
WANO	World Association of Nuclear Operators

EXECUTIVE SUMMARY

The Slovenian Nuclear Programme

The Republic of Slovenia has a small nuclear programme (Figure 1): one operating nuclear power plant, one research reactor and one central storage facility for institutional radioactive waste. In addition, there is also a closed and remediated uranium mine at Žirovski Vrh with two remediated disposal sites for mining and milling waste at the site. The geographical locations of the nuclear and radiation facilities are given in the figure below. The Republic of Slovenia has no facility for the final disposal of radioactive waste or spent nuclear fuel.

Figure 1: **The nuclear programme in the Republic of Slovenia**

The Krško Nuclear Power Plant (Krško NPP) is one of the main pillars of the Slovenian power system. It is situated on the left bank of the River Sava in the south-eastern part of Slovenia. It is a Westinghouse two-loop pressurised light water reactor with nominal output power of 727/696 MWe (gross electrical power/net electrical power). It is designed to operate until the end of 2023. In 2012 the Slovenian Nuclear Safety Administration issued a decision approving modifications that will enable the long-term operation of the Krško NPP. It is planned that the operation of the NPP will be extended from 2023 until 2043, pending the successful conclusion of periodic safety reviews in 2023 and 2033. The plant is owned by state-owned Slovenian and Croatian electrical power companies (GEN energija, d.o.o. and Hrvatska Elektroprivreda d.d., respectively).

The plant is operated by the company Krško NPP d.o.o. The Krško NPP is the major producer of radioactive waste in the Republic of Slovenia. All operational radioactive waste and spent nuclear fuel are stored within the area of the plant. Spent nuclear fuel is currently stored under water in the spent fuel pool. In order to improve the safety of spent fuel storage as one of actions following the Fukushima accident, it was decided to construct a dry storage facility for spent fuel with a design lifetime of 100 years. According to current plans, it should be operational at the end of the year 2022.

Solid radioactive waste is treated and then packed into steel drums, which are then stored in the solid radwaste storage facility.

In 2018, the construction of the new Waste Manipulation Building was completed. With the construction of the new Waste Manipulation Building, the plant provided new premises for the storage of drums in the process of the manipulation and preparation for transport, collection, and sorting of radioactive waste.

The Jožef Stefan Institute Reactor Infrastructure Centre (JSI Reactor Infrastructure Centre) is a part of the Jožef Stefan Institute (JSI). It is located in Brinje, about 10 km northeast of Ljubljana. The main purpose of the Centre is to operate the TRIGA Mark II research reactor for the needs of the JSI and other research groups. The TRIGA Mark II research reactor is a General Atomics open-pool type research reactor with a thermal power of 250 kW. It was initially licensed in 1966 and was re-licensed for steady state and pulse operation after renovation and reconstruction in 1991. The facility is used in research projects and for education. The fuel elements are kept in the reactor building of the JSI Reactor Infrastructure Centre. In addition to spent fuel, the reactor produces a small amount of low- and intermediate-level waste (LILW). One part of the JSI Reactor Infrastructure Centre is a hot cell laboratory, which is, *inter alia*, also licensed for the treatment of institutional radioactive waste.

The research reactor is operated by the JSI, a public research institution that is financed from the national budget by the Ministry of Education, Science and Sport. In 2015 the operator of the TRIGA Mark II research reactor decided to extend the operation of the reactor until at least the conclusion of the next periodic safety review in 2024.

The Žirovski Vrh Uranium Mine was in operation in the period from 1984 to 1990. Its lifetime production was 610,000 tons of ore, from which 452.5 tons of U_3O_8 were produced. The Žirovski Vrh Uranium Mine ended operations in 1990. The decision to close it was influenced by economic reasons, since its uranium production was no longer economically competitive. In 1992, the Republic of Slovenia, as the owner of the Žirovski Vrh Uranium Mine, established a company named Žirovski Vrh Mine d.o.o. to carry out the permanent closure of the mine (Permanent Cessation of Exploitation of the Uranium Ore and Prevention of the Consequences of the Mining in the Uranium Mine at Žirovski Vrh Act). The financial resources for decommissioning and environmental remediation were provided from the national budget.

All entrances to the underground mine are now closed. The uranium ore mill has been decommissioned and the resulting waste has been disposed of at the Jazbec mining waste disposal site. All mining waste from numerous other mining waste piles has been moved to this site and disposed of. The total amount of disposed material at this site is 1,910,425 tons, with a total activity of 21.7 TBq. At the Boršt hydro-metallurgical tailings disposal site, 610,000 tons of hydro-metallurgical waste, 111,000 tons of mine waste, and 9,450 tons of material collected during the decontamination of the hydro-metallurgical tailings in the Boršt site vicinity have been disposed of, with a total activity of 48.8 TBq. Closure works at the Jazbec disposal site have been completed and the Agency for Radwaste Management (ARAO) started the long-term surveillance and maintenance of the site in 2015. The closure of the Boršt disposal site has been delayed due to the activation of a landslide and the required additional remediation works.

Two studies were carried out in 2015 and 2016. In the first study, the distribution of tailings in the case of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. On the basis of the study, the Ministry of the Environment and Spatial Planning ordered an additional study on the radiation exposure of residents and the workers who would carry out the remediation of the deposited material on the riverbeds of the Todraščica, Brebovščica and Poljanska Sora Rivers. In 2016 and 2017, additional intervention measures for reducing the speed of landslide movements were carried out. In 2018, the Expert Project Council for monitoring the remediation work on the hydro-metallurgical tailings prepared a final report. The effects of the maintenance, monitoring and intervention measures to reduce the groundwater impact on the stability of the Boršt hydro-metallurgical tailings disposal site performed between 2010 and 2018 were assessed, as well as the current state of the Boršt disposal site. In 2019, the monitoring network of the Boršt hydro-metallurgical tailings disposal site was renovated and upgraded with nine additional deep piezometers. The safety report for the Boršt hydro-metallurgical tailings disposal site is under revision. This document is the basic document for the closure of the disposal facility and the transition to long-term surveillance and maintenance, which will be carried out by the ARAO as part of a mandatory service of general economic interest.

The Central Storage Facility for Radioactive Waste (CSF) in Brinje is intended for the storage of low- and intermediate-level radioactive waste arising from medical, industrial and research applications. The construction of the facility started in 1984 and it was put into operation in 1986. In 1999, the responsibility for managing and operating the storage facility was transferred from the JSI to the ARAO. Following refurbishment and two and a half years of trial operation, a new operating licence was issued in early 2008; in 2018 the first periodic safety review was finished and the new operating licence is valid until 2028.

The Agency for Radwaste Management is a public utility for the implementation of radioactive waste management as a mandatory service of general economic interest. It also provides technical support regarding radioactive waste management to its stakeholders. It was established by the Slovenian Government and is responsible for radioactive waste management, including the management of institutional radioactive waste, long-term surveillance and maintenance of disposal sites for uranium mining and milling waste, and the disposal of radioactive waste from the Krško NPP. It is financed from the national budget and fees paid by waste producers, whereby the liabilities for further waste management are transferred from them to the State.

Activities regarding the siting and construction of an LILW repository are financed from the Fund for Financing the Decommissioning of the Krško NPP and Disposal of Radioactive Waste from the Krško NPP.

Governmental Policy

The governmental policy in the area of the safety of spent fuel management and the safety of radioactive waste management is governed by national nuclear legislation and international agreements. Based on such legislation, a number of measures have been implemented to protect the environment and the public from the harmful impacts of radioactive waste and spent fuel. The most important measures are:

- The establishment and functioning of the regulatory body, the Slovenian Nuclear Safety Administration (SNSA), which is the competent authority in the area of nuclear and radiation safety and radioactive waste management, which was established in 1987. Previously, the functions of the regulatory body were performed by the Committee for Energy and Industry.
- The establishment of the ARAO as a public utility for radioactive waste management by the Slovenian Government (1991).
- The establishment of Žirovski Vrh Mine d.o.o., a public enterprise for the decommissioning of the uranium production site (1992).
- The establishment of the Fund for Financing the Decommissioning of the Krško NPP and Disposal of Radioactive Waste from the Krško NPP (1995).

In addition, the Government has prepared several documents pertinent to policy in the area of radioactive waste management. The most important are as follows.

The Resolution on the National Energy Programme adopted by the Slovenian National Assembly in 2004. In this document the following policy was adopted:

- The share of nuclear energy shall be maintained at the current level.
- The Krško NPP shall operate until at least 2023.
- Adequate measures shall be implemented in order to ensure the safe and reliable operation of the Krško NPP.
- A decision on extending the operating life of the Krško NPP shall be adopted in 2011 on the basis of an evaluation of the programme, which shall start in 2008.

On 27 February 2020, the Government of the Republic of Slovenia adopted the **Comprehensive National Energy and Climate Plan of the Republic of Slovenia (NEPN)**, in accordance with EU Regulation 2018/1999 on the Governance of the Energy Union and Climate Action, which, among other things, envisages "continuing the use of nuclear energy and maintaining excellence in the operation of nuclear facilities in Slovenia".

The Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on Regulation of the Status and Other Legal Relations Regarding the Investment, Exploitation and Decommissioning of the Krško NPP (hereinafter: the Agreement). The following policy is adopted in the Agreement:

- The decommissioning of the Krško Nuclear Power Plant and the management of its radioactive waste and spent fuel are the joint responsibility of the contracting parties, and they should ensure efficient common solutions from both economic and environmental protection points of view.
- If the contracting parties do not reach an agreement on a common solution to radioactive waste and spent fuel management during the regular lifetime of the Krško NPP, they undertake that within two years of that time they must complete the removal of the operational radioactive waste and spent fuel from the location of the Krško NPP (one half by each party) and that they will individually bear the costs of the management thereof (including the subsequent division and removal of radioactive waste from decommissioning).
- The contracting parties shall, in equal shares, ensure funds for the preparation of the decommissioning programme and its execution and funds for the preparation of the programme for the disposal of radioactive waste and spent fuel. If the contracting parties agree on a joint solution to the disposal of

radioactive waste and spent fuel, they shall finance it in equal shares or shall finance their shares of the activities.

- The Republic of Slovenia and the Republic of Croatia shall jointly prepare and approve a new plan for the decommissioning of the Krško NPP and the disposal of LILW and high-level waste (hereinafter: the Decommissioning Plan).
- The Republic of Slovenia and the Republic of Croatia shall establish funds for the management and collection of financial resources for decommissioning and radioactive waste disposal costs.

In July 2015, the Intergovernmental Commission confirmed the decision of the NPP owners to extend the operation of the plant until 2043, in line with international practice and recommendations and with the goal of ensuring sustainable nuclear safety. The Intergovernmental Commission also approved the construction of a dry spent fuel storage within the Krško NPP site. The dry spent fuel storage will be financed by the owners. The construction costs are included in the Krško NPP operating costs.

At the same session, the Republic of Slovenia presented the project of the Vrbina LILW repository and invited the Republic of Croatia to study its interest in joining the project.

In 2016, a new revision of the Krško NPP Decommissioning Programme of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme started. The Coordination Committee was established in 2017 to monitor the preparation of new revisions of both programmes. In addition to monitoring the preparation of new revisions of both programmes, the Coordination Committee also searched for possibilities for the joint disposal of Slovenian and Croatian radioactive waste from the Krško NPP. The Interstate Commission concluded in September 2019 that a joint solution to the disposal of low- and intermediate-level radioactive waste (hereinafter: LILW) was not possible, which means that each country must take care of its share of LILW radioactive waste. Regarding the disposal of HLW and SF after the cessation of the operation of the Krško NPP a joint solution is foreseen between the two states.

In 2019, the third Revision of the Krško NPP Decommissioning Programme and the third revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme were completed, and in 2020 they were approved by the Intergovernmental Commission. In these documents annuities for each country are calculated and presented with respect to the internal rate of return.

By a decision of the Slovenian Government, the Slovenian electrical power company GEN energija, d.o.o. should continue to contribute into the Slovenian fund for financing one half of the decommissioning and spent fuel and radioactive waste disposal, with payments increased from the previous rate of 0.30 euro cents per kWhe to 0.48 euro cents per kWhe starting 1 August 2020 until the next revisions of the Programmes are approved.

The Resolution on the National Programme for Radioactive Waste and Spent Fuel Management for the 2016-2025 period (ReNPRRO16–25) was adopted by the Slovenian National Assembly in April 2016. This Resolution replaces the Resolution on the National Programme on Radioactive Waste and Spent Nuclear Fuel Management for the Period 2006–2015. It contains the radioactive waste and spent fuel management policy, as well as strategies (concrete measures) for achieving the policies/objectives. According to the Programme, the Krško NPP, the major radioactive waste generator, shall continue to operate until 2043, pending the successful conclusion of periodic safety reviews in 2023 and 2033.

The spent fuel will be transferred to dry storage for a period of approximately 60 years, when the spent fuel repository should be operational. The option of regional or multinational disposal has been kept open. The LILW waste repository shall be built in Slovenia. The selected type of repository envisages the disposal of radioactive waste in a near-surface silo. The National Programme envisages two scenarios: the baseline scenario allowing for the disposal of half of the waste, and the extended scenario, which, in accordance with the Agreement on the Krško NPP, provides for the disposal of all LILW waste from the Krško NPP. The spent fuel from the Triga Mark II research reactor will be managed (disposed) together with the spent fuel generated by the Krško NPP. The institutional waste stored at the Central Storage Facility for Radioactive Waste in Brinje that meets the waste acceptance criteria (WAC) shall be disposed of in the LILW repository. Radioactive waste containing naturally occurring radionuclides is to be managed in accordance with the established level of radioactivity and other waste properties.

Based on the adopted third revision of the Krško NPP Decommissioning Programme and the third revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme, ReNPRRO16–25 will be supplemented.

The Resolution on Nuclear and Radiation Safety in the Republic of Slovenia (for the period 2013–2023) was adopted by the National Assembly in June 2013. The Resolution is a programmatic, high-level national policy document that contains a descriptive part divided into chapters; for each chapter, the objectives which must be delivered during the period of validity of the Resolution are set. The Resolution therefore comprises the national policy, strategy and plan. The focus of the chapters is as follows:

- fundamental safety principles;
- a description of nuclear and radiological activities in Slovenia;
- a description of international cooperation in the field of nuclear and radiation safety;
- a description of the existing legislation (including binding international legal instruments, e.g. conventions);
- a description of the institutional framework;
- the competences of professional support (research, education and training).

Siting and design of the LILW repository

The Vrbina site (Municipality of Krško) was proposed at the beginning of 2007. Within the process of preparing the Spatial Plan of National Importance for the Vrbina site, the SNSA issued guidelines determining the content and scope of the special safety analysis of the LILW repository. Considerable effort and attention were devoted to communication with the stakeholders, including the local communities and non-governmental organisations.

The municipal council of Krško gave its consent to the proposal of the national spatial plan in July 2009. With the adoption of the Decree on a Detailed Plan of National Importance for an LILW repository in Vrbina in the Municipality of Krško, at the end of 2009 the procedure for the siting of the repository was completed. Further procedures were delayed due to various administrative reasons. The investment programme for the project, which is a prerequisite for most of the other steps, was signed by the Minister of Infrastructure and Spatial Planning in the summer of 2014. Since 2014, activities related to the LILW repository project have made significant progress.

In 2019, the cross-border impact assessment was begun, and it is planned to be finished in 2020. In parallel, the public hearing process in Slovenia is on-going. The new revision of the safety case (safety report) is under preparation. The current target is that the repository could start receiving waste in 2024.

The following websites are available for additional information:

- Slovenian Nuclear Safety Administration: http://www.ursjv.gov.si/
- Slovenian Radiation Protection Administration: http://www.uvps.gov.si/
- Ministry of Infrastructure: http://www.mzi.gov.si/
- Krško NPP: http://www.nek.si/
- Jožef Stefan Institute Reactor Infrastructure Centre: http://www.rcp.ijs.si/
- Jožef Stefan Institute: http://www.ijs.si/
- Agency for Radwaste Management: http://www.arao.si/
- GEN energija, d.o.o.: https://www.gen-energija.si/
- Žirovski Vrh Mine d.o.o.: http://www.rudnik-zv.si/
- Fund for Financing the Decommissioning of the Krško Nuclear Power Plant and for the Disposal of Radioactive Waste from the Krško Nuclear Power Plant: http://www.sklad-nek.si/

An overview matrix is presented in Table 1.

Table 1: **Overview matrix**

Type	Long-term Management Policy	Funding	Current Practice/Facilities	Planned Facilities
Spent Fuel	Geological disposal, as a reference scenario, multinational option kept open	Decommissioning Fund (levy on kWhe)	On-site wet storage at the NPP	Dry storage, then geological disposal or disposal in multinational repository
Nuclear Fuel Cycle Waste	LILW repository HLW together with SF	Decommissioning Fund (levy on kWhe)	On-site storage	LILW repository HLW in geological repository
Application Waste	Central Storage for Radioactive Waste, then transfer to the LILW repository	Users and the State	Central Storage for Radioactive Waste	LILW repository
Decommissioning Liabilities	National programme for RW and SF management Bilateral agreement with Croatia	Decommissioning Fund (levy on kWhe)	Periodic review of the Decommissioning Plan	LILW repository HLW & SF repository in 2065 at the earliest
Disused Radioactive Sealed Sources (DSRS)	Central Storage for Radioactive Waste, then transfer to the LILW repository (DSRS category 3-5)	Users and the State	Central Storage for Radioactive Waste (DSRS category 3-5), removal from the country (repatriation) (DSRS category 1&2)	LILW repository (DSRS category 3-5) or together with high-level waste (DSRS category 1&2)

SECTION A: INTRODUCTION

On 29 September 1997, the Republic of Slovenia signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter: the Convention). The Convention was ratified by the National Assembly in February 1999. It entered into force for the Republic of Slovenia in June 2001.

In this seventh report, fulfilment of the obligations in the period 2017-2019 is evaluated. The report presents the achievements in and contributions to enhancing the safe handling and disposal of spent fuel and radioactive waste.

This report has been prepared in order to meet the obligation to report under Article 32 of the Convention. It is structured in accordance with IAEA guidelines INFCIRC/604/Rev.3. In order to ensure more readability, certain information is provided in the form of attachments and referred to in the text. The information provided in the report presents the status as of the end of 2019.

In the following sections, fulfilment of Articles 3 to 32 of the Convention is evaluated separately. It can be concluded that Slovenian regulations and practices are in compliance with the obligations of the Convention.

SECTION B: POLICIES AND PRACTICES

Article 32, Paragraph 1: Reporting

In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:

(i) spent fuel management policy;

(ii) spent fuel management practices;

(iii) radioactive waste management policy;

(iv) radioactive waste management practices;

(v) criteria used to define and categorise radioactive waste.

(i) Spent Fuel Management Policy

The first strategic document related to radioactive waste and spent fuel management was approved in 1996, only five years after the Republic of Slovenia became independent. This document was the 1996 Strategy on Spent Fuel Management, which included general directions regarding how to manage all spent fuel in Slovenia.

On the basis of the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of the Status and Other Legal Relations Regarding the Investment, Exploitation and Decommissioning of the Krško NPP (hereinafter: the Agreement), the Republic of Slovenia and the Republic of Croatia jointly prepared and approved a Programme for the Decommissioning of the Krško NPP and the Disposal of LILW and High-Level Waste (hereinafter: the Decommissioning Programme). In accordance with the requirements from the Agreement, a revision of the document should be adopted every five years.

In 2006, Slovenia approved the first revision of the national strategy: The Resolution on the 2006–2015 National Programme for Managing Radioactive Waste and Spent Nuclear Fuel (hereinafter: the 2006 Resolution). This resolution included all relevant topics regarding the management of radioactive waste and spent fuel, from legislation and the identification of different waste streams in Slovenia, to the management of radioactive waste and spent fuel. The 2006 Resolution duly implements the relevant provisions of the Agreement with Croatia.

According to all revisions of the Decommissioning Programme, for all domestic scenarios disposal in deep geological formations is considered a safe long-term solution to spent fuel and high-level waste. In preparing the evaluation, the Swedish concept was used as a guideline.

In 2016, Slovenia adopted the second revision of the national strategy: The Resolution on the National Programme for Managing Radioactive Waste and Spent Nuclear Fuel 2016–2025 (hereinafter: the 2016 Resolution). This document incorporates several relevant changes affecting spent fuel management plans that have taken place since 2006. Regarding spent fuel management and disposal, one of the main changes is that in the 2016 Resolution the dry storage of SF generated at the Krško NPP is foreseen to start approximately 6 years earlier, mainly for safety reasons.

As a consequence of the Fukushima nuclear accident in March 2011 and in view of reducing the risk of a nuclear accident at the Krško NPP and in light of the SNSA decision to assess the options for improving the safety of the spent fuel pool, the Krško NPP carried out a study assessing different possibilities for storing spent fuel at the Krško NPP and proposed, in order to ensure uninterrupted operation and sufficient storage capacity, that a dry storage facility for spent fuel with a design lifetime of 100 years should be constructed.

The construction of a dry storage facility for spent fuel was also addressed by the Intergovernmental Commission for monitoring the implementation of the bilateral Slovenian-Croatian Agreement on the

Krško NPP at its 10th session in July 2015. The Intergovernmental Commission decided that the construction of a dry storage facility at the Krško NPP site to be used until the cessation of the NPP's operation is part of a joint solution to spent fuel disposal and in accordance with point seven of Article 10 of the bilateral Slovenian-Croatian Agreement on the Krško NPP. According to the decision of the Intergovernmental Commission, the construction and operation of the joint dry storage facility until 2043 should be financed from Krško NPP operational costs.

The 2016 Resolution also requires that the Krško NPP spent fuel owners evaluate reprocessing as an option that could reduce the volume and radiotoxicity of waste for final disposal.

After the period of dry storage, spent fuel or high-level waste generated from the Krško NPP decommissioning or spent fuel processing is to be further treated, packaged and disposed of. For spent fuel or HLW, a deep geological repository should be built to ensure adequate isolation of the waste from the environment.

The construction of a deep geological disposal (national, regional, or multinational) is necessary regardless of the selected option for storage, processing, and other forms of spent fuel management.

The 2016 Resolution included the option of shared facilities and regional cooperation in waste management, including a dual-track approach. For long-term spent fuel management, a dual-track strategy has been adopted as a reasonable solution in the present situation. The dual-track approach in the Slovenian strategy includes the option of multinational disposal and the basic reference conceptual scenario for national geological disposal.

The revised national strategy opened the possibility of the disposal of spent fuel in the national repository beginning slightly earlier compared to the previous version. In the revised national strategy, the beginning of the national spatial plan process determining the location of spent fuel and the HLW repository is to be adopted by 2055, the repository is to be constructed in the period between 2055 and 2065, and the commissioning of the spent fuel repository is to start in 2065. The closure of the repository and commencement of the regulatory control and maintenance of the repository is to begin after 2075.

The strategy in the third revision of the Krško NPP Decommissioning Programme of 2019 assumes that the SF and HLW dry storage facility may be in operation for at least 60 years after the end of Krško NPP operation. The Krško NPP will be used for storing all SF and HLW generated at the NPP until a deep geological repository is developed. The duration of the storage period is determined by considering the cooling of the SF and the optimal loading of disposal canisters in two variants or scenarios: a storage period at least of 60 years after Krško NPP shutdown until 2103 (the optimal solution) and a storage period of 32 years after Krško NPP shutdown until 2075 (an alternative solution). The start of operation of the deep geological repository is set based on the chosen dry storage period.

In 2019, under the joint Slovenian-Croatian preparation of the Third Revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme, a new reference scenario for a deep geological repository in hard rock was developed. For the purpose of cost analysis, it was assumed that the SF and HLW generated by Krško NPP decommissioning is managed jointly, first in dry storage on the location of the Krško NPP, and subsequently disposed of in a joint repository in Slovenia or Croatia. The two basic scenarios, both with Krško NPP operation until 2043, as was decided by the responsible authorities, are examined as follows:

- Base case scenario – start of regular operation of the SF repository in 2093;
- Sensitivity case scenario – start of regular operation of the SF repository in 2065 as defined in the Slovenian ReNPRRO16-25.

In both scenarios, all activities necessary for a deep geological repository are the same; operation is planned to last for 10 years.

In order to take into account the changed timeline of the dry storage facility and the revision of the conceptual design scenario for the deep geological repository, the national policy and strategy will be updated and amended in the coming years in the form of a new Resolution on the National Programme for Managing Radioactive Waste and Spent Nuclear Fuel.

In parallel with the national disposal programme, the multinational disposal option is possible. Both options go in parallel until a decision on the construction of the national repository or participation in a multinational repository is made.

Given that the operator of the TRIGA Mark II research reactor decided to continue the operation of the facility and considered different options regarding spent fuel management, a proposal was made for the final disposal of the spent fuel together with the spent fuel generated by the Krško NPP.

The Agency for Radwaste Management (hereinafter: the ARAO), as the provider of a mandatory service of general economic interest in Slovenia, will continue to monitor international developments in spent fuel and HLW management – permanently. According to the 2016 Resolution, the ARAO is to conduct planning and carry out development-related activities for the continuation of dry storage after the cessation of Krško NPP operation and for ensuring the final disposal of the spent fuel and HLW generated by the Krško NPP, and of the reprocessed spent fuel and HLW generated by the TRIGA Mark II research reactor and the Krško NPP, in a national, regional, or multinational repository.

In this respect, progress made in international and regional efforts to draft a joint regional programme on disposal is also to be considered.

With regard to final disposal options, the ARAO participates at the EU level in two programmes that address the possibility of building a multinational/regional repository for spent fuel and high-level waste (ERDO-WG and IGD-TP) and is also involved in the work of the International Framework for Nuclear Energy Cooperation (IFNEC).

(ii) Spent Fuel Management Practices

The Republic of Slovenia has no facilities for off-site management of spent fuel. The spent fuel generated by the Krško NPP and the JSI Reactor Infrastructure Centre (the TRIGA Mark II research reactor) is managed in wet storage facilities that are an integrated part of these nuclear facilities.

Krško NPP

Spent fuel is stored in the spent fuel pool inside the Fuel Handling Building of the Krško NPP. In 2003, the project of increasing the storage capacity of the spent fuel pool (reracking) was completed. Following the reracking, 1,694 storage locations are available for spent fuel. Following the accident at Fukushima in 2011, more restrictive requirements were implemented for the safe storage of nuclear fuel in the spent fuel pool under potential beyond design bases accidents. By the end of 2019, 1,320 locations were filled with nuclear fuel. Part of the Krško NPP Safety Upgrade Programme is the construction of a dry storage, which would consequently improve nuclear safety due to its passive nature and by reducing the number of fuel assemblies in the pool. The timeline for the construction of the dry storage facility is in line with the SNSA Safety Upgrade Programme decision, which assumes the finalisation of safety upgrades and measures by the end of 2021. The relevant Krško NPP activities started in 2016 and the contract for the construction of a dry storage facility was signed at the beginning of 2017.

Following the reracking, the spent fuel racks are now of two types. The old racks are designed without neutron poison control. These racks provide 621 cells (6 × 72, plus 3 × 63 cells), and constitute a storage capacity for spent fuel plus one full core for emergency unload. The new racks are designed with neutron poison control and comprise nine modules providing 1,073 usable cells.

The spent fuel racks are designed to withstand shipping, handling, normal operating loads (impact and dead loads of fuel assemblies), and Safe Shutdown Earthquake and Operating Base Earthquake seismic loads meeting Seismic Category I and American Institute of Steel Construction requirements.

Technical characteristics of the spent fuel pool

The spent fuel pool structure is made of reinforced concrete. The walls and floor of the pool are covered with a stainless-steel liner. Underneath the liner plates there is a system of embedded leak collection channels. A spent fuel pool leak detection system is provided to monitor the integrity of the liner of the spent fuel pool, the fuel transfer canal, and the cask loading area.

Removable gates are provided in the spent fuel pool to enable the submerged transfer of fuel assemblies between the spent fuel pool and the transfer canal or the cask loading area. When the gates are in place, the canal and the cask loading area may be drained.

The spent fuel pool cooling and clean-up system is designed to remove the decay heat generated by the spent fuel assemblies stored in the spent fuel pool and to maintain the cooling water at the desired temperature, level, clarity and chemical specifications. The cooling system consists of two redundant pumps and three heat exchangers with associated piping, valves and instrumentation. The third heat exchanger was installed in April 2002 in the framework of spent fuel pool reracking.

The water purification system with a spent fuel pool demineraliser and filter is designed to provide adequate purification in order to enable the plant personnel unrestricted access to the spent fuel storage area and to maintain the optical clarity of the spent fuel cooling water. Water surface clarity is maintained by the operation of the spent fuel skimmer system.

System piping is arranged in such a way that the failure of any pipeline cannot drain the spent fuel pool below the water level required for radiation shielding. A depth of approximately 3.05 m of water over the top of the stored spent fuel assemblies is required to limit direct radiation to 0.025 mSv/h.

Whenever a fuel assembly with defective cladding is removed from the reactor core, a small quantity of fission products may enter the spent fuel cooling water. The provided purification loop removes fission products and other contaminants from the water. By maintaining radioactivity concentrations in the spent fuel cooling water at 18.4×10^4 Bq/cm^3 (β and γ radiation) or less, the dose at the water surface is 0.025 mSv/h or less, thus providing the plant personnel unrestricted access.

A criticality analysis for the spent fuel pit racks was performed as a design basis criterion. For the old racks, calculations were performed for an infinite array of cells with a spacing of 296.42 mm by 304.80 mm to verify that the configuration is critically safe. For the new racks, criticality safety is ensured by geometrically safe configuration, the use of a borated stainless steel absorber sheet and a procedure to verify that the reactivity equivalence curve is met.

Fuel management strategy

All the spent fuel is stored in the spent fuel pool. To minimise the amount of spent fuel and reduce fuel costs, the Krško NPP is extending the burnup of fuel elements. The average spent fuel burnup in the spent fuel pool is 39.6 GWD/MTU, while the last three spent fuel regions had an average burnup of 52.3 GWD/MTU. The Low Leakage Loading Pattern was introduced in the design several years ago. By using this type of design, an additional reduction in spent fuel production was achieved. As a consequence of the Fukushima nuclear accident in March 2011, in view of reducing the risk of a nuclear accident at the Krško NPP and in light of the SNSA decision to assess the options for improving the safety of the spent fuel pool, it was decided to construct a dry storage facility for spent fuel with a design lifetime of 100 years. According to current plans, it should be constructed by the end of 2022.

The JSI Reactor Infrastructure Centre

Two spent fuel pools are part of the TRIGA Mark II research reactor. The first spent fuel pool was constructed with the reactor in 1966 and is no longer in use. The second one was constructed in 1992. Its capacity is 195 spent fuel elements and it is located in the basement of the reactor building. It is accessible by crane through a cover in the reactor hall floor. The pool is 3.5 m deep and is lined with stainless steel sheets. It is equipped with an on-line water radioactivity monitor.

Both pools have been empty since 1999, when all spent fuel elements (a total of 219) were shipped to the USA. The new pool is maintained as operational and prepared for immediate use if necessary.

In 2007, 10 fresh fuel elements were transferred to the French company AREVA and shipped to France. The total number of the remaining fuel elements (irradiated and fresh) at the reactor is 84.

A detailed criticality analysis of the spent fuel racks design was performed. Heat removal is not applicable for the TRIGA Mark II research reactor fuel. A safety analysis of accidents involving spent fuel during normal operation and fuel handling was performed and is included in the safety analysis report.

(iii) Radioactive Waste Management Policy

In the 2016 Resolution, LILW management is treated as an integral process, covering all stages from waste generation to waste disposal. Various current and near-future radioactive waste streams are taken into account, considering both present and planned waste management practices. Besides radioactive waste from the Krško NPP, other small producers (from medicine, industry and research) and other activities involving radioactive waste (the uranium mine undergoing decommissioning, NORM, the decommissioning of reactors, etc.) are also described. The Programme includes an analysis of measures for the minimisation of radioactive waste production and its treatment and conditioning before disposal.

The strategy for radioactive waste management during the operation of nuclear and radiation facilities is founded on the principle of using such processes, technologies, and methods that generate the least operational waste, and on further radioactive waste management that reduces the waste volume in the radioactive waste storage facilities and at their final disposal sites. The strategy promotes the usage of such processes, technologies, and methods that reduce the volume and quantity of radioactive waste and meet the waste acceptance criteria for final disposal, where they exist.

The prime responsibility for radioactive waste management in nuclear and radiation facilities rests with the holders of operating licences. Radioactive waste is to be managed in accordance with the approved safety analysis reports for the operation of individual nuclear facilities. Storage is to be implemented for the purpose of efficient and safe phased disposal at the LILW repository. In the field of radioactive waste management, the strategy promotes the concept of the clearance of radioactive materials from regulatory control in accordance with the prescribed criteria in order to avoid the unnecessary generation of radioactive waste.

The construction and operation of a repository for short-lived LILW is one of the principal goals of LILW management in Slovenia. The limited storage capacities at nuclear facilities call for decisions to be taken and practical solutions found.

A significant step forward in solving this problem was made by the selection and approval of a site for LILW disposal in 2009. The Vrbina site in the municipality of Krško was adopted by the governmental decree on the national spatial plan. The selected type of repository envisages the disposal of radioactive waste in a near-surface silo. The location and design of the repository enable extension by means of additional silos. The Investment Programme for the LILW Repository in Vrbina, Krško, which was confirmed in July 2014, envisages two scenarios: the baseline scenario allowing for the disposal of half of the waste, and the extended scenario, which, in accordance with the Agreement on the Krško NPP, provides for the disposal of all LILW waste from the Krško NPP. The repository must be designed with a capacity enabling the disposal of any kind of LILW generated in Slovenia, except for small quantities of long-lived or other waste. The repository's timeline for construction, operation, decommissioning and closure was recently adjusted according to the project documentation for obtaining a building permit, which took into account the Krško NPP lifetime extension until 2043, the new Krško NPP decommissioning time schedule, whereby it is planned that decommissioning will conclude in 2058, and delays due to administrative procedures. In April 2019, preliminary approval for the radiation and nuclear safety of the nuclear facility was issued by the SNSA in the procedure for issuing environmental protection approval. The repository design project documentation is completed and finalised on the basis of the external expert review required by the 2017 Act. The process of cross-border environmental impact assessment and the process of securing environmental approval in Slovenia should be completed to fulfil one of the prerequisites in the process of obtaining a building permit for the construction of the LILW repository.

Responsibility in the field of LILW management is clearly defined. Three independent parties – the generators of radioactive waste, the SNSA as the regulatory body, and the ARAO as the provider of radioactive waste management as a mandatory service of general economic interest – are involved in the process of radioactive waste management. The operators of nuclear and other radiation facilities are responsible for radioactive waste management at their facilities. The ARAO is an independent implementing organisation that concludes contracts in connection with its activities within the ministry competent for energy. The ARAO has responsibility for takeover, collection, transport, preliminary treatment and storage prior to disposal, the construction of a repository, and the disposal of radioactive waste and spent fuel not originating from power-generating nuclear facilities. The ARAO's mandatory service of general economic interest also encompasses the conditioning of radioactive waste and spent fuel prior to its disposal and the disposal of radioactive waste and spent fuel originating from power-generating nuclear facilities, as well as the management, long-term surveillance and maintenance of the disposal sites for mine and hydro-metallurgical tailings originating from the extraction and exploitation of nuclear minerals, and the management and long-term surveillance and maintenance of radioactive waste and spent fuel repositories. All activities are made transparent to the public through annual reports, via the internet and through outreach activities.

(iv) Radioactive Waste Management Practices

Within the scope of the Convention, the Central Storage Facility for Radioactive Waste in Brinje, the Boršt hydro-metallurgical tailings disposal site and the Jazbec mine waste disposal site at the former Žirovski Vrh Uranium Mine are the only radioactive waste management facilities in the Republic of Slovenia. The LILW that is generated by the operation of the Krško NPP is managed and stored at the Krško NPP site, while the waste produced by the operation of small producers (the JSI Reactor Infrastructure Centre and in industry, research and medicine) is managed in the Central Storage Facility for Radioactive Waste in Brinje.

Central Storage Facility for Radioactive Waste in Brinje

Institutional radioactive waste is stored in the Central Storage Facility for Radioactive Waste (CSF), situated in Brinje near Ljubljana. The facility is operated by the ARAO.

The ARAO holds a licence to carry out a radiation practice. The licence to carry out a radiation practice includes the following activities:

- the collection of radioactive waste at the waste producers' premises;
- the collection of radioactive waste on-site in the event of accidents;
- the collection of radioactive waste in cases where the waste producer is unknown;
- the dismantling of sealed radioactive sources at the user's premises (less complex sources);
- the treatment and conditioning of radioactive waste in a hot cell laboratory for the purposes of storage; and
- the transport of radioactive materials as a part of radioactive waste management as a mandatory service of general economic interest.

The ARAO has a Radioactive Waste Management Programme. The Programme is an operational document for radioactive waste management valid for two years. It contains information on the organisation of activities and methods for carrying out activities, recording and reporting, definitions of responsibilities for services, information on basic documents for carrying out activities, information on packaging, information on radioactive waste, management procedures and methods, measures to minimise radioactive waste generation, clearances and capacities in place, and consideration of interdependencies between all stages of management, and the alignment of management procedures with operative programmes under the national programme for radioactive waste management.

The radioactive waste inventory in the CSF has been characterised, treated and conditioned. The ARAO has been performing treatment and conditioning of radioactive waste as a regular activity at a nearby processing facility (a hot cell laboratory). ARAO staff carry out waste sorting, characterisation and compression, the dismantling of disused sealed radioactive sources, and the solidification of liquid radioactive waste.

During the development of the WAC for storing institutional radioactive waste in the CSF, the ARAO considered the WAC for the planned LILW repository, the IAEA TECDOCs, IAEA Safety Standards, IAEA Safety Standards Series, national legislation, and operators' practices.

A series of new documents related to the facility and revisions of existing documents have been produced in the last three-year period, including the revision of the Safety Report for CSF and its reference documentation. The first periodic safety review (PSR) of the CSF was finished and the new operating license of the CSF was granted for the next 10 years.

Žirovski Vrh Uranium Mine

The uranium mine ceased operation in the summer of 1990. The environmental remediation project which ensures conditions for the closure of mining facilities is carried out by the public company Žirovski Vrh Mine d.o.o. Long-term surveillance and maintenance of the mine waste disposal site and the hydro-metallurgical tailings disposal site after their closure is ensured by the ARAO, the provider of a mandatory service of general economic interest. Environmental remediation activities as well as long-term management activities are financed from the state budget.

All surfaces in the mining area affected by uranium production have been decontaminated and have been returned to unrestricted land use. The contaminated material produced by mining, uranium ore processing and decontamination has been disposed of at two disposal sites nearby the mine: the Jazbec mine waste disposal site and the Boršt hydro-metallurgical tailings disposal site. All other former temporary mine waste disposal piles and contaminated waste materials (metal, plastics and construction waste) were relocated to the Jazbec mine waste disposal site.

Parts of the mine's galleries have been backfilled with mine waste and some contaminated scrap material arising from the decommissioning of the ore processing area. All entrances to the mine have been sealed. Long-term monitoring of the water flow and the radiological and chemical parameters of mine water discharges is ensured by the ARAO.

No regular monitoring is required at the decommissioned site where the processing of uranium ore took place. The site was released without restriction to the local municipality for the development of the local economy.

Environmental remediation works at the Jazbec mine waste disposal site were finished in 2009. A five-year transitional post-operational period followed, when the efficiency of the remediation measures was checked by monitoring the relevant radiological and chemical parameters. After proving that the remediation had been successful, the administrative procedure for the permanent closure of the mine waste disposal site was completed in 2015. The area acquired the status of a facility of the state infrastructure. The management of the site with the aim of maintaining the achieved environmental performance of the site has been assigned to the ARAO. The scope of long-term surveillance is defined in the safety report, which must be reviewed every ten years or more frequently in the case of extraordinary events. The revision of the safety report regarding the monitoring programme and authorised limit values for air and water discharges was confirmed in 2019.

The Boršt hydro-metallurgical tailings disposal site is situated on a hillside, 535–565 m above sea level. During the short operational life of the site, approximately 610,000 tons of hydro-metallurgical tailings and 73,000 tons of mine waste were deposited there. In 2004, an additional 38,000 tons of mine waste were transported to Boršt for the purpose of its final arrangement. During 2008 and 2009, 9,450 tons of contaminated materials from the decontamination of auxiliary objects were deposited at Boršt. The total mass of the deposited materials is 730,450 tons. The area of Boršt is 42,000 m^2. The hydro-metallurgical materials are sands and slimes under 28 mesh (0.5 mm). The average activity of ^{238}U is 1,000 Bq/kg and 8,600 Bq/kg for ^{226}Ra.

The environmental remediation of the Boršt hydro-metallurgical tailings disposal site is not yet finished and the conditions for its closure are not yet fulfilled. The main problem is a landslide at the base of the tailings site. In 2016 and 2017, additional intervention measures were carried out in order to further reduce the groundwater level at the Boršt disposal site and thereby reduce the velocity of the landslide.

In 2018, the Expert Project Council for monitoring the remediation work on the hydro-metallurgical tailings prepared a final report. The effects of the maintenance, monitoring and intervention measures to reduce the groundwater impact on the stability of the Boršt hydro-metallurgical tailings performed between 2010 and 2018 were assessed, as well as the current state at the Boršt disposal site. The current rate of movement is approximately 3 cm per year (2019). Although an expert group concluded that the probability of the collapse of the slope is negligible, they proposed the investigation of the landslide by additional deep piezometers. In 2019, the monitoring network of the Boršt hydro-metallurgical tailings disposal site was renovated and upgraded with nine additional deep piezometers.

In 2015 and 2016, two studies were carried out. In the first study, the distribution of tailings in the case of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. On the basis of the study, the

Ministry of the Environment and Spatial Planning ordered an additional study on the radiation exposure of residents and the workers who would carry out the remediation of the deposited material on the riverbeds of the Todraščica, Brebovščica and Poljanska Sora Rivers. The results of both studies were included in the revised safety report.

In the meantime, it was decided to implement the emergency drainage measures that were proposed by the expert advisory board. In 2016, an external contractor started to implement the emergency drainage measures in the passageway of the tunnel under the hydro-metallurgical tailings of the Boršt site.

The current arrangement of the hydro-metallurgical tailings ensures protection against background waters, prevention of the spread of soluble components into underground and surface waters, the reduction of radon exhalation and the prevention of erosion by rainfall. The multilayer cover with a total thickness of 2.05 m is composed of a drainage layer (mine waste and crushed stone), compacted clay (the sealing layer), local material (the protecting layer), and grassed topsoil. The radon exhalation rate from the hydro-metallurgical surface before the arrangement was 1 – 5 Bq/m^2s, and after final arrangement it is now less than 0.1 Bq/m^2s. Institutional control of the radioactivity of the effluent water, ground water, air, ground water level, surface integrity and stability will be needed in the future.

By carrying out the final arrangements of the Boršt hydro-metallurgical tailings disposal site and the Jazbec mine waste disposal site, the radiation limitations set according to the authorised limits were achieved.

Krško NPP

The Krško NPP has its own Radioactive Waste Management Programme, supplemented by a technical report. The Programme is revised and updated at least every two years. The Krško NPP considers this document a valuable source of input for future decision-making and long-term planning in the area of operational radioactive waste management. Waste generation rates are predicted based on the present situation and future options. The available storage capacity for radioactive waste at the Krško NPP is assessed by extrapolation. In addition, a Radioactive Waste Committee was formed at the Krško NPP as an interdisciplinary team, through which communication and transparency in the area of radioactive waste management have been enhanced. Due to slow progress in the construction of the repository for LILW, the storage capacities at the NPP are almost exhausted. The NPP is planning to provide additional storage capacity in the waste preconditioning area of the storage building. The entrance area of the storage building is adjusted for the preconditioning of waste by the construction of a new Waste Manipulation Building. With the construction of the new Waste Manipulation Building, the plant provided new premises for the storage of drums in the process of the manipulation and preparation for transport, collection, and sorting of radioactive waste.

Radioactive waste treatment and conditioning

During the operation of the Krško NPP, various radioactive substances in liquid, gaseous and solid form are generated. Radioactive substances are collected, segregated and processed to obtain a final form for storage in the plant's radioactive waste storage locations. Depending on the processing method, radioactive substances are collected and segregated. These radioactive substances are processed in a system for radioactive waste treatment. The system is constructed for collecting, processing, storing and packaging waste in a suitable form to minimise releases into the environment. Three fundamental systems are used for radioactive waste management, i.e. systems for liquid, solid and gaseous radioactive waste.

The plant is provided with a **Gaseous Waste Processing System** consisting of two parallel closed loops with compressors and catalytic hydrogen recombiners and six decay tanks for compressed fission gases. Four of the tanks are used during normal plant operation, while the remaining two are used during reactor shutdown. The capacity of the tanks is adequate for more than one month's gaseous waste hold-up. Within this period, the majority of the short-lived fission gases decay, while the remaining gases are released into the atmosphere under favourable meteorological conditions. Automatic radiation monitors in the ventilation duct prevent uncontrolled release when the radioactive gas concentration exceeds the permissible level.

Liquid radioactive waste arising from all sources during the operation of the Krško NPP is processed by the **Liquid Waste Processing System**, consisting of tanks, pumps, filters, evaporators and two demineralisers. The system is designed to collect, segregate, process, recycle and discharge liquid radioactive waste. The system design considers the potential exposure of personnel and ensures that the quantity of radioactivity released into the environment is as low as reasonably achievable.

All solid radioactive waste generated during plant operation, maintenance activities and servicing is collected in the Solid Radioactive Storage Facility. Used spent resins, evaporator concentrates (boric acid), used filters and other contaminated solid waste, such as paper, towels, working clothes, laboratory equipment and various tools, form most of the solid waste. Compressible solid waste is compressed and encapsulated in standard 208 l drums, while dried evaporator concentrate and sludges and dried spent resin are stored in stainless steel drums. These drums are presently stored in the Solid Radwaste Storage Facility within the plant area.

The radioactive waste volume reduction programme

Numerous programme improvements, design changes and work practice improvements have been pursued at the Krško NPP to decrease the generation rate of radioactive waste of various types. With the introduction of an 18-month fuel cycle, the generation of radioactive waste was additionally reduced.

Segregation techniques are used for collecting non-contaminated materials separately, which allows waste streams to be processed separately. Metal materials exceeding exemption/clearance levels are stored onsite before melting. To reduce the volume of the solid radioactive waste to be stored, supercompaction campaigns are carried out.

The original Westinghouse procedure for evaporator bottoms and spent resin treatment was replaced with a treatment system for these types of waste called the In-drum Drying System. The drying process converts the accumulated wet spent resins into a dry free-flowing bead resin condition. The dried primary resins are filled directly into 200 l stainless steel heavy drums with biological shields (150 l of usable volume). Dried secondary spent resins are filled into 200 l stainless steel drums without biological shields. The drying and volume reduction process for evaporator bottoms and sludges converts the concentrate into dry solid waste products with low residual moisture and no free water. The Krško NPP uses an external service for the incineration of combustible waste and the melting of radioactive metallic waste material.

The risks associated with radioactive waste management are kept reasonably low. Different types of waste are segregated in an early collection phase and stored separately to avoid chemical interactions. Tube-type containers are used as an overpack for the storage of standard 200 l drums and the products of supercompaction in the plant's radioactive waste storage facility. Any new type of radioactive waste resulting from a new technology being used is evaluated and incorporated into the safety analysis report.

Safety Review

The 2nd Krško NPP periodic safety review phase was completed on 15 December 2013. The radioactive waste management programme was reviewed, including an evaluation of the design basis for the durability and integrity of waste packages. The periodic safety review showed that the durability and integrity of the radioactive waste packages are within acceptable levels.

There was also a recommendation by the IRRS mission dealing with strengthening administrative control over the storage of radioactive waste at the Krško NPP, particularly in terms of the accessibility and integrity of the containers. After the IRRS mission, a thorough analysis was carried out that showed that any solution of this problem before the removal of the waste to the final repository would represent such an additional radiation protection burden and such costs that could not justify the small benefit of slightly reducing the current risk. The final repository is expected to be operational in a few years.

Small Producers of Radioactive Waste in the Republic of Slovenia

Management of institutional radioactive waste (from medical and industrial applications and research activities) was delegated to the relevant public utility as a mandatory service of general economic interest, i.e. to the radioactive waste management organisation ARAO. This includes the collection of waste at the producers' premises, the transport of waste, and the treatment, conditioning, storage and disposal of waste. The ARAO is also responsible for the management of radioactive waste in the event of industrial accidents and for historical waste.

The Jožef Stefan Institute Reactor Infrastructure Centre

Only a small amount of solid radioactive waste has been produced during the lifetime of the TRIGA Mark II research reactor (approximately 200 litres per year). This waste mainly consists of contaminated material and equipment (paper, plastics, glassware, etc.) and contaminated mechanical and chemical filters (e.g. ion exchange resins). Spent resins are collected in drums. The activity content is estimated to be less than 1 GBq/m^3. The waste is transferred to the Central Storage Facility for Radioactive Waste in Brinje.

The reactor does not directly produce any radioactive liquid waste. However, some radioactive liquids are produced during the chemical treatment of irradiated samples in the adjacent research laboratories. This liquid waste is collected and further conditioned. Wastewater containing radionuclides is collected in a special 20 m^3 decay tank. After measuring the isotope concentration and activity, the liquids are released into the River Sava in accordance with the prescribed limits.

No gaseous radioactive waste that needs further treatment or storage is produced. Radioactive gases produced due to normal reactor operation (mainly argon) are released through controlled atmospheric release venting.

Radioactive Waste Management in Industry and Research

Radioactive sources are widely used in industry and research. There are a number of industrial applications, for example in industrial radiography, thickness, level and density gauges, moisture detectors, eliminators of static electricity, lightning conductors, etc. In the Republic of Slovenia, 75 industrial and research organisations were using 704 sealed sources as of the end of 2019. Spent and disused radioactive sources were either returned to the suppliers or shipped to the Central Storage Facility for Radioactive Waste in Brinje.

The requirements for the use and storage of disused radioactive sources and waste are set out in the 2017 Act (Articles 16–23). A licence must be obtained to conduct radiation practices. An applicant shall submit a plan for the use and storage of the radiation source, as well as a plan for the handling of the radioactive waste resulting from the radiation practice.

During the decontamination and decommissioning of buildings at the Reactor Infrastructure Centre of the Jožef Stefan Institute used for the processing of uranium ore, which took place from 2005 until 2007, as many as 31 drums of waste contaminated with naturally occurring radioactive material (NORM) were produced. Part of this material (12 drums) was transferred to the Central Storage Facility in February 2010. In accordance with the SNSA's approval of conditional clearance, the Institute sent part of the material, i.e. 12 drums of contaminated construction material and soil, to a municipal landfill in June 2011. Since it is not allowed to dispose of metal items or wood at any municipal landfill, the remaining 7 drums are still being temporarily stored at the location of the Reactor Infrastructure Centre in Brinje.

Radioactive Waste Management in Medicine

In the Republic of Slovenia, unsealed radioactive sources (radiopharmaceuticals) for diagnostics and therapy are used in seven clinics or hospitals. The main users are the Institute of Oncology and the Ljubljana University Medical Centre's Department of Nuclear Medicine. There is no production of radiopharmaceuticals in the Republic of Slovenia.

The Institute of Oncology imported (among other sources) 0.51 TBq of ^{131}I, and the Ljubljana University Medical Centre's Department of Nuclear Medicine imported 0.40 TBq of ^{131}I in 2019. All other users together imported 0.07 TBq of ^{131}I in 2019. The Institute of Oncology uses decay storage tanks to control releases of radioactive effluents. The Ljubljana University Medical Centre's Department of Nuclear Medicine releases the effluents directly into sewerage systems. Patients from other hospitals are not hospitalised. It is estimated that less than 0.3 TBq of ^{131}I is released annually into the environment.

Short-lived radioactive waste (residues contaminated with ^{131}I, ^{123}I, ^{125}I, ^{99m}Tc, ^{99}Mo, ^{201}Tl, ^{177}Lu, ^{90}Y, ^{111}In, ^{67}Ga, ^{18}F or ^{223}Ra) produced during medical practices is stored locally at the users' locations. After decay, the material is transferred to the municipal disposal sites. In 2010, the Ljubljana municipal waste disposal site was equipped with a portal radiation monitor, which raised an alarm on several occasions in the period from 2011 to 2013. It was determined that certain short-lived radioisotopes from medical practices had not decayed below clearance levels before being transferred to the disposal site. Corrective measures and procedures were later agreed upon and implemented. Over the last seven years no alarms have been reported to the SRPA or to the SNSA.

Other small amounts of solid radioactive waste, mainly containing ^{57}Co, ^{137}Cs, ^{68}Ge, ^{153}Gd or ^{106}Ru (in total, less than 1 GBq) are temporarily stored at local sites and periodically transported to the Central Storage Facility for Radioactive Waste in Brinje.

(v) Criteria used to define and categorise radioactive waste

The Regulation on Radioactive Waste Management and Classification of Radioactive Waste takes into account, with some modifications, the radioactive waste categorisation system recommended by the "EC Recommendation on a Classification System for Solid Radioactive Waste" (OJ L 265, 13 October 1999, p. 37).

The provisions of this regulation apply to substances in gaseous, liquid or solid form; they apply to objects or equipment containing radioactive substances or that are so contaminated that they exceed clearance levels, if generated as waste from radiation practices or from intervention measures, if their holder intends or has to discard them since their further use is not foreseen, or if the holder does not have a licence for their use in accordance with the regulations on protection against ionising radiation.

With regard to their aggregation state, radioactive waste is divided into solid, liquid and gaseous waste.

With regard to the level and type of radioactivity, solid radioactive waste is categorised as follows:

1. transitional radioactive waste;
2. very low-level radioactive waste, for which the competent regulatory body for nuclear and radiation safety may approve conditional clearance;
3. low- and intermediate-level radioactive waste (LILW), with insignificant heat generation, which is classified into two groups:
   - 3.1 short-lived LILW, containing radionuclides with a half-life shorter than 30 years and a specific activity of alpha emitters equal to or lower than 4,000 Bq/g for an individual package, but on average not higher than 400 Bq/g in the overall amount of LILW;
   - 3.2 long-lived LILW, where the specific activity of alpha emitters exceeds the limitations for short-lived LILW;
4. high-level radioactive waste, which contains radionuclides whose decay generates such an amount of heat that this has to be considered in its management;
5. radioactive waste containing naturally occurring radionuclides that are produced in the processing of nuclear mineral materials or other industrial processes and are not sealed sources of radiation in accordance with the regulations on the use of radioactive sources and radiation practices.

The Decree on Activities Involving Radiation defines the clearance of radioactive material.

The regulatory control of solid radioactive material is terminated with a decision of the ministry competent for the environment or health, if the specific concentration of radionuclides in the material does not exceed the values determined in Table 1 or Table 2 of the Decree on Activities Involving Radiation (clearance levels). In case the specific concentration of radionuclides in the material exceed clearance levels, the decision on clearance is based on a radiation protection assessment.

SECTION C: SCOPE OF APPLICATION

Article 3: Scope of Application

1. *This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.*
2. *This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.*
3. *This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.*
4. *This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.*

The Convention applies to the safety of spent fuel management at the Krško NPP and in the JSI Reactor Infrastructure Centre. No spent fuel reprocessing is foreseen.

It also applies to the safety of the operational waste from the Krško NPP, the safety of the mining, milling and decommissioning waste from the Žirovski Vrh Uranium Mine and the safety of the waste from small non-power applications which are stored in the Central Storage Facility for Radioactive Waste in Brinje.

The 2017 Act does not stipulate any special legal provision for the spent fuel or radioactive waste that results from military or defence programmes. Therefore, the same legal provisions are applicable to such waste. However, it should be noted that there is no radioactive waste from the defence programme of the Republic of Slovenia.

SECTION D: INVENTORIES AND LISTS

Article 32, Paragraph 2: Reporting

This report shall also include:

(i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

(ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

(iv) an inventory of radioactive waste that is subject to this Convention that:

(a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

(b) has been disposed of; or

(c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

(v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

(i) List of Spent Fuel Management Facilities

The Republic of Slovenia has no off-site spent fuel management facilities. The spent fuel that is generated by the operation of the Krško NPP and the JSI Reactor Infrastructure Centre (the TRIGA Mark II research reactor) is managed in storage facilities that are integral parts of these nuclear facilities.

(ii) Inventory of Spent Fuel

Krško NPP

The Fuel Handling Building is a part of the Krško NPP. It is operated under the plant's licence and is therefore not considered an independent nuclear facility. The Fuel Handling Building consists of a spent fuel pool and the fuel handling system.

There were 906 spent nuclear fuel assemblies in the spent fuel pool at the end of 2019. There are altogether 1,322 fuel assemblies in the spent fuel pool (including the Fuel Rod Storage Basket and Strainer Basket for Fuel Rods), but not all have been declared to be fully used. The fuel batches of the spent fuel assemblies with corresponding region numbers are listed in Section L, Annex (d), Table 9. These fuel assemblies will probably never return to the core unless emergency core loading has to be performed.

There are eight spent fuel groups stored in the Krško NPP's spent fuel pool:

- All Westinghouse standard type fuel assemblies, as well as Siemens KWU fuel assemblies, which do not have a Removable Top Nozzle, are considered spent fuel (fuel batches No. 1 ["A"] to No. 18 ["T"] and KWU ["H"].
- Fuel assemblies from fuel batches No. 19 ["U"] to No. 31 ["AJ"] with either:
  - an average burnup higher than 50 GWD/MTU or
  - previously declared as spent fuel.
- The Fuel Rod Storage Basket (FRSB) containing single fuel rods from repaired fuel assemblies is also considered to be spent fuel.

- Fuel rod segments containing nuclear material stored in the Strainer Basket for Fuel Rods (SBFR); and
- Damaged fuel assemblies that cannot be repaired and reused in the core (AD11, AD12, AD13, AD17 and AE03).

JSI Reactor Infrastructure Centre

There are two interim storage pools that are part of the JSI Reactor Infrastructure Centre. The old storage pool is not in use. The newer storage pool is maintained in operational condition and prepared for immediate use if necessary. Both pools have been empty since 1999, when all spent fuel elements (a total of 219) were shipped to the USA for final disposal.

(iii) List of the Radioactive Waste Management Facilities

The Central Storage Facility for Radioactive Waste in Brinje, the Boršt hydro-metallurgical disposal site and the Jazbec mine waste disposal site at the Žirovski Vrh Uranium Mine are the only radioactive waste management facilities in the Republic of Slovenia pursuant to the Convention. The operational waste from the Krško NPP is managed and stored in storage under the operating licence for the Krško NPP.

Central Storage Facility for Radioactive Waste in Brinje

The storage facility is a near-surface concrete building whose roof is covered by a layer of soil. The building is subdivided by concrete walls into ten storage sections and an entrance area. The ground plan of the facility is 10.6 m × 25.7 m and its height is 3.6 m. A small area is intended as a checkpoint between the radiologically controlled and supervised area, the area for loading and unloading waste, and for internal transport. The storage section at the back of the building is deeper relative to the level of the other sections.

The facility is equipped with a ventilation system for reducing radon concentration and air contamination in the storage facility. To obtain relatively low and constant humidity, it is equipped with an air-drying system. The water and sewage collection system is designed as a closed system to retain all liquids from the storage facility in the sump. Liquids are discharged after measurements of radioactive contamination show that this is below the regulatory limit. The storage facility is physically and technically protected against fire, acts of violence, burglary, sabotage, etc.

Jazbec Mine Waste Disposal Site at the Žirovski Vrh Uranium Mine

The Jazbec mine waste disposal site has been remediated and closed since 2015. It is located on the north-eastern slope of the hill named Žirovski Vrh at an altitude of 427 to 509 metres above sea level, and the area inside the security fence is 74,239 m^2. The pile area was reshaped and covered with a final 1.95-m-thick layer of radon exhalation barrier and soil. The whole surface is grass covered; the growth of shrubs and trees is prevented by regular mowing.

The remediation design and the safety analysis report on the final remediation of the Jazbec mine waste disposal site were realised in 2004. The remediation was completed in 2008. Since September 2013, the Jazbec mine waste disposal site has been a national infrastructure facility. After proving that the remediation was successful, the administrative procedure for permanently closing the Jazbec mine waste disposal site was completed in 2015. The management and maintenance of the closed site is provided by the ARAO, as the provider of a mandatory service of general economic interest.

Boršt Hydro-metallurgical Tailings Disposal Site at the Žirovski Vrh Uranium Mine

The Boršt hydro-metallurgical tailings disposal site is located on the north-western slope of Boršt Hill at an altitude 535-565 metres above sea level. The waste inventory is provided in Table 17. During the operation and construction of the Boršt hydro-metallurgical tailings disposal site some mine waste was used to consolidate the surfaces used for hydro-metallurgical tailings transportation. In the remediation process the slopes were minimised and a rock support scarp was constructed at the head of the hydro-metallurgical tailings. The surfaces were covered by a 0.5 m-thick layer of mining waste or inert material overlaid by a layer of a radon exhalation barrier and soil with a thickness of 2.05 m, thus with a total of 2.55 m.

In 1991, a few months after a heavy rainfall, a landslide beneath the deposited hydro-metallurgical tailings was activated. About 4.5×10^6 m^3 of the hillside became unstable and sliding started at a rate of about 0.5 to 1.0 mm per day. The main reason for the landslide was probably the extremely high groundwater level. In 1994 and 1995, a drainage tunnel of nearly 600 metres in length was constructed together with vertical drainage wells. Consequently, the speed of the landslide's movement was reduced in 1995 to a rate of less than 0.1 mm per day (2019).

The design of the remediation and the safety analysis report on the final remediation were approved in 2005. The remediation was completed in 2010. In 2008, during intensive work on the implementation of the final arrangement of the hydro-metallurgical tailings, the landslide was reactivated. An expert team was set up to assess the situation and to propose mitigation measures. The team concluded that the probability of a sudden collapse of the landslide was negligible, but proposed investigation of the incoming water using drill holes.

In 2015 and 2016, two studies were carried out. In the first study, the distribution of tailings in the case of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. On the basis of the study, an additional study was performed on the radiation exposure of residents and the workers who would carry out the remediation of the deposited material on the riverbeds of the Todraščica, Brebovščica and Poljanska Sora Rivers. Dose assessment covered all important exposure pathways originating from disposal material. In the event of the total disintegration of the disposal facility, the radiological impact on the environment and the local population in the Todraščica Valley would be 4.52 mSv/year for a member of the public who would remain there and continue to live as before. This is one order of magnitude higher than during the operational period of the mine. The authorised limit for population exposure after the remediation of the uranium exploration site was set at 0.3 mSv/year. A conservative exposure assessment was carried out also for workers engaged in remediation work. The workers would receive 1.5-2.9 mSv/year.

The results of both studies were included in the revised safety report. The safety report provides measures to remedy such a very unlikely event.

In the meantime, additional intervention measures for reducing the speed of the landslide's movements were performed in 2016 and 2017. It is planned that the drainage bores will lower the water's back-flow in the landslide zone. Furthermore, it is supposed that the groundwater level will not rise critically in the case of intensive or long-lasting precipitants and that it will be lower in the pile's base and in the pile itself in the impact area of drainage wells.

Krško NPP

The Krško NPP includes the following buildings for radioactive waste management:

The Auxiliary Building, where the systems for solid, liquid and gaseous waste processing are located. The building is located adjacent to the Fuel Handling Building and the Reactor Building within the Radiologically Controlled Area. Appropriate monitoring and radiological control are provided during all stages of radioactive waste processing. The main activities related to waste management in this building are pre-treatment (waste collection, segregation, chemical adjustment, decontamination), treatment (radionuclide removal, volume reduction) and conditioning (drying, immobilisation, packaging). The conditioned waste is transported to the Solid Radwaste Storage Facility by forklift or an electric cart (using a special shield when necessary).

The Solid Radwaste Storage Facility, an interim storage, originally built as a five-year storage. Its operating licence was extended in 1988 due to the lack of an LILW repository. It is a reinforced concrete structure, seismically designed, located adjacent to the Auxiliary Building. The total area is 1,470 m^2; following an area optimisation project, by applying a special steel structure to support the storage of waste on the second level, the useful volume was increased to allow waste storage for a longer period of time. The storage time in the Solid Radwaste Storage Facility is variable and dependent on waste generation rates and waste management plans. The inner area is divided into six fields by 60-cm-thick interior concrete walls; the exterior walls and the ceiling are 100 cm thick, providing appropriate insulation and radiological shielding. The facility has provisions for storing different types of solid radioactive waste separately and retrieving them for further processing (supercompaction, incineration, melting and clearance after the decay of the radionuclides) or disposal at a later time. The Storage Facility is equipped with a ventilation system, smoke detectors and a local radiation monitor.

The Decontamination Building, an interim storage, built for decay storage of two old steam generators and radioactive waste produced through the replacement of steam generators and other larger components. It is a seismically-designed reinforced concrete structure consisting of the following three areas: the decontamination area, a "mock-up" area, and an area for the storage of old steam generators. The building meets the requirements for a LILW storage. The outer wall and the roof slab design were governed by radiological shielding requirements.

The Waste Manipulation Building (WMB) is a seismically designed reinforced concrete shielded structure, located near the Auxiliary Building and the Solid Radwaste Storage Facility, providing a functional connection between the two buildings. Systems and equipment in the WMB provide capabilities for the collection, treatment and conditioning of low and intermediate level waste (LILW) as well as waste assay measurements, preparation for transport, and radiological control of materials. Maintenance hot-shops and the holdup of borated primary water in excess from refuelling operations are enabled in the building as well.

(iv) Inventory of Radioactive Waste in the Central Storage Facility for Radioactive Waste in Brinje

At the end of 2019, 90 m^3 of radioactive waste (RW) was stored at the CSF, with a total weight of 50 tons and a total activity of 3.2 TBq. The storage facility is already filled to around 80% of capacity, and consequently the operator is taking measures towards volume reduction. In the last five years, the ARAO has taken over up to 2.7 m^3 of unprocessed RW per year from waste producers – gross volume including packaging.

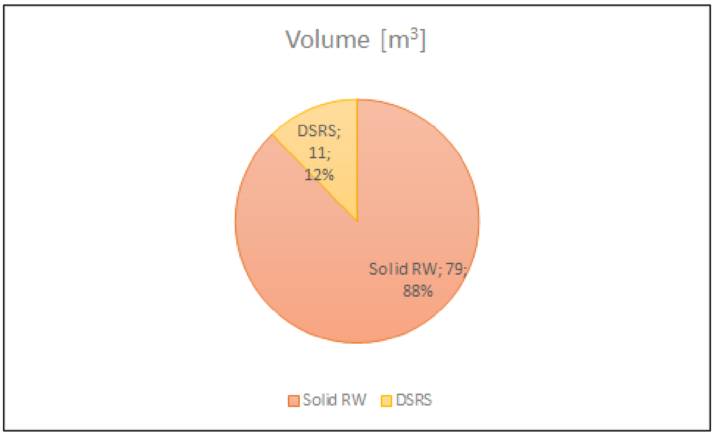
Due to the conditioning of DSRS, the volume of stored RW in the storage facility remained at the same level in recent years. It is a routine practice in the treatment of DSRS (including ionisation smoke detectors) that the device is disassembled, and the associated radioactive source is recovered and conditioned for storage. The rest of the non-radioactive material (plastic, metal and electronic components) is removed from CSF. After such conditioning, the radioactive part is in a more appropriate form for storage and requires significantly less space in the storage facility.

RW generated by small producers is divided into three main groups: solid RW (Group I), DSRS (Group II), and other radioactive waste (Group III).

Unconditioned DSRS are stored in the original shielding containers; conditioned sealed sources are encapsulated and inserted in a proper shielded container.

Solid RW is mostly packed in metal drums, while some unconditioned RW is packed in small plastic or metal containers. The drums contain mostly contaminated materials such as paper, glass, soil, sand, metal pieces and plastic materials.

Figure 2: **Inventory of institutional RW and DSRS at the CSF as of the end of 2019**



The inventory of RW is given in Section L, Annex (e), Table 15. DSRS accounted for 95% of the RW activity stored at CSF as of the end of 2019; the remaining activity is represented by solid RW. As much as

60% of RW stored at the end of 2019 contained short-lived radionuclides (^{60}Co, ^{137}Cs, ^{90}Sr, etc.), whereas the remainder contained long-lived radionuclides (^{226}Ra, ^{241}Am, ^{232}Th, etc.).

In 2019, the greatest portion of RW at the CSF, in terms of volume fraction, was from Group I. Solid RW accounted for approximately 88% of the stored inventory volume, whereas DSRS accounted for the remaining percentage. Among solid RW, combustible waste (compressible and incompressible waste) accounted for 28%; slightly less than half of the combustible waste is also compressible, while the remaining 30% was incompressible, non-combustible waste in a special form, or bulky items (T4), regarding which further processing is not reasonable. Although DSRS contribute substantially to the activity, the share of the volume they occupied in the storage facility was only 12% (including ionisation smoke detectors). RW from the other radioactive waste group (liquid and mixed waste) is rarely taken over since it must be pre-treated before it is brought into the CSF.

The Jazbec mine waste disposal site and Boršt hydro-metallurgical tailings disposal site

Basic data on mine waste and other debris at the Jazbec and Boršt disposal sites are summarised in Section L, Annex (e), Tables 16 and 17, which present the situation as of the end of 2019. The inventory of the radioactive material disposed of at both sites is not expected to change since the Jazbec waste pile is already closed and the Boršt hydro-metallurgical tailings disposal site is in the final phase of environmental remediation and is also not in a position to accept additional waste material.

Krško NPP

See Section L, Annex (e), Tables 10, 11, 12, 13 and 14.

(v) Nuclear Facilities in the Process of Being Decommissioned

There are no nuclear facilities currently being decommissioned. The Žirovski Vrh Uranium Mine, which is a radiation facility in accordance with the definition in the 2017 Act, is the only facility which has been successfully decommissioned in the Republic of Slovenia.

SECTION E: LEGISLATIVE AND REGULATORY SYSTEM

Article 18: Implementing Measures

Each Contracting Party shall take, within the framework of its national Act, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

The legislative, regulatory and administrative measures, and other steps necessary for implementing the obligations of the Republic of Slovenia under the Convention are discussed in this report.

Article 19: Legislative and Regulatory Framework

1. *Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.*
2. *This legislative and regulatory framework shall provide for:*

(i) the establishment of applicable national safety requirements and regulations for radiation safety;

(ii) a system of licensing of spent fuel and radioactive waste management activities;

(iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a license;

(iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;

(v) the enforcement of applicable regulations and of the terms of the licenses;

(vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.

3. *When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.*

1. Legislative and Regulatory Framework

The most prominent piece of legislation is the Act on Protection against Ionising Radiation and Nuclear Safety – ZVISJV 1 (Official Gazette of the Republic of Slovenia, No. 76/17 and 26/19; hereinafter: the 2017 Act), which entered into force in January 2018. The previous Act was adopted in 2002 and was subsequently revised four times. Due to the implementation of the European Directives and the transposition of the latest international standards in the field of radiation protection and nuclear safety, the decision was made to draw up a new law instead of amending the existing one. It has to be noted that after the adoption of the 2017 Act substantial work was devoted to updating the whole set of secondary legislation (the so-called Rules), which is nearly finished.

Less than half year after the entry into force of the 2017 Act, the SNSA started preparations for amending the Act due to perceived problems in implementing the provisions on the security clearance of foreign nationals who perform work in a nuclear facility and involving the handling of radioactive materials and the transport of nuclear materials. The Act Amending the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1A) was adopted by the National Assembly on 16 April 2019.

In the area of radioactive waste and spent fuel management, the 2017 Act defines the rules on the functioning of the Agency for Radioactive Waste Management as a mandatory service of general economic interest, as well as its organisation, funding, infrastructure and criteria for the determination of fees. The 2017 Act furthermore clearly defines the duties of the Agency for Radioactive Waste Management regarding orphan sources management.

On 6 March 2006, the Minister of the Environment and Spatial Planning adopted the Rules on Radioactive Waste and Spent Fuel Management. These Rules regulate the classification of radioactive waste according to the level and type of radioactivity, radioactive waste and spent fuel management, the extent of reporting on generated radioactive waste and spent fuel and the manner and extent of keeping a central record of generated radioactive waste and spent fuel and on keeping records of stored and disposed of radioactive waste and spent fuel.

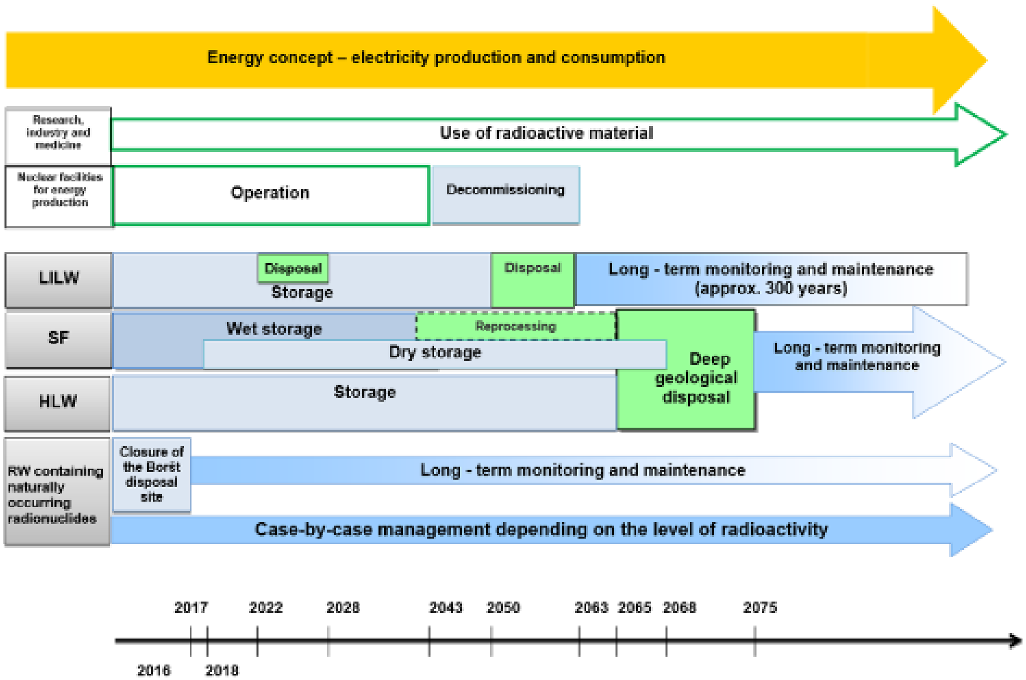
It is planned that after the adoption of the 2017 Act, these Rules will be replaced by new rules.

On 22 April 2016, the National Assembly of the Republic of Slovenia adopted the Resolution on the National Programme on Radioactive Waste and Spent Fuel Management for the Period 2016–2025 (hereinafter: ReNPRRO16–25). This resolution, which builds on and replaces the Resolution on the National Programme on Radioactive Waste and Spent Nuclear Fuel Management for the Period 2006–2015, contains the radioactive waste and spent fuel management policy, as well as strategies (concrete measures) for achieving the policies/objectives.

The main objective of the ReNPRRO16–25 is to ensure safe and efficient management of RW and SF in Slovenia in accordance with the principles of decision-making and actions based on the latest findings from domestic and foreign research, cutting-edge technologies and the best practices and operational experiences, and, consequently, to ensure the safety of people and the environment at all times and to simultaneously provide long-term, technologically modern and rational infrastructure support to users of nuclear and radiation technologies, including the necessary scientific and research activities, funding and communication with the public. The programme includes the principle of seeking a joint solution with the Republic of Croatia to the disposal of radioactive waste from the Krško NPP. The basic elements of the ReNPRRO16–25 and the timeline are shown in the Figure 3.

The ReNPRRO16–25 is appropriately placed in the overall Slovenian legal framework in this field. Based on the provisions of the 2017 Act, it is in line with the provisions of the Intergovernmental Agreement between Slovenia and Croatia on the co-ownership of the Krško NPP and its content fully complies with the requirements of the EU directive on the safe management of spent fuel and radioactive waste[1].

Figure 3: **Basic elements of the National Programme on Radioactive Waste and Spent Nuclear Fuel Management for the Period 2016–2025 and the timeline**



On 20 June 2013, the National Assembly of the Republic of Slovenia adopted the Resolution on Nuclear and Radiation Safety in the Republic of Slovenia for the Period 2013–2023. The Resolution represents a high-level national policy paper. Based on its transitional provision, the SNSA must report to the National Assembly on the implementation of the provisions of the Resolution once a year; such report is an integral

[1] Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, OJ L 199 (2 August 2011).

part of the SNSA's Annual Report on Radiation and Nuclear Safety, which is adopted by the Government and subsequently by the National Assembly of the Republic of Slovenia. In such report, success in achieving the objectives of the Resolution must be presented.

A comprehensive overview of the legislative and regulatory framework that governs nuclear and radiological safety is attached to this report (Section L, Annex (f)). The list consists of the national legal framework and the international instruments (multilateral and bilateral treaties, conventions, agreements and arrangements) to which the Republic of Slovenia is party.

(2i) National Safety Requirements and Regulations on Radiation Safety

In addition to the main principles (*inter alia*, "justification", "optimisation", "ALARA", "prime responsibility for safety", and the "causer pays" principles), the 2017 Act also includes, with respect to radiation protection areas, provisions on:

- notification to carry out radiation practices or to use a radiation source;
- the licensing of radiation practices or use of a radiation source;
- general principles on the protection of people against ionising radiation;
- the classification of facilities (nuclear, radiation and less important radiation facilities);
- licensing procedures with respect to the siting, construction, trial operation, operation and decommissioning of nuclear, radiation and less important radiation facilities;
- radioactive contamination and intervention measures;
- radioactive waste and spent fuel management;
- the import, export and transit of nuclear and radioactive materials, radioactive waste and spent fuel;
- the physical protection of nuclear materials and facilities;
- non-proliferation and safeguards;
- administrative tasks and inspection, and
- penalties.

Based on the 2017 Act, six decrees have been adopted by the Government and eight rules have been adopted by the competent ministers. Some of the rules and decrees are not newly adopted and continue to apply, even though they were adopted based on the Ionising Radiation Protection and Nuclear Safety Act from 2002. In the period since the sixth report under the Joint Convention, the Decree on Dose Limits, Reference Levels and Radioactive Contamination was adopted and entered into force on 4 April 2018. The decree transposes into the Slovenian legal system a significant part of the provisions of the Basic Safety Standards Directive[2] (hereinafter: the BSS Directive) on the dose limits and reference levels for existing and planned exposures as well as for emergency exposures.

Furthermore, the Decree on the National Radon Programme entered into force on 21 March 2018, which was adopted to manage long-term health risks from exposure to radon. The UV4 sets out, *inter alia*, a strategy for managing increased radon exposures, including targets and performance indicators for reducing health risks, reference levels of radon concentrations in work and living environments, criteria for determining multi-radon areas and specific radiation protection measures for these areas, and the method and methodology for determining the annual average of radon concentrations.

On the very same day when the Decree on the National Radon Programme entered into force, the Decree on the Programme of the Systematic Monitoring of Working and Residential Environments and Raising Awareness about Measures to Reduce Public Exposure to Natural Radiation Sources, in the part defining the measures related to the effects of radon, ceased to apply.

The above-mentioned Decree on the Programme of the Systematic Monitoring of Working and Residential Environments and Raising Awareness about Measures to Reduce Public Exposure to Natural Radiation Sources completely ceased to apply with the adoption of the Decree on Reduction of Exposure due to Natural Radionuclides and Past Activities or Events (UV5), which was published in the Official Gazette of RS, No. 38/18 on 6 June 2018 and entered into force on 21 June 2018. With the UV5 some provisions of

[2] Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (OJ L 13, 17. 1. 2014).

the BSS Directive were transposed into the Slovenian legal system. This regulation sets out industrial activities, in which the material contains increased content of natural radionuclides, and the identification of past or existing activities or events of work in two circumstances, for which it could be certain that they originated from the past activities or emergencies.

On 21 March 2018 the Decree on Radiation Activities was adopted, replacing the previous decree of the same name in this area from 2017. This Decree lays down the sources of ionising radiation for which notification is not required; radiation practices that do not need to be notified; the types of radiation sources that only need to be entered in the register of radiation sources before use and those for which a license for use must be obtained before use; the criteria and conditions for the classification of radiation practices requiring the registration of a radiation practice and the radiation practices for which a license for carrying out a radiation practice must be obtained; the criteria for identifying high-activity and dangerous radiation sources, and the acceptability criteria for the use of consumer products.

At the beginning of 2019, the Decree on Checking the Radioactivity of Consignments that Could Contain Orphan Sources entered into force. The Decree regulates the comprehensive legal framework that seeks to prevent or at least mitigate the undesirable effects that can be caused by unmanaged radioactive sources. At the same time, some provisions of the BSS Directive relating to the search for sources of unknown origin were transposed into the Slovenian legal system. The Decree basically follows the previous one from 2007, i.e. Decree on Checking the Radioactivity of Shipments of Metal Scrap. However, it extends the range of those who will need to perform measurements, namely operators of major postal centres, airports and ports, contractors for the management of waste electrical and electronic equipment in installations for processing such equipment, and the managers of municipal waste management centres. The Decree entered into force on 2 March 2019; however, all new obligations apply since 2 March 2020.

Finally, the Decree on the Areas of Limited Use of Land due to a Nuclear Facility and the Conditions of Facility Construction in These Areas (UV3) was adopted on 19 December 2019 and entered into force on 4 January 2020. It aims to ensure its consistency with other legislation in the field of construction and spatial planning, while ensuring the implementation of radiation and nuclear safety measures that restrict the use of land near a nuclear facility. Limited use of land reduces the possibility of an industrial or other disaster occurring outside a nuclear facility that could have an impact on nuclear safety. At the same time, population density limits and requirements regarding local infrastructure facilities are also determined to reduce the potential of damage to human health should an emergency occur in a nuclear facility. The provisions of the regulation are thus based on the principle of integrity such that, when issuing regulations, opinions and permits, and when deciding on other administrative matters, exercising control, and performing other tasks within its competence, it determines all possible appropriate and reasonable measures to prevent damage to human health and radioactive contamination of the environment. For existing nuclear facilities, namely the nuclear power plant in Krško, the TRIGA MARK II research reactor, and the Central storage of radioactive waste in Brinje, the restricted areas remain unchanged compared to the provision of the previous Decree on Areas of Restricted Use due to Nuclear Facilities and on the Conditions for Construction in these Areas from 2004. The conditions for the construction of individual facilities are harmonised with the new general regulation on the classification of facilities adopted on 30 May 2018 (The Decree on the Classification of Structures) based on the Construction Act. The list of parcels around the Krško Nuclear Power Plant has also been updated, which, despite the general ban on the construction of residential buildings in the wider area of controlled use, is permitted.

Several ministerial rules were also adopted after the last national report of October 2017, mainly following the adoption of the 2017 Act.

On 20 April 2018, the Rules on the Use of Radiation Sources and Radiation Activities (JV2/SV2) were published. These Rules basically follow the Rules from 2006, but they transpose into Slovenian legislation the provisions of the new BSS Directive relating to the handling of high-activity sources. The Rules define measures for the protection of radioactive sources. They no longer address the management of radiation sources in medicine, which is defined in the Rules on the Criteria for Using Ionising Radiation Sources for Medical Purposes and for the Deliberate Exposure of Individuals for Non-Medical Purposes (SV3).

On 19 March 2018, the new Rules on Radioactivity Monitoring (JV10) were adopted. The main changes were made due to the transposition of the BSS Directive and harmonisation with the 2017 Act. The Rules prescribe the scope and manner of implementation of the radioactivity monitoring programme and redefines the quality requirements for measurements. The conditions to be fulfilled by monitoring contractors have been supplemented based on experiences during the implementation of the previous regulation, and other shipments and scrap electrical and electronic equipment have been added to the requirements for radioactive waste measurements. The scheme of operational monitoring programmes was expanded with the scheme of a monitoring programme for low- and intermediate-level radioactive waste. The scheme for the emergency monitoring programmes in the event of an emergency were updated, as well as the programmes for emergency preparedness.

Furthermore, in the field of radiation safety in medicine or veterinary use, the Minister of Health alone or in agreement with the Minister of the Environment and Spatial Planning issued several regulations:

- in June 2018, the Rules on the Criteria for using Ionising Radiation Sources for Medical Purposes and for the Deliberate Exposure of Individuals for Non-Medical Purposes (SV3);
- in July 2018, the Rules on Special Radiation Protection Requirements and the Method of Dose Assessment (SV5);
- in June 2018, the Rules on Authorising Ionising Radiation Practitioners (SV7);
- in July 2018, the Rules on Authorising Radiation Protection Experts (SV7A);
- in July 2018, the Rules on the Obligations of Persons Carrying Out a Radiation Practice and Persons Possessing an Ionising Radiation Source (SV8); and
- in July 2018, the Rules on Radiation Protection Measures in Controlled and Monitored Areas (SV8A).

The Slovenian legislation is based on broadly accepted international standards. Furthermore, all the European Union Directives from the field of radiation and nuclear safety have been completely transposed into Slovenian legislation.

Within the legislative and regulatory framework covering spent fuel and radioactive waste management, the following decrees and acts should be mentioned:

- The Decree on the Establishment of the Public Agency for Radwaste Management;
- The Decree on the Method and Subject of and Conditions for Performing the Public Service of Radioactive Waste Management;
- The Fund for Financing the Decommissioning of the Krško Nuclear Power Plant and the Disposal of Radioactive Waste from the Krško NPP Act;
- The Permanent Cessation of Exploitation of the Uranium Ore and Prevention of the Consequences of Mining in the Uranium Mine at Žirovski Vrh Act; and
- The Decree on the Method, Subject of, and Conditions for Performing the Compulsory Public Utility Service of Long-term Surveillance and Maintenance of Landfills for Mining and Hydro-metallurgical Tailings Resulting from the Extraction of and Exploitation of Nuclear Mineral Raw Materials.

(2ii) Licensing System

A system for licensing spent fuel and radioactive waste management is provided in the 2017 Act, while the Rules on Radiation and Nuclear Safety Factors (JV5) lay down details on the documentation that must be submitted together with the application in a particular phase of licensing. The prescribed licensing process is of a general nature, so it is applicable to the whole spectra of nuclear and radiation facilities.

The basic classification of facilities is provided by the 2017 Act itself, where in definition No. 29 of Article 3 it provides that a nuclear facility is “a facility for the processing or enrichment of nuclear materials or the production of nuclear fuels, a nuclear reactor in critical or sub-critical assembly, a research reactor, a nuclear power plant or heating plant, a facility for the storage, processing, treating or disposing nuclear fuel or high radioactive waste, or a facility for the storage, processing or disposal of low- and intermediate-level radioactive waste.” Therefore, the entire spectrum of licensing requirements (for siting, construction, trial operation, operation, decommissioning and/or closure of the repository) must be complied with by the applicant (the investor or operator of the facility) in accordance with the provisions of the 2017 Act and of the Rules on Radiation and Nuclear Safety Factors.

The licensing system for a nuclear facility can be divided into three steps after the preliminary conditions (the planning of the location of the nuclear facility in the national site development plan) are fulfilled:

- the application for a license to construct a facility – based on the integral procedure including approval of the environmental impact assessment – the competent body is the Ministry of the Environment and Spatial Planning, with the approval of the SNSA;
- the application for a license for trial operation – the competent body is the Ministry of the Environment and Spatial Planning, with the approval of the SNSA;
- the application for operation and decommissioning (or closure in the case of a repository for radioactive waste) – the competent body is the SNSA.

The general requirements for the design basis for a radioactive waste or spent fuel storage facility and for a radioactive waste repository are laid down in the Rules on Radiation and Nuclear Safety Factors.

In the licensing processes intended to obtain prior consent (of the SNSA) to the construction permit for the facility, the investor/operator shall attach to the licence application, in addition to the design documentation, a safety analysis report, the opinion of an authorised radiation and nuclear safety expert (authorised by the SNSA), and other prescribed documentation as determined by the Rules on Radiation and Nuclear Safety Factors.

In the subsequent licensing processes (for approval of the trial operation, operation, decommissioning or closure of the facility), the licensee must submit the above-described application with an appropriately amended set of documents and opinions. The operating experience and feedback and any modifications to the facility must be clearly documented and described.

The general provisions and the responsibilities of holders of radioactive waste and spent fuel (as well as of the State) are defined in Section 4.7., "Radioactive waste and spent fuel management" of the 2017 Act. The 2017 Act (Articles 121-129) contains provisions on the following:

- radioactive waste and spent fuel management;
- mandatory service of general economic interest (management of radioactive waste, radioactive waste disposal, long-term surveillance and maintenance of closed radioactive waste repositories or mining waste disposal and tailings);
- the long-term surveillance and maintenance of closed radioactive waste repositories or repositories of mining and hydro-metallurgical tailings;
- the national programme for radioactive waste and spent fuel management; and
- national infrastructure facilities.

The Rules on Radioactive Waste and Spent Fuel Management contain, *inter alia*, provisions on the following:

- the classification of radioactive waste with regard to the aggregation state and level and type of radioactivity;
- the requirements for radioactive waste and spent fuel management (general requirements – radioactive waste or spent fuel management procedures, programmes and plans; special requirements – sorting, treatment and packing, labelling, keeping, storing, decay-keeping, handover and takeover, reshuffling, liquid and gaseous radioactive waste release, disposal, acceptance criteria for storage or disposal, waste from the exploitation and reprocessing of raw nuclear mineral material, and very-low-level radioactive waste management); and
- record-keeping and reporting (the holder's records, the central records, reporting, loss and findings).

The Decree on the Method and Subject of and Conditions for Performing the Public Service of Radioactive Waste Management contains, *inter alia*, provisions on the following:

- the scope and type of the public service;
- the general requirements for performing the public service;
- the requirements that must be fulfilled by the performer of the public service;
- the rights and duties of the use of the public service;
- financial sources and the method of establishing the price; and
- inspection.

The public service for radioactive waste management referred to in Article 122 of the 2017 Act was established in 1991 as the Agency for Radwaste Management (ARAO) with the Governmental Decree on the Establishment of a Public Agency for Radwaste Management adopted at that time based on the Environmental Protection Act.

(2iii) System of Prohibition of the Operation of a Spent Fuel or Radioactive Waste Management Facility without a Licence

Spent fuel and radioactive waste management facilities are defined by the 2017 Act as nuclear facilities. Consequently, all relevant licences are needed, including an operating licence. The operation of such a facility without a licence is prohibited according to Article 87 of the Act.

In the penal provisions of the 2017 Act, a financial penalty is foreseen for the violation the above-mentioned prohibition.

(2iv) System of Appropriate Institutional Control, Regulatory Inspection, and Documentation and Reporting

Institutional control and regulatory inspection with respect to the safe management of spent fuel and radioactive waste rests with the SNSA. Within the scope of inspection, an inspector may:

- issue decisions and orders within the framework of administrative proceedings;
- order measures for radiation protection and measures for radiation and nuclear safety to ensure that the licensee fulfils all legal requirements regarding safety;
- order the termination of a radiation practice or use of a radiation source where the inspector finds that a proper licence has not been issued or if there is a failure in following the prescribed methods for handling the radiation source or radioactive waste; an appeal against such a decision of an inspector shall not hinder its execution; and
- seal any radiological device that does not meet the acceptance criteria for proper operation.

The 2017 Act has only one article (Article 178) on inspection, since the Inspection Act prescribes the general principles of inspection, its organisation and status, the rights and duties of inspectors, inspection measures and other issues relating to inspection, which are to be followed also by nuclear and radiation safety inspectors.

The Rules on Radioactive Waste and Spent Fuel Management also contain provisions regarding documentation and reporting. They determine that a holder who temporarily stores, stores, conditions or disposes of radioactive waste or spent fuel and a holder wo discharges radioactive waste shall keep records of radioactive waste or spent fuel, provide information on its temporary storage, conditioning through any technological process, storage or discharge, or clearance and handover to the public service provider. The holder shall keep this record in accordance with the programme or radioactive waste management plan and must send the data regarding the generation of radioactive waste or spent fuel to the Central Register of Radioactive Waste or Spent Fuel, managed by the SNSA.

(2v) The Enforcement of Applicable Regulations and of the Terms of Licences

The enforcement of applicable regulations and of the terms of licences is ensured by the application of penal provisions, inspection, and provisions relating to the issuance, renewal, amendment, withdrawal and expiration of licences, as provided for in the 2017 Act.

Based on the Inspection Act as well as on the 2017 Act, a graded approach in enforcement policy is ensured. Inspectors may (if in their assessment such a measure is sufficient and appropriate) only warn the licensee of the irregularities and set a date by which the corrective measures must be carried out. The inspector may also (among other measures) perform all measures (as listed below) in line with the Minor Offences Act or report (in the case of a criminal offence) the licensee to the public prosecutor.

Within the scope of an inspection, an inspector may:

- issue decisions, conclusions and/or orders within the framework of administrative proceedings;
- order measures for radiation protection and measures for radiation and nuclear safety;
- order the cessation of a radiation practice or use of a radiation source when it is established that an applicable license has not been issued or if the prescribed methods of handling a radiation source or radioactive waste have not been followed. An appeal against such decision of an inspector does not prevent its execution.

Inspectors may also terminate a radiation practice or prohibit the use of a radiation source if someone performs/carries out a radiation practice or uses a radiation source without an appropriate licence; however, inspectors do not revoke or suspend any of these licences. This can only be done by the authority that issued the licences (in most cases, the SNSA), although the inspector may propose such a measure.

(2vi) Allocation of Responsibilities

As described above, the legislative framework (the 2017 Act, the Decree on the Method and Subject of and Conditions for Performing the Public Service of Radioactive Waste Management and the Rules on Radioactive Waste and Spent Fuel Management) determines a clear allocation of the responsibilities of the bodies involved in the management process of spent fuel and radioactive waste (producer, holder, mandatory state-owned public services, regulatory body), and also defines the system of recording and reporting.

Article 20: Regulatory Body

1. *Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
2. *Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.*

1. Regulatory Body – the Slovenian Nuclear Safety Administration (SNSA)

The SNSA, as a regulatory body in the area of nuclear and radiation safety, is a functionally autonomous body within the Ministry of the Environment and Spatial Planning (hereinafter: the Ministry). The SNSA's responsibilities and competences are defined in the Governmental Decree on Administrative Authorities within Ministries.

The SNSA performs administrative and developmental tasks in the field of nuclear and radiation safety, radiation practices and the use of radiation sources (with the exception of medicine and veterinary medicine), environmental protection against ionising radiation, the physical protection of nuclear materials and facilities, the non-proliferation and security of nuclear materials, radiation monitoring and liability for nuclear damage; it also carries out inspection duties in the above areas and cooperates in radiological or nuclear emergency events with the State Civil Protection Headquarters in the determination of protective measures for the population and in informing the public.

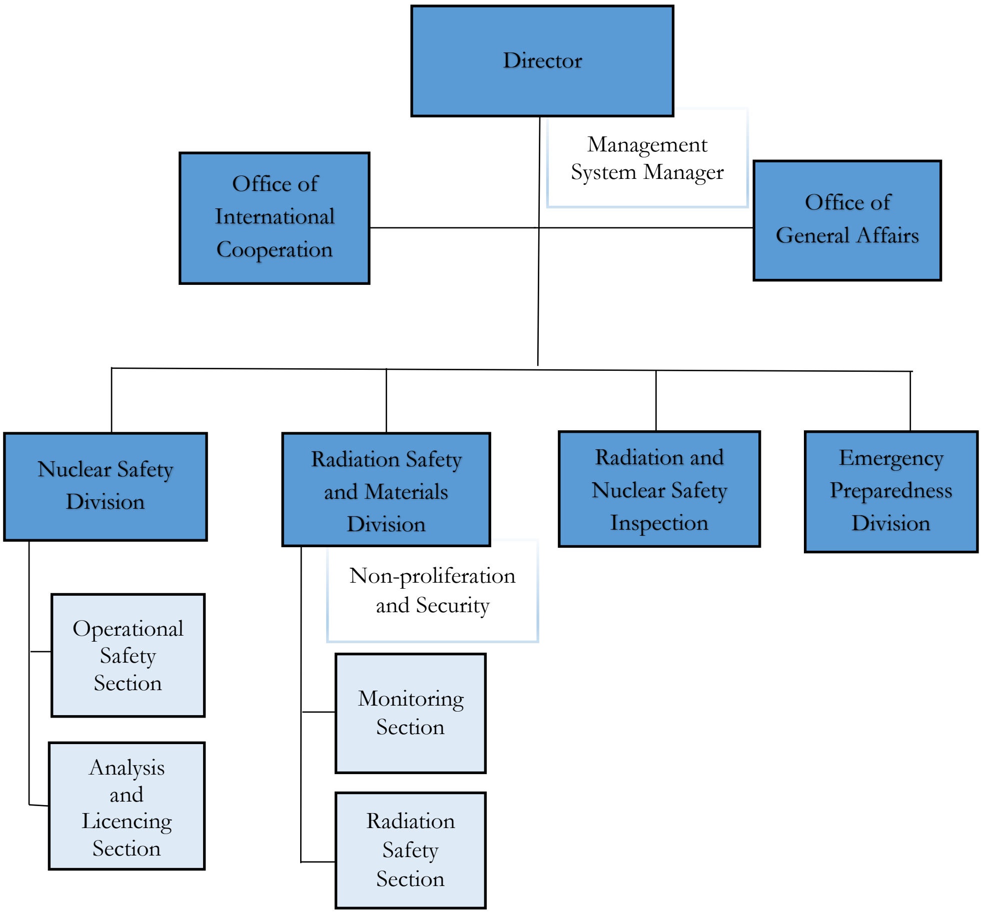
The legal basis for its administrative and professional tasks in the field of nuclear safety, radiation protection and inspection are given by the 2017 Act and implementing decrees and rules adopted on the basis thereof and by-laws within the wider area of nuclear and radiation safety, as well as by ratified and published international treaties in the field of nuclear energy and nuclear and radiation safety. A detailed presentation of the legislation in force is available on the SNSA website.

The precise competences of the SNSA and other relevant administrative bodies that are entrusted with implementation of the legislative framework to govern the safety of spent fuel and radioactive waste management are prescribed in particular in the 2017 Act and other legislation listed in Section L, Annex (f) of this report.

The SNSA is generally organised into four divisions and two offices. These are:
- the Nuclear Safety Division;
- the Radiation Safety and Materials Division;
- the Emergency Preparedness Division;
- the Radiation and Nuclear Safety Inspection Service;
- the International Co-operation Service; and
- the General Affairs Service.

The SNSA's internal organisational units are shown in Figure 4.

Figure 4: **Internal organisational units of the SNSA**



The staff of the SNSA are interdisciplinary, consisting of employees with a range of educational backgrounds: physicists, mechanical, electrical and chemical engineers, geotechnologists, architects, metallurgists, geologists, lawyers, linguists, and administrative workers.

At the end of 2019, the SNSA had 44 employees, of whom11 held a doctorate and 11 a master's degree; 21 had completed higher or university education, and one had completed secondary school education. With respect to gender structure, there are 20 women employed at the SNSA (45%) and 24 males (55%), while the average age of employees is 49.6 years, ranging from 23 to 66 years.

The SNSA has a so-called "systematic approach to training" system to ensure competence and optimise the training and internal organisation of the SNSA. This system is designed and built primarily on the basis of IAEA TECDOC 1254. During development, this concept was adapted to the needs of the SNSA and named SAT-SNSA. This system includes the SNSA organisational structures and all key processes. It also defines all job positions, and all work tasks and competences. Regular updating is achieved by means of annual career planning interviews. Based thereon, the SNSA prepares a so-called Educational and Training Plan for its employees each year. Recently the SNSA improved the system through the better preparation of training needs. Initial and refresher training courses were added for each job position. Previously, training needs were based on competences and a gap analysis for job positions. With these improvements it became possible to prepare more effective training plans.

The course on "Fundamentals of Nuclear Technology" was attended by some new staff members of the SNSA and other courses at the Nuclear Training Centre in Ljubljana are frequently included in such programmes; a part of such individual programmes are events (courses and workshops) organised by the IAEA, and many SNSA staff attended courses on Westinghouse technology organised at the US NRC Training Centre in Chattanooga, TN.

Due to financial restrictions and Government policies that greatly limit budgetary resources, since 2013 the SNSA has not been able to extend a contract with an external auditor and therefore could not maintain the ISO 9001standard; however, in its business the SNSA still preserves all of the elements necessary for the implementation of the management system in accordance with this standard as well as in accordance with the IAEA GSR Part 2 "Leadership and Management for Safety".

The Director of the SNSA is the head of the regulatory authority and represents the SNSA. At the governmental and parliamentary level, the SNSA is represented by the Minister of the Environment and Spatial Planning. The Director is responsible to the Minister for his or her work and for the work carried out by the SNSA. The organisation of the SNSA is prepared by the Director and approved by the Government on the motion of the Minister.

On 1 May 2019 the SNSA gained new leadership. The long-time director, who had led the SNSA since September 2002, retired at the end of April 2019 and was succeeded by a long-time SNSA staff member who, before being appointed as new director, had served as the Head of the Emergency Preparedness Division.

Regulatory matters relating to spent fuel and radioactive waste management are dealt with by the Radiation Safety and Materials Division.

The budget of the SNSA is determined on the basis of the activities carried out in the previous year, taking into account new needs, which have to be well justified. The budget is the only source of financing for the SNSA's basic activities. The operators of nuclear or radiation installations and other licensees do not pay any licensing or inspection fees. The only fee that is applicable under the general Act on Administrative Fees is the so-called administrative tax for the licensing (administrative) procedure, which is of symbolic value. Such fees are paid into the state budget and not directly to the SNSA. Furthermore, if the SNSA determines that some expertise is needed within the licensing (administrative) procedure, the applicant bears the costs under the relevant provision of the Act on General Administrative Procedure.

Although the SNSA is part of the Ministry, it still has its own share of the Ministry's budget and is independent in allocating funds for the programmes, projects and other expenses from its budget. The state budget is prepared on the basis of a biannual cycle. The composition of the SNSA's budget for 2017, 2018 and 2019 is shown in Table 2. This budget comprises all activities within the SNSA's areas of competence.

Table 2: **The SNSA budget for 2017, 2018 and 2019**

Structure		**2017 (in EUR)***	**2018 (in EUR)***	**2019 (in EUR)***
Salaries		1,607,791	1,540,651	1,666,986
Material Expenses		276,500	117,129	199,679
Investments and maintenance costs		21,000	66,500	79,906
Membership fees (IAEA, OECD/NEA membership)		280,827	401,461	372,009
International projects		90,000	244,399	154,541
Outsourcing	Nuclear Safety	80,000	110,668	80,633
	Radiation Safety	101,000	136,803	140,489
Total		**2,457,118**	**2,617,611**	**2,694,243**

Note: *The figures for individual years are slightly different from those presented in previous reports because the SNSA budget for each year occasionally changes in line with adjustments to the state budget.

2. Other Regulatory Bodies

The 2017 Act assigns responsibility in the area of radiation practices and the use of radioactive sources in health and veterinary care to the Slovenian Radiation Protection Administration (SRPA) within the Ministry of Health. In general, the responsibilities are divided between the SNSA and the SRPA in the area of radiation protection, while the area of nuclear safety is the SNSA's sole responsibility. The SNSA is responsible for monitoring emissions into the environment, while the SRPA is responsible for monitoring the exposure of the population. Based on the 2017 Act, the SNSA is competent for issuing consents for mining work, licensing operations, the completion of decommissioning and the closure of repositories, while the SRPA performs inspection tasks in the area of radiation protection (dose limits, the protection of exposed workers, etc.).

The SRPA's responsibilities and competences are (as for all other governmental bodies) also defined in the Decree on Administrative Authorities within Ministries: "The SRPA performs technical, administrative and developmental tasks in the area of radiation practices and the use of radiation sources in health and veterinary care; the health protection of people against the detrimental effects of ionising radiation; systematic inspection of work premises and living spaces due to the exposure of people to natural radiation sources; implementation of monitoring the radioactive contamination of foodstuffs and drinking water; assessment of compliance and the authorisation of radiation protection experts; inspection duties in the above mentioned areas; and the reduction, restriction and prevention of the effects of non-ionising radiation detrimental to health."

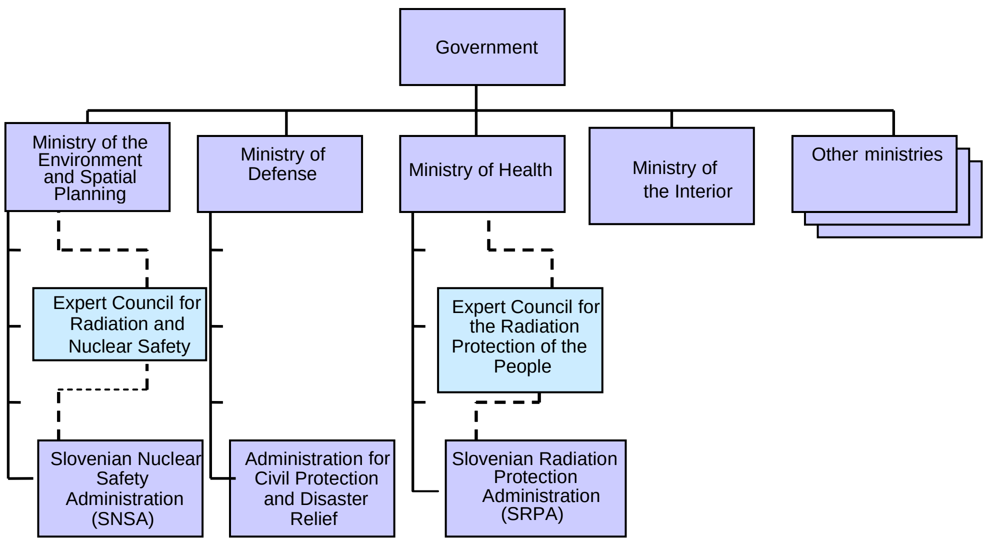
Besides the SNSA and the SRPA, some other administrative bodies, ministries and organisations are also entrusted with the implementation of the 2017 Act, in particular:

- The Administration for Civil Protection and Disaster Relief (within the Ministry of Defence), as the leading authority for emergency preparedness and response;
- The Ministry of the Interior has, *inter alia*, competences in the area of the physical protection of nuclear materials and nuclear facilities in general, while the SNSA approves the safety analysis report, to which the physical protection plan is attached as a separate and restricted document; for the physical protection plan of nuclear facilities the prior consent of the SNSA is needed and then it is approved by the Ministry of the Interior;
- The Environmental Agency within the Ministry of the Environment and Spatial Planning;
- The Spatial Planning Directorate within the Ministry of the Environment and Spatial Planning; and
- The Directorate for Energy (within the Ministry of Infrastructure).

Based on the 2017 Act, the Expert Council for Radiation and Nuclear Safety was appointed as an advisory body to the Ministry of the Environment and Spatial Planning and the SNSA; at the same time, the Expert Council for the Protection of People against Ionising Radiation, with responsibility for radiological procedures and the use of radiological sources in health and veterinary care, was appointed as an advisory body to the Ministry of Health and the SRPA.

The position of the SNSA and the SRPA in the governmental structure is shown in Figure 5.

Figure 5: **The SNSA and the SRPA within the governmental structure**



3. Effective Independence

The effective independence of the regulatory body (the SNSA) is ensured by the overall effect of various provisions of different laws and by-laws that generally define, *inter alia*, the following: the position of administrative bodies such as the SNSA and the SRPA within the structure of the ministries; the structure of the state budget; the reporting scheme within the governmental framework; and the decision-making hierarchy in appeal processes within administrative procedures.

The SNSA is a part of the state administration. Based on the Public Administration Act, the SNSA, in terms of its administrative decisions, is an independent body within the Ministry of the Environment and Spatial Planning. Administrative decisions encompass all decisions taken by the SNSA within the licensing process and within inspection control. Decisions adopted by the SNSA within its scope of competence are taken solely and exclusively by the SNSA and cannot be dictated or imposed on the SNSA by the Ministry of the Environment and Spatial Planning, the Minister or any other body within the Ministry. In some cases, the 2017 Act provides that an appeal against an SNSA ruling is not possible. This does not mean, however, that the licensee has no judicial remedy available. The licensee may not file an appeal in an administrative procedure (where the decision would be taken by the Ministry of the Environment and Spatial Planning), but does have a constitutional right to submit its case to a court within a civil law procedure.

In accordance with the 2017 Act, besides licensing, also the inspection and enforcement of nuclear and radiation safety fall within the competence of the SNSA. The inspection powers include control over implementation of the provisions of the 2017 Act, regulations and decrees issued in accordance with the 2017 Act, and other terms of licences. Within the scope of inspection, an inspector may:

- issue decisions, conclusions and/or orders within the framework of administrative proceedings;
- order measures for radiation protection and measures for radiation and nuclear safety; and
- order the cessation of a radiation practice or use of a radiation source when it is established that the applicable licence has not been issued or if the prescribed methods of handling a radiation source or radioactive waste have not been followed.

An appeal against a decision of an inspector does not prevent its execution.

The enforcement of applicable regulations and the terms of licences is ensured by the application of penal provisions and inspection provisions, as well as by provisions related to suspending the operation of a nuclear facility, as provided by the 2017 Act.

The office of the Director of the SNSA is not a political position in the Slovenian legal system (unlike the office of a Minister or State Secretary), but rather it is the highest level in the structure of employees (i.e. civil servants) within the governmental administration. Open competition for the position of Director of the SNSA (or certain other positions in governmental bodies, for example managing directors, secretaries-general and the heads of bodies within ministries and of administrative units) is carried out by a special Competition Commission, which in each case shall be appointed by the governmental Council of Officials. The whole procedure is set out in the Civil Servants Act. Once appointed, the Director of the SNSA is directly subordinate to the Minister and reports to the Minister, but in administrative decisions he or she is independent of the Minister or any other body within the Ministry. The Public Administration Act and the 2017 Act ensure the *de jure* independence of the SNSA.

SECTION F: OTHER GENERAL SAFETY PROVISIONS

Article 21: Responsibility of the Licence Holder

1. *Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.*
2. *If there is no such license holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.*

The provisions on the prime responsibility of the licence holder for the safety of nuclear and radiation facilities and also for the safety of spent fuel management or radioactive waste management is one of the main principles of the 2017 Act.

Article 87 of the 2017 Act provides the following specific requirement: "A nuclear facility, a radiation facility or a less important radiation facility may not be constructed, tested, operated or used in any other way, or permanently ceased to be used, without a prior approval or permit issued pursuant to this Act. The safety of a facility, including the safety of handling radioactive substances, radioactive waste or spent fuel which is found or produced in the facility, must be ensured by the operator."

The system of licences is set up to ensure that facilities are designed, constructed, commissioned and prepared for operation in accordance with national and international codes, standards and experiences.

A clear requirement for the handling of radioactive waste and spent fuel is determined in Article 121 of the 2017 Act, which provides that a holder of radioactive waste and spent fuel shall ensure that the radioactive waste and spent fuel are handled in the manner prescribed and that the transfer of the burden of disposing of radioactive waste and spent fuel to future generations is avoided as far as is possible. The producers responsible for the occurrence of radioactive waste and spent fuel must ensure that the radioactive waste is produced in the smallest possible quantities.

The costs of radioactive waste and spent fuel management must be paid by the person responsible for its generation or by the holder of the waste if the ownership was transferred to him by the person responsible for its occurrence, or if he or she acquires it in any other way.

If the person responsible for the generation of radioactive waste or spent fuel is not known, the State must assume full responsibility for its management.

The holder of radioactive waste and spent fuel must forward the information on the generation thereof to the central registry of radioactive waste and spent fuel, which is maintained by the Slovenian Nuclear Safety Administration.

Article 22: Human and Financial Resources

Each Contracting Party shall take the appropriate steps to ensure that:

(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility,

(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning,

(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

The licensee has the prime responsibility for the safety of its facilities. This responsibility includes the provision of adequate financial and human resources both to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for their decommissioning.

Krško NPP

(i) Human Resources

The Krško NPP has overall responsibility for its design, engineering, construction, licence application, operation, fuel management, procurement and quality assurance procedures, as well as for radioactive waste management. The Krško NPP is organised in several divisions, including the Technical Operations Division, which is responsible for operating, maintenance and technical services; the Engineering Services Division, responsible for design, engineering, configuration management, licensing, procurement engineering and the process information system; the Quality and Nuclear Oversight Division, which is responsible for quality assurance, quality control and independent nuclear oversight; the Procurement Division; the General Administrative Division; and the Finance Division. In all positions, qualified personnel perform all the various activities needed for radioactive waste and spent fuel management. At the end of 2019, 628 people, both technical and non-technical staff, were employed at the Krško NPP.

The handling of radioactive waste is the responsibility of the Chemistry Department, which is a part of the Technical Operations Division. The Chemistry Department is also responsible for decontamination activities.

The Nuclear Fuel Engineering Department, which is a part of the Engineering Service Division, is responsible for the accountability and control of special nuclear materials and for spent fuel management. The handling of processes themselves is carried out by the Nuclear Fuel Engineering Department and the Operations Department.

Radiological control is carried out by the Radiation Protection Department, which is also part of the Technical Operations Division.

Personnel Qualifications and Experience

All technical posts at the Krško NPP are assessed. The minimum requirements in terms of educational qualifications, the number of years of experience in relevant positions and certified competence to undertake certain tasks are ensured by the Krško NPP.

The qualifications consist of the basic formal education and special knowledge. Special knowledge involves basic principles of the operation of nuclear power plants, radiological protection, industrial safety, safety culture, and other areas. The courses and training exercises are organised by the Training Department, which is also responsible for the record keeping of personnel qualifications.

The process of identifying potential candidates for leadership positions and for succession planning was implemented in accordance with best industry practices. Employee engagement and motivation are monitored on an annual basis to support the expectations defined in the human resources policy.

Training

All personnel working at the plant receive basic introductory training. The training course is comprehensive, addressing, *inter alia*: organisational arrangements, area designations and arrangements for working in radiologically controlled areas, plant layout and services, industrial safety, quality assurance, and emergency response.

Training in radiological protection is provided at different levels of complexity, depending on the level of responsibility of the employee. A basic training course is given to all personnel before they enter a radiologically controlled area, with the objective of ensuring that they have sufficient understanding of the principles of ionising radiation to enable them to work safely in the controlled area. A more advanced course is provided for the personnel permanently working in a controlled area or with systems that contain radioactive material. Personnel specialised in health physics attend the most advanced course.

Personnel dealing with radioactive waste and spent fuel are educated and trained to perform their duties. Special services in this area are also provided from abroad.

(ii) Financial Resources

The expenses for radioactive waste treatment, conditioning and storing, and for spent fuel storage are part of the production costs. The financial resources for these activities are ensured during the operational period of the Krško NPP.

According to the Agreement, the owners of the Krško NPP, GEN energija, d.o.o. and Hrvatska Elektroprivreda d.d., are obliged to ensure the funds for the decommissioning and final disposal of radioactive waste and spent fuel.

The Slovenian share of funds for the decommissioning of the Krško NPP and for the post-operational radioactive waste and spent fuel management are ensured through the Act Governing the Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP. This Act was amended in 2003 in light of the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of the Status and Other Legal Relations Regarding the Investment, Exploitation and Decommissioning of the Krško NPP.

The Croatian share of funds for the decommissioning of the Krško NPP and for post-operational radioactive waste and spent fuel management is ensured in accordance with the bilateral Agreement through the adequate Croatian Fund for Decommissioning and Spent Fuel Management. The Croatian Fund was established by the Act on Governing the Fund for Financing the Decommissioning and Disposal of Radioactive Waste and Spent Fuel of the Krško NPP. This act was adopted by the Croatian legislature in October 2007.

Jožef Stefan Institute Reactor Infrastructure Centre

(i) Human Resources

The TRIGA Mark II research reactor operation staff (the full-time staff consist of four reactor operators, three radiological protection technicians, the head of the radiological protection group, the quality assurance manager, and a secretary; while the part-time staff consists of the head of reactor operation and the head of the reactor infrastructure centre) are responsible for spent fuel and radioactive waste handling and management. The staff are appropriately trained and equipped.

The Hot Cell Laboratory operates under the TRIGA Mark II research reactor operating licence. The staff are the same as for the TRIGA research reactor.

The TRIGA Mark II research reactor operation staff are responsible for and trained to perform specific tasks in spent fuel management and radioactive waste management. The specific knowledge, training, skills and certificates required for reactor operators to carry out these tasks are a radiological protection certificate, a crane operator certificate, a forklift driver certificate, a welder certificate and remote manipulation skills.

The personnel must also have some practical experience with spent fuel shipment projects and the treatment of spent sealed sources for storage.

(ii) Financial Resources

The financial resources for maintaining the safety of spent fuel and radioactive waste at the JSI Reactor Infrastructure Centre are provided from the budget for the operation of the reactor. Financial provisions for decommissioning are not provided. However, as the Republic of Slovenia is the owner of the facility, it will also have the responsibility to ensure financial resources for proper decommissioning and spent fuel management.

The Agency for Radwaste Management

(i) Human Resources

The ARAO is a mandatory service of general economic interest public utility service and the number of employees is defined by the Government. At present, there are four organisational units and several independent services, including the QA/QC Service and the Radiation Protection Service. The ARAO has a qualified staff of 21 persons who perform all phases of institutional radioactive waste management as a mandatory service of general economic interest and a staff competent to manage the licensing phase for the LILW repository, where subcontractors are also involved in performing specialised tasks. The ARAO radiation protection service is responsible for the implementation of radiation protection measures and supervision of the radiation exposure of the workers. The Radiation Protection Service is also responsible for monitoring the environmental impacts of facilities for radioactive waste management (the Central Storage Facility, the Jazbec mine waste disposal site) and for general surveillance and management of the Jazbec waste pile since 2016.

Due to the 2012 decision of the Slovenian Government to suspend recruitment in the public sector, the ARAO did not hire new employees despite some departures; the number of employees in the ARAO has fallen by almost 17% over the previous five years. This downward trend over the past few years halted at the end of 2018 and in 2019 as the number of employees increased by four staff working in the field of the LILW repository project.

In the ARAO all professional positions require a broad professional background and flexibility on the part of the staff, who have a diverse and adequate professional structure. The employees at the ARAO have at least the level of education required for the job classification, some even higher. More than two thirds of the employees have a degree in science or technology. The ARAO has also taken on younger professionals who were involved in specialised professional training courses and other types of education. In the last few years, special attention has been devoted to the professional development of employees working in the field of the LILW repository project. The professional development of employees is an important part of ARAO policy. Participation in training courses, workshops, seminars and conferences is supported in order to maintain the high quality of the team and its outputs.

(ii) Financial Resources

The financing of the ARAO is based on the annual work plan and is subject to annual contracts between the ARAO and both the Government and the Fund for the Decommissioning of the Krško NPP. Unfortunately, a considerable slowdown of regular work from past years has continued due to delays in contracting with the Government and the Fund for the Decommissioning of the Krško NPP.

Institutional radioactive waste management is financed from the national budget and from fees paid by waste producers, when liabilities for further waste management are transferred therefrom to the State. The fees are defined by the Government and have been unchanged since 2000.

LILW repository licensing, construction and operation, and the disposal of half of the LILW from the Krško NPP are financed mainly from the Fund for the Decommissioning of the Krško NPP and the state budget for the portion of radioactive waste not originating from the Krško NPP. This funding is also supervised by the Government. The money is collected through a levy on kWhe delivered to the Slovenian grid and had not changed up to 2020. In 2020, the third revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme and the third revision of the Krško NPP Decommissioning Programme were approved by the Intergovernmental Commission. In these documents the annuities for each country were calculated and presented in respect of the internal rate of return. By a decision of the Slovenian Government, the Slovenian electrical power company GEN energija, d.o.o. should continue to make increased payments in the amount of 0.48 euro cents per kWhe, starting 1 August 2020, until the next revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme and the next revision of the Krško NPP Decommissioning Programme are approved.

Žirovski Vrh Uranium Mine

(i) Human Resources

At the beginning of 2002, the Žirovski Vrh Uranium Mine was transformed into the public company Žirovski Vrh Mine d.o.o. At the same time, a new company organisation was also established.

Žirovski Vrh Mine d.o.o. has an adequate and experienced staff of eight people (four permanent staff and four other staff), mostly monitoring staff. It is standard practice that additional expertise, the elaboration of projects and major remedial activities are contracted out on a commercial basis.

(ii) Financial Resources

The financial resources for the activities of the public company Žirovski Vrh Mine d.o.o. are provided solely from the state budget.

The Institute of Oncology Ljubljana – Department of Nuclear Medicine

(i) Human Resources

The staff working with radioisotopes at the Institute of Oncology have appropriate education and experience, as required by the national legislation.

Currently, the Isotope Laboratory staff are sufficient (4 medical doctors, 2 radiopharmacists, 9 radiological engineers, 1 maintenance worker and 3 nurses). The number of staff has been relatively constant over the last eight years, although it may need to be increased if new nuclear medicine techniques are introduced.

(ii) Financial Resources

The Institute of Oncology is mainly financed by the Slovenian health insurance scheme and to a lesser extent from the budget of the Ministry of Health. The Department of Radiological Safety at the Institute of Oncology strives to ensure additional financial resources for its projects connected to radiological safety and the safe storage and disposal of radioactive waste.

Ljubljana University Medical Centre – Department of Nuclear Medicine

(i) Human Resources

The Department of Nuclear Medicine consists of three sections: the Section for Thyroid Diseases, the Section for Nuclear Medicine Diagnostics, and the Section for Radiopharmacy and Clinical Radiochemistry. At present, 89 persons are employed at the Department (23 medical doctors, 4 radiopharmacists, 4 biochemists, 1 biologist, 1 physicist, 2 electrical engineers, 10 radiological engineers, and 12 senior hospital nurses, with the others being technicians and administration and maintenance personnel). The staff working with radioisotopes in this Department have appropriate education and experience, as required by the national legislation.

(ii) Financial Resources

The functioning of the University Medical Centre's Department of Nuclear Medicine is ensured by the Health Insurance and the Ministry of Health.

Article 23: Quality Assurance

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

Article 93 of the 2017 Act and its 2019 amendment and the Rules on Radiation and Nuclear Safety Factors (Official Gazette of the Republic of Slovenia, No. 74/2016; hereinafter: Rules JV5) explicitly require that safety management measures are taken for all activities related to nuclear and radiation facilities, from the design stage, through operation, and to the decommissioning stage. An investor or an operator of a radiation or nuclear facility must ensure that the facility is managed safely and in accordance with the provisions of the Act. The operator of the radiation or nuclear facility must develop, apply, evaluate and continually improve its management system and must describe the latter in documents according to the requirements determined in detail by the minister competent for the environment.

Krško NPP

The company NEK d.o.o., as the licence holder, is responsible for the overall quality of the design, construction, operation, maintenance and modification of the plant. The quality assurance programme was already implemented in the design and construction of the plant and was in full compliance with the following: United States Atomic Energy Commission Appendix B to 10 CFR 50 Quality Assurance Criteria for NPPs and Fuel Reprocessing Plants, the quality assurance (QA) guidance provided in the US Atomic Energy Commission WASH 12833 Guidance on QA Requirements During the Design and Procurement Phase of Nuclear Power Plants, and the WASH 1309 Guidance on QA Requirements During the Construction Phase of Nuclear Power Plants.

Since the beginning of its operation, the overall Krško NPP Quality Assurance Programme and its applicable procedures have been implemented to ensure that all planned and systematic actions necessary to provide adequate confidence that all items or services will satisfy the given requirements as regards quality are in place. The overall requirements for quality, as one of the major objectives of Krško NPP operation, are set forth in the updated safety analysis report, which serves as a basis for the operating licence. The Krško NPP Quality Assurance Programme is implemented and maintained so as to comply with national legislation, best international practice and recognised industrial standards.

The Krško NPP's policy is to establish and implement an integrated management system bringing together in a coherent manner all the requirements for managing the organisation. The main aims of the system are to achieve and improve safety by planned and systematic actions necessary to provide adequate confidence that all these requirements are satisfied, and to ensure that health, environmental, security, quality and economic requirements are not considered separately from safety requirements. The policy is established by the Management Board's Statement of Policy and Authority and implemented through the Quality Assurance Programme presented in the quality document QD-1 and applicable programmes and procedures. The QD-1 is developed and maintained by the Quality and Nuclear Oversight Division and approved by the Management Board.

The Krško NPP management system is a set of interrelated and interacting elements; it establishes policies and objectives and enables those objectives to be achieved in a safe, efficient and effective manner. Safety is the paramount element in the Krško NPP management system, overriding all other demands. Having an integrated management system in accordance with Slovenian regulatory requirements (Rules JV5) and IAEA Safety Standards requirements is essential for maintaining and continuously enhancing safety. An integrated management system provides a number of benefits together with enhanced safety and business performance. Over the 30 years of the Krško NPP's operation, the quality requirements and related documents have been revised and upgraded several times. The latest revision of the QD-1 Quality Assurance Plan was issued in 2016.

One of the most obvious changes of the QD-1 was to harmonise all elements with an integrated management system defined in Plant Management Programme MD-2: "Management System – Process Organisation", bringing together in a coherent manner all the requirements for managing the organisation.

The Quality Assurance Programme applies to safety-related and seismically-designed structures, systems and components, including their foundations and supports, and non-safety related SSC (Augmented Quality), as identified on the Q-List in the Master Equipment Component Database. Activities affecting the quality of these structures, systems and components are controlled to an extent consistent with their importance to safety. The Quality Assurance Programme is implemented by all Krško NPP departments, while programme requirements are also extended to contractors and suppliers in line with the importance of their services and scope of supply for nuclear safety.

The ISO 14001:2004 environmental management standard was implemented in 2008, and amended by ISO 14001:2015. In addition, the internationally recognised standard for industrial safety, i.e. BS OHSAS 18001:2007, was introduced into Krško NPP practice (in 2011), and will be superseded by ISO 45001:2018 in 2020.

Internal audits within the Krško NPP are performed in annual and two-year intervals in accordance with the requirements. Internal audits cover functional and cross-functional areas in accordance with IAEA, ANSI, NRC, EPRI and WANO guidelines. Audit results are reported and documented through the company's Corrective Action Programme, where audit findings are tracked until they are implemented.

Krško NPP suppliers are audited in three-year intervals, in accordance with requirements. For international suppliers, the Krško NPP takes part in NUPIC audits and surveys.

In line with its policy of monitoring and constantly upgrading nuclear safety and QA requirements, the Krško NPP has been following the efforts of the nuclear industry at large (the IAEA, WANO, INPO, EPRI, ASME, and others) and enhancing its management system to improve safety and excel in operation. The Krško NPP will continue to develop its internal management system processes and requirements in the future. The most important objective of the entire organisation – to ensure safe and efficient power plant operation – will continue to be the most important goal of the Quality Assurance Programme.

Jožef Stefan Institute Reactor Infrastructure Centre

QA at the JSI Reactor Infrastructure Centre is part of the Jožef Stefan Institute's QA Programme. The Director of the JSI and the head of the reactor operation department are responsible for its implementation. Specific internal QA and quality control-related documentation is applied. QA activities connected with reactor operation are subject to both internal audits (Jožef Stefan Institute QA management and an audit team) and external inspections by the regulatory body. The QA Programme is subject to periodic reviews.

The JSI Reactor Infrastructure Centre QA is implemented and maintained to a great extent in accordance with following standards:

- SIST EN ISO 9001:2015;
- IAEA GS-R-3;

and acceptance criteria defined in:

- the programme for the assessment of a request to perform work in the hot cell laboratories;
- the programme for performing work in the hot cell laboratories;
- the programme for informing the public of unusual events on the reactor site;
- the programme for the assessment of a request to perform work at the reactor;
- the programme for performing work at the reactor and the instructions for performing work in the hot cell laboratories;
- the programme for monitoring operating experience; and
- the programme for monitoring operating indicators.

Agency for Radwaste Management

The integrated management system, including all aspects related to safety, health, environmental, quality, security and economics, based on IAEA safety standard GSR Part 2, ISO 9001:2015 and Rules JV5 (Chapter 5), places the required priority on safety as the paramount consideration guiding decisions and actions.

Annual internal audits and management reviews are implemented to assess the suitability, adequacy and effectiveness of the ARAO management system. Independent management system certification is conducted according to ISO 9001:2015. Such certificate confirms that the ARAO has established its management system based on selected standards, and that the system is properly documented, implemented and maintained.

The ARAO continuously improves the effectiveness of its integrated management system and the corresponding core management processes in order to safely achieve company goals and enhance the safety culture as a key factor in reducing the likelihood of safety-related events and mitigating their potential impacts. Based on the ARAOs mission and vision, the main objectives are presented through the public website of the ARAO.

Žirovski Vrh Uranium Mine

The basic objective of Žirovski Vrh Mine d.o.o. is to ensure the permanent cessation of uranium ore exploitation and to mitigate the consequences of uranium production at the Žirovski Vrh Uranium Mine. The system of quality control and quality assurance was formally introduced in Žirovski Vrh Mine d.o.o. for the purpose of uranium mine remediation at the end of 2005 (Quality Assurance Manual – 1st edition, December 2005). The Manual was revised following personnel and organisational changes (Quality Assurance Manual – 3rd edition, June 2007).

The Quality Assurance Manual, together with the reference document, contains instructions and procedures with reference to quality control and defines efficient implementation of the responsibility for the operational quality of the company.

Internal audits of individual activities and procedures are carried out on the basis of the annual programme. On the basis of finding discrepancies, corrective measures have been introduced to ensure quality during the implementation of the permanent cessation of uranium ore exploitation and the prevention of the consequences of mining in the Žirovski Vrh Uranium Mine and the protection of the environment and people against the consequences of the mining operations.

Slovenian Nuclear Safety Administration

In 2001, the SNSA decided to establish and implement a documented quality management system based on the Government Programme on Management for Excellence in the State Administration, taking into consideration IAEA Safety Series No. 50-C/SG-Q, "Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations"; Code and Safety Guides Q1–Q14, IAEA, 1996; IAEA-TECDOC-1090, "Quality Assurance within Regulatory Bodies", 1999, and simultaneously ISO 9001, "Quality Management Systems – Requirements", Third Edition, 2000.

In 2006, the SNSA upgraded the quality management system by introducing an integrated management system, supported by the requirements of the new IAEA safety standard GS-R-3 "Management System for Facilities and Activities".

In December 2007, an external certification audit took place and the SNSA successfully obtained the ISO 9001:2000 certificate for its management system. In December 2010, an external recertification audit was carried out in accordance with ISO 9001:2008. The external auditor concluded that the SNSA management system complied with this newer standard.

Due to the lack of financial resources, the SNSA decided not to pursue a second external recertification audit, which was foreseen for December 2013, and thus it lost the certificate for the management system's compliance with ISO 9001:2008. However, even though the SNSA no longer has a formal certificate of its management system's compliance with ISO 9001:2008, it continues to carry out all activities in accordance with the requirements of this standard and the IAEA standard GS-R-3 and ensures continuous improvement of the effectiveness and efficiency of its operations.

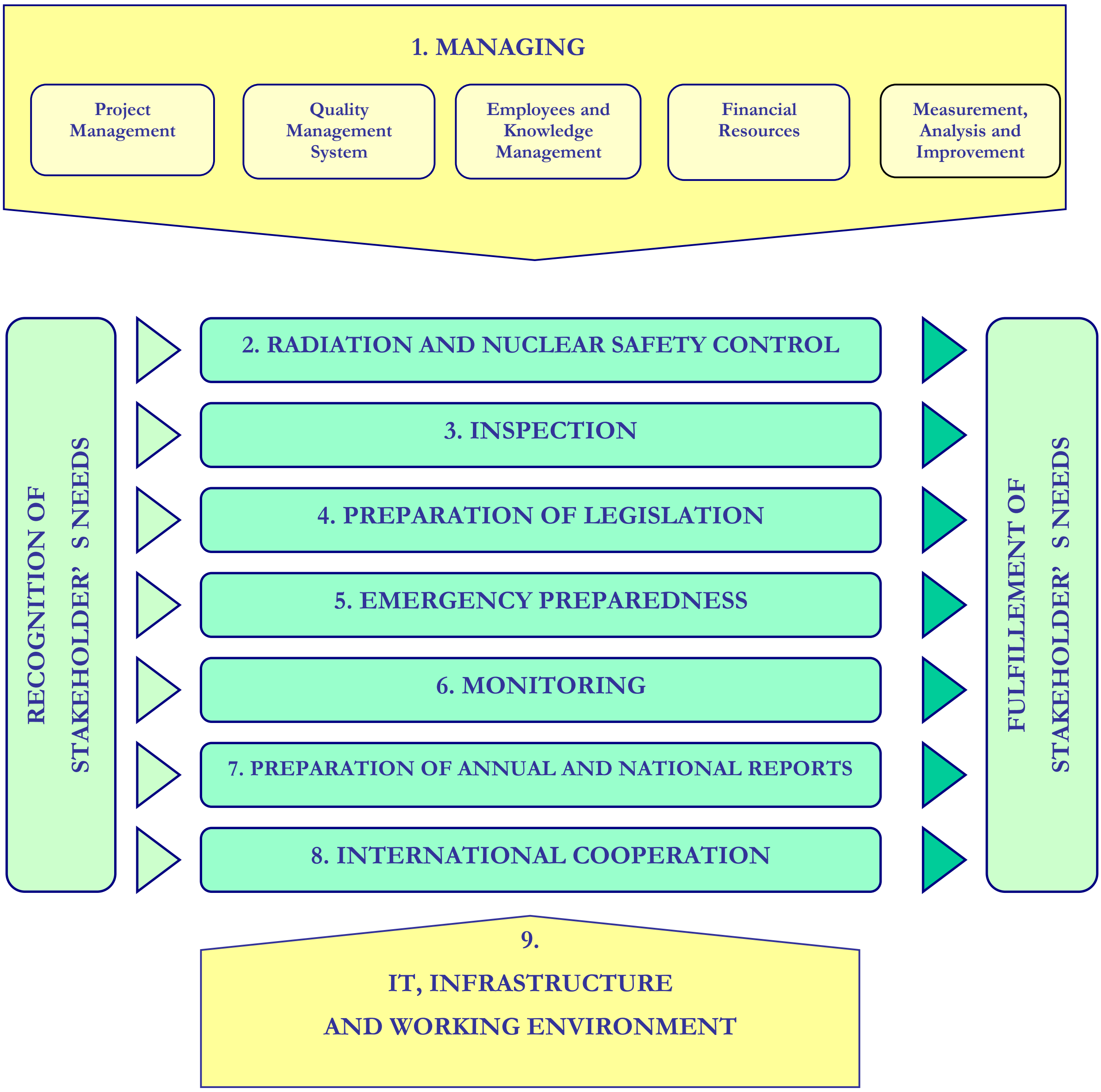
In 2019, the SNSA brought its management system in line with the additional requirements of the newly issued IAEA safety standard GSR Part 2 "Leadership and Management for Safety", and ISO 9001:2015 "Quality Management Systems – Requirements".

In April 2019, a new, 12th edition of the SNSA Management System Manual was issued which, in addition to the already-mentioned ISO 9001:2015 and IAEA GSR Part 2 standards, also complies with the new IAEA guidelines relating to management systems in regulatory bodies, namely:

- IAEA General Safety Guide No. GSG-12 "Organization, Management and Staffing of the Regulatory Body for Safety", Vienna 2018; and
- IAEA General Safety Guide No. GSG-13 "Functions and Processes of the Regulatory Body", Vienna 2018.

The aim of the SNSA management system is to ensure the implementation of the SNSA's mission and to achieve its vision while taking into consideration the SNSA's values and optimally use the available resources. The SNSA's management system covers all SNSA activities and is designed in such a way that it integrates all requirements relating to safety, health, environmental, security, quality human and organisational factors, societal and economic elements, so that safety is not compromised. The SNSA's management has continuously ensured that SNSA employees are familiar with the management system, its documentation and its vision, mission, values and management policy. The SNSA's management system is based on a process approach. The processes are divided into one management process, seven core processes, and one supporting process (Figure 6).

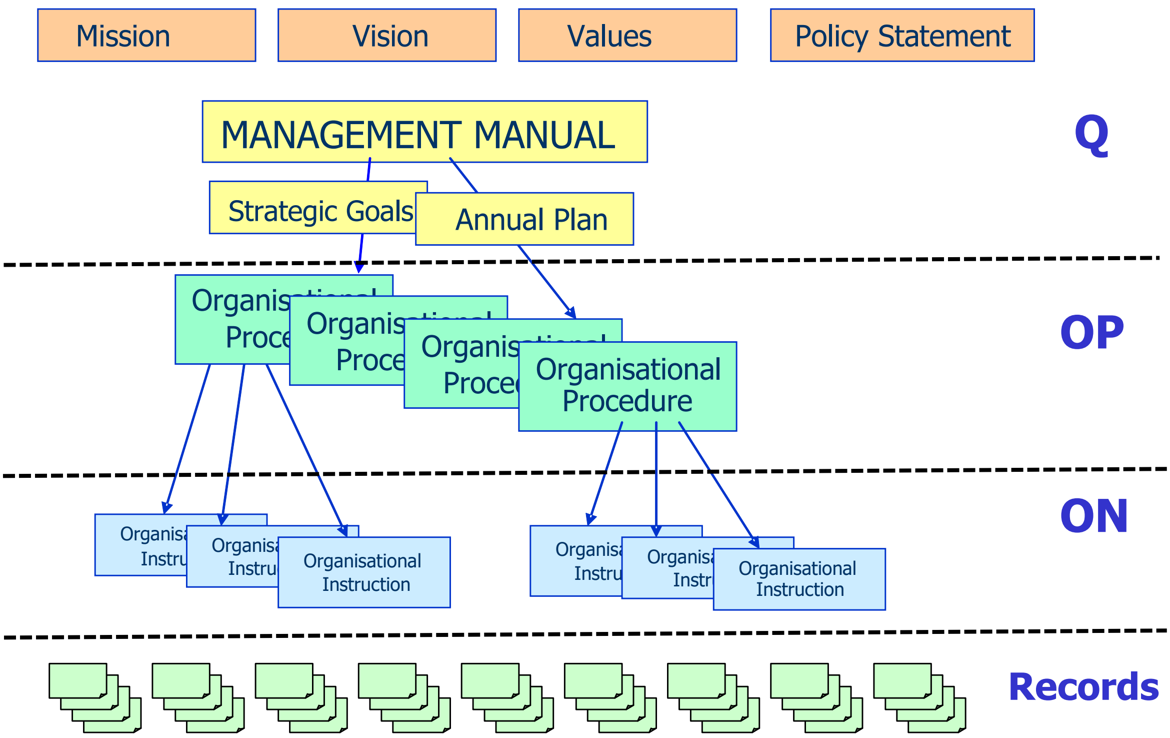
Figure 6: **The SNSA Management System**



The SNSA management system is documented at five levels of management system documentation (Figure 7):

- Level 0: The mission, vision, values and policy statement of the SNSA;
- Level 1: The management manual (Q), which defines the concept of the management system in the SNSA. This level also includes the SNSA's strategic goals and annual plan;
- Level 2: Organisational procedures (OP), where the management of processes is described;
- Level 3: Organisational instructions (ON), where the detailed performance of individual activities is defined;
- Level 4: Records resulting from the performance of SNSA activities.

Figure 7: **SNSA management system documentation**



During the period from March 2017 to March 2020, several internal audits of the SNSA's management system were performed. At the beginning of each calendar year, management reviews of the SNSA's management systems are carried out to ensure its continuing suitability, effectiveness and efficiency. Based on the findings, deficiencies have been remedied and several improvements to the management system have been introduced.

According to requirement 14 of GSR Part 2 "Measurement, Assessment and Improvement of Leadership for Safety and Safety Culture", in 2019 the SNSA started to implement activities related to the self-assessment of leadership for a safety and safety culture.

The regulatory requirements for the licensee's management systems are defined in the Slovenian legislation, namely in the 2017 Act and its amendment in 2019 and subsidiary legislation.

The 2017 Act defines the requirements related to management systems. Namely, Article 93, *inter alia*, additionally defines that as part of its management system the operator of a radiation or nuclear facility shall:

- establish, implement, assess and continually improve the management system, which shall ensure appropriate compliance with the requirements as to radiation and nuclear safety, nuclear protection, readiness for emergencies, health, the environment, the security of information systems and data, quality and efficiency, and ensure that safety aspects are appropriately considered in all activities of the operator of a radiation or nuclear facility;

- set up controls of contactors of equipment and providers of works depending on their importance for radiation and nuclear safety;
- set up controls and ensure that works are performed by companies who have an established management system and have qualified and experienced workers in the expert area of the works concerned; and
- ensure that the relationships and behaviour of employees in its organisation lead to a good safety and security culture. The safety culture and security culture must be included in the management system. Through self-assessment and regular reviews of the management system, the operator shall review the effectiveness and efficiency of the safety and security culture.

Furthermore, Article 94 of the Act determines that the provisions of Article 93 on establishing, implementing, assessing and continuous improvement of the management system shall, *inter alia*, also apply to the authority for nuclear safety.

The most important regulation defining quality management systems is the Rules on Radiation and Nuclear Safety Factors (JV5). Chapter Five (Articles 52 to 74) of the above-mentioned regulation, i.e. "Management System", is dedicated to the requirements as to ensuring a process-oriented integrated management system. Currently, the regulation is under revision. Changes to the provisions of Chapter 5 are based on the requirements of the IAEA standard GSR Part 2 "Leadership and Management for Safety".

Article 24: Operational Radiation Protection

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:

(i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;

(ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and

(iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.

2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:

(i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and

(ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.

3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

Legislation, Regulations and Requirements

Radiation protection legislation as applied to nuclear and radiation facilities, including radioactive management, is regulated by the 2017 Act. The subsidiary regulations and decrees published more recently are mostly based on Council Directive 2013/59/Euratom.

Consequently, several subsidiary regulations concerning the licencing and management of radiation and nuclear facilities, as well as their operational safety, had to be aligned with the Council Directive, including the Rules on the Use of Radiation Sources and on Activities Involving Radiation, the Decree on Limit Doses, Reference Levels and Radioactive Contamination and the Rules on the Monitoring of Radioactivity.

The two competent authorities for radiation protection are the Slovenian Nuclear Safety Administration (SNSA), under the Ministry of the Environment and Spatial Planning, and the Slovenian Radiation Protection Administration (SRPA), under the Ministry of Health. The SNSA is responsible for licensing and inspections in industry (including nuclear facilities), research, education, and administration, while the SRPA has adequate competence for sources used in medicine and veterinary care.

According to the 2017 Act, the design, planning, subsequent use and operation of sources and their handling (including the handling of radioactive waste) shall be performed in such a manner so as to ensure that exposure is as low as reasonably achievable (ALARA), taking into account economic and social factors. Radiation protection experts and technical support organisations are authorised to perform, *inter alia*, consultation, radiation safety assessments and dose calculations. Several technical support organisations are authorised in Slovenia to perform specific tasks regarding the radiation protection of workers and the public, radiological surveillance, the monitoring of individuals, the monitoring of the radioactivity of the environment, interventions, etc. Five medical institutions are authorised to carry out health monitoring of workers in this field.

The prescribed annual limit of an effective dose for workers is 20 mSv and the annual equivalent dose limit for skin or extremities is 500 mSv, except in the case of eye lenses, regarding which the annual limit is 20 mSv. In general practice, it has been found in the last decade that exposure of 20 mSv per year was exceeded in only a few cases. Since 1999, the Republic of Slovenia has had a computerised registration system for the occupational radiation exposure of workers in the country, including external radiation workers. In total, approximately 18,100 workers (together with external radiation workers) have been registered, with an average of around 1,300 workers per year working in the nuclear fuel cycle.

The general limit for the annual effective dose for members of the public is 1 mSv. Additionally, the annual equivalent dose limit for ocular lenses is 15 mSv per year, and for the skin 50 mSv per year. Dose constraints were used for specific cases (the nuclear power plant, the research reactor, the uranium mine and central storage facility).

1. **Steps taken to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable**

The radiation protection standards in radioactive waste management facilities and structures and spent fuel storages were already implemented during the licensing procedure. The Report on the Safety Assessment of Exposed Workers against Radiation must be submitted as part of the licensing documentation and the licensee must ensure comprehensive measures to protect workers and the public, as required by Article 27-29 ("Basis of radiation protection") of the 2017 Act. In implementing the ALARA principle, these measures devote special attention to the protection of pregnant women, breastfeeding women, students and workers employed by contractors, among others. The holder of a licence for the operation of a nuclear facility (including radioactive waste storage) shall ensure its own special organisational unit for radiation protection, which is responsible for planning and implementing measures for radiation protection. In all other cases, the person responsible for radiation protection may be contracted by the licensee. The individual dosimetry is based on thermoluminescent (TL) dosimetry or optically stimulated luminescent (OSL) and/or the monitoring of workplaces, as appropriate. Dosimetric services are authorised by the SRPA.

According to Article 158 of the 2017 Act and the Rules on the Monitoring of Radioactivity, operational monitoring of radioactivity shall be ensured by the radiation facility or nuclear installation to protect the public and the environment. Operational monitoring of radioactivity shall entail:

- the monitoring of radioactive discharges from a radiation facility or nuclear installation into the environment;
- the monitoring of environmental radioactivity (in the air, in surface and underground waters, and in the ground) and the monitoring of the radioactivity of drinking water, foodstuffs and animal feed as the result of radioactive discharges.

Radioactive discharges are monitored and reported at regular intervals (weekly, monthly, quarterly and annually), as prescribed in the licencing documents and in the Rules on the Operational Safety of Radiation and Nuclear Facilities. Public exposure is estimated annually via all exposure pathways. The operator shall also carry out monitoring of the effects of remediation works in the event of an emergency.

2. **Steps to ensure that discharges are limited to keep exposure to radiation as low as reasonably achievable and that no individual is exposed, in normal situations, to radiation doses that exceed national prescriptions for dose limitation, with due regard to internationally endorsed standards on radiation protection**

The legal bases for the control of discharges in normal operation are the 2017 Act (Article 159, "Monitoring of radioactivity in the environment"), the Rules on the Monitoring of Radioactivity, and the Rules on Radioactive Waste and Spent Fuel Management.

According to the 2017 Act, two levels of radiation monitoring ensure that no individual is exposed to radiation above the prescribed dose limits in normal situations.

(a) Monitoring of the discharges from radiation facilities and nuclear installations

The control of radioactive discharges into the environment from nuclear installations is carried out regularly by the operator. Independent measurements of discharges are also provided, although in a limited scope, by technical support organisations under the supervision of the SNSA as the regulatory authority. The discharge limits for nuclear installations were set by the SNSA in relation to the dose constraints. The monitoring of radioactive discharges from nuclear installations and radiation facilities in the Republic of Slovenia started in the early 1980s, with extensive programmes at the Krško NPP (1981), the Žirovski Vrh Uranium Mine (1985), the JSI Reactor Infrastructure Centre (1986), and the Central Storage Facility for Radioactive Waste in Brinje (1986). Radioactive discharges from hospitals with nuclear medicine departments are monitored at times to verify if annual effective doses for reference individuals in the environment are below 10 µSv. Rough estimates of discharged activities for very short-lived isotopes are calculated every year, based on the purchased and applied activity of radioisotopes. The Institute of Oncology regularly orders measurements of radioactivity in its decay tanks by approved radiation protection experts. When the specific activity decreases below authorised limits, the liquid waste is discharged into the municipal sewerage system. The Institute keeps all records and reports.

(b) Environmental monitoring of radioactivity

Monitoring of environmental radioactive contamination in the surroundings of nuclear facilities is performed exclusively by the authorised technical support organisations. The radiation exposures of representative members of the population are estimated based on measured data and modelling.

Monitoring of radioactivity in the environment is performed in accordance with the Rules on the Monitoring of Radioactivity. Samples are taken from the environment – air, water and soil, from underground and drinking water, and from foodstuffs and animal feed, and are then analysed. The exposure of the public as a result of environmental contamination due to the operation of facilities in the nuclear fuel cycle is estimated and compared with the dose constraints and limits.

An automatic radiation monitoring system in the Republic of Slovenia was developed soon after the Chernobyl accident. In the last decade, the SNSA has also established a comprehensive database on past discharges and environmental radioactivity measurements. The database is updated on a yearly basis with data collected through various monitoring programmes. The objective of this computerised database is to analyse and visualise the statuses and trends of historical records. All these data could be used as the input data for modelling the radiation exposure of a representative person of a reference group(s).

In 2018, a new application was developed for the assimilation and analysis of all available data on radioactivity, as well as the issuance of alerts in the event of elevated values. Presently, it gathers data from all on-line measuring sites (72 dose rate stations, 3 aerosol radioactivity measurements, and 2 ground deposition spectrometers) as well as all laboratory measurements performed within the framework of environmental and operational monitoring. Additionally, it also serves as an informational sharing point where the public and expert communities can see real-time data on environmental radioactivity in Slovenia.

During the operating lifetime of the nuclear facility, in the event of an unplanned or uncontrolled release of radioactive materials into the environment, appropriate corrective measures are ensured to control the release and mitigate its effects. See also Article 25: Emergency Preparedness.

Measures Taken by Licence Holders

Krško NPP

(a) Radiation Protection

In accordance with the 2017 Act, the Radiological Protection Unit at the Krško NPP is organised to implement radiation protection measures such as measurements, assessment and keeping records of received effective doses for all workers who have access to the controlled area, regardless of whether they are members of the NPP staff, contractors, inspectors or visitors. Radiation protection related to the management of radioactive waste at the plant site is one of the most important tasks of the Radiological Protection Unit. This task is in compliance with the general radiation protection measures established in the plant.

From the viewpoint of radiological protection, the power plant area comprises the controlled area and the supervised area. The controlled area (the area under constant radiological surveillance) includes the Reactor Building, the Fuel Handling Building, the Auxiliary Building, a part of the Intermediate Building, the primary laboratory, the hot machine workshops, the decontamination area, the Building for Decontamination, and the areas for the processing and storage of radioactive waste.

In the controlled area – where irradiation and contamination are highly probable – the Krško NPP staff and contractors must be equipped with regular protection equipment, electronic alarm dosimeters and optically stimulated luminescent personal dosimeters (OSLs). Internal contamination is measured using a whole-body counter for all workers working in the radiologically controlled areas where there is a risk of internal contamination (i.e. during annual outages or major maintenance works).

The ALARA committee is responsible for adopting and reviewing the ALARA programmes. During the ALARA planning procedure, radiological conditions are analysed, personal protection equipment is defined, and radiological control determined, so all key elements are taken into account.

The Monitoring Programme covers the measurements of liquid and gaseous discharges, measurements of activity in plant systems, the inventory of the onsite radioactive waste storage facility, environmental radioactivity and meteorological measurements, and preparedness for radiation measurements in cases of emergency. The operator is obliged to notify the SNSA in advance of all gaseous discharges into the atmosphere.

Organisational arrangements for controlling the production and release of radioactive discharges and waste are in place. The existing top-level plant policy and waste management programme keep the radiological impact from radioactive discharges and waste within the authorised limits and as low as reasonably achievable. Arrangements for the minimisation of radioactive waste generation are in place. All relevant elements regarding waste minimisation are taken into consideration (the fuel integrity programme, the reduction of leakages, the decontamination process, segregation practices, etc.).

The three-year average collective dose for the whole plant is shown in Figure 8. The major decrease in recent years is a result of the previous dose reduction plan with several improvements accompanied by steam generator replacement, shielding improvements, reactor vessel head replacement, RTD by-pass removal in 2013, and, after 2015, the elimination of fuel damage mechanisms by reactor vessel up-flow conversion, and improving work planning practices.

Figure 8: **Collective radiation exposure – three-year rolling average at the Krško NPP in the period 2000–2019**

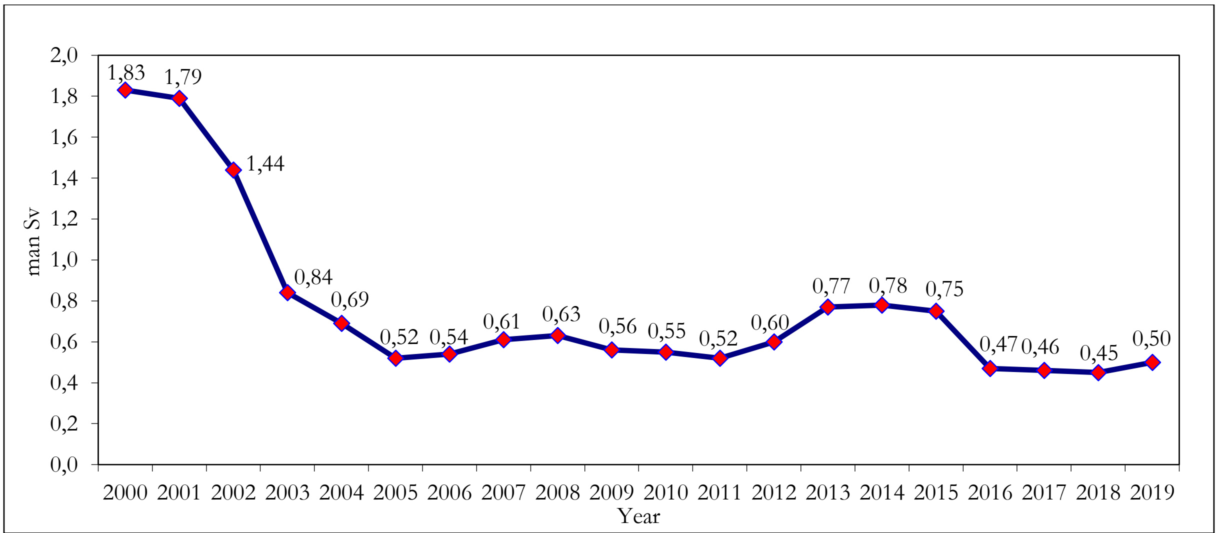


Table 3 shows the dosimetry data for the last three years (2018 and 2019 were outage years, and 2017 had no outage).

In this period, the maximum individual doses were due to waste manipulation jobs. The Waste Manipulation Building began operation, with additional local shielding and space in place.

Table 3: **Dosimetry data in the 2017–2019 period at the Krško NPP**

Year	Collective dose (man Sv)	Maximum individual dose (mSv)	Average individual dose (mSv)
2017	0.06	7.56	0.08
2018	0.78	9.69	0.52
2019	0.67	6.68	0.42

(b) Liquid and Gaseous Discharges

In accordance with the licence for operating the Krško NPP, the total dose constraints for a member of the public are as follows:

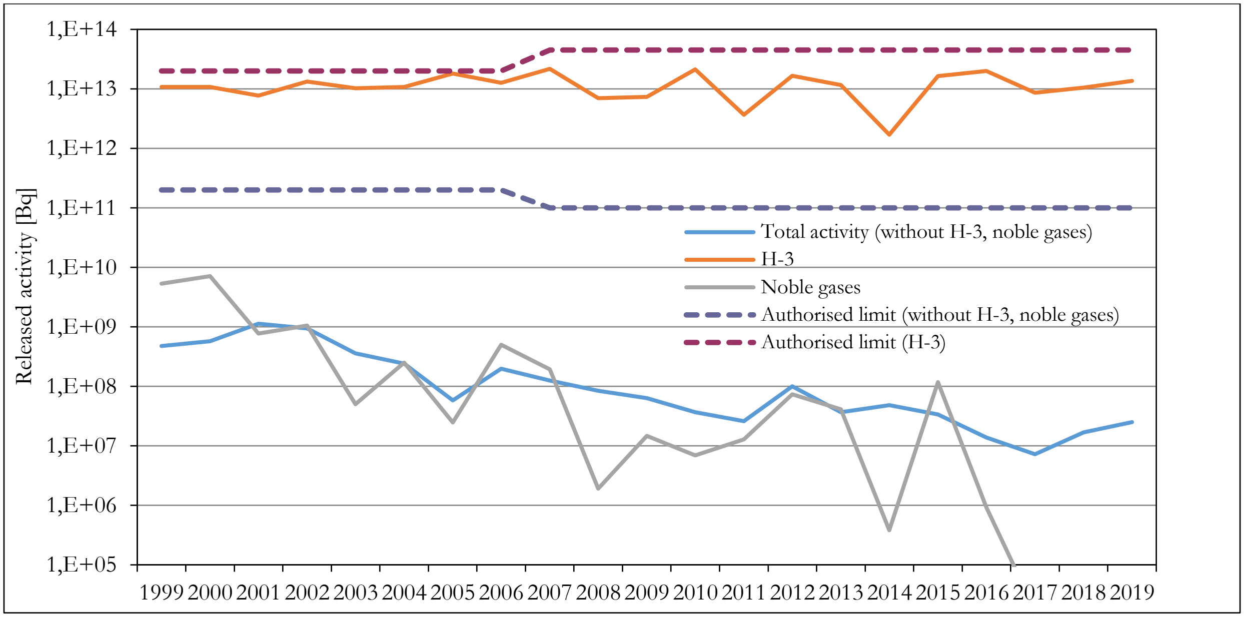
- The effective dose constraint at a distance of 500 m from the reactor and beyond – for doses due to liquid and gaseous radioactivity releases during normal operation – is less than or equal to 50 µSv/year.
- The radiation dose constraint from the radioactive waste storage building and the reactor is less than or equal to 200 µSv/year at the site fence.

The limits of radioactive discharges into the environment were initially authorised in the operating licence of the Krško NPP, issued on 6 February 1984. In 2007 the operating limits were revised and slightly modified in order to ensure compliance with the standard Radiological Effluent Controls for Pressurised Water Reactors (RETS). The modification was made in order to include the corresponding effective dose as an additional parameter for the control of plant operation performance.

The regular control of radioactive discharges was set out in the technical specifications (RETS) for plant operation and comprises the measurement of the concentrations and flow rates of gaseous and liquid discharges at the source. In addition, the dose rates of external radiation and the radioactivity in the air are measured on-site. The competent authorities are regularly informed by the Krško NPP of discharges of radioactive materials into the environment on a daily, weekly, monthly, quarterly and yearly basis.

Liquid radioactive discharges (Figure 9) are released into the Sava River via the Essential Service Water System outlet upstream of the dam. The dominant radionuclides in the liquid discharges are ^{3}H, ^{14}C, ^{58}Co, ^{60}Co, ^{137}Cs, ^{110m}Ag and ^{55}Fe. The activities of ^{134}Cs, ^{59}Fe and ^{125}Sb are up to two to three orders of magnitude lower. The main contribution to the dose originates from ^{3}H, ^{14}C and radioisotopes of caesium and cobalt. The dose to the reference group due to liquid discharges is assessed as being below 0.1 µSv per year.

Figure 9: **Radioactive liquid discharges from the Krško NPP, 1999-2019**

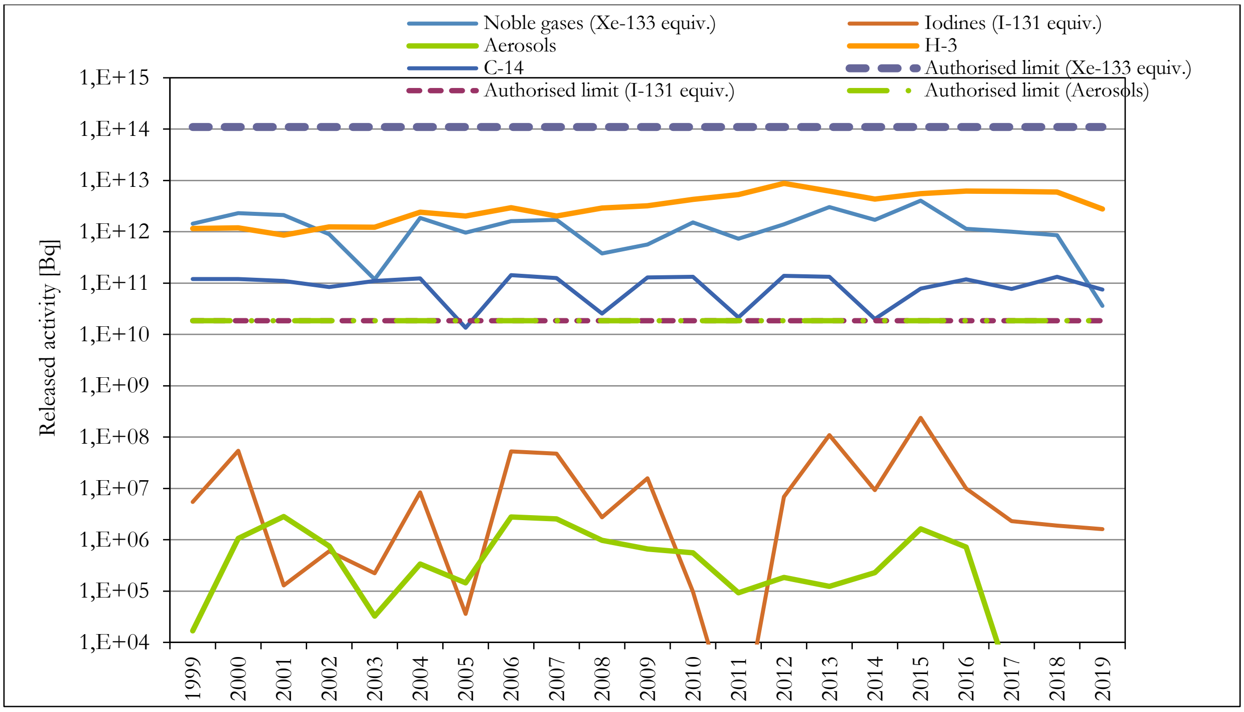


Notes:

- the limit for fission and activation products is 100 GBq (since 2007);
- the limit for ^{3}H is 45 TBq (since 2007);
- the radioactivity of noble gases was below the prescribed detection limit in the released water for the last two years.

Radioactive gases (Figure 10) from the Krško NPP are released into the atmosphere mainly from the reactor building and fuel handling building ventilation system via the common plant vent. The radiation monitoring system continuously measures and monitors the concentrations of individual radioactive elements at both discharge points. The conservatively estimated gaseous ground release dose at a distance of 500 metres from the reactor was 0.86 µSv in 2017, 0.11 µSv in 2018 and 0.36 µSv in 2019.

Figure 10: **Radioactive gaseous discharges from the Krško NPP, 1999–2019**



Notes:

- The limit for noble gasses was expressed in ^{133}Xe equivalent activity until 2006; since 2007 there is no specific limit, but the total annual dose limit of 50 µSv must be observed;
- the released activity of ^{131}I for 2011 was less than the limit of detection.

Conservatively estimated individual exposures for members of the public are based on directly measured discharge values, environmental sampling programme results and on model calculations. This amounts to a value of an effective dose usually around 0.1 µSv/year for an adult. The dose assessment showed that exposures to members of reference groups are well below the regulatory limit of 50 µSv/year and less than 0.01% of exposure due to natural radiation.

Central Storage Facility for Radioactive Waste in Brinje

(a) Radiation Protection

Radiation protection in the Central Storage Facility (CSF) for Radioactive Waste in Brinje includes occupational radiation protection (the protection of workers) and on-site and off-site monitoring of the storage facility (the protection of the public). Workplace radiation monitoring is performed regularly inside the CSF. The measurements include the gamma and neutron dose rate, the gamma and neutron radiation field, radionuclide contamination of surfaces and air, radon and radon equilibrium equivalent concentrations, and the concentration of gamma emitters in the wastewater coming from the CSF.

Radioactive waste management and other activities in the CSF are performed according to defined procedures, always also considering radiation protection. A radiation protection worker is present at all activities involving ionising radiation sources of higher activity or in non-routine activities. Personal dosimetry is provided for all radiation workers and annual doses are regularly reported to the competent regulatory body. The radiation exposure data for workers in the CSF due to radioactive waste management activities from 2005 to 2019 are given in Table 4.

Higher personal and collective doses correspond to intensified handling of stored radioactive waste due to the management of historical radioactive waste in 2005 and 2008 (sorting, dismantling, re-packaging, rearrangement inside the CSF), the introduction of self-supporting metal pallets for the storage of waste packages in 2015, and the dismantling of DSRS starting in 2017. These waste management measures substantially decreased the level of dose rates in the CSF and the emissions of radon from the CSF.

Table 4: **The radiation exposure of workers at the Central Storage Facility due to radioactive waste management, 2005–2019**

Year	Number of workers	Average [mSv]	Maximum individual dose [mSv]	Collective dose [man mSv]
2005*	20	0.199	1.68	4.07
2006*	15	0.045	0.35	0.9
2007*	27	0.046	0.38	1.23
2008*	21	0.175	1.420	3.68
2009	9	0.032	0.147	0.284
2010	10	0.011	0.040	0.105
2011	9	0.021	0.073	0.192
2012	9	0.014	0.065	0.127
2013	9	0.033	0.092	0.296
2014*	8	0.067	0.193	0.536
2015	8	0.136	0.345	1.084
2016	7	0.039	0.096	0.274
2017	6	0.072	0.268	0.429
2018	7	0.030	0.210	0.393
2019	6	0,056	0.106	0.333

Note: * staff of the ARAO and sub-contracting workers

(b) Liquid and Gaseous Discharges

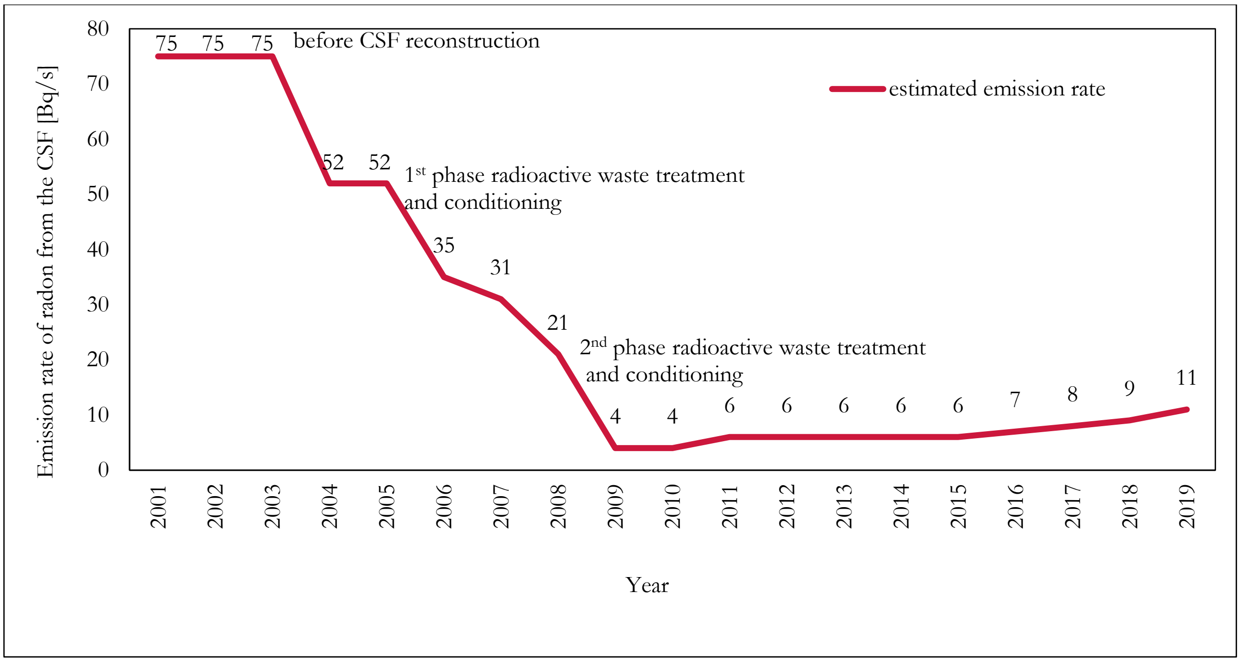
The scope of monitoring includes emissions (measurements of gaseous and liquid discharges) and environmental concentrations of radioactivity near the CSF. Since 2008, when the 2nd phase of treatment and conditioning of the stored waste took place, the average emission rate of radon has been below 10 Bq/s (Figure 11). A trend of a slight increase in radon emissions can be seen in the last few years. However, the results are still within the measurement uncertainty.

The sanitary water and condensate from the air drying apparatus is collected in the container and checked for radioactive contamination before release. Thus far, no water contamination has been measured.

Assessment of the public dose considered two pathways of dose exposure: radon progeny inhalation and external exposure. The annual effective dose for the most exposed representative of the reference group staying in the vicinity of the CSF site for a part of his or her routine work is estimated to be from 1.0 – 1.5 μSv in the last few years. The annual effective dose received by a farmer who occasionally works in a field near the site is estimated to be around 0.03 μSv.

The conservatively estimated public exposure due to the operation of the CSF is far below the dose constraint of 100 μSv/year set in the operational licence for the CSF, which was issued by the SNSA in April 2018.

Figure 11: **The emission rate of radon from the CSF in the period 2001–2019**



Jožef Stefan Institute Reactor Infrastructure Centre

(a) Radiation Protection

Radiation protection at the Jožef Stefan Institute Research Reactor Infrastructure Centre is implemented and performed by the Radiation Protection Service of the Institute. In total, 31 persons from the Reactor Department, from the service, and from the Radiochemical Laboratory were exposed to ionising radiation in 2019, with an average annual dose of 0.093 mSv (not taking into account the neutron dose). The collective annual dose in 2019 was 2.87 man mSv.

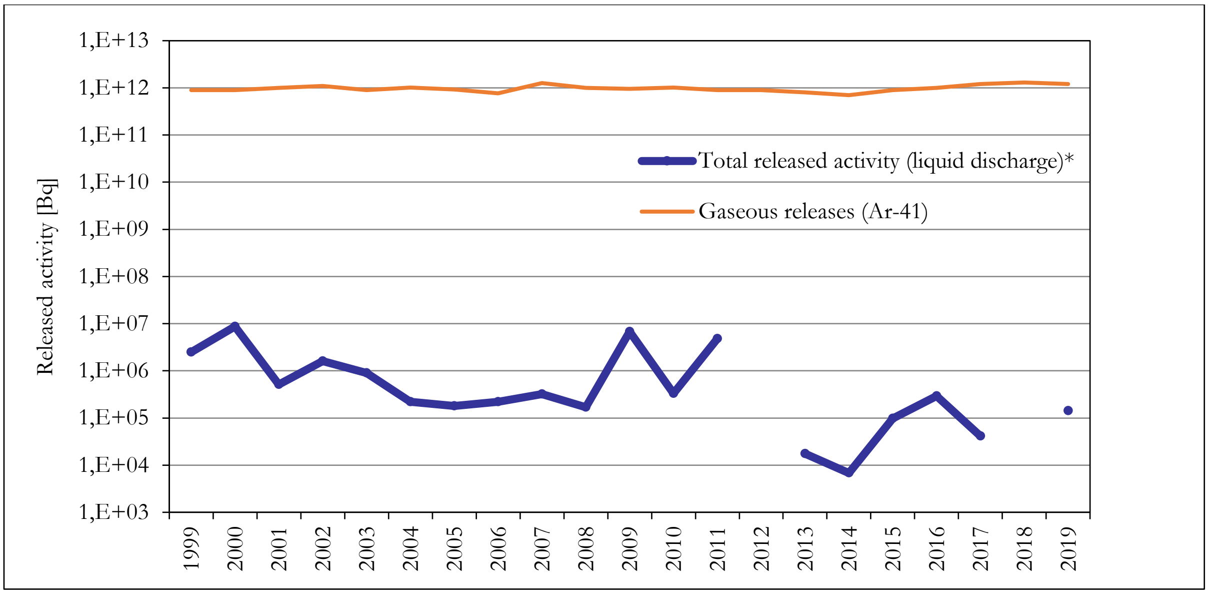
Table 5: **Radiation exposure of workers at the JSI Reactor Infrastructure Centre due to radiation practices and radioactive waste management, 2010-2019**

Year	Number of workers	Average [mSv]	Maximum individual dose [mSv]	Collective dose [man mSv]
2010	26	0.008	0.044	0.203
2011	28	0.004	0.032	0.101
2012	29	0.007	0.036	0.189
2013	27	0.019	0.118	0.512
2014	24	0.024	0.136	0.0567
2015	23	0.038	0.0242	0.0876
2016	30	0.035	0.0208	1.053
2017	26	0.044	0.20	1.15
2018	32	0.072	0.41	2.31
2019	31	0.093	0.36	2.87

(b) Liquid and Gaseous Discharges

The liquid discharges mostly originated from the radiochemical laboratory using reactor activation products. The annual reactor discharge of ^{41}Ar is proportional to the time of reactor operation and is estimated to be typically about 1 TBq (1.3 TBq in 2019).

Figure 12: **Discharges from the JSI Reactor Infrastructure Centre in the period 2011–2019**



Note: * Liquid discharges for 2012 and 2018 were less than the limit of detection.

For the exposure of the public, only two exposure pathways were considered: external exposure due to ^{41}Ar immersion and the ingestion of contaminated released water. In 2019 the total dose received by a representative person was estimated to be less than 1 µSv/year (0.02 µSv/year for a farmer at a distance of 100 m and 0.52 µSv/year for a permanent resident living in a village at a distance of 0.5 km). The authorised dose limit for the operation of the research reactor is 50 µSv/year.

Žirovski Vrh Uranium Mine

(a) Radiation Protection

Within the scope of decommissioning, the Radiological Protection Unit of Žirovski Vrh Mine d.o.o. is responsible for tasks related to the radiation protection of workers and the general population.

Measuring occupational exposure to ionising radiation is based on the time records of an individual worker relating to his or her work at different workplaces and on the following workplace measurements:

- measurements of radon and the potential alpha energy of radon progeny in the air; and
- measurements of external radiation (measured with TLDs on a quarterly basis).

The main contribution to occupational exposure comes from radon and radon progeny.

Table 6: **The radiation exposure of workers at the Žirovski Vrh Uranium Mine due to radioactive waste management, 1996–2019**

Year	Number of workers**	Average [mSv]	Maximum individual dose [mSv]	Collective dose [man Sv]
1989*	350	5.0	18.00	1.75
1996	55	0.9	2.64	0.05
1997	70	1.3	3.40	0.09
1998	65	1.5	2.97	0.10
1999	60	1.0	1.89	0.06
2000	61	< 1.0	1.95	0.05
2001	64	< 1.3	2.95	0.08
2002	103	1.5	4.58	0.15

Year	Number of workers**	Average [mSv]	Maximum individual dose [mSv]	Collective dose [man Sv]
2003	133	1.8	5.39	0.24
2004	103	2.1	5.93	0.22
2005	87	0.99	4.60	0.09
2006	64	0.34	0.77	0.02
2007	95	0.17	0.40	0.02
2008	102	0.22	1.50	0.03
2009	38	0.34	0.47	0.008
2010	7	0.57	1.32	0.004
2011	7	0.52	1.47	0.0036
2012	8	0.12	0.28	0.0007
2013	9	0.05	0.10	0.0004
2014	8	0.08	0.26	0.0007
2015	8	0.07	0.23	0.0006
2016	8	0.08	0.27	0.0006
2017	8	0.22	1.71	0.0018
2018	8	0.12	0.45	0.0010
2019	8	0.06	0.24	0.0005

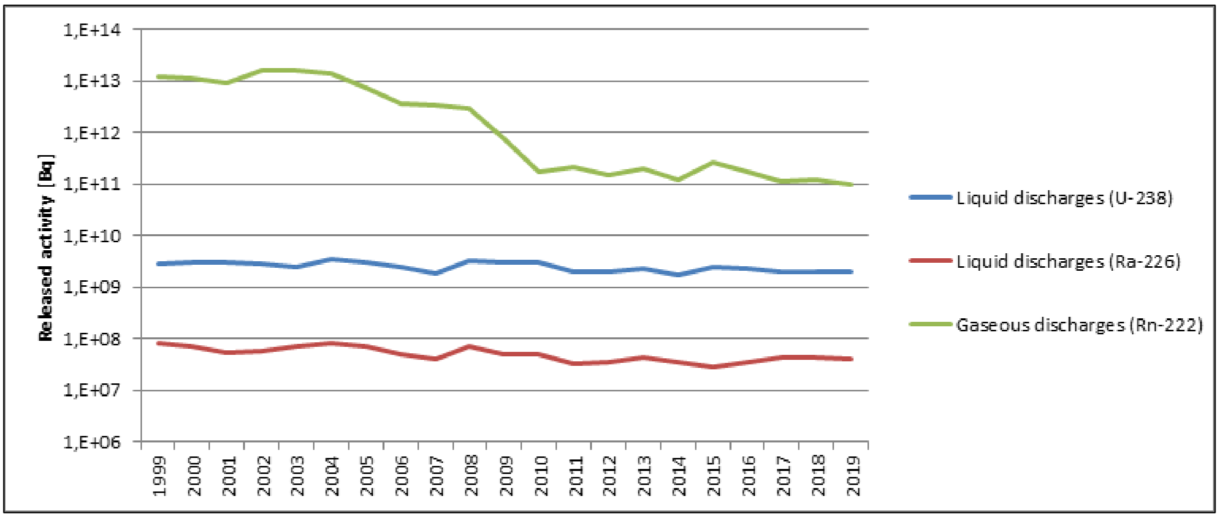
Notes:
* in the period of regular operation; 1989–2001 effective equivalent dose; 2002–2019 effective dose
** staff and contractors (outside workers)

(b) Liquid and Gaseous Discharges

Monitoring of radioactive discharges into the environment was performed regularly during all operational phases (1985–1990) and in the post-operational phase (from 1991 onwards).

The permanent discharges of dissolved long-lived radionuclides in percolating and run-off water from disposal sites and in mine water were reduced due to progressive remediation. It is expected that future fluctuations will mainly depend on weather conditions in the respective years. The radon release estimation is based on field measurements of the radon exhalation rate (Figure 13).

Figure 13: **Radioactive discharges at the Žirovski Vrh Uranium Mine in the period 1999–2019**



Note: For the year 2016, radon discharges were estimated based on partial measurements, past experience and extrapolation.

The impact of the mine discharges extends over an area inhabited by about 330 people. The dose assessment was made for a representative of each reference population group: a 1-year-old child, a 10-year-old child, and an adult resident older than 18 years of age. The inhalation of radon and its progeny is the main factor contributing to the public exposure caused by past mining activities. In 2019, the exposure of an adult member of the public was estimated to be 0.071 ± 0.021 mSv, of which radon and its short-lived products contributed 0.068 ± 0.011 mSv. The authorised limit for an adult of the population's reference group due to radiation exposure from the former uranium mine is 0.3 mSv/year.

Nuclear Medicine Departments

(a) Radiation Protection

Occupational exposure at the Institute of Oncology is monitored through regular individual monitoring of external exposure and workplace monitoring. The annual dose of the majority of workers at the Institute of Oncology did not exceed the value of 1 mSv in the period 2001–2019. Individual radiological engineers and radiopharmacists, mainly those handling the ^{18}F isotope, received a higher dose, but still below 5 mSv. The maximum annual dose in 2019 was 2.7 mSv. No worker has exceeded the annual limit of 20 mSv during the past 20 years. All of the above-mentioned values reflect the total exposures and include exposure during the handling of radioactive waste and its storage. No special tasks regarding radioactive waste are performed and no separate doses related to radioactive waste management are recorded. This is because the total collective dose is less than 20 man mSv per year. Only a few percent of this dose is due to work with waste.

Occupational exposure at the University Medical Centre's Department of Nuclear Medicine is monitored through regular individual monitoring and workplace monitoring. All staff are under dose control. In 2019, the effective dose of 89% of workers did not exceed 1 mSv and exposures between 1 and 2 mSv were measured for 11% of workers. The maximum annual dose, 1.5 mSv, was recorded for a radiological engineer from the Section for Nuclear Medicine Diagnostics. The quoted values are the result of overall individual exposures, i.e. they are not related only to waste management. The total annual collective dose is below 40 man mSv.

Management of radioactive waste at nuclear medicine departments is performed according to the set procedures. Personal protection equipment is used where appropriate. Intermediate local storage for waste materials with short-lived contamination is in place elsewhere.

(b) Liquid and Gaseous Discharges

The Institute of Oncology has a system of decay storage tanks to control the radioactivity released. Faecal sludge is released into the hospital sewerage system only after the defined period (about four months) required for the activity of the radionuclides to decrease below the prescribed limit.

Liquid discharges from the University Medical Centre's Department of Nuclear Medicine are monitored from time to time (on average every 5–10 years) and are estimated from the administered activities.

Five other small departments of nuclear medicine in the country deal with radiopharmaceuticals with essentially lower activities. Patients are dismissed from hospitals after iodine ^{131}I therapy and no special decay tanks for radioactive discharges are in place, so such discharges are estimated in the same way as above.

In total, less than 0.3 TBq of ^{131}I is released into the environment annually.

Article 25: Emergency Preparedness

1. *Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.*
2. *Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.*

Regulatory Requirements

The nuclear emergency preparedness and response in Slovenia is regulated in the latest consolidated version of the Protection against Natural and Other Disasters Act and the 2017 Act. There are two authorities with responsibilities and competences to regulate and supervise emergency preparedness at nuclear facilities. The Administration for Civil Protection and Disaster Relief is responsible for protecting the population during a nuclear accident and for the organisation of civil protection units at nuclear installations. The SNSA is responsible for regulatory control over on-site procedures and measures related to the on-site emergency plan. Their roles were described in more detail in the First National Report.

Concerning safety, the 2017 Act stipulates that every applicant shall submit, together with the application for a construction permit for a nuclear facility, an operator's emergency plan in the event of a nuclear accident. During trial operation and operation of the nuclear facility, the radiological emergency plan shall be updated, including all changes made during the construction and testing period. The on-site radiological emergency response plan is a constituent element of the safety analysis report.

The provisions of the 2017 Act mostly focus on intervention measures in the event of an emergency. According to these provisions, the operator needs to be capable of classifying accidents, assessing the consequences of such events, and proposing remedial measures. In the operator's emergency plan, intervention measures should be planned in accordance with the emergency class declared. The operator shall provide to emergency planners all the requested data it has available. The operator shall maintain emergency preparedness and provide responses as stipulated in the emergency plan. The prompt notification, without undue delay, of any such event is required, and the public needs to be informed of important facts in the emergency plans.

The Regulation on the Elaboration of Emergency Plans stipulates that the on-site nuclear emergency plan should be coordinated at the national and local levels and the nuclear emergency plans should be revised at least every five years. Emergency plans are public documents and should be presented to the public within 90 days of their adoption. The regulation also specifies the set of data relevant for the emergency that is to be supplied to the authorities by companies obliged to have an on-site emergency plan.

Overall National Emergency Preparedness Scheme and Off-Site Emergency Plans

The responsibilities and competences for emergency planning and maintaining emergency preparedness for an accident at a nuclear facility are specified at four levels: operator, local, regional and national. The State is responsible for the local and national radiological emergency response planning and maintenance of the radiological response plans.

National Emergency Response Plan for Nuclear and Radiological Accidents (hereinafter: the National Plan) was last updated in 2010. Besides a possible accident at the Krško NPP, the plan also covers accidents at other nuclear and radiation facilities in the Republic of Slovenia, nuclear or radiological accidents abroad with a potential impact on Slovenia, and other radiological accidents involving sources of ionising radiation.

At the end of 2013, an Inter-Ministerial Committee for emergency planning met in relation to the establishment of two working groups for the revision of the National Plan and for resolving emergency monitoring issues. The working group for the revision of the National Plan has drafted revision 4.0, which as of mid-2020 was still in the process of reconciliation. Most revisions in the National Plan refer to the IAEA standard GSR Part 7 (General Safety Requirements – GSR) and include the post-Fukushima improvements and some of the requirements of the EU BSS directive[3].

In October 2019, a new Evacuation Time Estimate (ETE) for the Krško Nuclear Power Plant was conducted. Due to the new infrastructure (bridges, regional roads and motorways), the ETE values have significantly changed since the last ETE from 1997. In some scenarios, the 90th percentile ETE for the 10 km full EPZ decreased by 2 hours and 25 minutes when compared to the 1997 study, while the 100th percentile ETE for the full EPZ decreased by 4 hours.

The JSI has a standby Ecological Laboratory with a Mobile Unit (ELME), which is a special unit for radiological and emergency response at the national level. It is intended to assist in any radiological emergency. It also performs radiation measurements and interventions in the event of the loss or dispersion of radioactive materials. Since 2007, the mobile unit of the Institute of Occupational Health has also been actively participating in emergency drills in field measurements and the testing of radiation monitoring preparedness in the vicinity of the Krško NPP.

The On-site Radiological Emergency Response Plan

Krško NPP

The Krško NPP has competence and sole responsibility for on-site emergency preparedness and response and maintains its on-site radiological emergency response plan (RERP). The on-site RERP is harmonised with the National Plan and was last updated in October 2019 (rev. 36).

The Krško NPP's RERP takes into consideration the IAEA's recommendations, the US 10 CFR 47 NUREG-0654 requirements, and the post-Fukushima lessons learned. It also covers the spent fuel pool and on-site radwaste facilities.

The objectives of the Krško NPP's RERP are:

- to identify and evaluate the type and classification of an emergency, including extensive damage and beyond design-basis accidents;
- to take on-site emergency measures and procedures to ensure the protection of the health and safety of plant personnel and members of the public in the surrounding area;
- to identify the on-site emergency response organisation and responsibilities for the overall command and co-ordination between the particular on-site and off-site emergency measures;
- to identify additional plant support required in the event of an emergency from the off-site support organisation, the Civil Protection Headquarters of Slovenia, and other competent authorities;
- to identify emergency response facilities, equipment, communications, protective and other means of managing emergencies;
- to take on-site recovery measures to manage or mitigate the consequences of an emergency and to ensure conditions for recovery;
- to provide a basis for maintaining on-site emergency preparedness; and
- to provide co-ordination between the Krško NPP and off-site local, regional and state authorities to ensure effective emergency planning and preparedness, including public information about protective measures.

The Jožef Stefan Institute Reactor Infrastructure Centre

The TRIGA Mark II research reactor has an on-site radiological emergency response plan, which was updated in February 2017. Off-site radiological emergencies are covered in the National Plan. Urgent protective actions for the off-site population are not expected. According to the safety analysis report, the

[3] 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, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom, OJ L 13 (17 January 2014).

most severe possible accident (total loss of all reactor coolant) would not cause a core meltdown, so no significant radioactive release into the environment is expected even in the worst-case scenario.

The emergency procedures are subject to internal and external verification and approval. The emergency procedures include reactor status data, the identification of an emergency situation, a description of appropriate actions, raising the alarm, reporting, informing, and responsibilities for the following internal and external emergency events:

- radiological reactor accidents (loss of reactor shielding – primary water, release of radioactivity in the controlled area, release of radioactivity outside the controlled area, loss of water in spent fuel pool);
- non-radiological accidents or events (fire in the reactor building, earthquake, sabotage and unauthorised access, riots and demonstrations, an off-site chemical emergency due to an accident in the chemical plant in the vicinity of the Reactor Infrastructure Centre).

The most severe operational accident (loss of coolant in the pool) would not significantly affect the spent fuel if it was stored in the reactor pool (since 1999 there has been no spent fuel). The off-site consequences of a gap release from damaged spent fuel elements are negligible.

Central Storage Facility for Radioactive Waste in Brinje

The ARAO is responsible for on-site emergency preparedness and response and maintains an on-site radiological emergency response plan. The emergency response plan for the Central Storage Facility for Radioactive Waste in Brinje is designed for events identified in the safety assessment as relevant emergency events related to the operation of the facility and the handling of radioactive waste. The plan defines the competences and responsibilities of the personnel responsible for emergency preparedness and the response to an emergency situation. The emergency response plan was updated and upgraded in 2017 in accordance with the results of practical exercises and with the aim of improving the plan.

Žirovski Vrh Uranium Mine

Radiological emergency situations are not expected at either the Jazbec or Boršt disposal sites. The Jazbec disposal site was closed in 2015; therefore, the area has become an object of national infrastructure, and public service and maintenance on the side has been provided by the ARAO since the end of 2015. In 2016 and 2017, additional rehabilitation work started at the Boršt disposal site, which is expected to slow down the sliding of the base (the drainage tunnel). In 2019, the monitoring network was renovated and upgraded with an additional nine deep piezometers. As part of the long-term surveillance and maintenance programme, the surfaces of the Jazbec mine waste disposal site and the Boršt hydro-metallurgical tailings disposal site are controlled regularly. In the event of heavy rain or an earthquake, additional site controls are conducted. The rate of sliding of the base of the Boršt hydro-metallurgical tailings disposal site is measured in real time, using a GPS system, at control points on the hydro-metallurgical tailings. Since 2018, geodetic surveillance has been carried out twice a year. A network, entitled "*Vrtine-2*", has been added to the basic landslide surveillance network.

Slovenian Nuclear Safety Administration

The SNSA emergency plan is harmonised with the National Plan. It consists of procedures for the SNSA emergency team.

The SNSA emergency team has two expert subgroups in addition to communicators and other supporting positions – one for analysing any nuclear accident, and another for dose assessment. The full composition of the team comprises 19 members working in 12-hour shifts.

The SNSA’s main role during a nuclear or radiation emergency is to recommend protective measures for the population to the Slovenian civil protection commander. In addition, the SNSA issues press releases to the public and responds to the media and public inquires and notifies and informs neighbouring countries, the EU, and the IAEA.

For primary communication between all organisations involved in the response to a radiation emergency in Slovenia, and also the Croatian Ministry of the Interior, the Civil Protection Directorate, and the

Department for Radiological and Nuclear Emergency, a special on-line communication system provided by the SNSA, i.e. the KID, is used.

Exercises

In accordance with the rolling programme of the national commission, one national exercise must be organised every three years.

The SNSA emergency response is ensured by regular training of the members of emergency expert groups and verification response teams, and through exercises, regular testing of equipment and participation in international activities. Each year, the SNSA also actively participates in annual Krško NPP exercises and conducts several internal exercises.

The emergency response training, drills and exercises are an integral part of the Krško NPP radiological emergency preparedness programme. It incorporates the human element with emergency response facilities, emergency equipment and emergency procedures to develop and maintain key emergency response skills and ensure the readiness and efficiency of its emergency preparedness and response team.

The programme is based on a routine annual schedule of the activities and includes the plant personnel, plant contractors, and off-site support organisations.

Emergency response training consists of initial, continuing (requalification) and specialised (proficiency) emergency response training.

The Krško NPP carries out the following emergency response drills:

- facilities and on-site emergency response organisation activation;
- implementation of severe accident strategies with mobile equipment;
- placing flood protection equipment;
- evacuation and accountability;
- post-accident sampling;
- off-site field monitoring, dose assessment and off-site protective measure recommendations;
- on-site radiation protection and radiological control;
- firefighting;
- first aid and medical response; and
- emergency notifications.

The objectives of the drills are verified in on-site integrated exercises, carried out twice a year. The exercises are prepared by the Exercise Organisation Group, which is also in charge of the preparation of the formal scenarios, including spent fuel and radioactive waste accidents. Within a five-year period, all emergency response segments are tested. The exercises are prepared and conducted regularly using the plant's full-scope simulator, which is also used for the Main Control Room (MCR) and Emergency Control Room (ECR) simulations. The Krško NPP emergency support organisations and local and governmental agencies also participate in the integrated exercises. The last on-site integrated exercise was conducted in November 2019. The first annual exercise in 2020 was cancelled due to the COVID-19 pandemic. The last national one-day table-top exercise was conducted in November 2019. In June 2019, a regional table-top exercise was conducted, in which, in addition to the IAEA, two neighbouring countries participated (Austria and Croatia). The exercise was prepared jointly by the Krško NPP, ACPDR, and SNSA.

Exercises for ensuring the safety of first responders in the event of a nuclear or radiological emergency have been carried out since 2019 in the framework of the ENRAS project. These are joint exercises of Slovenian and Croatian firefighting units, conducted to exercise procedures used in different scenarios. Their purpose is to improve the preparedness of firefighters in the event of a nuclear or radiological accident, and to ensure appropriate safety during such a response.

In January 2019 the first exercise of cybersecurity in the nuclear sector, called KIVA[2019], was organised in Slovenia. All domestic stakeholders (the nuclear facility operator, competent authority, technical support organisation, and suppliers of computer equipment), which would take action in the event of such a cyberattack, participated in the exercise. The exercise was of a table-top nature and its scenario involved a cyberattack on a nuclear facility, with access to the physical security control system and theft of sensitive information. The analysis of the exercise revealed that the communication between the stakeholders caused some difficulties. Despite some challenges, the exercise was extremely successful and, as such, represents the basis for carrying out further exercises of this type in support of preparedness for this type of incident – the next one is under preparation for 2020/21.

The ARAO regularly organises dedicated training programmes and practical exercises for employees of the Central Storage Facility. The ARAO maintains regular contacts with the Professional Fire Brigade of Ljubljana, the responsible police station, and the contractor responsible for physical protection services. The upgrading of theoretical training and the exchange of information is organised regularly. The ARAO also maintains the required equipment and is responsible for professional dosimetry.

International Agreements and International Projects

Slovenia is party to the Convention on Early Notification of a Nuclear Accident and to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Slovenia has also signed bilateral agreements with Austria, Croatia, Hungary and Italy on the early exchange of information in the event of a radiological emergency.

In 2015, Slovenia invited an Emergency Preparedness REView (EPREV) mission to Slovenia, which was conducted in 2017. The international mission reviewed the entire national framework in this field, including legislation and regulation, plans and procedures on all levels, as well as the personnel and material capacities of Slovenia for responses in the event of a nuclear or radiological accident. It made 19 recommendations representing actions to address non-compliance with IAEA requirements and standards, 12 proposals that represent actions to more effectively implement requirements and standards, and 3 good practices.

The mission report was the basis for the action plan adopted by the Government of Slovenia. The action plan comprises 31 actions, which include the mission's observations and findings, the action to be taken, the leading and participating organisations and deadlines for the implementation. According to the governmental decision, the SNSA role is to monitor the progress of the EPREV Action Plan.

In March 2020 the Government of the Republic of Slovenia took note of the implementation of the EPREV Action Plan. Considering that some of the tasks are long-term and challenging, the status of the implementation has been relatively successful, since 54% of the tasks have been completed (the amendment of the hazard assessment for nuclear and radiological emergencies, an analysis of the notification and activation system of the SNSA emergency response team, a poster for emergency workers, including for the purposes of providing non-designated emergency workers with just-in-time training, a poster on information for the general public on the health hazards and health effects in the event of a radiological emergency, also addressing the most vulnerable members of the public, amended procedures for requesting and receiving international assistance, an exercise wherein the SNSA's officer on duty would provide advice remotely during an initial response to a radiological emergency, etc.). Some of the tasks (the revision of the national emergency plan, the development of a protection strategy, decontamination procedures, guidelines for treatment, and for the designation of medical personnel to treat radiation injuries, etc.) are still ongoing and must be completed by the end of 2020.

Slovenia is also very active in the HERCA working group. The SNSA is the editor of the "Country Fact Sheets", established in 2015, which include information on national emergency response arrangements, with the aim of enhancing knowledge and facilitating communication during a nuclear or radiological emergency.

In 2019, Slovenia continued its positive international cooperation with its neighbouring country Croatia in harmonising protective measures taken by each state during a response to a nuclear or radiological emergency. One of the emergency planning zones (the extended emergency planning zone – 20 km from the NPP) also partially covers territory in Croatia, so the harmonisation of protective actions in the event of an off-site emergency is crucial. As a result of this cooperation, in 2016 the Croatian authority competent for nuclear and radiation safety became a full user of the Slovenian on-line communication system in the event of a nuclear or radiological emergency (KID), in order to facilitate the HERCA-WENRA approach in harmonising protective actions in the event of an off-site emergency. Furthermore, in March 2019 a bilateral arrangement for nuclear or radiological emergency preparedness and response, based on the HERCA-WENRA approach, was prepared in the document entitled *Arrangements for nuclear or radiological emergency preparedness and response*. Constructive dialogue on this topic between the two countries has been established.

Article 26: Decommissioning

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(i) qualified staff and adequate financial resources are available,

(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied,

(iii) the provisions of Article 25 with respect to emergency preparedness are applied,

(iv) records of information important to decommissioning are kept.

In the Republic of Slovenia there is no nuclear facility in the process of being decommissioned (there is ongoing remediation of the two waste disposal sites at the former uranium mine at Žirovski Vrh, but these are radiation facilities). In order to assess the financial contribution to the decommissioning fund, the Decommissioning Plan for the Krško NPP is being revised.

Krško NPP

The initial Krško NPP Decommissioning Programme was developed in 1996. The Agreement between Slovenia and Croatia on the Krško NPP of 2003 required the preparation of a Decommissioning Plan for the Krško NPP by the Slovenian and Croatian authorities for the management of radioactive waste. In accordance with the Agreement, a review of the Program for the Decommissioning of the Krško NPP and the Disposal of Low- and Intermediate-Level Waste and Spent Fuel was prepared in April 2004. The Decommissioning Programme must be updated at least every five years. The aim of periodic revisions of the Decommissioning Programme is to revise it, implement new international standards, and use best practices through the period of plant operation. These revisions are needed to provide an estimation of expenses of the future decommissioning and radioactive waste and spent fuel management and will represent the basis for decommissioning funds in Slovenia and Croatia.

A revision of the Decommissioning Programme was started in September 2008. The first version of the document was drawn up by June 2010 and the second version by February 2011. These two versions have been neither discussed nor approved by the Intergovernmental Commission for monitoring the implementation of the Bilateral Slovenian-Croatian Agreement on the Krško NPP. In July 2015, the Intergovernmental Commission held a session where it was briefed on progress concerning the revised Decommissioning Programme. The Commission decided to suspend all the activities in connection with the drawing up of this programme and identified the need to draft a new revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of the RW and SF from the Krško NPP. The Krško NPP was appointed to prepare the third revision of the Decommissioning Programme in cooperation with the ARAO and the Fund for financing the decommissioning of the Krško NPP and the disposal of Krško NPP radioactive waste and spent nuclear fuel from Croatia (the Croatian Fund). In 2019 the third revision of the Decommissioning Programme was issued and in November of 2019 approved by the SNSA.

At the 13th session of the Intergovernmental Commission in September 2019, the Intergovernmental Commission reviewed the final version of the third revision of the Krško NPP Decommissioning Programme and decided that the Programme was suitable for forwarding for further administrative procedures in the Republic of Slovenia and the Republic of Croatia. The Intergovernmental Commission gave final approval to the third revision of the Decommissioning Programme at its 14th session in July 2020.

The third revision of the Krško NPP Decommissioning Programme was prepared according to the decommissioning strategy "Immediate Dismantling" after a final shutdown in 2043. It contains the operation of the spent fuel dry storage (SFDS) and its decommissioning as well as the successive conventional demolition of the other remaining buildings. Two cases are considered. The base case considers operation of the SFDS until 2103, and the sensitivity case until 2075.

The third revision starts with a description of the facility and a presentation of the revised physical inventory. The subsequent chapters present a description of the decommissioning and dismantling techniques as well as the planned decommissioning activities. The chapters that follow describe waste management, including the treatment of materials and the packaging of radioactive waste. For the purpose of revision preparation, it is considered that 50% of the LILW is disposed of in N2d containers (Slovenia), and the other 50% is disposed of in Reinforced Concrete Containers (RCC, Croatia). The Attachments show the alternative results if 100% of the LILW is disposed of in N2d containers or RCC. The Attachments additionally provide different options for cementation (packaging). The option with the lowest costs for the disposal of 50% of the LILW in N2d containers and the other 50% in RCC is taken into account for the waste management strategy.

The planning and cost estimation use a so-called "work breakdown structure" (WBS).

The revision of the planning of the Krško decommissioning project results in the following main milestones presented in Table 7.

Table 7: **Main milestones for the decommissioning project**

	Base case	Sensitivity case
Start of the project (Pre-decommissioning actions)	2040	
Final shutdown / D&D approval	2043	
Old steam generators dismantled and packed	2045	
Finalisation primary loop	2047	
Finalisation RPV internals	2049	
Finalisation RPV	2051	
Finalisation biological shield	2052	
Building structures cleared – brown field	2058	
End of operation SFDS	2103	2075
Status – green field	2107	2079

During the planning work for the third revision no critical technical problems were found, and they are not expected to arise. The state of the relevant technology attained by now is high enough to realise all present and future decommissioning projects. However, considering that during the coming decades the volume of the decommissioning of installations will reach levels never handled before, the advancement of several aspects of existing techniques would be entirely desirable with regard to, for example, dose reduction, the simplification of processes, increased efficiency, minimising waste, and cost reduction.

The waste treatment and disposal (e.g. availability of a final repository and the corresponding repository requirements) have a huge impact on the entire decommissioning project and thus on the decommissioning costs. A decision about these aspects in due time is very important in order to ensure better planning reliability for the next revisions.

(i) Staff and Financial Resources

The Slovenian share of funds for the decommissioning of the Krško NPP is collected and managed by the Fund for the Decommissioning of the Krško NPP. Following the first revision of the Decommissioning Programme in 2004, the levy per kWhe was increased from approximately 0.2 to 0.3 euro cents. In 2012, the SNSA approved the Ageing Management Programme, which enables the operation of the Krško NPP beyond 2023. The operation of the Krško NPP could be extended from 2023 to 2043 (assuming the successful conclusion of periodic safety reviews in 2023 and 2033). Such a decision would have a significant impact on the Decommissioning Programme, the Decommissioning Fund and the National Programme for the Management of Radioactive Waste and Spent Nuclear Fuel. The decommissioning of the Krško NPP could occur after 2043 and it is assumed that the Krško NPP staff will perform decommissioning together with external contractors. In July 2020 third revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme and the third revision of the Krško NPP Decommissioning Programme were approved by the Intergovernmental Commission.

The total nominal costs without VAT for the Krško NPP decommissioning project (including operation and decommissioning of the SFDS) for the base case have been assessed at EUR 417.6 million. For VAT an additional EUR 56.4 million is calculated. The total costs without VAT for the sensitivity case have been assessed at EUR 405.3 million. For VAT, an additional EUR 56.1 million is calculated.

In both cases, Slovenian VAT of 22% is taken into account, except in the case of Krško NPP personnel costs and the costs of compensation for the limited use of space, which are not subject to VAT.

By a decision of the Slovenian Government in July 2020, the Slovenian electrical power company GEN energija, d.o.o. should continue increased payments from the previous rate of 0.3 euro cents per kWhe to 0.48 euro cents per kWhe, starting 1 August 2020, until the next revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme and the next revision of the Krško NPP Decommissioning Programme are approved.

(ii) Operational Radiation Protection, Discharges and Unplanned and Uncontrolled Releases

There are no specific regulations on the decommissioning of nuclear facilities. All legal requirements and limitations that are applicable to all operating facilities are also applicable to nuclear facilities in the decommissioning process.

(iii) Emergency Preparedness

As no decommissioning is being performed at the moment, there is no need for an emergency preparedness plan. However, one is required and shall be prepared as part of the application for the licence for decommissioning.

(iv) Records of Information

The Engineering Support Department at the Krško NPP is in charge of record keeping and maintaining the database required by regulations, including regarding decommissioning.

Jožef Stefan Institute Reactor Infrastructure Centre

A research project estimating the quantity and composition of LILW resulting from dismantling was carried out. A Decommissioning Plan for the reactor was prepared in 2007 and 2016 and revised in 2020. At present, there are no plans to shut down this reactor in the near future. It has been estimated that not more than 60 tons of LILW would be produced in decommissioning.

Žirovski Vrh Uranium Mine

Properly qualified staff are available to accomplish all the remaining tasks and activities at the Boršt disposal site. Adequate financial resources are available to accomplish remediation activities at the Boršt hydro-metallurgical tailings disposal site. For this purpose, the Ministry of the Environment and Spatial Planning provides financial means from the national budget.

Part of the funds necessary for monitoring and maintenance of the Jazbec mine waste disposal site for activities regarding the service of general economic interest are provided by the state budget.

The safety of remediation of the Jazbec mine waste disposal site and the Boršt hydro-metallurgical tailings disposal site is ensured through licensing and regulatory supervision similarly as for the decommissioning of other nuclear or radiation facilities.

The Central Storage Facility for Radioactive Waste in Brinje

The operation of the CSF, as public national infrastructure for the storage of institutional radioactive waste, ensures a safe storage area for radioactive waste for as long as it is produced by different activities in the country and for as long as there is a need for radioactive waste storage. After the cessation of operation, the CSF's decommissioning is envisaged under two possible scenarios, which differ with respect to the commencement of the decommissioning.

There are no nuclear reactions in the facility that could cause neutron activation, and no contamination of the facility or of the immediate surroundings is envisaged during the life cycle of the CSF. The results of contamination control show that no contamination of partition walls, floors and ceilings, metal pallets, the surface of radioactive waste packages, movable and electro-mechanical equipment, and underground tank and piping wastewater is to be expected. Two scenarios were developed for the CSF's decommissioning in the preliminary decommissioning programme formulated in 2012:

- Under the first scenario, all LILW from the CSF will be transported to the LILW repository in 2022. After 2022, the CSF will be decontaminated and put into unrestricted use. The removal of the facility is not envisaged.
- Under the second scenario, all LILW from the CSF that meets the waste acceptance criteria for disposal in the LILW repository will be transported to and disposed of in the LILW repository in 2022. The CSF will remain in operation as a central storage facility for institutional radioactive waste in the period during the temporary shutdown (standby mode) of the LILW repository. According to this scenario, the CSF will be decontaminated and put into unrestricted use after the final filling of the LILW repository in 2061. The removal of the facility is not envisaged.

The ARAO is responsible for conducting an eligibility analysis by 2024 and for assessing the need for the continuation of the operation of the CSF after 2025 when the disposal of radioactive waste from the CSF in the LILW repository is envisaged. Depending on the results of the eligibility analysis regarding the continuation of the operation of the CSF after 2025, either the procedures for the decontamination of the CSF are to commence or the CSF is to continue operating.

The ARAO, as the licence holder, is responsible for decommissioning planning and implementation. It is planned that the entire decommissioning project will last approximately one year. The decommissioning of the facility will be financed from the state budget and the payments of radioactive waste generators in accordance with the tariff of the mandatory service of general economic interest.

A new revision of the CSF decommissioning programme is under preparation and is expected to be completed by the end of 2020.

SECTIONS G AND H: SAFETY OF SPENT FUEL MANAGEMENT AND SAFETY OF RADIOACTIVE WASTE MANAGEMENT

The Republic of Slovenia has no separate legally binding documents on the safety of spent fuel management and the safety of radioactive waste management. The main legal pillar in this area is the 2017 Act. In this Act the general safety requirements are applicable to both the safety of spent fuel management and the safety of radioactive waste management. Some specific requirements regarding the type of activity are stipulated in separate articles of the 2017 Act. Thus, in order to avoid redundancy in the text, the requested information under Sections G and H is presented jointly.

Article 4: General Safety Requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed,

(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted,

(iii) take into account interdependencies among the different steps in spent fuel management,

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards,

(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management,

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation,

(vii) aim to avoid imposing undue burdens on future generations.

Article 11: General Safety Requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed,

(ii) ensure that the generation of radioactive waste is kept to the minimum practicable,

(iii) take into account interdependencies among the different steps in radioactive waste management,

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards,

(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management,

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation,

(vii) aim to avoid imposing undue burdens on future generations.

The criticality and removal of residual heat generated during radioactive waste and spent fuel management are adequately addressed in the 2017 Act through the approval of the safety analysis report by the SNSA. The content of the safety analysis report is determined in the Rules on Radiation and Nuclear Safety Factors (JV5) and in non-binding guidance on the content of the safety case for a particular type of nuclear facility.

The requirement that the generation of radioactive waste associated with spent fuel management and the generation of other radioactive waste is kept to the minimum practicable, consistent with the type of fuel-cycle policy, is ensured through the 2017 Act. Paragraph (2) of Article 121 stipulates that any person responsible for the generation of radioactive waste and spent fuel shall ensure that radioactive substances occur in the smallest possible quantities.

The interdependencies among the different steps in spent fuel management and radioactive waste management are addressed through the Resolution on the 2016-2025 National Programme for Managing Radioactive Waste and Spent Nuclear Fuel, adopted by the Slovenian National Assembly in 2016. The producers of radioactive waste and spent fuel have to consider the interdependencies among different steps of their management in the safety analysis report and operating licences. The requirement to consider interdependencies among different steps in spent fuel and radioactive waste management is also provided in the Rules on Radioactive Waste Management.

The provisions ensuring the effective protection of individuals, society and the environment, by applying suitable protective methods at the national level as approved by the regulatory body, are included within the framework of national regulations.

The biological, chemical and other hazards that may be associated with spent fuel and radioactive waste management are taken into account through the Environmental Impact Assessment Report and safety analysis report for each particular nuclear and disposal facility. The content of the Environmental Impact Assessment Report is prescribed by the regulation issued by the Ministry of the Environment (2017 Act, Article 97), while the content of the safety analysis report for the disposal of spent fuel and radioactive waste (2017 Act, Article 101) and uranium mining and ore processing waste (2017 Act, Article 106) shall be prescribed by the SNSA, which also acts as the licensing authority for the approval of the safety analysis reports.

Article 121 of the 2017 Act contains a provision on avoiding actions that impose reasonably predictable impacts on future generations. There are no special provisions requiring that impacts should not be greater than those permitted for the current generation in the Republic of Slovenia. This subject is addressed implicitly throughout all legally binding documents in the area of nuclear and radiation safety.

In 2015 the SNSA prepared the Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel Management for the Period 2016-2025 (ReNPRRO16-25), which replaces the resolution from 2006. The 2016 resolution, *inter alia*, assumes the construction of a dry storage facility for spent fuel.

As a consequence of the Fukushima accident in March 2011, the SNSA issued a decision to the Krško NPP stipulating that safety measures must be undertaken in order to prevent severe accidents and/or mitigate their consequences. The decision, *inter alia*, stipulates that the Krško NPP has to address all possibilities to decrease the risk associated with spent fuel management, having in mind also a change in the long-term strategy. In the second half of 2012, the Krško NPP prepared and submitted a document with an evaluation of spent nuclear fuel storage options. The recognised and confirmed optimal solution was the construction of a dry storage, which would consequently improve nuclear safety due to its passive nature and by reducing the number of fuel assemblies in the pool. The timeline for the construction of the dry storage is in line with the SNSA Safety Upgrade Programme decision, which at the end assumes the finalisation of safety upgrades and measures by the end of 2021. The Krško NPP activities started in 2016 and the contract for the construction of a passive dry storage facility was signed at the beginning of 2017.

Article 5: Existing Facilities

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

Article 12: Existing Facilities and Past Practices

Each Contracting Party shall in due course take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility,

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

The Republic of Slovenia has no spent fuel management facilities. The spent fuel that is generated by the operation of the Krško NPP and the JSI Reactor Infrastructure Centre (the TRIGA Mark II research reactor) is managed in storage sites that are integrated parts of these nuclear facilities. Similarly, the LILW generated at the Krško NPP is managed and stored in storage sites under the operating licence for the Krško NPP. The legislative provisions for nuclear facilities were applied for the siting, construction and operation of these storage sites.

The facilities that are subject to this paragraph are the Central Storage Facility for Radioactive Waste in Brinje, the Boršt hydro-metallurgical tailings disposal site and the Jazbec mine waste disposal site at the former Žirovski Vrh Uranium Mine.

The Central Storage Facility for Radioactive Waste in Brinje was put into operation in 1986, when nuclear legislation was not yet fully implemented. The operation of the storage facility was initially not licensed on the basis of nuclear and radiation safety legislation. The operator (JSI) obtained a licence for the use of this facility on the basis of the Construction Act. In 1998, the SNSA required by a decree that the operator apply for an operating licence under the 1984 Act and prohibited further operation of this facility, except for emergency cases.

When the management and operation was transferred to the national waste management organisation, the ARAO, in 1999, the SNSA required that the new operator meet the requirements of the above decree. By the end of 2002, plans for the reconstruction and modernisation of the facility were prepared. In 2004, all activities regarding the modernisation and refurbishment of the facility were concluded.

The refurbishment of the Central Storage Facility for Radioactive Waste in Brinje and the licensing were performed in compliance with the 2002 Act. The licence for trial operation of the Central Storage Facility for Radioactive Waste was issued in 2005 and the licence for operation was issued in April 2008. A revision of the Safety Report for CSF and its reference documentation were produced in the last three-year period. The first periodic safety review (PSR) of the CSF was concluded and the new operating license of the CSF was granted for the next 10 years.

The remediation of the Žirovski Vrh Uranium Mine has been in progress since the cessation of its operation in 1990. Remediation actions at the Jazbec site were finished in 2008. The final remediation work on the Boršt disposal site has been delayed due to the activation of a landslide. From the legal perspective, the uranium mine, the ore processing facilities, and the disposal sites for mining and ore processing waste were not nuclear or radiation facilities at the time of their operation. The principal Act governing their operation and closure was the Mining Act. By the 2017 Act, mining ore processing waste repositories were defined as radiation facilities, requiring SNSA consent. The key document is the safety analysis report. After finishing and checking the performance of environmental remediation activities at the Jazbec disposal site, the SNSA issued a decision to revoke the status of a radiation facility and license for the facility closure. Regular control and maintenance of the closed site is provided as a public service by the national waste management organisation ARAO. Although the facility does not have the status of a radiation facility, the provisions of nuclear legislation have to be followed when applicable.

Article 6: Siting of Proposed Facilities

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime,

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment,

(iii) to make information on the safety of such a facility available to members of the public,

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

Article 13: Siting of Proposed Facilities

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure,

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure,

(iii) to make information on the safety of such a facility available to members of the public,

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

The course of the procedure in the process of licensing nuclear facilities such as repositories is stipulated in the 2017 Act, the Environment Protection Act, the Spatial Planning Act, the Act on the Siting of Spatial Arrangements of National Significance in Physical Space, the Construction Act, the Rules JV5, the Decree on Categories of Projects for which an Environmental Impact Assessment is Mandatory, and the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment.

The above-mentioned legislation provides the framework for the preparation of the nuclear and radiation safety documentation and documentation for environmental impact assessment. It stipulates which consents and licences are to be issued and the manner of public participation.

According to the 2017 Act and the Environment Protection Act, the safety documentation concerning nuclear and radiation safety during the siting and licencing of a nuclear facility shall consist of three main documents: a special safety analysis, an environmental impact assessment report and a safety analysis report. The content of all three documents is similar, as they are prepared for the same facility, but they differ regarding the level of details presented.

Article 95 ("Location of a nuclear facility") of the 2017 Act determines that the selection of a site for the location of a nuclear facility shall be based on a special safety analysis, which will be used to assess all the factors at the site of the nuclear facility that may affect the nuclear safety of the facility during its operating lifetime and the impacts of the operation of the facility on the population and the environment.

The Environmental Protection Act forms the basis for the environmental impact assessment. The Decree on Categories of Projects for which an Environmental Impact Assessment is Mandatory determines that an environmental impact assessment is mandatory for spent fuel management facilities and radioactive waste management facilities and for the disposal of mining tailings and hydro-metallurgical tailings.

Public involvement in the siting process is ensured through prescribed public hearings, consultations and presentations and by making all the information available to the public. In the siting phase, it takes place in the framework of a strategic environmental assessment (SEA) and in the licensing phase in the framework of an environmental impact assessment (EIA).

Siting of the SF and HLW Disposal Facility

The decision on the siting and construction of the national facility for the management and disposal of spent fuel is part of the broader "dual tack" approach to a deep geological repository as described in the Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management for the Period 2016–2025 and the Programme for the Decommissioning of the Krško NPP and the Disposal of LILW and Spent Nuclear Fuel from the Krško NPP. In parallel with the national disposal programme, a multinational disposal option is possible. Both options go in parallel until the choice of one of the options is made.

It is assumed that the site selection process for HLW and SF disposal will be based on the same principles as were applied for site selection for the LILW repository in Slovenia. The site selection process comprises all activities that are intended for the selection of a final geological repository site. It is a mixed mode process, which includes expert assessment, applications from local communities, and public participation. It consists of four stages: the concept and planning stage, the area survey stage, the site characterisation stage, and the site confirmation stage.

Time schedules for the disposal base case scenario and the sensitivity case scenario as presented in Article 32 – Spent Fuel Management Policy of this report, are similar to the way they are defined in ReNPRRO16-25; the basic difference is that they are just shifted in a way such that the sensitivity case scenario starts with the activation of the geological programme already in 2025, to be prepared for operation in 2065, whereas the base case scenario starts the geological programme in 2053, to be prepared for operation in 2093.

The sequence of activities in each scenario is the same; the difference is only in the year of the start of the second phase (activation) of the geological programme. To start with regular operation at a fixed time, it is assumed that the site selection stage has to begin 38 years earlier for both base case and sensitivity case scenarios. In the last part of the site selection stage, i.e. site confirmation, construction of an underground research laboratory is foreseen, as shown in Table 8. For the base case scenario, confirmation of the decision on a national or multinational approach will be made before 2069.

Table 8: **Start of the main activities of the geological disposal siting programme**

Activity/case	Base case (year)	Sensitivity case (year)
Activation of the geological programme	2053	2025
Start of the site selection process	2055	2027
Start of construction of the UTF	2079	2051
Start of site investigations in the UTF	2083	2055
Confirmation of the final site	2086	2058
Start of the repository construction	2087	2059

For the base case scenario, confirmation of the decision on a national or multinational approach will be made before 2069.

Siting of the LILW Disposal Facility

Due to the growing need for the final disposal of LILW, the final solution for the short-lived LILW is the key issue of radioactive waste management in the Republic of Slovenia. The ARAO successfully accomplished the siting procedure for the LILW repository and the site was approved in December 2009.

The ARAO decided on a combined mode site selection process. This in practice means a combination of technical screening and volunteer siting. It is flexible, transparent and ensures strong public involvement.

At the end of 2004, the official administrative procedure for the siting of the repository was announced. In accordance with the procedure, all Slovenian municipalities were invited to take part in the procedure of searching for a repository site. By the deadline for submitting applications, 4 May 2005, eight municipalities had announced their intention to participate.

The proposed locations were discussed by the municipalities in pre-comparative studies and evaluated from a safety, functional, technical, economic, environmental, spatial and social point of view. On the basis of the prepared pre-comparative study, in November 2005 the Government of the Republic of Slovenia confirmed three potential locations for more detailed consideration in the further process of selecting the location of a LILW repository, the location of Vrbina in the Municipality of Krško, Globoko in the Municipality of Brežice, and Čagoš in the Municipality of Sevnica.

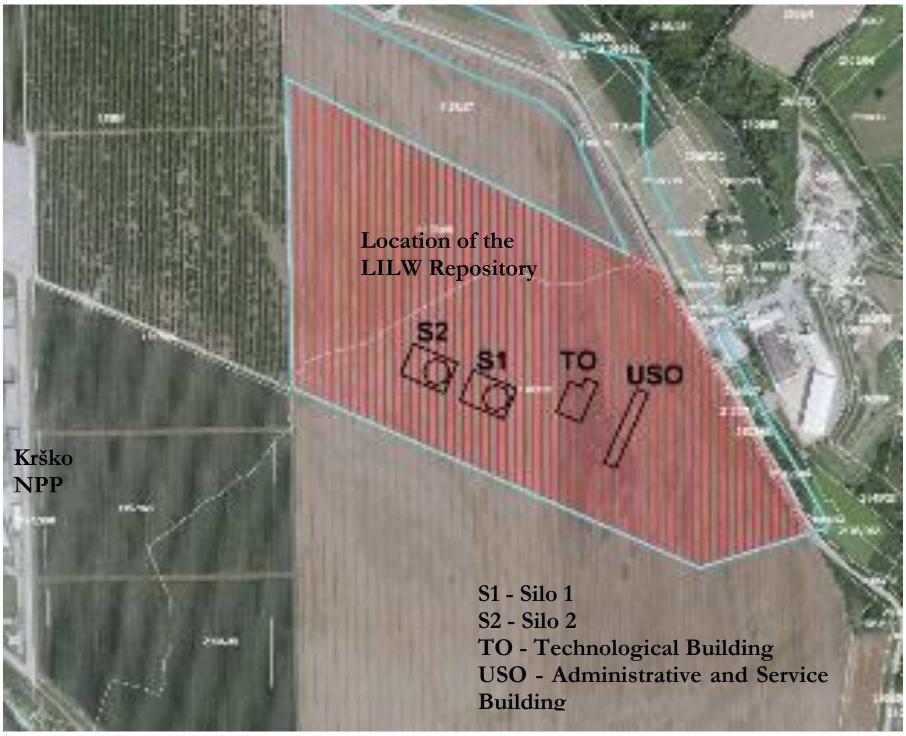
Activities in the area of the design concept of the repository began to be intensively implemented in May 2006 with the elaboration of the Design Bases as one of the basic starting points for design. During the formulation of the Design Bases, the Municipality of Brežice adopted a decision to withdraw the Globoko site from the procedure and to try to identify an alternative site to participate in the procedure. Since after the call for the submission of guidelines back in March 2006 the Municipality of Sevnica had already withdrawn from the procedure, the formulation of the Design Bases proceeded only for the Vrbina site. At the same time, in July 2006 work began on the expert basis for studying variants only for the Vrbina site. As part of the formulation of the expert basis for the Variant Study, produced in August 2006, the technical adequacy was checked for the recorded alternative solutions regarding repository facilities at the Vrbina site and it was concluded that it would be possible to construct various variants of repository facilities at the site. For the needs of the Variant Study, a multilateral assessment of the acceptability of the activity was made by comparing variants from five aspects – functional, safety, environmental, spatial and economic aspects – as well as the aspect of acceptability in the local environment.

The overall assessment of the evaluation showed that the solution with silo disposal units shows the highest degree of suitability for construction at the Vrbina site.

After years of intensive siting work, the Detailed Plan of National Importance for a Low- and Intermediate-Level Radioactive Waste Repository in Vrbina in the Municipality of Krško, was prepared and adopted at the end of the 2009 by the Slovenian Government. With the adoption of the Decree on the Detailed Plan of National Importance for a LILW Repository, the location and type of repository were confirmed. The selected type of repository envisages the disposal of radioactive waste in near-surface silos. Disposal silos are built from the surface down in low permeability silt layers in a saturated zone under groundwater. The concept combines properties of surface type repositories (disposal from the surface) and properties of underground repositories (the placement of disposal units in low-permeable saturated geological formations).

The location of the LILW repository in Vrbina in the Municipality of Krško is shown in Figure 14.

Figure 14: **Approved location of the LILW repository in Vrbina in the Municipality of Krško**



Article 7: Design and Construction of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases,

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account,

(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by the decommissioning of a spent fuel management facility.

Article 14: Design and Construction of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases,

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account,

(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared,

(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

The measures prescribed in Articles 7 and 14 of the Convention are ensured through the licensing process for the construction of nuclear facilities.

The permit for the construction of a nuclear facility is issued by the Ministry of the Environment and Spatial Planning on the basis of the Construction Act; the opinion issued by the SNSA (2017 Act, Article 97) is one of the conditions for such. In issuing an opinion, the SNSA evaluates the technologies incorporated into the design and construction of the spent fuel management or radioactive waste management facility from the point of view of nuclear and radiation safety and environmental protection.

According to Article 97 of the 2017 Act, an application for an opinion shall include project documentation, a safety analysis report, including relevant evaluations, and the opinion of an authorised expert for radiation and nuclear safety. The project shall be in compliance with the design bases according to the provisions of Chapter II of Rules JV5. The content of the project documentation and the methods of its preparation and revision are prescribed by the rules governing project and technical documentation and, in the case of mining works, with the provisions of the rules governing the method of the compilation, sequence, contents and revision of mining works project documentation. The key document governing the technical and safety measures for the construction and operation of a nuclear facility is the safety analysis report. The content of the safety analysis report for the disposal of uranium mining and ore processing tailings and mines is prescribed in detail by the SNSA. The main content of the safety analysis report is prescribed by the 2017 Act and Rules JV5. The detailed content of the safety analysis report for the LILW repository was prepared by the SNSA in the form of guidelines issued in 2012.

Chapter II of Rules JV5 sets the requirements for the design bases for radiation and nuclear facilities and the main principles that the design of radiation or nuclear facilities should adhere to. It includes general provisions for the design bases and specific provisions for, *inter alia*, safety functions, physical protection, site conditions, postulated initiating events, normal operation, events and accidents, facility states, capability for decommissioning and emergency preparedness.

Design Basis for the LILW Repository

The silo repository type was confirmed with the adoption of the Decree on the Detailed Plan of National Importance for a LILW Repository in Vrbina in the Municipality of Krško. The area included in the plan is 18 ha. The planned LILW repository, with a net area of about 10 ha, includes all structures, systems and components required for its operation as an independent nuclear facility. An area for an additional two silos is reserved for future extension of the capacity if needed.

According to Article 99 of the 2017 Act, the preparation of design bases for nuclear facilities, in different stages of the facility life cycle, is prescribed. In 2016, the design basis for the LILW repository was prepared as a part of the application for environmental consent. In the design basis all the requirements for the planned LILW repository are collected, which are then implemented in the final design. The Design Bases address all phases of the facility (design, construction, trial operation, operation, termination of operation, idle phase, decommissioning, closure, post-closure and long-term surveillance and maintenance), as well as all the main characteristics of the repository design, including the features of the site and the extent and layout of the repository, and the facilities, structures, systems and components and devices required to ensure safety at all phases of the repository.

Design for the Construction Permit for the LILW Repository

With the development of the design and following recommendations and suggestions from the expert missions and international reviews, some optimisations of the design were proposed. The design was analysed in additional studies. The focus was on the silo design (water tightness), the access shaft (incorporation into the silo) and the design of the closing structure of the silo. Additionally, studies were performed regarding the necessary capacity of the repository, possible optimisations regarding waste packages, the characteristics of the backfill material, treatment for disposal (suggested optimisations of waste packages), and the disposal of larger components.

The foreseen layout of structures, systems and components shall ensure the relevant conditions for the safe operation of the repository.

From the landscape architecture aspect, the repository includes the following areas:

- the eastern part of the repository, where access from the municipal road is provided;
- a narrow area of the repository intended for administrative/service activities and waste acceptance, waste disposal in disposal units, and the provision of the physical security of the repository; this area is surrounded by a fence;
- free surfaces for the repository; and
- surfaces required for connections to infrastructure.

Areas within the disposal area and a major part of the inner areas of the waste conditioning structure are classified as radiologically controlled areas and are protected by a fence.

At the entrance area of the repository there is an entrance to the repository, an access road connected to the municipal road, parking for employees and visitors, and green open areas.

The narrow area of the repository includes a flood protection embankment, the structures of the repository, the necessary infrastructure and landscape arrangements within the fence of the repository.

The area outside the narrow area of the LILW repository consists of a free surface and the outer maintenance road, which runs along the fence of the repository.

The area for connection to infrastructure consists of structures for access to the repository (an access road) and all connections necessary to meet the needs of the new repository (water, electricity, sewage systems, IT, etc.).

The narrow area of the repository is intended for administrative and service activities, the acceptance of waste, the disposal of waste, and the security of the repository. The size of the area is approximately 6 ha, with the following structures:

- the Administrative and Service Building;

- the Technological Building;
- the Disposal Silo with a hall above the silo; and
- the Control Pool.

In accordance with the level of protection against flooding, structures are situated on a flood protection embankment for protection against probable maximum flood. The dimensions and shape of the embankment are in accordance with the technological requirements. The repository is surrounded by an external service road.

In the Administrative Building there are facilities and systems for repository management activities, service and administrative activities, access control, personal and vehicle entrance control, as well as control of the repository area.

The service part of the building is intended for energy supply, fire protection water, municipal waste collection, the storage of equipment and geological samples, and workshops. This part of the building contains all infrastructure, energy and service premises needed for the safe and smooth operation of the repository.

The Technological Building is located in the central part of the repository. It is designed for temporary storage and, if necessary, the repair of damaged waste containers, basic laboratory research, and the control of technological processes, and the other necessary technological and service functions of the repository, as well as functions for ensuring radiation safety. Functionally, the building is designed in such a manner that its construction can be performed in two stages. The technological building is also the entrance and exit point regarding the controlled area of the LILW repository.

The silo is designed as a reinforced concrete cylindrical structure with an inside diameter of 27.3 m and a height (depth) of 55 m. A vertical communication shaft runs inside the silo. The central part of the shaft consists of stairs and an elevator, with installation shafts on the side. The entrance to the communication shaft is provided from the hall or from the outside.

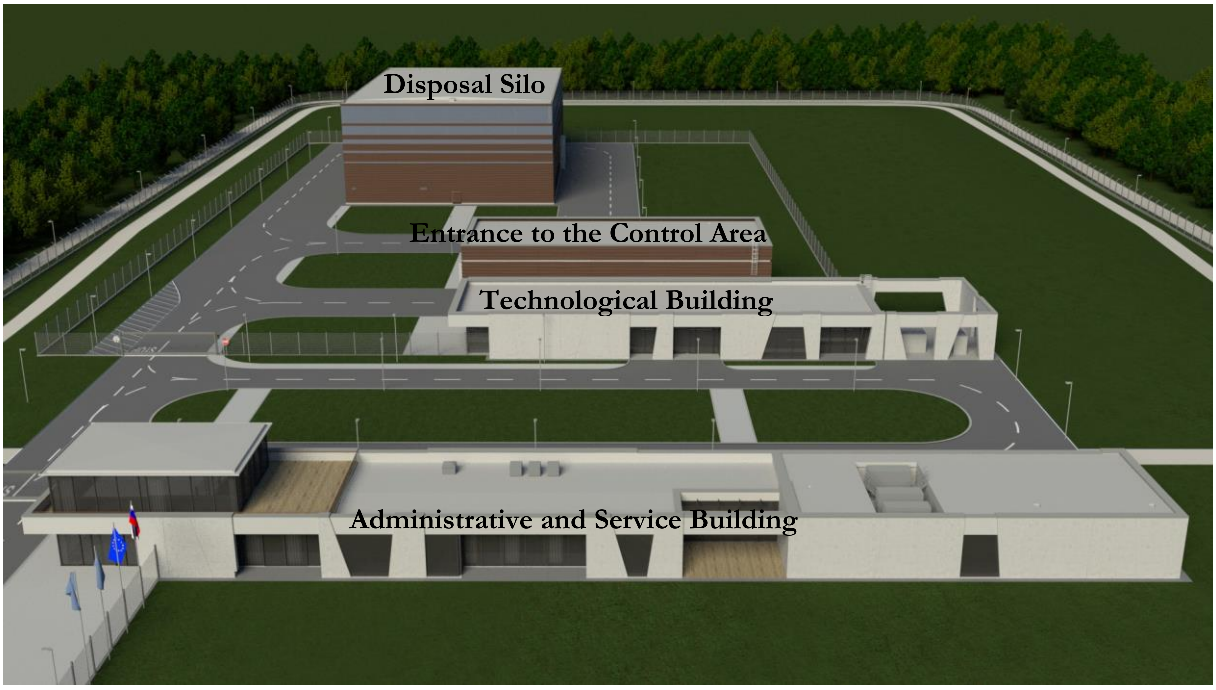
The net floor area of the silo enables the arrangement of 99 containers on one level. The height of the silo is designed to contain 10 levels of containers, including the closing structure, a reinforced concrete plate and a clay barrier. The closing barrier is below the level of the existing aquifer.

The hall above the silo is located in the central part of the repository in the radiologically controlled area and covers the entire floor area of the silo, including the handling area. The hall protects the silo and gantry cranes for the disposal of containers from weather conditions.

The Control Pool is designed to collect water from the silos, from the hall above the silo and from the Technological Building resulting from the cleaning of the floor, and the decontamination of tools and equipment. The construction of the Control Pool is in line with the technological requirements.

Figure 15 shows the structures inside the LILW repository in Vrbina, Krško, as shown in the design for the construction permit.

Figure 15: **The LILW repository facilities based on the design for the construction permit**



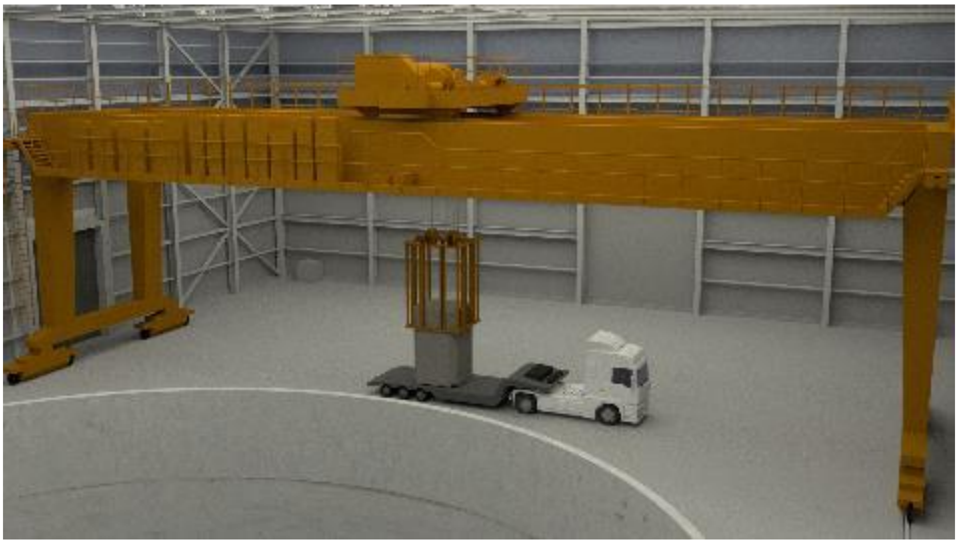
The reinforced concrete container is one of the engineering barriers that must comply with all required safety functions. The basic geometry of the container was determined on the basis of the 4 TTC overpacks, which are the most commonly used overpack at the Krško NPP. The chosen design in terms of both design and materials meets all the basic safety functions for concrete containers.

Figure 16 shows the reinforced concrete container as presented in the design for the construction permit.

Figure 16: **A reinforced concrete container for the disposal of LILW**

During the period of operation, the silo is protected by a hall, where a portal gantry crane is located. All waste will be put in reinforced concrete containers prior to disposal. In total, 950 type N2d containers, with a maximum (design) weight of 40 t will be disposed of. The disposal containers will be transported to the handling area near the silo by vehicle and then disposed of using the gantry crane and special grippers. The empty spaces will then be backfilled with backfilling material. The last layer of the containers will be covered with a reinforced concrete plate and a layer of fairly impermeable material (e.g. clay).

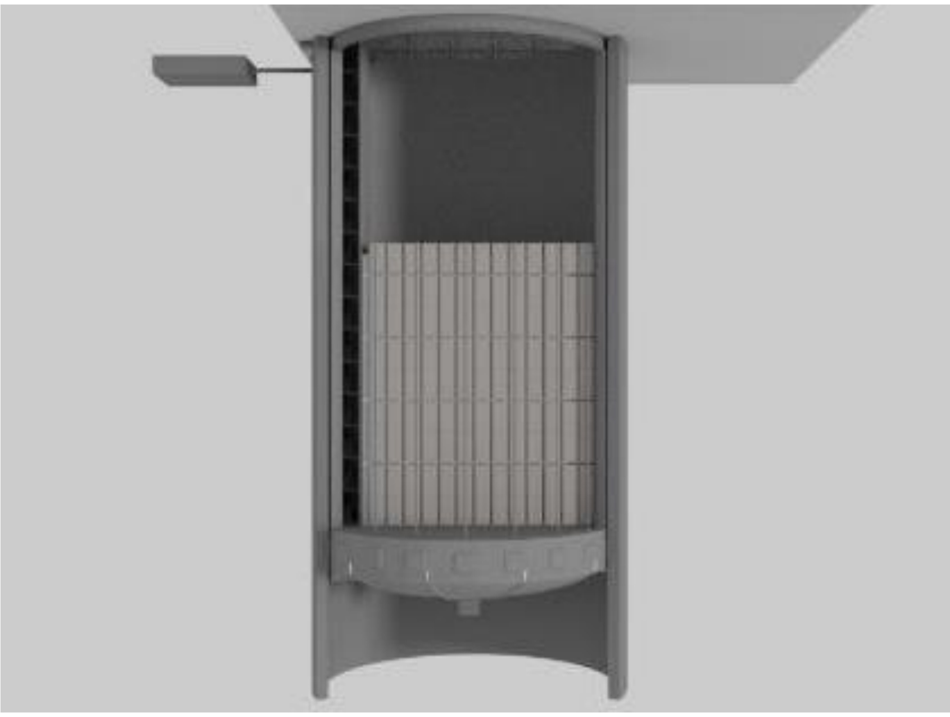
Figure 17: **N2d container unloading from the transport vehicle by the gantry crane and special grippers**



The repository concept is flexible and covers as many future developments in the programme as could reasonably be expected. It consists of a modular approach and an intermittent mode of operation. Each silo is an independent unit and the number of silos is expandable. The second silo will be constructed when the first one has been filled and the need for a second one arises. The repository can operate intermittently, i.e. it can be temporarily in standby mode for longer or shorter periods of time. The repository also has the potential to accommodate all LILW from the Krško NPP.

Figure 18 shows a cross section of the silo as in the design for the construction permit.

Figure 18: **The LILW disposal silo cross section as shown in the design for the construction permit**



Article 8: Assessment of Safety of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out,

(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

Article 15: Assessment of Safety of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out,

(ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body,

(iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

Assessment of Safety before Construction

The assessment of safety before the construction of a spent fuel management facility or a radioactive waste management facility is ensured by Article 101 of the 2017 Act. It is ensured through the provision requiring that an application for a licence shall contain project documentation, a safety analysis report and the opinion of an authorised expert for radiation and nuclear safety.

Article 43 of Rules JV5 lays down the general contents of the safety analysis report, which shall provide the following information:

- a site description, a general description of the facility and its normal operation, and a description of how the facility's safety is ensured;
- a description of the programme for trial operation;
- a description of the technical characteristics of the radiation or nuclear facility and a description of performance in all operational states of the facility;
- a description of the facility's design concept and the approach adopted to meet the fundamental safety objectives and a description of the design bases of the radiation or nuclear facility and of their methods of fulfilment;
- a detailed description of the safety functions, of all safety systems, and of safety-related structures, systems and components (SSCs), their design bases and the functioning of all safety-related SSCs in all operational states of the facility;
- a list of regulations and standards applied as the basis for descriptions and safety analyses covered in the safety analysis report;
- a description of the plant organisational set-up of the facility operator intended for ensuring nuclear safety;
- an assessment of the safety aspects relating to the facility site;
- a description of safety analyses performed to assess the safety of the radiation or nuclear facility in response to postulated design-basis events and a comparison with the technical acceptance criteria;
- a description of the probabilistic safety analyses;

- a description of the emergency operational procedures and of the severe accident management guidelines in the case of a nuclear facility;
- a description of the measures for protection against internal fires;
- a description of the emergency plan for the facility and of the facility operator's internal organisational set-up for emergency events and of its alignment with the national protection and rescue plan in the event of a nuclear accident;
- a description of the measures providing for SSC inspection, testing and surveillance; a description of the operational experiences feedback programme; and a description of the ageing management programme;
- a description of the training and education of the personnel;
- the operating limits and conditions of safe operation and technical bases explaining the expert bases for each operating condition or limit;
- a description of the strategy for protection against radiation – a description of the methods and measures for the protection of exposed personnel against ionising radiation, including an assessment of their protection against radiation and an assessment of the exposure of the general population and the environment;
- a description of any radioactive and nuclear materials and other sources of radiation;
- a description of the radioactive waste and spent fuel management programme;
- a description of all activities in the facility's operational phase planned to facilitate termination of operation and decommissioning;
- a description of the management system;
- an outline of the physical protection of the facility and nuclear and radioactive substances;
- the anticipated and maximum allowable releases of radioactive substances into the environment;
- the programme of meteorological measurements and radioactivity monitoring during operation; and
- in the case of a radioactive waste repository, a spent fuel repository, a hydro-metallurgical tailings repository or a mining tailings repository, a plan for long-term surveillance.

The safety analysis report shall be amended when changes in the situation referred to therein arise during the construction or decommissioning of the facility or during the period of trial operation.

The SNSA shall issue consent for construction within 24 months after the submission of a complete application. Article 107 of the 2017 Act allows the SNSA to issue a special decision splitting the contents of the application into thematically related subjects to obtain partial opinions in order to shorten the time period for the issuance of consent for construction. In April 2017 and in June 2019, the SNSA issued a decision to split the contents of the application into content-based thematic sections. This approach will contribute to a more systematic review of the documentation and accelerate the overall licensing process.

Assessment of Safety before Operation

After construction work has been completed, every nuclear facility shall undergo a period of trial operation. Prior to the start of the trial operation of a nuclear facility, it is mandatory to obtain the consent of the SNSA. An application for consent for the start of trial operation shall contain a safety analysis report updated with any changes that have occurred during construction, the opinion of an authorised expert for radiation and nuclear safety, and other prescribed documentation.

Article 26 of Rules JV5 determines the contents of the application for consent for the start of the trial operation of a radiation or nuclear facility.

The SNSA shall issue consent for trial operation for a fixed period, which may not exceed two years. The consent for trial operation may be extended. There is no right to appeal against the refusal of consent for the start of trial operation.

The Safety Case and Safety Assessment for the LILW Repository

After the end of the siting of the LILW repository, the preparation of the safety case for the licensing thereof was started. The main goal of this phase is to attain confidence that the combination of the repository site and the disposal concept is safe, especially regarding long-term safety. This information is used both in the licence application and to support the environmental impact assessment. As a part of the safety case, a new iteration of the safety assessment was prepared. The purpose of this was to develop reasonable assurance that the facility will remain within regulatory safety constraints for a long time into the future, as determined in legislation. The safety assessment was undertaken using the Improvement of Safety Assessment Methodologies (ISAM methodology) of the International Atomic Energy Agency, which has become an internationally accepted standard for conducting safety assessments. At each stage of the process, the methodology is intended to focus attention on key issues that need to be addressed to develop confidence that the final decision is well supported, documented and fully coherent.

The selection and classification of postulated initiating events were placed into two sub-groups:

- initiating events for the operation, closure and decommissioning of the repository;
- definition of the Features, Events, and Processes (FEPs) for the repository in the post-closure period.

The list of postulated initiating events was used for selecting initiating events during operation, closure and decommissioning of the repository, and was supplemented by the anticipated operating occurrences as defined in the reference documentation for repository operation.

The FEPs for the repository in the post-closure period were reviewed and those with no relevance to the Vrbina LILW repository were excluded. Suitable scenarios were then developed from the FEPs that remained.

The scenario development process for the repository's long-term safety resulted in the identification of five main scenarios:

- a nominal scenario,
- early failure of engineering barriers,
- river meander and surface erosion,
- inadvertent human intrusion, and
- changes in hydrological conditions,

for which analyses were conducted. For all of these scenarios, detailed models were prepared to calculate the impact of the facility on people and the environment. At the end of the process, all the results were evaluated. All dose assessments from scenarios on a representative person showed that doses are expected to be under the limits given by the regulatory body. Limits were taken from the IAEA standard, international practice and Annex IV.6 of Rules JV5.

On the basis of the initiating event analysis and final design, the scenarios for the operational phase of the disposal facility were developed and analysed.

The post-closure safety assessment and operational safety assessment showed that the proposed concept and the design of the facility meet the regulatory safety criteria for post-closure and operational safety with a good margin for all the analyses conducted. This conclusion is contingent on a number of basic assumptions that form the foundation of the safety assessment analyses. On the basis of these studies, it is concluded that there is high confidence that the Vrbina repository meets regulatory constraints with a sufficient margin.

Article 9: Operation of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the license to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements,

(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary,

(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures,

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility,

(v) incidents significant to safety are reported in a timely manner by the holder of the license to the regulatory body,

(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate,

(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

Article 16: Operation of Facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the license to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements,

(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary,

(iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility, the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure,

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility,

(v) procedures for characterisation and segregation of radioactive waste are applied,

(vi) incidents significant to safety are reported in a timely manner by the holder of the license to the regulatory body,

(vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate,

(viii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body,

(ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

Initial Authorisation for Operation

The operating licence is issued by the SNSA only after the Ministry of the Environment and Spatial Planning issues, in accordance with the Construction Act, a licence for the use of a facility.

The application for the operating licence shall contain an updated safety analysis report, an opinion from an authorised expert for radiation and nuclear safety, and other documentation prescribed by Article 27 of Rules JV5. The safety analysis report shall be updated with any changes that occur during the trial operation.

A licence shall be issued by the SNSA within 90 days of receiving a complete application and information on the trial operation indicating that all the conditions for radiation and nuclear safety have been fulfilled.

Operational Limits and Conditions

In accordance with Article 101 of the 2017 Act, the proposed operational limits and conditions (technical specifications as part of the safety analysis report) have to be submitted to the regulatory body as a part of the safety analysis report first already with the application for consent for construction, then with the application for consent for trial operation, and subsequently with the application for the operating licence.

Article 46 of Rules JV5 sets the basic requirements for operational limits and conditions and also defines that they shall be specified for all operational states of the facility.

Article 47 of Rules JV5 defines the contents of the operational limits and conditions, which should contain:

- a definition of terms;
- safety limits;
- limits on operating parameters for safety systems;
- limits on operating parameters and stipulation of the minimum amount of operable equipment, including the number of SSCs important for safety, which should be in operational or standby condition;
- necessary measures in cases of exceeded operating limits and conditions, and the time available for taking such measures;
- requirements for surveillance; and
- requirements for the minimum staffing levels to ensure safe operation in different operational states of the facility.

Article 3 of the Rules on the Operational Safety of Radiation or Nuclear Facilities (JV9) defines the application of operational limits and conditions. It is required that the personnel licensed to operate and monitor the technological process in a radiation or nuclear facility shall be highly knowledgeable as to the contents, purposes and technical bases of the operational limits and conditions. Information on the operational limits and conditions shall be accessible to all personnel involved in operating the facility. In facilities fitted with a control room, such information shall be available in the control room.

The operational limits and conditions shall be reviewed and kept updated as appropriate in accordance with operational experience and developments in science and technology and upon any modification to the facility that warrants or requires such updates.

Articles 116 and 117 of the 2017 Act outline the procedure for the approval of changes to the safety analysis report. The procedure defines three classes of changes according to safety relevance:

- changes for which it is necessary to notify the SNSA;
- changes for which the intention of their implementation shall be reported to the SNSA; and
- changes of significance for radiation or nuclear safety and for the implementation of which a licence from the SNSA shall be obtained.

Rules JV9 define the methodology for the assessment and classification of modifications and the method and form of reporting and proposing modifications to radiation or nuclear facilities.

Operation, Maintenance, Monitoring, Inspection and Testing

In accordance with Article 27 of Rules JV5, the documentation submitted for the application for an operating licence shall also contain a list of prepared operating procedures, a report on trial operation, a radioactive waste or spent fuel management programme, management system documentation, a decommissioning programme, a programme for monitoring operational experiences, a programme for monitoring ageing, programmes for SSC maintenance, testing and inspection, the results of pre-operation monitoring, a safety analysis report, an opinion by an approved radiation and nuclear safety expert, and other prescribed documentation. At the request of the SNSA, the investor or the operator of a radiation or nuclear facility shall make licence application reference documentation available.

Periodic safety review

In accordance with Article 112 of the 2017 Act, the operator of a radiation or nuclear facility shall ensure regular, full and systematic assessment and inspection of the radiation or nuclear safety of the facility through periodic safety reviews.

The operator shall draw up a report on a periodic safety review and submit it to the SNSA for approval.

Where a report on a periodic safety review indicates the need to change the conditions of operation or the limitations from the safety analysis report with the aim of improving radiation or nuclear safety, the operator shall draw up a proposal for any such changes.

An approved report on the periodic safety review shall be a condition for the renewal of the licence for the operation of the nuclear facility.

The frequency, contents, scope, duration and method of performing periodic safety reviews and the methods of reporting such reviews are defined in Chapter V of Rules JV9.

Exceptional review of the safety analysis report

According to Article 119 of the 2017 Act, the operator shall evaluate and verify the safety of the facility and ensure a review of the concordance of the safety analysis report with the conclusions of the evaluation and verification of safety directly after any emergency at the facility or after the completion of work relating to the mitigation of the consequences thereof.

Engineering and Technical Support

In-house capabilities have been developed to perform engineering and technical support at the existing nuclear facilities. The Krško NPP, the Jožef Stefan Institute Reactor Infrastructure Centre, the ARAO and the Žirovski Vrh Mine d.o.o. are capable of processing minor design changes in-house. The capability to prepare purchase specifications, review bids and bidder selection, quality assurance, quality control and engineering follow-up of projects, and the review and/or acceptance testing of products are possible to a certain extent at all of the above facilities. Other engineering and technical support is provided through outsourcing to Slovenian research and engineering organisations or abroad. However, major projects require an open invitation to tender. The Ministry of Education, Science and Sport financially supports research and development projects in the field of nuclear safety in the Republic of Slovenia through a research fund, with the participation of the nuclear industry and the SNSA.

Characterisation and Segregation of Radioactive Waste

According to Article 121 of the 2017 Act and the Rules on Radioactive Waste and Spent Fuel Management, the licence holder shall collect radioactive waste, classify them with regard to the aggregation state and the level and type of radioactivity, report on radioactive waste and spent fuel generation, keep accounting records for the waste, label the waste, provide for the processing, transport and storage of waste, and perform activities in such a manner that the lowest possible quantities of radioactive waste are generated, taking into consideration safe working conditions, radiation protection and economic criteria.

Incidents Significant for Safety

Article 120 ("Reporting on the operation of facilities") of the 2017 Act stipulates that an operator shall submit exceptional reports to the SNSA containing information on:

- equipment malfunctions that could cause an emergency, emergencies themselves, and measures taken for the mitigation of the consequences of the defects or emergencies;
- mistakes made by workers while handling or operating a facility that could cause an emergency;
- deviations from operational limitations and conditions; and
- all other events or operational circumstances that significantly affect the radiation or nuclear safety of the facility.

Chapter III of Rules JV9 prescribes detailed requirements for reporting and for the notification of the regulatory body by the operator of a nuclear facility. The regulations distinguish between routine reporting and notification and reporting in the event of an abnormal event. They specify the time period for each report. Reporting criteria are also provided and abnormal events are specified.

According to Article 135 of the 2017 Act, the licence holder is required to report to the ministry that issued the operating licence and to other competent agencies on an emergency in the shortest possible time.

Programmes to Collect and Analyse Relevant Operating Experience

In accordance with Article 90 of the 2017 Act ("The use of experience gained during operational events"), the operator of a radiation or nuclear facility shall ensure that programmes for collecting and analysing operating experience at nuclear facilities are implemented.

The method and frequency of reporting on the implementation of programmes for collecting and analysing operating experience are defined in Chapter II.2 of Rules JV9.

In the assessment, examination and improvement of radiation and nuclear safety, the operator of a radiation or nuclear facility shall take into account the conclusions of the programmes referred to in the first paragraph of this title.

Decommissioning plans

In accordance with Article 3 of the 2017 Act ("Definitions"), the decommissioning of a facility shall mean all measures leading to cessation of control over a nuclear or radiation facility pursuant to the provisions of the 2017 Act. Decommissioning includes both decontamination and removal of the facility or dismantling procedures and the removal of radioactive waste and spent fuel from the facility.

The legal requirements for approval for decommissioning a nuclear facility comprise a two-step procedure and are defined in Articles 101 and 109 of the 2017 Act, which prescribe that an investor intending to decommission a radiation or nuclear facility shall attach to an application for consent for decommissioning and to the project documentation a safety analysis report and the opinion of an authorised expert for radiation and nuclear safety, and to an application for a permit for commencement of decommissioning activities the updated safety analysis report, an opinion of an authorised expert for radiation and nuclear safety and other documentation. The detailed contents of these applications are defined in Articles 31 and 32 of Rules JV5.

In the case of the decommissioning of a facility, the content of the safety analysis report shall refer to the decommissioning of the facility and the related measures for radiation or nuclear safety.

Two special acts have been approved by the Slovenian National Assembly for the decommissioning of nuclear facilities, namely the Act Governing the Fund for Financing the Decommissioning of the Krško Nuclear Power Plant and the Disposal of Radioactive Waste from the Krško NPP and the Permanent Cessation of Exploitation of the Uranium Ore and Prevention of the Consequences of the Mining at the Uranium Mine at Žirovski Vrh Act. Through the legal provisions of these two Acts, the legal framework is established for the financing and planning of decommissioning activities for the respective facilities.

Article 17: Institutional Measures after Closures

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

(i) records of the location, design and inventory of that facility required by the regulatory body are preserved,

(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required, and

(iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

In the safety report of the repository facilities relating to the time period following the closure thereof, all the possible risks relating to the spent fuel or radioactive waste shall be assessed, as well as the exposure of the population after the closure and the exposure of the workers working at the repository during the maintenance thereof and the long-term supervision of the repository facility following closure (Article 103 of the 2017 Act).

The plan for the long-term post-closure supervision of a repository for radioactive waste or a disposal site for uranium mining and milling waste material shall include the following:

- the extent and content of the operational monitoring of radioactivity at the repository, the monitoring of natural phenomena affecting the long-term stability of the repository and the functioning of the individual parts of the repository; and
- the criteria on the basis of which decisions on carrying out maintenance work at the repository shall be made, dependent on the results of the operational monitoring referred to in the previous indent and on inspection (Article 106 of the 2017 Act).

The records on the location, design and inventory of a facility required by the regulatory body are preserved through the provision of Article 110 ("Application for a permit"), which stipulates that it is necessary to attach to the application for a closure permit a safety analysis report, an opinion from an authorised expert for radiation and nuclear safety, and other prescribed documentation.

Article 110 of the 2017 Act further stipulates that the owner or operator of a facility that has obtained a permit for the disposal of spent fuel, radioactive waste, or mine and hydro-metallurgical tailings shall ensure the maintenance and supervision of the disposal site in line with the conditions laid down in the safety analysis report.

Article 123 ("Long-term surveillance and maintenance of closed repositories") of the 2017 Act stipulates that the long-term surveillance and maintenance of repositories of mining and hydro-metallurgical tailings resulting from the extraction of nuclear mineral materials is provided as a service of general economic interest.

The contents of applications for a permit for the closure of a radioactive waste or spent fuel repository or for the closure of a repository for mining or hydro-metallurgical tailings are defined in Rules JV5 in Articles 36 and 37, respectively.

Žirovski Vrh Uranium Mine

The closure of the uranium mine, including the environmental remediation activities on disposal sites for mining and milling waste material, is carried out by the public company Žirovski Vrh Mine d.o.o., which was established by the Permanent Cessation of Uranium Ore Exploitation and Prevention of the Consequences of Uranium Mining Act. The environmental remediation at disposal sites was carried out under the control and with the approval of the regulatory body competent for nuclear and radiation safety (SNSA). The radiological safety requirements were defined in the safety report, which also includes the post-closure period and defines the general programme of long-term surveillance and maintenance of the location. After closure, the disposal site became a facility within the state infrastructure, and was thus excluded from legal transactions. The Government of Republic of Slovenia assigned the management of the Jazbec disposal site as national infrastructure to the ARAO in 2016.

The long-term surveillance and maintenance of the uranium mining waste disposal site is ensured as a permanent mandatory service of general economic interest performed by the ARAO with no time restrictions. Its scope is defined in the Decree on the Method, Subject and Conditions for the Provision of the Obligatory Public Utility Service of the Long-Term Surveillance and Maintenance of Landfills of Mining and Hydro-Metallurgical Tailings from the Extraction and Exploitation of Nuclear Minerals. Fulfilling the requirements for record keeping, reporting and updating the safety report and the programme of long-term surveillance and maintenance of the disposal site is supervised by the SNSA, although the closed uranium mining waste disposal site is not considered to be a radiation facility and its environmental radiological impact cannot be distinguished from the natural background radiation.

After the closure of the Boršt hydro-metallurgical tailings disposal site, which is expected to take place in the near future, the same long-term surveillance and maintenance measures will be implemented as in the case of the Jazbec disposal site.

Planned LILW repository in Vrbina, Krško

After closing the repository, it will enter the transitional period prior to post-closure institutional control and maintenance. During this period, the operator identifies and monitors the effectiveness of the performed activities for closure and carries out the necessary maintenance and corrective measures that bring the repository to a state appropriate for the repository to be submitted for post-closure institutional control and maintenance. Active long-term surveillance and maintenance is planned to commence at the beginning of 2063, once all preparatory activities have been performed for a transition to monitoring following the period of the transition of the repository to long-term surveillance and maintenance (2060–2062) and after the monitoring and maintenance provider has taken over the repository for long-term surveillance and maintenance. Active long-term surveillance and maintenance will last 50 years (2063–2113), unless another duration is determined in subsequent revisions of the project documentation, based on a safety analysis and operational experience.

The repository technological facility following decommissioning and other non-technological facilities at the repository may also be used for requirements relating to active long-term institutional surveillance and maintenance or may be temporarily used for other activities.

Institutional control of the repository shall cover the area of the repository surrounded by the outer perimeter fence, the auxiliary structures, the plateau near the disposal facilities and any immediate surroundings that could have an impact on the repository or in which the impact of the repository can be detected by means of measurement procedures. The precise area for monitoring the environment outside of the repository fence will be determined in subsequent revisions of the project documentation.

Active long-term institutional control

In the period of active long-term institutional control, the provider of management, long-term surveillance and maintenance of the repository will provide, in accordance with the confirmed and valid safety analysis report, in particular the following:

- the technical monitoring of the closed repository, in order to monitor the provision of the safety functions;
- maintenance of the physical protection of the facility;
- regular maintenance works and cleaning on systems that will still be functioning, including measuring equipment;
- any necessary repairs and maintenance of the covering, filling and service elements of the repository;
- monitoring the growth of vegetation at the repository and the prevention of forest growth on the grassy area.

Within the scope of monitoring radioactivity at the repository and monitoring the surrounding environment during the period of active institutional control, it will be necessary to conduct measurements of external (gamma) radiation, measurements of the groundwater characteristics and measurements of liquid discharges from the system for removing water from the disposal part of the repository.

Passive long-term institutional control

After the end of active long-term institutional control, the repository will pass into the phase of passive long-term institutional control. The above-ground facilities of the repository will be removed or transferred to unrestricted 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 institutional control. The plateau can also be removed. The passive control phase is planned to last a maximum of 250 years after the end of active long-term institutional control of the repository (2114- 2363), unless another duration is determined in subsequent revisions of the project documentation, on the basis of a safety analysis and operational experience.

The repository shall be prepared for long-term passive institutional control when the long-term active control period comes to an end. The preparations will include in particular:

- the removal of all equipment for the performance of measurements and other forms of active control;
- the removal of the facilities that were required for active monitoring, or the transfer of the facilities to unrestricted use; and
- the removal of the fence or the discontinuation of fence maintenance.

Long-term passive monitoring of the repository will primarily be carried out for:

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

For the purposes of the storage of repository records, at least two types of information will be archived for as long a period as possible and for potential use:

- information, data, records and documents relating to activities during operation and decommissioning, data on disposed waste, data on emergencies, site data, site maps, photos of the repository and the surrounding environment, etc.;
- data obtained through monitoring of the repository and the surrounding environment (radiological, meteorological, etc.).

Article 10: Disposal of Spent Fuel

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

Krško NPP

After the period of dry storage, spent fuel or high-level waste generated from decommissioning or from spent fuel processing is to be further treated, packaged and disposed of. For spent fuel and HLW, a deep geological repository should be built to ensure adequate temporal isolation of the waste from the environment.

For long-term spent fuel management, a dual-track strategy has been adopted as a reasonable solution in the present situation. In parallel with the national disposal programme, a multinational disposal option is possible.

The reference scenario for Slovenia's own repository in suitable hard rock was first developed in 2004 and revised 2019. ReNPRRO16-25 assumes the disposal of spent fuel in 2065, with an option to also consider the construction of a regional repository or use of disposal services provided by a disposal facility in a host country. Both options continue in parallel until the choice of constructing a national repository or participation in a multinational repository is made.

Slovenia is a member of the ERDO-WG, which brings together a group of EU countries to consider a model for the development of joint disposal solutions for the benefit of its Member Countries. The main reason for cooperation and integration in this area is Slovenia's extremely small-scale nuclear programme and that by participation in joint programmes it can achieve significant positive economic effects.

The reference conceptual design is based on the best available current knowledge of future inventories and the operation of both nuclear facilities in Slovenia. The national concept scenario includes the overall geological disposal programme, including research, development, and implementation activities for the siting, construction, operation, and closure of a geological repository.

No site investigations for a deep geological repository have been carried out in Slovenia, and no specific data for geological disposal are available now. The reference scenario is made for a generic location in hard rock media. For some specific aspects, assumptions and estimates based on expert assessments were used.

Only direct disposal of spent nuclear fuel (no reprocessing) is envisaged and the repository will be constructed in a hard rock environment at a depth of 500 m.

The following basic requirements are considered in the reference scenario from 2019:

- In total, 2,282 SF elements will be disposed of.
- In addition to SF, decommissioning HLW from the NPP, packed in 7 Holtec HI-SAFE containers with a disposal volume of 237 m^3, 650 m^3 of SF dry storage operational and decommissioning waste, 172 m^3 of encapsulation facility operational and decommissioning waste, and 3,000 m^3 of repository operational and decommissioning waste (5% of waste is assessed to be long-lived HLW) will be disposed of in the geological repository. The disposal of this waste is anticipated to take place in the abandoned underground service compartments or, as an alternative, in a special underground compartment.
- An Underground Testing Facility (UTF) will be constructed as the first phase of the disposal facility.
- The generic site of the shared repository will be in a hard rock formation in Slovenia or Croatia.
- In the pre-activation stage before the adoption of a chosen repository concept, the reference design also includes monitoring of the status and development of all available SF disposal methods, including disposal in a sedimentary rock formation. In this stage, maintenance and periodic revision of the deep geological disposal programme, R&D, international cooperation and project administration will be carried out.
- In the base case scenario, the site selection programme will begin in 2055, the final site for which spatial planning commences will be chosen in 2065 and it will be designated in 2069; the site will be confirmed in 2086, and construction will begin in 2087.
- The site of the repository is 200 km from the SF storage facility at the NPP site.

- Four assemblies of SF will be encapsulated into each copper canister for disposal. In all scenarios, the encapsulation plant is part of the above-ground repository facilities. As an alternative, encapsulation at a shared regional encapsulation plant 1,000 km away from the SF storage at the NPP site is considered.
- The disposal area is located at a depth of 500 m; an alternative depth of 800 m is also evaluated.
- The disposal area is accessed by way of an access ramp. Alternatively, access via an access shaft is also considered.
- Disposal boreholes are vertically oriented and lie 9 m apart. Distances of 8 and 10 m and space requirements for an additional 20% of boreholes are also considered.
- As an alternative to the basic scenarios that assume that SF disposal will be in a shared bilateral repository in Slovenia or Croatia, a multinational option for disposal is considered. A multinational/shared regional repository, including an encapsulation plant, 1,000 km from the SF storage at the NPP site is considered.
- Regarding the spatial planning, construction, public investments and nuclear safety requirements, relevant Slovenian legislation and corresponding procedures are considered.

The disposal concept follows the Swedish SKB KBS-3V model of disposal and includes at the repository site all structures, systems and components needed for the repository to operate as an independent nuclear facility. Due to operating requirements and necessary physical protection measures, the entire repository area will be divided into four areas: an unfenced area with support buildings and systems, an industrial area with fences due to industrial security (including offices, production buildings and workshops), a technological above-ground area with fences due to radiological and nuclear safety (with an encapsulation plant, service buildings and auxiliary systems) and underground facilities (an access ramp and tunnels, a service area and disposal tunnels with disposal boreholes).

Construction of the geological repository will start 6 years prior to the start of regular operation in 2093 (basic scenario). It will begin with the construction of auxiliary above-ground structures. Then, construction of the encapsulation plant and of the underground structures will begin. Construction of these structures will last for 5 years.

The encapsulation plant is part of the disposal concept in both basic scenarios. The encapsulation plant (EP) is located at the repository site. The plant will contain units for the acceptance of transport containers with SF, for the encapsulation of SF in copper canisters including the handling area, for dispatching and transporting canisters to underground disposal facilities, a unit for the treatment and packaging of LILW, an office building, a storage and auxiliary facilities and systems. In the proposed concept, the encapsulation plant has an annual production capacity of 60 copper canisters per year, which allows sufficient capacities for all SF during the operational period. After the encapsulation is completed, the plant will be decommissioned, and radioactive decommissioning waste will be transported to the repository. The operational period for the encapsulation plant is 10 years in both basic scenarios after 1 year of trial operation. Its operation is to cease simultaneously with the cessation of repository operation.

Spent fuel will be encapsulated according to the Swedish concept. Fuel assemblies will be inserted and sealed into massive copper canisters. Their main function is to isolate spent fuel assemblies from their environment. A canister is approximately a 1 m-diameter and 4.7 m-high cylinder with a 5 cm-thick anticorrosion overpack of copper. From the inside, it is reinforced by a cast iron insert which can accept four PWR fuel assemblies. The insert also serves as a pressure-bearing component. After inserting the spent fuel assemblies into the canister, the lid of the canister is sealed by an electron beam welding machine. The weight of a canister filled with SF is about 25 t.

The underground part of the repository is situated at a depth of 500 m below the ground surface. Alternatively, a depth of 800 m is also considered. It consists of two areas: a central service area and a disposal area. The underground level can be reached in several ways: for personnel through a service shaft, for waste and other cargo through a spiral ramp (with at least a 15 m curved radius to enable access by long vehicles, and a 10% slope) or alternatively through a vertical access shaft with an 8.0 m-clear diameter. The ramp is 5 km (alternatively 8 km) long, 7 m wide and 7 m high. The service shaft has 5 m of clear diameter. It contains two elevators (cages). The main cage will be used for the transportation of personnel and light equipment. The small cage will be used in the event of an emergency for personnel. Both cages may be used for shaft inspection. The service shaft is also used as part of the ventilation system (air intake). The repository is supplied with a 3 m wide ventilation shaft, which can serve as an emergency exit as well.

Out of the 571 disposal boreholes required to accommodate all the fuel canisters, only a few dozen are required to start operation. The rest will be drilled as required for waste emplacement activities.

Long-lived institutional LILW, decommissioning HLW and long-lived LILW from Krško NPP, HLW and other RW from SFDS decommissioning, long-lived LILW and eventually HLW from the operation and decommissioning of the geological disposal facility and encapsulation plant will be disposed of in one of the abandoned vaults of the service area. Alternatively, a special repository room will be excavated approximately 70 m above transverse drift.

Decommissioning and closing activities will start after all spent fuel has been disposed of.

However, a part of decommissioning and closure activities, i.e. the backfilling and sealing of disposal vaults, will begin already during the operation of the repository. It is assumed that the decommissioning of above-ground structures and the closure of underground structures will be carried out in the same time period. Decommissioning activities will last for 5 years (2104-2108), while closure activities will last for 2 years (2109-2110).

Active institutional control and maintenance of the repository is anticipated by the 2017 Act and ReNPRRO16-25.

Active institutional control and maintenance will start after the closure of the repository, when all activities for transfer into institutional control have been completed and when the competent organisation takes over the repository for institutional control. It is presently assumed that active institutional control will last for 50 years after repository closure, but the duration of this phase will be determined subsequently on the basis of a safety analysis. Passive institutional control of the repository is planned as a type of surveillance primarily including activities regarding keeping the data on the repository and retaining the repository land ownership. The duration of passive institutional control is not yet defined; the actual duration will be determined on the basis of a safety analysis.

Jožef Stefan Institute Reactor Infrastructure Centre

At present, no spent fuel from the TRIGA Mark II research reactor is planned for disposal. The future quantities of spent fuel depend on a decision to be made by the operator and owner of the research reactor concerning the operation of the reactor after 2026.

The spent fuel management will be arranged jointly with the spent fuel disposal of the Krško NPP unless the Government finds another solution.

SECTION I: TRANSBOUNDARY MOVEMENT

Article 27: Transboundary Movement

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

In so doing:

(i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorised and takes place only with the prior notification and consent of the State of destination,

(ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilised,

(iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention,

(iv) a Contracting Party which is a State of origin shall authorise a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement,

(v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.

2. A Contracting Party shall not license the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

3. Nothing in this Convention prejudices or affects:

(i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law,

(ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin,

(iii) the right of a Contracting Party to export its spent fuel for reprocessing,

(iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

The Slovenian legislation (the 2017 Act and the Rules on Transboundary Shipments of Radioactive Waste and Spent Fuel) regarding the transboundary movement of radioactive waste and spent fuel is harmonised with Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel and with the Commission Decision of 5 March 2008 establishing the standard document for the supervision and control of shipments of radioactive waste and spent fuel referred to in Council Directive 2006/117/EURATOM.

Transboundary movement is covered in Articles 126–128 of the 2017 Act, Subparagraph 4.9, "Shipments into and out of EU Member States – The import, export and transit of nuclear and radioactive substances and radioactive waste."

The SNSA issues permits for the import from, export to, and shipment into and out of other EU Member States and the transit of certain radioactive and nuclear materials. Detailed provisions defining for which shipments a permit is necessary are stipulated in the 2017 Act and in the Rules on Transboundary Shipments of Nuclear and Other Radioactive Materials. It is necessary to obtain SNSA consent for shipments from and into other EU Member States and for licences for the import, export or transit of radioactive waste and spent fuel. Before issuing consent or a licence, the SNSA evaluates the measures relating to radiation and nuclear safety throughout the duration of the transport of radioactive waste and spent fuel from the place of origin to the final destination.

The SNSA may refuse to issue an approval for the import, export or transit of radioactive waste and spent fuel if it has concluded that the country of export or the country receiving the consignment does not have the technical, legal or administrative resources necessary for the safe handling of radioactive waste or spent fuel, such as for shipments to a destination south of latitude 60 degrees South.

The established legislation implements all obligations under Article 27 of the Convention.

Experiences

In the past, there were several transits performed on the territory of the Republic of Slovenia under the framework of the US and Russian research reactor spent fuel return programmes.

The last transits of nuclear material took place in October and November 2012, with regard to which we reported in the 5th Slovenian report under the Joint Convention. All those shipments were accomplished professionally and successfully within strong international cooperation, and by such Slovenia contributed to nuclear non-proliferation.

Besides these occasional transits, approximately every three years there is a shipment of radioactive waste from the Krško NPP that is sent for incineration and melting to another EU Member State. The last shipment was sent in November 2018 and has not yet returned in Krško NPP.

In September 2019, about 30 tons of radioactively contaminated material originating from the company Cinkarna Celje were sent to the United States. As early as August 2018, the SNSA issued a permit for the export of this waste on the basis of Council Directive 2006/117/EURATOM, after obtaining all the consents of the transit countries (Austria, Germany, and Belgium) and the US as the country of destination. The waste was finally disposed of at the US Ecology, Inc. facility in Idaho in November 2019. In accordance with Council Directive 2011/70/Euratom, the SNSA also notified the European Commission of the intended shipment in early September 2019.

SECTION J: DISUSED SEALED SOURCES

Article 28: Disused Sealed Sources

1. *Each Contracting Party shall, in the framework of its national Act, take the appropriate steps to ensure that the possession, re-manufacturing or disposal of disused sealed sources takes place in a safe manner.*
2. *A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national Act, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.*

In the Republic of Slovenia, radioactive sealed sources are used in medicine, industry and research applications. Minor quantities are also used by certain state institutions (e.g. customs, the police and the army).

Licensing is required for all activities dealing with sealed sources: for shipments from and to other EU Member States, for import or export, for carrying out a radiation practice, for use, for transport or transit – the last two based mainly on the activity of the sealed sources. The competent authorities (the SNSA and the SRPA) keep records on sealed sources (and other sources, too) in use.

In accordance with Article 170 of the 2017 Act, a register of radiation practices and a register of radiation sources shall be maintained. The registers shall be maintained as public registers by the SNSA, except for the register of radiation practices and of radiation sources in health and veterinary care, which shall be maintained as a public register by the SRPA. The contents of the registers are prescribed in Article 171 of the 2019 Act and in Chapter VI of the Rules on the Use of Radiation Sources and on Activities Involving Radiation.

The aforementioned Rules also set a basis for the termination of the use of radioactive sources. A person carrying out a radiation practice who terminates the use of a radioactive source shall report this, within 15 days, to the SNSA or the SRPA. Where radioactive sources are involved, a person carrying out a practice involving radiation shall hand them over, within three months, to the ARAO or to another holder of a licence to carry out a radiation practice, or return it to the manufacturer or supplier. A person carrying out a radiation practice shall, within eight days of the transfer of a radioactive source, send a notification, i.e. a document on the transfer of the radioactive source that records the transfer of the radioactive source to another person, to the SNSA or the SRPA.

When sealed sources are no longer in use, they become disused. Since 1986, disused and spent sealed radioactive sources from small producers have been stored at the Central Storage Facility for Radioactive Waste in Brinje. In 1999, the national public service for managing waste from small producers was established by a governmental decree. The ARAO, being assigned to perform this public service, became responsible for operating the storage and management of waste and disused sealed sources from small producers.

Until 2000, the acceptance of waste for storage was free of charge. Since then, according to the "polluter pays" principle, each waste producer or holder has had to pay a fee for the acceptance of a radioactive waste/disused radioactive source. If the waste producer or holder is not known, the expenses are covered from the national budget. When accepted into the Central Storage Facility for Radioactive Waste in Brinje, the liabilities for the disused radioactive source are transferred to the ARAO, which becomes responsible for the further management of the disused and spent sealed radioactive source, including future disposal. Under certain conditions, sources transferred to this storage could be returned to some Slovenian users (e.g. devices for industrial radiography or powdered U-substances used for e-microscopy) or even sent abroad (e.g. ionising smoke detectors or devices for industrial radiography, encompassing depleted uranium).

The Republic of Slovenia is not a significant producer of sealed sources. The JSI has practically ceased the production of radioactive sources for the domestic market (no such sources have been produced since the First Report under the Convention in 2003), so the return of exported sources is essentially a hypothetical issue. The JSI, from time to time, has sent (back) to some other European Union or other countries different activated, still radioactive, "products" which are, on the other hand, not typical sealed sources (e.g. activated teeth (^{32}P), irradiated e-components (^{182}Ta) etc).

However, in 2003 the SNSA started an action to promote the transfer of disused sealed radioactive sources that remain with their former users to the ARAO. As a result, several hundred sealed radioactive sources of various activities have been transferred since then, including calibration sources and "historical sources". In addition, many radioactive sources and items with added radionuclides once used in defence (e.g. compasses) have been transferred, appropriately treated and safely stored at the Central Storage Facility for Radioactive Waste in Brinje since then. Disused sealed sources from industrial radiography (^{192}Ir and ^{75}Se; also one case with ^{60}Co) or brachytherapy (^{192}Ir) of high-activity (i.e. Category 2 at the time of manufacturing) have been returned to the foreign suppliers. Those companies that predominantly use ^{192}Ir in industrial radiography replace decayed sources with new ones almost annually. ^{192}Ir, used in brachytherapy, is replaced several times per year. There are up to 20 transfers of such sources per year. In addition, the number of disused ionising smoke detectors, with mainly ^{241}Am transferred to the Central Storage Facility, amounted to more than 22,600 pieces in the period 2010-2018. The SNSA's inspectors have conducted close to 100 different inspections with regard to such smoke detectors – and the pertinent supervision was intensified in particular after 2010. At the beginning of 2020, a summary (analytical) report on the status of ionising smoke detectors in Slovenia was issued (prepared by the SNSA's staff).

Disused sealed sources are one of the regular themes in Radiation News (*Sevalne novice* in Slovenian), which is distributed quarterly to users of radiation sources and other stakeholders in the country. The SNSA, as the main author and distributor of Radiation News, assesses that in its more than 15 years this flagship outreach activity has proved itself to be a positive approach with added value.

Figure 19: **Radiation News**


Sevalne novice
Številka 49 april 2019
NOVA UREDBA O PREVERJANJU RADIOAKTIVNOSTI POŠILJK, KI BI LAHKO VSEBOVALE VIRE SEVANJA NEZNANEGA IZVORA

Nekaj izbranih vprašanj iz minulega obdobja

Disused sealed sources (and other contaminated items) can also enter into the scrap metal recycling stream. This happens practically everywhere in the world. The Slovenian experience shows that most cases of orphan sources are related to the import of scrap metal into Slovenia and to the transit of such material through the country. In order to minimise the number of sources outside regulatory control, several regulatory and law enforcement measures have been implemented. Customs and police officers are equipped with various radiation detection devices in order to prevent illicit trafficking and other unauthorised activities. Since 2002, the SNSA has had an officer on duty 24 hours a day to give advice in the event of the discovery of orphan sources or elevated radiation levels. Major scrap metal dealers and recyclers are equipped with portal monitors and various hand-held radiation detection equipment. The Decree on Checking the Radioactivity of Shipments of Metal Scrap (in force since 2008) was amended and "broadened" to the Decree on Checking the Radioactivity of Consignments that Could Contain Orphan Sources (in force since March 2020). When drafting this decree, Council Directive 2013/59/Euratom was also considered as one of the starting points. The broader scope includes different subjects (e.g. national airports and ports) to set up appropriated detection capabilities. Such measurements shall be performed only by certified organisations (there are approximately 20 of them at the time of writing this report). The experiences gained after almost a decade of validity of this Decree is fairly positive and the awareness thereof, including an adequate response, has improved in this regard. Authorised organisations have to provide annual reports. The number of orphan sources that end up in the Central Storage Facility is on the order of three per year. In addition, each year a handful of cases may occur that encompass the return of shipments with orphan sources (spent radioactive sources) transiting through Slovenia and measured and denied by the neighbouring countries.

SECTION K: GENERAL EFFORTS TO IMPROVE SAFETY

This section addresses the challenges and planned actions to improve safety that were listed in the rapporteur's report on Slovenia at the end of the last (6th) Joint Convention review meeting.

Host IRRS/ARTEMIS mission in 2021

Concerning hosting peer review missions, it was decided that, due to logistical reasons, in the second half of 2021, i.e. the Slovenian presidency of the EU Council, the IRRS and ARTEMIS missions would be scheduled in the first quarter of 2022 as two separate missions, but with a relatively short time in between in order to make use of the synergies, such as similar logistical arrangements and use of the materials that could serve both missions. The IRRS mission is going to be the first, followed by the ARTEMIS. The IAEA has been duly informed of this. The SNSA has already started with the internal preparations for the IRRS mission. The Preparatory Meetings for both missions will take place in the first half of 2021; the exact dates still need to be agreed with the IAEA. After those meetings, the details of the IRRS and ARTEMIS missions, as well as the dates, will be determined.

Spent Nuclear Fuel Dry Storage Licensing, Construction, and Operation

In December 2015, the Krško NPP prepared a document entitled "Technical Specification – Spent Fuel Dry Storage Construction", which was the officially published documentation aimed at selecting a vendor for the required equipment and an entity to carry out the project. Following the completion of the public procurement procedure, the Krško NPP selected the company HOLTEC (from the USA) as the most advantageous bidder.

A contract with HOLTEC was signed in February 2017. The licensing process for the SFDS is still on-going. A comprehensive environmental impact assessment and cross-border assessment with Austria and Croatia were successfully completed in May 2020. The licensing process to obtain the construction license is in progress and is planned to be completed at the end of 2020. In addition, approval of the safety analysis report by the SNSA is one of the preconditions to start the construction of a SFDS. The dry storage building is scheduled to be operational at the end of the year 2022 and fuel transportation from the pool to the dry storage building should start at the beginning of 2023. Four campaigns involving the transfer of casks with spent nuclear fuel are planned.

Radioactive Waste Management at the Krško NPP

The timely construction of the LILW repository is essential for the normal operation of the NPP. The Waste Manipulation Building (WMB) for handling waste was constructed and put into operation in 2018. With its construction, the plant is provided with new premises for radwaste operations. Moving some equipment out of the Solid Radwaste Storage Facility into the WMB will release an additional storage space for the period until the repository is operational.

Periodic Safety Review of the Central Storage Facility for Radioactive Waste in Brinje

The first periodic safety review of the Central Storage Facility (CSF) started in 2015 and was finished in 2018. An approved report on the periodic safety review was a condition for the renewal of the licence for the operation of the CSF. The ARAO was granted a new operating licence for the CSF in April 2018. 69 issues were identified, which will be addressed by the end of 2021. By January 2020, 60 identified issues had been completed.

Another result of the PSR is the completely revised Safety Report and its reference documentation (safety case). A comprehensive safety analysis was prepared, based on the current and anticipated future inventory. The Safety Report has been developed according to the IAEA General Safety Guide No. GSG-3 – The safety case and safety assessment for the predisposal management of radioactive waste.

LILW repository licensing, construction, and operation

In a process that had taken place since November 2004 and in which the public had also been intensively involved, the location of the LILW repository was selected in December 2009, with the adoption of the Decree on the National Spatial Plan for the LILW repository at the Vrbina site in the Municipality of Krško.

The design documentation and other documentation have been in the drafting process since the site was approved. The design solutions are the input data for the majority of the documentation required for an assessment of the environmental impact and for obtaining a construction permit. The conceptual design of the LILW repository was drawn up in 2016 on the basis of the design of the project for the acquisition of a construction permit, the coordination and optimisation of the design solutions and the guidelines of the architecture commission. The document is an appendix to the application for obtaining an environmental permit. The project documentation for the acquisition of a construction permit has already been prepared by the ARAO and revised by an independent expert organisation for radiation and nuclear safety.

The main field research confirmed the preliminary results and provided the necessary input data for the project design and the safety analyses. The majority of the primary research was carried out in the micro location of the first disposal silo.

Land has been purchased for the repository facilities, which is currently being administered by the ARAO. The owner of the land is the Republic of Slovenia. The safety analyses were updated with regard to the development of the project solutions. The design basis of the repository for the environmental impact assessment phase (2019) and for the phase of safety analysis report preparation (2020) was drawn up as required by the Rules on Radiation and Nuclear Safety Factors. In 2018 and 2019, the reference documents used for the draft safety analysis report were completed, and in 2020 the reference documents used for the safety analysis report.

The environmental impact assessment together with the draft safety analysis report as an appendix and the conceptual design constitute the materials for the environmental impact assessment procedure, in relation to which in April 2019 the SNSA issued a prior consent on radiation and nuclear safety. A project for obtaining a construction permit for the LILW repository was drafted in 2019 and 2020 and will be completed on the basis of the revisions required pursuant to the 2017 Act. The ongoing process of cross-border environmental impact assessment and the process of environmental approval in Slovenia should be completed to fulfil one of the prerequisites in the process of obtaining a building permit for the construction of the LILW repository.

The suppliers and contractors for the construction of the LILW repository are not yet known and will be selected pursuant to the Public Procurement Act. The repository operator will be the ARAO, as the provider of radioactive waste management as a mandatory service of general economic interest.

The construction of the repository will proceed in accordance with the planned timetable for construction of the LILW repository. The repository construction will start in 2021 and is planned to be built in three years. During this period, one disposal silo, all technological and other facilities, and the associated infrastructure will be built. After that, trial operation is planned. According to Rules JV5, for a radioactive waste repository, consent for the facility's trial operation shall be construed to be a permit for the disposal of radioactive waste, while the possibility of removing waste from the disposal facility and recovery of the facility's original state has to be ensured. During trial operation, tests and experiments on the constructed and operation-ready repository will be carried out in order to verify and determine the compliance of the repository operation and system structure and components with the approved design solutions and the required design conditions.

Regular operation will begin in 2024 after the successful completion of the trial operation period and an operating permit has been obtained. On the basis of this permit, the repository will be put into regular operation. It is assumed that in the first phase of operation, LILW that was generated before the start of the repository standby phase will be disposed of. By the end of 2027, around 80% of Slovenia's share of operational waste from the Krško NPP and 57% of Slovenian institutional waste will be disposed of.

In 2027, the repository will enter into the standby phase when the existing storage facility at the Krško NPP is used for the temporary storage of operational waste.

The repository is planned to re-start operation in 2050, when disposal will take place for the remaining Slovenian share of operating waste generated by the Krško NPP, the remaining Slovenian institutional waste, as well as the waste generated during the decommissioning of the Krško NPP until 2058.

After the adoption of the decision on the final closure of the repository after the decommissioning of the Krško NPP, the decommissioning and closing of the repository will be initiated. Decommissioning of the repository is provisionally planned for 2058. It will be carried out only for the technological facilities. The closure of the disposal silo is planned for 2059. After closure, the repository will enter the period of post-closure institutional control and maintenance (see Article 17).

See also Sections G and H.

The Resolution with Croatia concerning the decommissioning of the NPP, the disposal of RW, and the management of SF

Since 2003, joint ownership of the Krško NPP has been regulated by the Intergovernmental Agreement, which, *inter alia*, states that management of RW and SF are the joint responsibility of the contracting parties, who must ensure an effective joint solution to the management of RW and SF from economic and environmental protection perspectives.

Pursuant to this Agreement, both parties are equally responsible for ensuring all material conditions, and the Republic of Slovenia is solely responsible for the control of nuclear and radiation safety. The parties agree on the common obligation to provide an effective joint solution to Krško NPP decommissioning and the disposal of RW and SF from an economic and environmental protection standpoint. The agreement stipulates that the decommissioning and disposal of RW and SF from the operation and decommissioning of the Krško NPP will be carried out in accordance with a disposal programme and a decommissioning programme, which should be revised at least every five years. The decommissioning programme should also be approved by the regulatory body of the Republic of Slovenia in charge of nuclear safety.

The programmes should be confirmed by the Intergovernmental Commission, which is formed by the contracting parties in order to monitor implementation of the Intergovernmental Agreement and initiate other businesses in accordance with the Intergovernmental Agreement. An equal number of Intergovernmental Commission members are appointed by both sides. The Krško NPP Decommissioning Programme and the Programme for the Disposal of the RW and SF from the Krško NPP are the key enforcement mechanisms of the Agreement regarding decommissioning as well as RW and SF management.

The second revision of the Decommissioning Programme of the Krško NPP and the Disposal of LILW and HLW, which was prepared in 2011, has not been discussed or approved by the Intergovernmental Commission for monitoring the implementation of the Bilateral Slovenian-Croatian Agreement on the Krško NPP. In 2015, the Commission decided to suspend all activities in connection with the drawing up of this Programme and identified the need to draft a new revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of the RW and SF from the Krško NPP.

In 2016 a new revision of the Krško NPP Decommissioning Programme of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme started. The ARAO and the Croatian Fund were appointed to prepare the new Programme for the Disposal of the RW and SF from the Krško NPP and the Krško NPP was appointed to prepare the Krško NPP Decommissioning Programme. The Intergovernmental Commission also appointed a Project Implementation Coordination Committee, with four members from each side, to monitor the preparation of both Programmes and search for possibilities for the joint disposal of Slovenian and Croatian radioactive waste from the Krško NPP.

In 2019, the third revision of the Krško NPP Decommissioning Programme and the third revision of the Programme for the Disposal of the RW and SF from the Krško NPP were completed. After administrative procedures in both countries, the Intergovernmental Commission approved the third revision of the Programme for the Disposal of the RW and SF from the Krško NPP and the Krško NPP Decommissioning Programme in July 2020.

In these documents annuities for each country are calculated and presented with respect to the internal rate of return.

By a decision of the Slovenian Government, the Slovenian electrical power company GEN energija, d.o.o. should continue to contribute into the Slovenian fund for financing one half of the decommissioning and spent fuel and radioactive waste disposal with increased payments from the previous value of 0.30 euro cents per kWhe to 0.48 euro cents per kWhe starting 1 August 2020 until the next revision of the Programmes.

The third revision of the Krško NPP Decommissioning Programme was prepared according to the decommissioning strategy "immediate dismantling" after final shutdown in 2043.

After searching for possibilities for the joint disposal of Slovenian and Croatian radioactive waste from the Krško NPP in 2018 and 2019, it was determined by the Intergovernmental Commission in September 2019 that a joint solution to the disposal of LILW was not possible and consequently such waste will be divided in half and each country will proceed to develop its own disposal capabilities.

Based on the existing Slovenian-Croatian Inter-governmental Agreement and conclusions from the meeting of the Intergovernmental Commission held in July 2015, the construction of a dry storage facility at the Krško NPP site is part of a joint solution to spent fuel management disposal until 2043. The construction and operation of the dry storage facility until 2043 should be financed from the Krško NPP's operational costs. Regarding the storage of HLW and SF after the cessation of the operations of the Krško NPP in 2043, negotiations will be ongoing, with the current plan being to develop a joint solution that involves either a repository in one of the countries, or joint participation in regional or multinational repository initiatives.

Plans to start preparatory activities to pursue the development of a national SF and HLW repository

The main milestone of the geological disposal programme is the start of the regular operation of the repository. Other activities are scheduled forward and backward from this main milestone. Other milestones identified in the geological disposal programme before construction and operation are:

- activation of the geological disposal programme;
- identification of candidate area(s);
- identification of candidate site(s);
- confirmation of the final site;
- incorporation into the Spatial Development Strategy of Slovenia or Croatia;
- the adoption of the national spatial plan; and
- issuance of the construction permit for the nuclear part of the repository.

In the HLW and SF geological disposal programme the identified activities are assigned into groups that represent different development stages of the geological repository. The following groups of activities are considered before the construction and operation of the repository:

- project administration;
- site selection;
- site investigations and monitoring;
- design;
- safety of the repository; and
- spatial planning.

Project administration

Project administration comprises activities that are necessary for successful management of the geological repository project from the site selection to its final closure stage. Since the geological disposal programme is part of the input data for the Krško NPP decommissioning plan, it is reasonable to anticipate periodic revisions of the programme. Revision of the reference scenario also includes (in the pre-activation stage) monitoring of the status and development of all available SF disposal methods, including disposal in the sedimentary rock formation. International cooperation, the establishment and control of the quality assurance programme and public relations are foreseen as supporting activities.

Site selection

The site selection process comprises all activities that are intended for the selection of a final geological repository site. The site selection process is not presently laid down in legislation. Thus, it is assumed that the selection process will be based on the same principles as were applied by the ARAO in its site selection for the LILW repository. It is a mixed mode process, which includes expert assessment, applications from local communities, and public participation. It consists of four stages: the concept and planning stage, the area survey stage, the site characterisation stage, and the site confirmation stage. Site selection for the base case scenario is envisaged to start in 2055, with successful confirmation of the final site in 2086.

Site investigations and monitoring

Site investigations and monitoring comprise activities by which the necessary data are obtained to optimise the placement of the repository within a specific site, and to evaluate the impacts of the repository and its operation on the environment. Site investigations before the commencement of operations are carried out within the scope of the spatial planning procedure and the design of the repository and will start in 2056.

Spatial planning is to start in 2065 and 2037 for the base case and sensitivity scenarios, respectively. The formal final confirmation of one candidate site is to be carried out within the scope of adaption of the National Plan.

Monitoring activities are also carried out at each stage of development of the geological repository. The monitoring programme will be defined and carried out prior to and during the construction and operation of the geological disposal facility.

An integral component of the site investigations and monitoring stage is also a performance and safety analysis. A preliminary safety assessment and safety case should be carried out at the siting stage in order to indicate the potential suitability of the site. It should include results from the site investigation and site characterisation. A comparison of the results regarding different potential sites could be made.

Design of the repository

The design of the geological repository will start in 2065 and is regulated by the Construction Act. The Act regulates the drawing up of design documentation and other supporting activities, such as obtaining design conditions and approvals. In accordance with the Environmental Protection Act and the Decree on environmental encroachments, the geological repository is assigned to a group of building structures for which an environmental impact assessment is required. Consequently, in the context of the Construction Act, the geological repository is defined as a building structure with environmental impact. The conceptual design documentation will be prepared for the complete scope of the repository. The subsequent design documentation will be prepared separately for the construction of the underground research laboratory and for the construction of other structures of the repository. An important milestone of the repository design will be achieved in 2086 with the final design of the construction permit, including environmental consent.

Safety for the repository

In accordance with the 2017 Act, the geological repository is a nuclear facility. Nuclear facilities are planned through the national spatial plan. Within the procedure for drafting the national spatial plan, the regulatory body for nuclear safety issues guidelines and opinions and specifies the content and scope of documentation regarding nuclear safety. The safety of a nuclear facility is assessed on the basis of a safety analysis report prepared by the proposed implementer of a nuclear facility and is included in the application for obtaining a construction permit. The 2017 Act also defines various consents and permits required for construction, trial operation, regular operation, decommissioning and closure, and regulates the physical protection of nuclear facilities.

Spatial planning

In Slovenia, spatial development projects are planned through spatial planning documents and nuclear facilities are defined as spatial development projects of national importance. The national spatial plan is based on the Spatial Development Strategy of Slovenia. This strategy includes requirements related to the management of radioactive waste and stipulates that solutions regarding the permanent disposal of high-level radioactive waste shall be sought in collaboration with the wider international community. For the purposes of the present geological programme, it is assumed that the construction of the repository may potentially occur on the territory of Slovenia and thus will be incorporated into the Spatial Development Strategy. Incorporation into the Spatial Development Strategy is envisaged in 2054 followed by the start of the preparation of the national spatial plan in 2065 with its final adoption in 2069.

Jožef Stefan Institute Reactor Infrastructure Centre

The owner has decided to operate the facility until at least 2024. The periodic safety review of the TRIGA Mark II research reactor and the hot cell laboratories started in 2011 and was completed in 2014. 100 issues were identified, which were merged into 85 actions and resolved in a 5-year period. All the actions were completed by the end of 2019, as far as was possible by the staff of the JSI. Some actions will result in changes to the RR TRIGA SAR, and these changes need to be approved separately. A new revision of the preliminary decommissioning programme was also completed and its description will also be included in the SAR. The actions derived from the PSR raised the reactor safety to the level that is required by the Slovenian legislation that was updated after the WENRA Reference levels of 2014.

The next periodic safety review is planned for the years 2021–2024. Following the review, the operational license can be extended for another 10 years.

Remediation of former Žirovski Vrh uranium mining sites

The uranium mine ceased operation in the summer of 1990. The environmental remediation project, which ensures conditions for the closure of mining facilities, is carried out by the public company Žirovski Vrh Mine d.o.o. The long-term surveillance and maintenance of the mine waste disposal site and hydro-metallurgical tailings disposal site after their closure is ensured by the ARAO, the provider of the mandatory service of general economic interest. Environmental remediation and long-term management activities are financed from the state budget.

All surfaces in the mining area affected by uranium production have been decontaminated and have been returned to unrestricted land use. The contaminated material produced by mining, uranium ore processing and decontamination has been disposed of at two disposal sites nearby the mine: the Jazbec mine waste disposal site and the Boršt hydro-metallurgical tailings disposal site.

Closure works at the Jazbec disposal site have been completed and the Agency for Radwaste Management (ARAO) started the long-term surveillance and maintenance of the site in 2015.

The Boršt hydro-metallurgical tailings disposal site is situated on a hillside and the closure of this facility has been delayed due to the activation of a landslide and the required additional remediation works.

Two studies were carried out in 2015 and 2016. In the first study, the distribution of tailings in the case of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. On the basis of the study, the Ministry of the Environment and Spatial Planning ordered an additional study on the radiation exposure of residents and the workers who would carry out remediation of the deposited material on the riverbeds of the Todraščica, Brebovščica and Poljanska Sora Rivers. In 2016 and 2017, additional intervention measures for reducing the speed of landslide movements were carried out. In 2018, the Expert Project Council for monitoring the remediation work on the hydro-metallurgical tailings prepared a final report. The effects of the maintenance, monitoring and intervention measures to reduce the groundwater impact on the stability of the Boršt hydro-metallurgical tailings disposal site performed between 2010 and 2018 were assessed, as well as the current state of the Boršt disposal site. In 2019, the monitoring network of the Boršt hydro-metallurgical tailings disposal site was renovated and upgraded with nine additional deep piezometers.

The safety report on the Boršt hydro-metallurgical tailings disposal site is under revision. This document is the basic document for the closure of the disposal site and the transition to long-term surveillance and maintenance, which will be carried out by the ARAO as part of the mandatory service of general economic interest.

Retaining the technical capabilities of nuclear institutions, including the regulatory body and associated public constraints

Retaining the technical capabilities of nuclear institutions, including the regulatory body, is a constant challenge for countries with small nuclear programmes. Knowledge and competence management is becoming increasingly important with the ageing of the existing regulatory and other institutional staff.

In recent years, the Slovenian Nuclear Safety Administration (SNSA) increased and improved the training programme by the implementation of a systematic approach to training. The SNSA devotes attention to education and training by monitoring and developing the careers of its employees and continuously offering them possibilities for improving their professional skills. In particular, each employee has to attend a two-month course entitled Fundamentals of Nuclear Technology. In addition, employees spend on average two to three weeks annually attending international workshops or technical meetings from their area of expertise.

The financial situation in Slovenia has improved in the last few years; budgetary funds provided to the SNSA are again at the normal level and stable; extra budgetary financial resources of the SNSA obtained on the basis of its cooperation and work on various projects to assist third countries, as tendered by the International Atomic Energy Agency and the European Commission, represent an important share of the total amount of funding. For this reason, in 2017 the SNSA was able to again finance some research and development necessary for the administrative control of radioactive waste and spent fuel management.

In December 2018, the SNSA organised an all-day working meeting on the challenges of nuclear and radiation safety on the topic "*Research and development*". The meeting was attended by approximately 48 experts from all prominent Slovenian organisations dealing with nuclear and radiation safety. At the meeting, colleagues presented their research projects relating to nuclear energy and radiation protection and also the problems they see mainly in funding for projects in the field of nuclear and radiation safety. The SNSA wanted to encourage the preparation of a research and development strategy in the field of nuclear and radiation safety in Slovenia. A research and development strategy in the field of nuclear and radiation safety in Slovenia would determine where we stand as regards research and which research areas in Slovenia need to be developed in the future. A common strategy for such research and development would help reduce the dispersion of areas and help secure adequate funding. The participants agreed to continue their efforts to develop a common strategy.

In past years, the SNSA investigated the possibility of establishing a special fund for financing appropriate research and development in the area of nuclear technologies, including radioactive and spent fuel management. During the collection of data to support such a project, it became evident that annually the nuclear industry and the state budget conclude contracts with research, development and engineering organisations and companies in Slovenia with a total value sufficient to support approximately 100 man/year of work. Such level of financing of domestic institutions, which has also been stable over the years, ensures reasonable stability of the nuclear expertise inside the country.

In 2020, the SNSA adopted a *Research and Development Strategy at the SNSA*, which was prepared with the aim of defining a multi-annual orientation towards research on and the development of nuclear and radiation safety to support the administrative control of nuclear and radiation safety, including radioactive waste and spent fuel management. On the basis of this document, the SNSA prepares annual operational research and development plans.

SECTION L: ANNEXES

(a) List of Spent Fuel Management Facilities

There are no off-site spent fuel management facilities in the Republic of Slovenia.

(b) List of Radioactive Waste Management Facilities

The Central Storage Facility for Radioactive Waste in Brinje, the Boršt hydro-metallurgical tailings disposal site and the Jazbec mine waste disposal site at the former Žirovski Vrh Uranium Mine are the only radioactive waste management facilities in the Republic of Slovenia.

Figure 20: **The Jazbec mine waste disposal site**

Figure 21: **The Boršt hydro-metallurgical tailings disposal site**

(c) List of Nuclear Facilities in the Process of Being Decommissioned

There are no nuclear facilities being decommissioned. The remediation works at the Boršt hydro-metallurgical tailings disposal site are in the final phase and the Boršt disposal site still holds the status of a radiation facility.

(d) Inventory of Spent Fuel

Spent Fuel Pool at the Krško NPP

Table 9: **The number, average burn-up, and total mass of the heavy metal of the fuel assemblies in each fuel batch**

Fuel batch	No. of fuel assemblies	Burn-up [GWd/MTU]	Heavy metal [kg]
1	41	18.6	16,335.0
2	40	24.3	15,788.4
3	40	30.9	15,613.2
4A	25	30.7	9,767.4
4B	16	34.3	6,258.0
5A	40	32.6	15,666.8
5B	2	30.2	780.1
6A	4	38.7	1,563.6
6B	1	36.7	390.6
6C	20	37.7	7,814.3
6D	16	41.6	6,221.7
7A	24	35.9	9,463.0
7B	2	36.4	785.5
7C	20	33.7	7,913.3
8A	16	44.9	6,246.4
8B	8	44.8	3,122.3
KWU	40	34.8	14,980.1
9	12	41.7	4,694.9
10A	8	40.5	3,119.2
10B	12	43.3	4,656.6
10C	8	47.3	3,090.3
11	40	40.1	15,646.9
11B	20	40.2	7,832.8
12	24	44.4	9,317.3
12B	8	39.8	3,129.7
13	40	43.0	15,598.0
14	36	42.3	14,031.6
14B	4	44.5	1,554.2
15	24	46.4	9,290.9
15B	12	37.1	4,702.6
16	16	45.0	6,224.6
16B	8	46.6	3,107.9
17	24	44.3	9,343.7
17B	4	40.1	1,568.8
18	28	43.7	10,741.6
19	30	44.0	11,558.7
20	28	45.1	10,843.4
21	22	44.3	8,507.0
22A	12	41.6	4,653.9
22B	32	46.8	12,353.9
23A	0		
23B	32	48.9	12,328.4
24A	0		
24B	8	52.1	3,068.8
25A	0		

Fuel batch	No. of fuel assemblies	Burn-up [GWd/MTU]	Heavy metal [kg]
25B	4	50.8	1,539.2
26A	3	53.2	1,148.3
26B	8	52.5	3,067.3
27A	4	35.7	1,563.6
27B	11	52.4	4,224.6
28A	1	35.7	389.6
28B	5	51.9	1,919.3
29A	0		
29B	12	52.4	4,605.7
30A	0		
30B	8	52.4	3,066.1
31A	0		
31B	1	50.1	384.2
FRSB1	1	27.8	60.4
SBFR1	1	35.8	0.2

Spent Fuel Pools at the JSI Reactor Infrastructure Centre

There are no spent fuel elements stored in the spent fuel pools at the JSI Reactor Infrastructure Centre.

(e) Inventory of spent fuel

Radioactive Waste Storage Facilities at the Krško NPP

Table 10: **Radioactive waste inventory in the Krško NPP Solid Radwaste Storage Facility as of 31 December 2019**

Type of waste	No. of drums	Volume [m^3]	Total beta/gamma activity [Bq]	Specific activity beta/gamma [Bq/m^3]
Incineration products (A)	76*	15.8	5.43E+09	3.43E+08
Blowdown Resins (BR)	1	0.2	9.08E+08	4.54E+09
Compressible Waste (CW)	7	1.5	2.43E+08	1.62E+08
Dried Concentrate (DC)	7	1.4	1.27E+09	9.07E+08
Evaporator Bottom (EB)	2	0.4	2.33E+08	5.83E+08
Filters (F)	117	23.4	1.15E+11	4.73E+09
Other (O)	7	1.5	3.97E+08	2.65E+08
Dried Primary Resins (PR)	1	0.15	1.56E+10	1.04E+11
Supercompacted Waste (SC)	617	197.4	1.34E+10	6.79E+07
Spent Resins (SR)	689	143.3	1.92E+12	1.34E+10
Supercompacted Waste (ST)	1,851	1,599.3	5.46E+11	3.41E+07
Primary (PR) and Blowdown (BR) Resins, Incineration Products (A) and Dry Concentrate (DC) in Tube-Type Containers (TI)	332	288.5	1.27E+13	4.40E+10
TOTAL	**3,707**	**2,273.8**	**1.53E+13**	**1.73E+11**

Note: *33 drums of incineration products (A) were inserted into 11 tube-type containers (TI).

Table 11: **Radioactive waste inventory in the Krško NPP Waste Manipulation Building as of 31 December 2019**

Type of waste	**No. of drums**	**Volume [m³]**	**Total beta/gamma activity [Bq]**	**Specific activity beta/gamma [Bq/m³]**
Compressible Waste (CW)	50	10.4	3.13E+08	6.26E+06
TOTAL	**50**	**10.4**	**3.13E+08**	**6.26E+06**

Table 12: **Radioactive waste inventory in the Krško NPP Decontamination Building as of 31 December 2019**

Type of waste	**No. of drums**	**Volume [m³]**	**Total beta/gamma activity [Bq]**	**Specific activity beta/gamma [Bq/m³]**
Incineration products (A)	19	4.0	4.37E+08	1.09E+08
Blowdown Resins (BR)	53	10.6	1.53E+09	1.44E+08
Compressible Waste (CW)	229	47.6	1.22E+09	2.56E+07
TOTAL	**301**	**62.2**	**3.19E+09**	**2.79E+08**

The specific radionuclides (beta, gamma) are ^{58}Co, ^{60}Co, ^{134}Cs and ^{137}Cs.

A description of the waste types and acronyms used is as follows:

- Evaporator Bottom (EB) – the residue from evaporating wastewater, containing boric acid, solidified in vermiculite cement packed in 208 l drums.
- Filters (F) – spent filters from the primary water purification and liquid waste processing system, packaged in standard 208 l steel drums with an inner concrete biological shield.
- Spent Resins (SR) – spent ion exchange resins from purification systems, embedded in 208 l drums with vermiculite cement.
- Compressible Waste (CW) – waste arising mostly from using personal protective clothes, coveralls, shoe covers, plastics, etc., packed into 208 l drums.
- Other (O) – miscellaneous waste arising during operation and maintenance activities, such as contaminated used parts, cables, hoses, valves, concrete, wood, etc., packed in 208 l drums.
- Supercompacted waste (SC) – radioactive waste of compressible waste type, supercompacted and packed in 320 l carbon steel overpacks (campaign conducted in 1988 and 1989).
- Supercompacted waste (ST) – radioactive waste of compressible waste and evaporator bottom types, supercompacted, spent resins inserted and packed in tube-type container.
- Incineration products (A) – ash, dust and other residues from the incineration of combustible waste.
- Primary Resins (PR) – spent ion exchange resins from primary water purification systems dried and packed in stainless steel drums with 3-cm-thick walls as a biological shield.
- Blowdown Resins (BR) – resins arising from the purification system of a secondary system, packed in stainless steel drums.
- TI package as Primary Resins (PR), Blowdown Resins (BR), Incineration Products (A) and Dry Concentrate (DC) additionally inserted in tube-type containers (3 drums of Primary Resins/Blowdown Resins/DC in 1 tube-type container).

The types of packages in the Solid Radwaste Storage Facility are as follows:

- 208 l standard drum – designed in accordance with the ANSI DOT-17H standard; appropriate for the following solid waste: compressible waste, other, filters, spent resins and evaporator bottom.
- 320 l overpack – used solely for the packaging of compressed standard 208 l drums from the first supercompaction campaign.
- 200 l stainless steel heavy drum with a biological shield (150 l of usable volume) – used for dried primary spent resins (Primary Resins) tested as a Type A Package in accordance with IAEA Safety Standards.
- 200 l stainless steel heavy drum without a biological shield – used for secondary spent resins (Blowdown Resins) and Dried Concentrate (DC) tested as a Type A Package. The use of stainless steel drums with biological shields started after the in-drum drying system for volume reduction was introduced.

- 200 l heavy carbon steel drum with coating – a limited number of this type of drum were filled with secondary spent resins (Blowdown Resins) and Dried Concentrate (DC). Periodic inspection of these drums is required to confirm corrosion resistance.
- 100 l drums containing ash from incineration – these drums are immobilised with concrete in 208 l drums.
- tube-type container, usable volume 869 l with a welded lid – an overpack, used in the second supercompaction campaign. Tested as an IP 2 container according to IAEA Safety Standards.
- tube-type container, usable volume 864 l with a flanged lid – used for in-drum drying system products and other types of radioactive waste as a preferred final package for interim storage in a solid radwaste storage facility, awaiting transport to an off-site disposal area. Tested as an IP 2 container in accordance with IAEA Safety Standards.

Table 13: **Contaminated/activated material inventory in the Decontamination Building – decontamination area, as of 31 December 2019**

Type of radioactive waste	Number of pieces	Volume [m³]	Mass [kg]	Contamination [Bq/dm²]	Packaging
Rx old head – CRDM	4	3	1,200	500	PE foil
Rx old head – DRPI	4	3	600	400	PE foil
Reactor screw tensioners	5	5	5,200	100	PE foil
Concrete blocks	4	10	19,000	100	PE foil
VA cooler	8	50	24,000	100	PE foil
PAR board	880	1	880	< 200	PE foil

Table 14: **Contaminated/activated material inventory in the Decontamination Building – old steam generators area, as of 31 December 2019**

Type of radioactive waste	Number of pieces	Volume [m³]	Mass [kg]	Activity/ Contamination/ Dose Rate	Packaging
Steam generators*	2	600	646,000	< 3.00E+12 Bq	N/A
Radlok containers (from 1 to 10)	10	36	2,500	10,000 Bq/dm²	PE reservoir
Regenerative and refuelling water heat exchanger	2	4	4,500	3.5 mSv/h	Metal container
Maintenance department equipment	2	2	1,900	1 mSv/h	Metal container
Steel ropes	8	1	1,300	300 Bq/dm²	Container
Tools for pressure monitoring of the reactor vessel temporary sealing lid	1	2	1,300	100 Bq/dm²	Metal container
Temporary lid seal of old steam generators	4	4	1,300	6,000 Bq/dm²	Metal container
Temporary reactor vessel lid	1	1.4	1,300	1,600 Bq/dm²	Metal container
Framatome steam generators equipment	4	1	1,300	4,000 Bq/dm²	Metal container
Rotor supports of the reactor coolant pumps	1	3	800	3,000 Bq/dm²	Metal container
Reactor coolant pumps equipment	2	4	1,000	4,000 Bq/dm²	Metal container
Spent parts of the reactor coolant pumps	1	2	800	5,000 Bq/dm²	Metal container
Inner parts of the CSAPCH01 pump	1	1	500	6,000 Bq/dm²	Metal container

Type of radioactive waste	Number of pieces	Volume [m³]	Mass [kg]	Activity/ Contamination/ Dose Rate	Packaging
Old cranes for the removal of reactor vessel screws	4	1	300	400 Bq/dm²	PE foil
Support plates of the steam generators from container No. 6	10	1	2,000	400 Bq/dm²	PE foil
Old Rx seal ring	1	1	500	2 mSv/h	PE foil
New Rx seal cover	1	1	500	400 Bq/dm²	Stainless steel container
Diving equipment	2	2	300	500 Bq/dm²	Container
Temporary Rx seal ring	1	16	1,500	500 Bq/dm²	Metal container
Reactor coolant pumps elevator	1	2	500	300 Bq/dm²	Metal container
Compressible waste press	1	2	400	100 Bq/dm²	PE foil
Reactor coolant pumps convenient elevator	3	2	200	100 Bq/dm²	Metal container
INETEC equipment	2	5	2,500	5,000 Bq/dm²	Metal container
Supercompactor cylinder and vacuum pump	4	1	1,000	20,000 Bq/dm²	PE foil
Lead shields	18	18	24,000	100 Bq/dm²	Metal containers
Reactor coolant pump motor base	2	2	700	4,000 Bq/dm²	Metal containers
Rod position digital system cables	4	4	1,000	500 Bq/dm²	Wooden containers
Spare winch for fuel handling	1	0.5	300	500 Bq/dm²	PE foil
Steam generators drying equipment	1	1.5	200	-	Metal container
Reactor coolant pump motor equipment	4	1	300	400 Bq/dm²	Metal container
SEG for WP equipment	2	6	4,000	5,000 Bq/dm²	Metal container
Ingots	80	14	49,700	< 50 µSv/h/pc	Steel and Al ingots
RCP motor oil cooler	1	1	1,000	100 Bq/ dm²	
RCP01 motor stator	1	4	8,200	500 Bq/dm²	Metal stand
VA pump motor (RB-126)	3	3	3,000	100 Bq/dm²	PE foil
SS heat exchanger	2	0.5	200	100 Bq/dm²	Metal containers
Rx head – old	1	21	70,000	2 mS/h	Container
Concrete blocks	3	25	90,000	5 µSv/h	PE foil
Containers	5	150	40,000	6,000 Bq/dm²	Container
Old RTD valves and insulation	7	7	3,400	10 mS/h	Metal containers
Filter housing from RB126	35	5	700	Activated	
VAC-PAC vacuum cleaner	2	2	500	200 Bq/dm²	
Fission cell drives	3	6	4,000	5,00 Bq/dm²	IP2 container

Type of radioactive waste	Number of pieces	Volume [m³]	Mass [kg]	Activity/ Contamination/ Dose Rate	Packaging
Testing electric cables	3	3	900	100 Bq/dm²	Metal container
Old hydrogen recombiners from RB	2	4	1,200	500 Bq/dm²	PE foil
TOTAL	249	973.9	977,500		

Central Storage Facility for Radioactive Waste in Brinje

Table 15: **Inventory of RW and disused radioactive sources stored at the CSF as of the end 2019**

Group	Subgroup and Type	Number of packages	Volume (m³)	Main radionuclides	Activity (Bq)
Group I – Solid RW	T1 (solid, compressible, combustible)	97	19	^{226}Ra, ^{60}Co, ^{241}Am, ^{109}Cd, ^{108}Ag, ^{238}U, ^{57}Co, ^{232}Th, ^{3}H	7.1E+08
	T2 (solid, compressible, non-combustible)	125	24	^{226}Ra, ^{60}Co, ^{241}Am, ^{109}Cd, ^{108}Ag, ^{238}U, ^{3}H, ^{238}U, ^{14}C, ^{228}Th, ^{106}Ru, ^{210}Pb	1.6E+10
	T3 (solid, non-compressible, combustible)	28	6	^{226}Ra, ^{60}Co, ^{232}Th	3.8E+09
	T4 (solid, non-compressible, non-combustible)	164	30	^{226}Ra, ^{60}Co, ^{109}Cd, ^{137}Cs, ^{108}Ag, ^{238}U, ^{14}C, ^{232}Th, ^{133}Ba	1.1E+11
Group II – DSRS	ZV0 (ionisation smoke detectors)	212	5	^{241}Am, ^{226}Ra	2E+10
	DSRS (other disused sealed radioactive sources)	179	6	^{226}Ra, ^{60}Co, ^{241}Am/Be, ^{238}U, ^{232}Th, ^{63}Ni, ^{55}Fe, ^{90}Sr, ^{106}Ru, ^{3}H, ^{152}Eu, ^{137}Cs, ^{85}Kr, ^{133}Ba, ^{241}Am	3E+12
Group III – other RW	L – liquid waste	0	0	/	0
	M – mixed waste	0	0	/	0
	TOTAL	805	90		3.2E+12
	Total mass	50 tons			

Jazbec mine waste disposal site at the Žirovski Vrh Uranium Mine

Table 16: **Mine waste and other debris at the Jazbec mine waste disposal site, situation as of the end of 2019**

Deposited	Mine waste and red mud 1982-1990 (mine ore production), contaminated material, technological equipment 1991-2007 (decontamination, demolition)
Final arrangement	2008
Closed	2015
Surface, total	67,325 m^2 (the drainage area of the mine waste disposal site) 74,239 m^2 (the area inside the safety fence)
Altitude	Bottom: 427 m; top: 509 m (above sea level)
Volume of disposed waste	Total volume of the disposed material: 1,198,900 $m^{3:}$ 854,500 m3 of mine waste, 126,000 m3 of low-grade uranium ore, 34,000 m3 of red mud, 2,600 m3 of filter cake from the mine water treatment station, 181,000 m3 of contaminated soil and rubble from uranium ore processing facilities and crash station demolition, 800 m^3 of technological equipment from uranium ore processing facilities and the crash station.
Amount of disposed waste	Total amount of disposed material: 1,910,425 t: 1,366,589 t of mine waste, 200,684 t of low-grade uranium ore, 48,000 t of red mud, 4,220 t of filter cake from the mine water treatment station, 289,723 t of contaminated soil and rubble from uranium ore processing facilities and crash station demolition, 1,209 t of technological equipment from uranium ore processing facilities and the crash station.
Average specific activity of disposed material	7.7 kBq/kg mine waste (53 g U_3O_8/t), 65 kBq/kg red mud (^{230}Th 97%), 34.4 kBq/kg filter cake (236 g U_3O_8/t), 29.2 kBq/kg low-grade uranium ore (200 g U_3O_8/t), < 2 kBq/kg contaminated soil and rubble
Total activity of disposed material	21.7 TBq
Dose rate, average	0.10 – 0.11 µSv/h

Note: most of the ^{230}Th was not contained in the hydro-metallurgical tailings which remained in the so-called red mud as a neutralisation by-product.

Boršt hydro-metallurgical tailings disposal site at the Žirovski Vrh Uranium Mine

Table 17: **Boršt hydro-metallurgical tailings disposal site with basic data, situation as of the end of 2019**

Deposited	Hydro-metallurgical tailings 1984-1990 and mine waste 1984-2004, contaminated material 2008-2009
Final arrangement	2010 arrangement of the hydro-metallurgical tailings, until 2019, remediation of the hydro-metallurgical tailings base rock sliding
Surface, total	42,000 m^2 (hydro-metallurgical tailings surface), 67,923 m^2 (surface inside the safety fence of the hydro-metallurgical tailings)
Altitude	Bottom: 535 m; top: 565 m (above sea level)
Volume of disposed waste	339,000 m^3 of hydro-metallurgical tailings, 70,000 m^3 of mine waste, 6,543 m^3 contaminated materials total volume of disposed material: 415,543 m^3
Amount of disposed waste	610,000 t of hydro-metallurgical tailings, 111,000 t of mine waste, 9,450 t contaminated materials, total amount of disposed material: 730,450 t
Average specific activity of disposed material	78.2 kBq/kg hydro-metallurgical tailings 10.2 kBq/kg mine waste
Total activity of disposed material	48.8 TBq
Dose rate, average	0.14 μGy/h (covered with a final layer)

Note: The specific activity of the contaminated materials from the procedure for the decontamination of the disposal's surroundings was not measured; however, it was low.

(f) References to National Acts, Regulations, Requirements, Guidelines, Etc.

- Ionising Radiation Protection and Nuclear Safety Act (Official Gazette RS, Nos. 76/17 and 26/19)

In addition to the 2017 Act, two resolutions:

- Resolution on Nuclear and Radiation Safety in the Republic of Slovenia for the Period 2013–2023 (Official Gazette RS, No. 56/13),
- Resolution on the National Programme for Managing Radioactive Waste and Spent Fuel for the Period 2016–2025 (Official Gazette RS, No. 31/16),

and the Acts and regulations stated below should also be mentioned.

Nuclear and Radiation Safety, Physical Protection, Safeguards, Quality Assurance

Based on the 2017 Act, the following decrees and regulations for implementing radiation protection and nuclear safety provisions were issued:

- Decree on Radiation Activities (Official Gazette RS, No. 19/18),
- Decree on Dose Limits, Reference Levels and Radioactive Contamination (Official Gazette RS, No. 18/18),
- Decree on the Areas of Limited Use of Land due to a Nuclear Facility and the Conditions of Facility Construction in These Areas (Official Gazette RS, No. 78/19),
- Decree on the National Radon Programme (Official Gazette RS, Nos. 18/18 and 86/18),
- Decree on the Reduction of Exposure due to Natural Radionuclides and Past or Existing Activities or Events (Official Gazette, No. 38/18),
- Decree on the Safeguarding of Nuclear Materials (Official Gazette RS, Nos. 34/08 and 76/17 – ZVISJV-1),
- Decree on the Criteria for Determining the Compensation Rate due to the Restricted Use of Areas and Intervention Measures in Nuclear Facility Areas (Official Gazette RS, Nos. 92/14, 46/15, 76/17 – ZVISJV-1 and 8/20),
- Decree on Checking the Radioactivity of Consignments that Could Contain Orphan Sources (Official Gazette RS, No. 10/19),
- Decree on the Implementation of Council Regulations (EC) and Commission Regulations (EC) on the Radioactive Contamination of Foodstuffs and Feedstuffs (Official Gazette RS, Nos. 52/06, 38/10 and 76/17 – ZVISJV-1),
- Decree on the Method, Subject of and Conditions for Performing the Compulsory Public Utility Service of Long-term Surveillance and Maintenance of Landfills of Mining and Hydro-metallurgical Tailings Resulting from the Extraction and Exploitation of Nuclear Mineral Raw Materials (Official Gazette RS, No. 76/15),
- Decree on the Method and Subject of and Conditions for Performing the Public Utility Service of Radioactive Waste Management (Official Gazette RS, No. 32/99, 41/04 – ZVO-1 in 76/17 – ZVISJV-1),
- Rules on the Expert Council on Radiation and Nuclear Safety (Official Gazette RS, Nos. 35/03 and 76/17 – ZVISJV-1),
- Rules on the Use of Radiation Sources and Radiation Activities (Official Gazette RS, No. 27/18),
- Rules on Authorised Experts on Radiation and Nuclear Safety (Official Gazette RS, Nos. 51/06 and 76/17 – ZVISJV-1),
- Rules on Providing Qualifications for Workers in Radiation and Nuclear Facilities (Official Gazette RS, Nos. 32/2011 and 76/17 – ZVISJV-1),
- Rules on Radiation and Nuclear Safety Factors (Official Gazette RS, Nos. 74/16 and 76/17 – ZVISJV-1),
- Rules on Radioactive Waste and Spent Fuel Management (Official Gazette RS, Nos. 49/06 and 76/17 – ZVISJV-1),
- Rules on the Safety Assurance of Radiation and Nuclear Facilities (Official Gazette RS, Nos. 81/2016 and 76/17 – ZVISJV-1),

- Rules on Radioactivity Monitoring (Official Gazette RS, No. 27/18),
- Rules on Transboundary Shipments of Radioactive Waste and Spent Fuel (Official Gazette RS, Nos. 22/09 and 76/17 – ZVISJV-1),
- Rules on the Transboundary Shipment of Nuclear and Radioactive Substances (Official Gazette RS, Nos. 75/08, 41/14 and 76/17 – ZVISJV-1),
- Rules on the Functioning of the Expert Council for the Issues of Ionising Radiation Protection, Radiological Activities, and the Use of Radiation Sources in Human and Veterinary Medicine (Official Gazette RS, Nos. 62/03 and 76/17 – ZVISJV-1),
- Rules on the Criteria for Using Ionising Radiation Sources for Medical Purposes and for the Deliberate Exposure of Individuals for Non-Medical Purposes (Official Gazette RS, No. 33/18),
- Rules on Special Radiation Protection Requirements and the Method of Dose Assessment (Official Gazette RS, No. 47/18),
- Rules on the Health Surveillance of Exposed Workers (Official Gazette RS, Nos. 2/04 and 76/17 – ZVISJV-1),
- Rules on Authorising Ionising Radiation Practitioners (Official Gazette RS, No. 39/18),
- Rules on Authorising Radiation Protection Experts (Official Gazette RS, No. 47/18),
- Rules on the Obligations of Person Carrying Out a Radiation Practice and Person Possessing an Ionising Radiation Source (Official Gazette RS, No. 43/18),
- Rules on Radiation Protection Measures in Controlled and Monitored Areas (Official Gazette, No. 47/18),
- Rules on the Use of Potassium Iodine (Official Gazette RS, Nos. 59/10 and 17/14 – ZZdr-2),
- Rules on the Implementation of National Screening Programmes for the Early Detection of Precancerous Changes and Cancer (Official Gazette RS, Nos. 57/18 and 68/19),
- Rules on the Monitoring of Radioactivity in Drinking Water (Official Gazette RS, Nos. 74/15 and 76/17 – ZVISJV-1),
- Rules on the Physical Protection of Nuclear Facilities, Nuclear and Radioactive Materials, and the Transport of Nuclear Material (Official Gazette RS, Nos. 17/13 and 76/17 – ZVISJV-1),
- Order on Establishing Basic Training and Periodic In-Service Training Programmes of Security Personnel Performing the Physical Protection of Nuclear Facilities, Nuclear or Radioactive Materials and the Transport of Nuclear Materials (Official Gazette RS, Nos. 12/13 and 76/17 – ZVISJV-1),
- Rules on the Equipment of Inspectors Carrying Out Inspection on Physical Protection of Nuclear and Radioactive Materials and Facilities (Official Gazette RS, Nos. 42/12 and 76/17 – ZVISJV-1).

Third Party Nuclear Liability

- Act on Liability for Nuclear Damage (Official Gazette RS, No. 77/10),
- Ordinance on Determining Persons for Whom the Conclusion of Insurance for Liability for Nuclear Damage Is Not Obligatory (Official Gazette RS, No. 110/10),
- Third Party Liability for Nuclear Damage Act (Official Gazette SFRY, Nos. 22/78 and 34/79) – The Act ceased to apply on the day the Act on Liability for Nuclear Damage entered into force (4 April 2011), except the provision of Article 20, which shall apply until the full application of the Act on Liability for Nuclear Damage,
- Decree on Establishment of the Amount of a Limited Operator's Liability for Nuclear Damage and on Establishment of the Amount of Insurance for Liability for Nuclear Damage (Official Gazette RS, No. 110/01) – the Decree shall apply until the full application of the Act on Liability for Nuclear Damage.

Civil Protection and Disaster Relief

- Protection Against Natural and Other Disasters Act (Official Gazette RS, Nos. 51/06 and 97/10 – official consolidated text),
- Decree on the Contents and Drawing Up of Protection and Rescue Plans (Official Gazette RS, Nos. 24/12, 78/2016 and 26/19),
- National Emergency Response Plan for Nuclear and Radiological Accidents, Version 3.0, 2010.

Administrative

- Public Administration Act (Official Gazette RS, Nos. 113/05 – official consolidated text, 89/07, 126/07 – ZUP-E, 48/09, 8/10 – ZUP-E, 8/15 – ZVRS-F, 21/12, 47/13, 12/14, 90/14 and 51/16),
- Inspection Act (Official Gazette RS, Nos. 43/07 – consolidated text and 40/14),
- General Administrative Procedure Act (Official Gazette RS, Nos. 24/06 – official consolidated text, 105/06 – ZUS-1, 126/07, 65/08, 8/10 and 82/13).

Energy and Environmental Matters

- Energy Act (Official Gazette RS, No. 60/19 – consolidated text),
- Decree on the Transformation of the Krško NPP, p.o., into the Public Company NEK d.o.o. (Official Gazette RS, Nos. 54/98, 57/98, 106/01, 59/02 and 10/03),
- Environmental Protection Act (Official Gazette RS, Nos. 39/06 – official consolidated text, 49/06 – ZMetD, 66/06, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15 and 30/16, 61/17 – GZ, 21/18 – ZNOrg and 84/18 – ZIURKOE),
- Decree on Environmental Encroachments that Require Environmental Impact Assessments (Official Gazette RS, Nos. 51/14, 57/2015 and 26/17),
- Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment (Official Gazette RS, Nos. 36/09 and 40/17),
- Decree on the Criteria for Determining the Likely Significance of Environmental Effects of Certain Plans, Programmes or Other Acts and Its Modifications in the Environmental Assessment Procedure (Official Gazette RS, No. 9/09),
- Decree laying down the Content of Environmental Report and on Detailed Procedure for the Assessment of the Effects on Certain Plans and Programmes on the Environment (Official Gazette RS, No. 73/05),
- Permanent Cessation of Exploitation of Uranium Ore and Prevention of the Consequences of Mining in the Uranium Mine at Žirovski Vrh Act (Official Gazette, RS, No. 22/2006 – official consolidated text),
- Decree Determining the Area and of the Compensatory Amount due to the Limited Use of the Environment in the Area of the Žirovski Vrh Uranium Mine (Official Gazette RS, Nos. 22/08 and 50/09),
- Decree on the Method, Subject and Conditions for the Provision of the Obligatory Public Utility Service of the Long-Term Surveillance and Maintenance of Landfills of Mining and Hydro-Metallurgical Tailings from the Extraction and Exploitation of Nuclear Minerals (Official Gazette RS, No. 76/15),
- Fund for Financing the Decommissioning of the Krško Nuclear Power Plant Krško and the Disposal of Radioactive Waste from the Krško NPP Act (Official Gazette RS, Nos. 47/03 – official consolidated text and 68/08).

Transport

- Act on the Transport of Dangerous Goods (Official Gazette RS, Nos. 33/06 – official consolidated text, 41/09, 97/10 and 56/15),
- Decision on the Publication of Amendments to Annexes A and B of the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR; Official Gazette RS, Nos. 9/03, 66/03, 9/05, 9/07, 125/08, 97/10, 14/13, 10/15, 9/17, 33/18 and 8/19).

Export of dual-use items

- Act Regulating Control of the Export of Dual-use Items (Official Gazette RS, Nos. 37/04 and 8/10),
- Regulation on Procedures for Issuing Authorisations and Certificates and on the Competence of the Commission for the Control of Exports of Dual-use Items (Official Gazette RS, Nos. 34/10 and 42/12).

General

- Decree on Administrative Authorities within Ministries (Official Gazette RS, Nos. 35/15, 62/15, 84/16, 41/17, 53/17, 52/18, 84/18, 10/19 and 64/19),
- Maritime Code (Official Gazette RS, No. 62/16 – official consolidated text, 41/17, 21/18 – ZNOrg and 31/18 – ZPVZRZECEP),
- The Criminal Code (Official Gazette RS, Nos. 50/12 – official consolidated text, 6/16 – corr., 54/15, 38/16 and 27/17),
- Minor Offences Act (Official Gazette RS, Nos. 29/11 – official consolidated text, 43/11, 21/13, 111/13, 74/14, 92/14, 32/16, 15/17 and 73/19),
- Spatial Planning Act (Official Gazette RS, Nos. 33/07, 70/08 – ZVO-1B, 108/09, 80/10 – ZUPUDPP, 43/11 – ZKZ-C, 57/12, 57/10- ZUPUDPP-A, 109/12, 76/14, 14/15 – ZUUJFO and 61/17 – ZureP-2),
- Spatial Management Act (Official Gazette RS, No. 16/17),
- Construction Act Official Gazette RS, Nos. 61/17 and 72/17 – corr.),
- Decree on the Detailed Plan of National Importance for the Low and Intermediate Level Waste Repository at Vrbina in the Municipality of Krško (Official Gazette of Republic of Slovenia, Nos. 114/09 and 50/12),
- Ordinance on the Transformation of the Public Company Agencija za radioaktivne odpadke p.o., Hajdrihova 2, Ljubljana, into the Public Service Institute (Official Gazette RS, Nos. 45/96, 32/99, 38/01, 41/04 – ZVO-1 and 113/09),
- Decree on the Method and Subject of and Conditions for Performing the Public Utility Service of Radioactive Waste Management (Official Gazette RS, Nos. 32/99, 41/04 – ZVO-1 in 76/17 – ZVISJV-1),
- Price List of the Public Service of Radioactive Waste Management (Official Gazette RS, No. 102/2000),
- Standardisation Act (Official Gazette RS, No. 59/99).

Multilateral and Bilateral Treaties, Conventions, Agreements/Arrangements

In accordance with Article 8 of the Constitution of the Republic of Slovenia, all announced and ratified international treaties also constitute an integral part of the Slovenian legal system and can be applied directly. The following international instruments, to which the Republic of Slovenia is party, should be mentioned:

Multilateral Agreements

- Statute of the International Atomic Energy Agency (including the Amendment of Articles VI and XIV),
- Agreement on the Privileges and Immunities of the International Atomic Energy Agency,
- Convention on the Physical Protection of Nuclear Material (including the Amendment from 2005),
- Convention on Early Notification of a Nuclear Accident,
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency,
- The IAEA Incident Reporting System (IAEA-IRS),
- Convention on Nuclear Safety,
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water,
- Treaty on the Non-proliferation of Nuclear Weapons,
- Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction in the Sea-Bed and the Ocean Floor,
- European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR),
- Convention on International Railway Carriage (COTIF), including Appendix B (RID),
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management,
- Comprehensive Nuclear-Test-Ban Treaty,

- Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960, as Amended by the Additional Protocol of 28 January 1964 and by the Protocol of 16 November 1982,
- Convention of 31 January 1963 Supplementary to the Paris Convention of 29 July 1960, as Amended by the Additional Protocol of 28 January 1964 and by the Protocol of 16 November 1982,
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention,
- Agreement between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in Implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons,
- Protocol Additional to the Agreement between the Republic of Austria, the Kingdom of Belgium, the Kingdom of Denmark, the Republic of Finland, the Federal Republic of Germany, the Hellenic Republic, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the Portuguese Republic, the Kingdom of Spain, the Kingdom of Sweden, the European Atomic Energy Community and the International Atomic Energy Agency in implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons.

Bilateral Agreements

- Arrangement between the SNSA and the US NRC for the Exchange of Technical Information and Co-operation in Nuclear Safety Matters,
- Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Hungary on the Early Exchange of Information in the Event of a Radiological Emergency,
- Agreement between the Republic of Slovenia and the Republic of Austria on the Early Exchange of Information in the Event of a Radiological Emergency and on Common Interests in the Field of Nuclear Safety and Radiation Protection,
- Arrangement between the Nuclear Safety Administration of the Republic of Slovenia and the Federal Ministry of Agriculture and Forestry, Environment and Water Management of the Republic of Austria regarding Co-operation in the Field of Radiation Protection and Strengthening of the Mutual Exchange of Data of the Aerosol Monitoring Systems,
- Arrangement between the Nuclear Safety Administration (SNSA) of the Republic of Slovenia and the Institute for Environmental Protection and Research (ISPRA) of the Republic of Italy for the Early Exchange of Information in the Event of a Radiological Emergency and Co-operation in Nuclear Safety Matters,
- Agreement between the Republic of Slovenia and the Republic of Croatia for the Early Exchange of Information in the Event of a Radiological Emergency,
- Agreement between the Government of the Republic of Slovenia and the Government of the Slovak Republic for the Exchange of Information in the Field of Nuclear Safety,
- Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of the Status and Other Legal Relations Regarding the Investment, Exploitation and Decommissioning of the Krško NPP,
- Agreement between the Government of the Republic of Slovenia and the Government of Canada for Co-operation in the Peaceful Uses of Nuclear Energy,
- Administrative Arrangement between the Slovenian Nuclear Safety Administration and Atomic Energy Control Board of Canada pursuant to the Agreement between the Government of the Republic of Slovenia and the Government of Canada for co-operation in Peaceful Uses of Nuclear Energy,
- Revised Supplementary Agreement between the International Atomic Energy Agency and the Government of the Republic of Slovenia concerning the Provision of Technical Assistance by the International Atomic Energy Agency to the Government of the Republic of Slovenia.

International acts that are not international treaties

- Memorandum of Understanding between the Slovenian Nuclear Safety Administration and the State Office for Nuclear Safety of the Czech Republic on the Exchange of Information on Nuclear and Radiation Safety Matters,
- Memorandum of Understanding between the Slovenian Nuclear Safety Administration and the Macedonian Radiation Safety Directorate on the Exchange of Information on Nuclear and Radiation Safety Matters,
- Memorandum of Understanding between the European Nuclear Safety Regulators Group and the International Atomic Energy Agency for International Peer Review Missions to the EU Member States,
- Memorandum of Understanding between the Slovenian Nuclear Safety Administration and the State Regulatory Agency for Radiation and Nuclear Safety of Bosnia and Herzegovina on the Exchange of Information on Nuclear and Radiation Safety Matters,
- Memorandum of Understanding between the Slovenian Nuclear Safety Administration and the National Nuclear Agency of the Republic of Albania on the Exchange of Information on Nuclear and Radiation Safety Matters,
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- CASSIOPEE, Study on Radioactive Waste Management Schemes in Slovenia: Final Report, Services Contracts 97-0289.00, 97-0379.00, PHARE: ZZ 9423/0301, ZZ 9528/0301. December 1998.
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- OSART Mission (IAEA), 17 October – 20 November 2003 and Follow-up Visit, 7-11 November 2005.
- WANO Peer Review Mission, 20 October – 3 November 2014.

- WATRP IAEA Mission, Review of the ARAO's Documentation and Technical Programme for the Development of the Slovenian National Repository for Low and Intermediate Level Radioactive Waste, 21-25 January 2008.
- INSARR (Integrated Safety Assessment for Research Reactors) performed a safety review of the TRIGA Reactor, 12-16 November 2012.
- IAEA Expert Mission, 27-28 August 2009, (Alain Van Cotthem, František Fiedler).
- IAEA Expert Mission, 8-10 March 2010; (M. Garamszeghy, J-M. Potier and L. Valencia).
- IAEA Expert Mission, 18-20 January 2011; (J. Pacovsky, R. Chaplow).

Furthermore, there were two additional international reviews of the LILW Repository Preliminary Design:

- Peer Review of LILW Repository Preliminary Design, Vrbina, Krško; Technum – Tractebel Engineering; Technical Note N° P.001189.050-001.A; June 2010.
- Review of the Preliminary Design of the Vrbina LILW Repository, URS, May 2010.
- End of Mission Report on the Expert Mission to provide comments and discuss the third revision of the Krško NPP RW and SF Disposal Programme, 26-29 May 2019, (Neil Chapman, Peter Ormai, John Mathieson).

(i) Other Relevant Material

General Description of the Krško NPP

The Krško NPP is the only nuclear power plant in the Republic of Slovenia. The Krško NPP commenced operations in autumn 1981. It has been operating commercially since 1983. It is equipped with a Westinghouse pressurised light water reactor. At present, the gross electrical output is 727 MWe and the net output is 696 MWe. The previously installed capacity of 676 MWe net electrical output was updated due to the replacement of the low-pressure turbines in 2006. In 2004, the Krško NPP started operating with an eighteen-month fuel cycle.

Figure 22: **The Krško NPP**

The Krško NPP was designed and operates in accordance with Slovenian safety regulations and its operating license. In addition, the Krško NPP systematically observes the regulations and industrial standards of the USA, which is the supplying country.

The regulations followed in the design, construction and operation of the Krško NPP are divided into the following categories:

- the Acts and standards of the former SFRY (during construction and the first years of operation) and the Republic of Slovenia;
- the US 10 CFR Code of Federal Regulations as applicable to the design of the Krško NPP;
- regulatory guidelines issued by the US regulatory authority;
- the US ANS/ANSI, ASME, and IEEE industrial standards;
- IAEA standards and guidelines.

Table 18: **Some technical data on the Krško NPP**

Reactor Thermal Power	MW	1,994
Gross Electrical Output	MW	727
Net Electrical Output	MW	696
Thermal Efficiency Factor	%	36
CONTAINMENT		
Height	m	71
Inside Diameter	m	32
Outside Diameter	m	38
Steel Shell Test Pressure	MPa	0.357
REACTOR COOLING SYSTEM		
Chemical Composition		H_2O
Additives		H_3BO_3
Number of Cooling Loops		2
Total Mass Flow	kg/s	9,220
Pressure	MPa	15.41
Total Volume	m^3	197
Temperature at Reactor (Vessel) Inlet	°C	287
Temperature at reactor (Vessel) Outlet	°C	324
Number of Pumps		2
Pump Capacity	m^3/s	6.3
Pump Driving Power	MW	5.22
NUCLEAR FUEL		
Number of Fuel Assemblies		121
Number of Fuel Rods per Assembly		235
Fuel Rod Array in a Fuel Assembly		16 x 16
Fuel Rod Length	m	3.658
Clad Thickness	cm	0.0572
Clad Material		Zircaloy-4, ZIRLO
Fuel Chemical Composition		UO_2
Pellet Diameter	mm	8.191
Natural Pellet Length	cm	1.346
Enriched Pellet Length	cm	0.983
Annular Pellet Length	cm	1.173
Standardised Pellet Length	cm	1.27
Total Weight of Nuclear Fuel	t	48.7
CONTROL RODS		
Number of Control Rod Assemblies		33
Number of Absorber Rods per Assembly		20
Total Weight of a Control Rod Assembly	kg	53.07
Neutron Absorber		Ag-In-Cd
Percentage Composition	%	80-15-5
Diameter	mm	8.36
Density	g/cm^3	10.16
Clad Thickness	mm	0.445
Clad Material		SS 304

Krško NPP Structures

All principal structures of the Krško NPP are located on a solid reinforced concrete platform situated on the Pliocene sandy-clay sediments of the Krško basin. The structures are designed and constructed to resist the hazard of earthquakes.

The Reactor Building, where the reactor, the reactor coolant system and the safety systems are installed, consists of an inner cylindrical steel shell and an outer reinforced concrete shield building. The containment airlock is equipped with a sealed passage chamber with double doors. Numerous piping and cable penetrations are double sealed. The Auxiliary Building, the Component Cooling Building, the Fuel Handling Building, the Diesel Generator Building and the Turbine Building are located adjacent to the Reactor Building.

Cooling water and essential service water intake structures are located on the bank of the Sava River above the Sava River dam, which maintains an adequate water level. The cooling water discharge structure is below the Sava River dam. In addition, cooling towers are provided for cooling circulating waters in case of low water flow of the Sava River.

Reactor Coolant System

The Westinghouse pressurised light water reactor with two cooling loops consists of a reactor vessel with its internals and head, two steam generators, two reactor coolant pumps, the pressuriser, piping, valves, and reactor auxiliary systems. Demineralised water serves as the reactor coolant, the neutron moderator, and for the dilution of the boric acid solution. In the steam generator, the reactor coolant gives up its heat to the feedwater on the secondary side of the steam generator to generate steam. Reactor coolant pressure is maintained by the pressuriser, which is supported by electrical heaters and water sprays, which are supplied with water from the cold leg of the reactor coolant. The data necessary for reactor control and reactor protection are provided by the neutron flux, reactor coolant temperature, flow rate, pressuriser water level and pressure detectors.

Reactor power is regulated by control rods. The control rods' drive mechanism is attached to the reactor head, while the absorber rods extend into the reactor core.

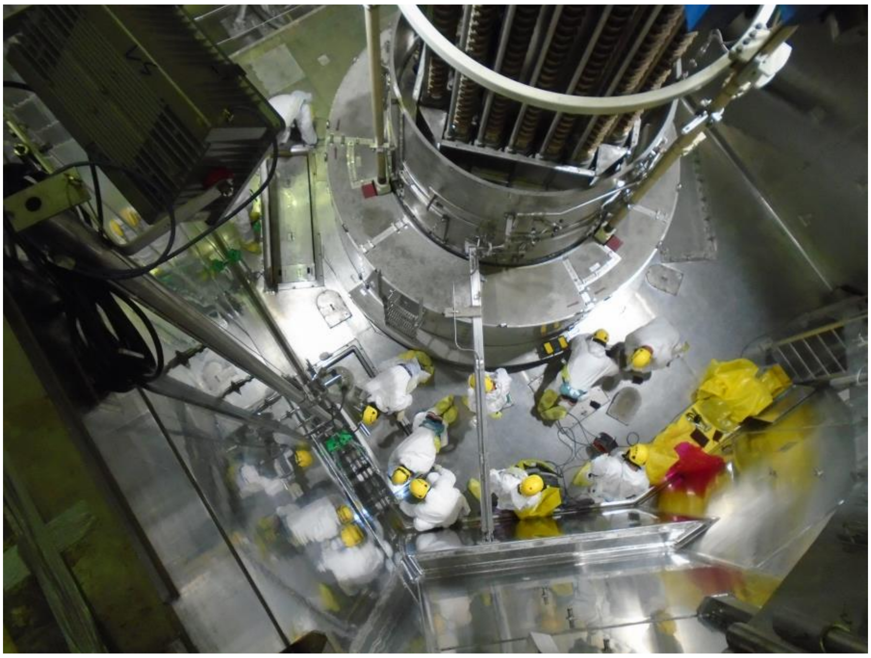
Long-term core reactivity changes and core poisoning with fission products are compensated by changing the boric acid concentration in the reactor coolant.

Nuclear Fuel

The reactor core is composed of 121 fuel assemblies. Each fuel element consists of fuel rods, top and bottom nozzles, grid assemblies, control rod guide thimbles and instrumentation guide thimbles. The fuel rods contain ceramic uranium dioxide pellets welded into zircaloy-4 or ZIRLO tubes. Uranium oxide fuel is shaped into sintered pellets and is enriched with ^{235}U.

Every 18 months, approximately half of the fuel assemblies are removed and fresh fuel is loaded. Fresh fuel assemblies are kept in the fresh fuel storage. During refuelling, fuel assemblies are removed from the reactor through the flooded transfer canal penetrating the containment vessel into the spent fuel pool. During refuelling, the reactor is open and the reactor cavity is flooded. The refuelling machine removes the spent fuel assemblies from the reactor core and replaces them with the fresh ones. Fuel assemblies remain in the reactor core for three years. Spent fuel assemblies are kept under water in the spent fuel pool, where they are cooled.

Figure 23: **Krško NPP reactor head**



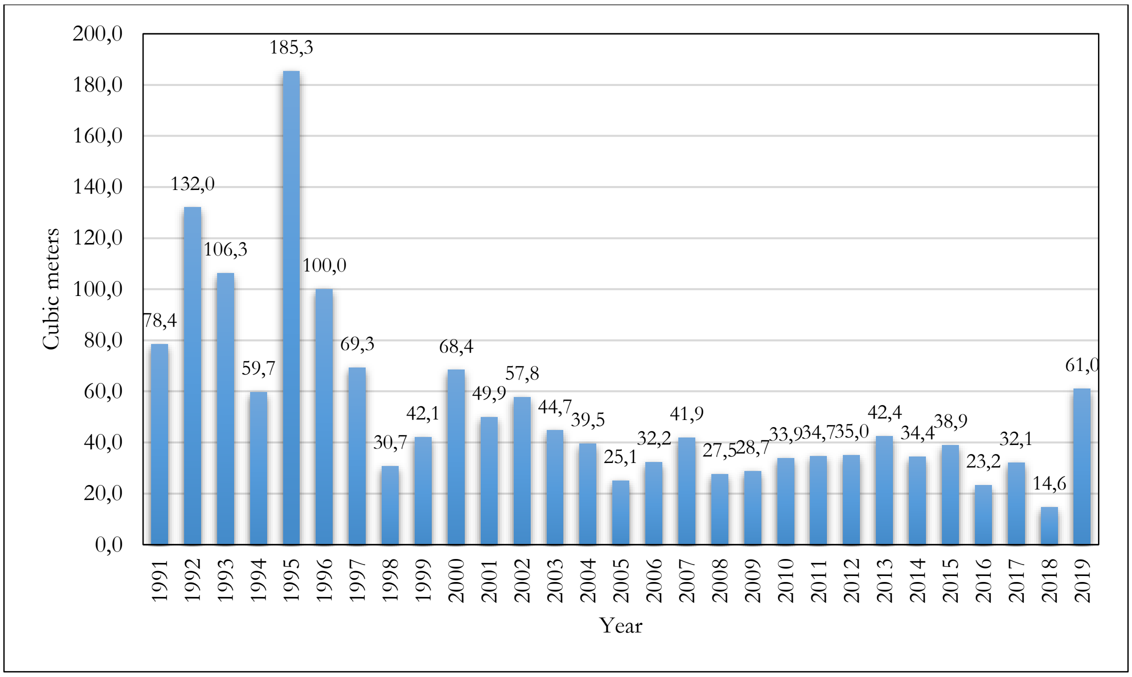
Performance Indicators of the Krško NPP

The volume of low and intermediate-level solid radioactive waste is one of the performance indicators of the Krško NPP. The purpose of the low-level solid radioactive waste indicator is to monitor progress toward reducing the volume of low-level waste production, which will decrease storage, transportation, and the final disposal needs, and improve public perception of the environmental impact of nuclear power. This indicator is defined as the volume of low-level solid radioactive waste that has been processed and is, in final form, ready for disposal during a given period. The volume of radioactive waste that has not completed processing and is not yet in final form is not included. Low-level solid radioactive waste consists of dry active waste, sludge, resins and evaporator bottoms generated as a result of nuclear power plant operation and maintenance. Low-level refers to all radioactive waste that is not spent fuel or a by-product of spent fuel processing.

It can be noticed that the trend as to the volume of low-level radioactive waste produced is positive, i.e. the amount of waste produced is lower from year to year. Contributors to this trend include improvement of the systems for radioactive waste treatment and the introduction of a highly restrictive programme for radioactive waste management control. The systems for radioactive waste treatment were improved by putting an in-drum drying system into operation, the reconstruction of the waste and boron evaporator packages, and the installation of the supercompactor.

One of the highest priorities at the Krško NPP in recent years has been to reduce the volume of low-level solid radioactive waste produced. The Krško NPP goal for the period 2005-2007 was ≤ 45 m^3 and for the period 2008-2019 ≤ 35 m^3. This task was more or less fulfilled, as it can be seen in the following chart that only in 2013, 2015 and 2019 did the amount of LILW exceed the goal (Figure 24). The amount of LILW in 2019 was exceeded due to the inaccessibility of the storage during the construction of Waste Manipulation Building in the previous year.

Figure 24: **Annual production of LILW at the Krško NPP**



General Description of the TRIGA Mark II Research Reactor

The TRIGA Mark II research reactor is a part of the JSI Reactor Infrastructure Centre. A view of the JSI Reactor Infrastructure Centre is shown in Figure 25.

Figure 25: **View of the JSI Reactor Infrastructure Centre**

The reactor is a typical 250 kW TRIGA Mark II light-water reactor with an annular graphite reflector cooled by natural convection. Approximately 40 litres of spent ion exchange resins, 200 litres of activated or contaminated experimental and protective equipment, and 100 litres of aluminium irradiation containers are produced annually during the operation of the reactor, as well as from work in the hot cell and controlled areas of the Department of Environmental Sciences. The Radiation Protection Unit of the Institute collects spent radioactive material in the temporary storage in the hot cell facility. After repacking, treatment (compression), and detailed characterisation, the material is declared radioactive waste. The Jožef Stefan Institute produces approximately two drums (< 0.5 m^3) of solid radioactive waste annually.

Figure 26: **JSI TRIGA Mark II reactor**

The core is placed at the bottom of a 6.25 m-high open tank with a 2 m diameter filled with demineralised water. The core has a cylindrical configuration. In total, there are 91 locations in the core, which can be filled with either fuel elements or other components, such as control rods, a neutron source, irradiation channels, etc. The core lattice has an annular but not a periodic structure. The elements are arranged in six concentric rings. Each location corresponds to a hole in the aluminium upper grid plate of the reactor. The core is supported by a bottom grid plate that in addition provides accurate spacing between the fuel elements. The top grid plate also provides accurate lateral positioning of the core components.

A graphite reflector enclosed in an aluminium casing surrounds the core. There are two horizontal irradiation channels running through the graphite reflector and the tangential irradiation channel. Other horizontal channels extend only to the outer edge of the reflector.

Fuel Elements

The TRIGA fuel element is a cylindrical rod with stainless steel cladding. There are cylindrical graphite slugs at the top and bottom ends, which act as axial reflectors. In the centre of the fuel material there is a hole that is filled by a zirconium rod. Between the fuel meat and the bottom graphite end reflector there is a molybdenum disc. The fuel is a homogeneous mixture of uranium and zirconium hydride. The basic data on the TRIGA fuel element is given in Tables 19 and 20.

Table 19: **Data on the standard TRIGA fuel element**

Component	Dimension [cm]	Material	Density [g/cm³]
Fuel element			
Outer diameter	3.8		
Element length	72.1		
Fuel material		U-ZrH	6.0
Outer diameter	3.6		
Inner diameter	0.64		
Height	38.1		
Zr rod		Zr	6.5
Diameter	0.64		
Height	38.1		
Axial reflector		Graphite	1.6
Diameter	3.6		
Height upper	6.6		
Height lower	9.4		
Supporting disc		Mo	10.2
Thickness	0.079		
Cladding		SS-304	7.9
Thickness	0.025		
Top and bottom ends		SS-304	7.9
Height top	10.4		
Height bottom	7.6		

Table 20: **Standard TRIGA fuel element**

Total mass of the uranium [g]	278.0
Mass of ^{235}U [g]	55.4
U in U-ZrH [wt.%]	11.9
Enrichment [wt.%]	19.9
H/Zr atom ratio	1.6