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Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

National Programme for the Management of Radioactive Waste

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Foreword

Leonore Gewessler

Austria is a country that has exemplified the responsible use of nuclear power throughout its history. In 1978, the Austrian populace decided against the use of nuclear energy. As a result, there is no high-level radioactive waste and spent fuel from nuclear power plants in Austria.

At the same time Austria is a country of cutting-edge medicine, innovative product development and internationally recognized research. In these areas, low- and medium-level radioactive waste arises. These include, above all, components from research reactors that are no longer required or work gloves from medical specialists. This waste is currently being stored according to the state of the art in the interim storage facility of Nuclear Engineering Seibersdorf GmbH. Until 2045, a decision to ensure long-term storage has to be made.

Only responsible disposal of the radioactive waste guarantees the protection of human health and prevents endangering the environment. This program sets out the applicable principles, the existing legal framework and the practice of the radioactive waste management in Austria and provides an overview of the quantities of radioactive waste currently in the interim storage facility of Nuclear Engineering Seibersdorf GmbH and those to be expected in the future.

Austria is at the beginning of a long and challenging process, the ambition of which is to find the best possible solution for the disposal of the radioactive waste generated in Austria. We are now taking the necessary measures to avoid unnecessary burdens for future generations.

With the present update of the National Waste Management Program, which was coordinated by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology, the Federal Government is taking account of the obligation to regularly revise the program.

Leonore Gewessler
Federal Minister for Climate Action, Environement, Energy, Mobility, Innovation and Technology

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Summary

Council Directive 2011/70/Euratom of 19 July 2011 on the establishment of a Community framework for the responsible and safe management of spent fuel and radioactive waste, obliges Member States to establish a National Programme for the Management of Radioactive Waste.

This “National Waste Management Programme” sets out the current principles, the existing legal framework and the practice of the management of radioactive waste in Austria and gives an overview of the currently existing and expected future quantities of radioactive waste. It describes how radioactive waste is currently managed as well as future steps including possible disposal options, taking into account the envisaged waste inventory.

Regarding the final disposal of radioactive waste, the Austrian Federal Government established the Austrian Board for Radioactive Waste Management (Entsorgungsbeirat) (formerly referred to as Task force “Disposal”). The Board involves ministries, representatives of the Federal Provinces, experts in the subject matter, stakeholders and representatives of the civil society and will address disposal-related issues and tasks in an efficient and transparent manner, and in accordance with the principles of Articles 141 and 142 of the Radiation Protection Act 2020.

The Austrian radioactive waste management policy aims at responsible predisposal management and safe disposal of the radioactive waste generated within the Federal territory. Radioactive waste generated in Austria arises from the use of radioisotopes in medicine, industry and research and is thus limited to the low- and intermediate-level categories. As there are no operational nuclear power plants in Austria, there is no generation of high-level radioactive waste, or spent nuclear fuel for management or disposal. The fuel elements of the research reactor at the TRIGA Center Atominstitut of the TU Wien (Vienna University of Technology), will be returned to the supplier (US Department of Energy) based on legal obligations and a take-back agreement with the supplier.

Radioactive waste not suitable for discharge or clearance, or, which, in the case of sealed radiation sources, cannot be returned to the supplier, must be handed over to Nuclear Engineering Seibersdorf GmbH (NES), which is the only officially licenced waste management facility in Austria. NES is contracted by the Republic of Austria to provide collection, sorting,

treatment, conditioning, as well as long-term interim storage of radioactive waste at the Seibersdorf location. At NES, radioactive waste is converted into a stable form utilising international best practice and state-of-the-art processing methods, which are also focussed on ensuring optimised volume reduction.

Austria's conditioned radioactive waste is stored at the interim storage facility of NES, which currently (as of 31 December 2021) contains around 12.500 waste packages (200 litre drums). Only a minor increase in the currently stored inventory is foreseen in the mid-term. The stored waste will remain in interim storage at the NES facility at Seibersdorf, until a final decision regarding disposal is taken. Thus, interim storage is contractually secured until 2045.

1 Introduction

With the novation of the Austrian Radiation Protection Act, the Radiation Protection Act 2020 (StrSchG 2020), Federal Law Gazette I No. 50/2020, the legal framework for radiation protection and the management of radioactive waste was updated according to European and international legal developments. Already in 2015, Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (hereinafter referred to as "Directive 2011/70/Euratom") has been fully transposed into national law with the amendments of the Radiation Protection Act (StrSchG), Federal Law Gazette I No. 133/2015, and the General Radiation Protection Ordinance (AllgStrSchV), Federal Law Gazette II No. 22/2015). The StrSchG 2020 and the General Radiation Protection Ordinance 2020 contain now the corresponding provisions as well as the legal framework for the establishment of a national programme for the management of radioactive waste (hereinafter referred to as the "National Waste Management Programme").

The objective of Directive 2011/70/Euratom is to ensure that the Member States of the European Union ensure a high level of safety in radioactive waste management and a continuous improvement of their management regime. Another aim is to ensure that citizens have access to all relevant information and are able to participate effectively in deciding on how and where radioactive waste is to be disposed of.

For this purpose, the Article 142 of the StrSchG 2020 requires the Austrian Federal Government, with the participation of the public and by conducting a Strategic Environmental Assessment, to establish a National Radioactive Waste Management Programme that contains the strategy and steps for the responsible and safe management of radioactive waste. In order to ensure an efficient development of the National Radioactive Waste Management Programme, for the purpose of coordination, the Federal Ministry of Agriculture, Forestry, Environment and Water Management has established an inter-ministerial Task force. In 2018, the competence was passed to the Federal Ministry of Sustainability and Tourism, now the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK).

Based on the preliminary National Waste Management Programme of August 2015, the Council of Ministers adopted in 2018 the National Waste Management Programme. This

programme described the current practice of the management of radioactive waste in Austria and illustrated the steps that Austria will take to dispose of its radioactive waste. The present updated version of the National Waste Management Programme takes into account the revision of the radiation protection law in 2020 and updates the numbers and figures regarding radioactive waste management according to current knowledge.

In the 1980ies, the Austrian Government conducted a project aimed to find a final repository for Austria's radioactive waste. According to the objectives of that time, a suitable site for a repository in deep geological formations was to be found. Several potential candidate sites resulted from that study. During the past 25 years, the standards and the state-of-the-art of the treatment of radioactive waste have evolved. To be able to consider them appropriately, the present National Programme defines a new strategy for the final disposal of radioactive waste arising in Austria. Therefore, earlier studies and the findings from the 1980ies have not been used as a basis for the National Programme now available.

The National Radioactive Waste Management Programme is in line with the "Guidelines for the establishment and notification of National Programmes, ENEF Working Group Risk, January 2013"[1].

[1] Guidelines for the establishment and notification of National Programmes under the Council Directive 2011/70/Euratom of 19 July 2011 on the responsible and safe management of spent fuel and radioactive waste. ENEF Working Group Risk, Working Group on National Programmes NAPRO, January 2013

2 Austrian Radioactive Waste Management

Radioactive waste originates from applications of radioactive substances in medicine, industry, education and research. Waste originates also wherever unneeded radiation facilities are decommissioned. Responsible radioactive waste management aims to protect human health and the environment and to avoid placing an unnecessary burden on future generations.

For the management of radioactive waste generated in Austria, Article 141 (1) to (4) of the StrSchG 2020 requires the following internationally recognised principles to be applied:

The Republic of Austria shall bear the ultimate responsibility for the safe management of radioactive waste arising in its territory. This basic principle reinforces national responsibility with regard to the Austrian radioactive waste management policy. This principle also applies when radioactive waste is transported to another country for treatment.

Since a comparatively small amount of radioactive waste needs to be disposed in Austria, cooperation with other states can be advantageous for various reasons, e.g. to support each other in research and development on the path towards a final repository. Therefore, such cooperation is possible between Member States of the European Union or States that have ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Federal Law Gazette III no. 169/2001. At the moment, no contracts are in place between Austria and other states or international facilities for the disposal of radioactive waste. If such cooperation leads to the conclusion that one possible solution would be the joint use of a final repository, Directive 2011/70/Euratom specifies concrete guidelines: The facilities must be approved for operation prior to the movement of the waste and has to meet the same high safety standards set out in the Directive that would apply to a final repository in one's own country.

A key element of the Austrian radioactive waste management policy is that no spent fuel arises for disposal in Austria. This is because, according to the Federal Constitutional Act for a Nonnuclear Austria, Federal Law Gazette I No. 149/1999, no nuclear facilities for energy

generation can be either constructed or operated. Further, whilst the construction and operation of research reactors in Austria are permitted, the operator of a research reactor must ensure that no spent fuel is left to be disposed in Austria. This is to be achieved by means of a take-back (return) agreement with the manufacturer or supplier of the fuel elements.

Radioactive waste minimisation (i.e. the prevention or avoidance of waste creation) is a basic principle when performing practices[2] with radioactive sources in general and when managing radioactive waste in particular. This is based on ecological, ethical and safety-relevant considerations, given that the potential impact on the environment and the safety risk during treatment and storage increases with the amount of waste. The burden on future generations should be kept as low as possible. Further, radioactive waste minimization together with volume reduction have important economic advantages, since both treatment and disposal are costly and smaller waste volumes will result in lower costs.

Interdependencies between the individual steps taken during the management of radioactive waste must be considered. The background of this principle is the close interlinking of the individual steps in the management of radioactive waste starting from its generation through to disposal, whereby decisions taken at any step can decisively influence a subsequent step. Each individual management step should be analysed and designed so that it, and subsequent steps, are optimized. For example, conditioned drums should be dried before being placed in an interim storage. With this measure, the possibility of corrosion of the inside of the waste drums is largely prevented.

An important principle is that radioactive waste shall be managed safely: radioactive waste must be isolated from humans and the environment also in the long-term. In this respect, aspects of passive safety must also be taken into account for the long-term. Examples are the use of corrosion-resistant drums for the interim storage of conditioned radioactive waste or design of a repository in such a way that it could be left to itself after the final closure, without risks.

[2] According to Article 3 No 73, a practice is “a human activity that can increase the exposure of individuals to radiation from a radiation source and is managed as a planned exposure situation”. The following are considered as practices:
1. the operation of beam generators and
2. the manufacture, production, processing, treatment, management, usage, storage and transport of radioactive material, regardless of whether the material contains artificial or natural radioactive substances.

The safety measures for a facility or an activity related to the radioactive waste management should be determined in a graded approach according to the risks. For example, the requirements for disposal facility are much more extensive than for an interim storage facility.

A fact-based and documented decision-making process is applied to all radioactive waste management steps. In addition to the scope of the safety measures themselves, the documentation of the decision-making process, insofar as it relates to safety aspects, should also be linked to the risk level and provide a basis for decisions on the management of the radioactive waste. The decision-making process shall be based on a summary of the arguments and facts demonstrating that the required standard for the safety of a facility for or activity related to the management of radioactive waste has been achieved.

According to Article 143 StrSchG 2020, Nuclear Engineering Seibersdorf GmbH (NES) is entrusted by the Republic of Austria with the predisposal management of the radioactive waste arising in Austria. This contract covers the acceptance, collection, sorting, conditioning and long-term interim storage of radioactive waste at Seibersdorf. The ongoing comprehensive modernization of the NES treatment and storage facilities provides the best technical conditions for safe treatment, conditioning and interim storage as defined in Directive 2011/70/Euratom.

According to Article 141 (4) No. 6, the costs of predisposal management as well as disposal of all radioactive waste are covered by the “polluter pays principle”. The aim of this principle is cost recovery through the polluters, also with regard to future disposal, so as not to burden future generations with the costs. In the case of transfer to NES, the companies/institutions where radioactive waste is generated have to pay a fee for treatment and interim storage and, on the other hand, a precautionary fee which the Federal Government may use as revenue exclusively for the purpose of financing a subsequent disposal of this waste. The Republic of Austria, on the other hand, is responsible for the costs of setting up disposal facilities and interim storage facilities and for making major adjustments to current technical standards.

Until a decision on disposal is taken, for the existing radioactive waste in Austria the concept of interim storage at NES in Seibersdorf is applied in the view of small quantity and low risk potential (more than 95 % low level radioactive waste). Waste treatment and interim storage at the Seibersdorf location is currently contractually secured until 2045.

3 Legal framework for radioactive waste management

Based on the general principles, Austria has established a legal and regulatory framework for all aspects of radioactive waste management with clear allocation of responsibilities to the various organisations. This legal basis for the management of radioactive waste and spent fuel is formed by the following laws and regulations:

- Federal Constitutional Act for a Nonnuclear Austria,
- Radiation Protection Act 2020 (StrSchG 2020),
- General Radiation Protection Ordinance 2020 (AllgStrSchV 2020),
- Ordinance on the Shipment of Radioactive Waste 2009 (RAbF-VV 2009), as amended.

Federal Constitutional Act for a Nonnuclear Austria

According to the Federal Constitutional Act for a Nonnuclear Austria, Federal Law Gazette I no. 149/1999, installations which serve the purpose of energy production by nuclear fission may neither be constructed nor operated in Austria. Research reactors are not affected by this prohibition. However, in accordance with Article 141 (3) of the Radiation Protection Act 2020, operators of such a nuclear installation are required to ensure that no spent fuel arises for disposal in Austria. For this purpose, the operator has to conclude a take-back agreement with the supplier of the fuel elements as a prerequisite for the granting of a licence (Article 49 (2) No. 2 leg. cit.). This ensures that no spent fuel arises for final disposal in Austria from the operation of research reactors.

Radiation Protection Act 2020

The Radiation Protection Act 2020 (StrSchG 2020), Federal Law Gazette I No. 50/2020, entered into force on 1 August 2020 and fundamentally revises the Austrian radiation protection legislation. The new act fully transposes Directive 2013/59/Euratom into national law. The provisions of Directive 2011/70/Euratom, which were transposed into national law in

2015 with the amendment of the old version of the Radiation Protection Act, were also adopted in the act of 2020.

Regarding radioactive waste, the following European Union directives are implemented:

- Council Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel (Official Journal L 337/21 of 5 December 2006);
- Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (Official Journal L 199/48 of 2 August 2011).
- Council Directive 2013/59/Euratom 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 (Official Journal L 13/1 of 5 December 2013)

The Radiation Protection Act 2020 created the legal framework for practices with radiation sources and other situations, in which persons may be exposed. International and European Union standards are the basis for these regulations.

Article 1 of the StrSchG 2020 defines the objective and the scope of the act. It states explicitly as an objective of the act, that in addition to the protection against the dangers from ionising radiation and the assurance of a high level of nuclear safety, spent fuel and radioactive waste shall be disposed of safely and in accordance with internationally recognised safety standards.

Regarding radioactive waste, the StrSchG 2020 contains the following definitions:

- Radioactive waste treatment: all practices that relate to the acceptance, collection, sorting, processing, conditioning and interim storage of radioactive waste in a dedicated facility (treatment facility).
- Radioactive waste management: all practices that relate to treatment or final disposal of radioactive waste in a dedicated facility (waste management facility), excluding off-site transportation.
- Final disposal: the emplacement of conditioned radioactive waste in a facility without the intention of retrieval.
- Interim storage: the storage of conditioned radioactive waste with the intention of retrieval.

For the construction, operation and decommissioning of waste management facilities, the licensing procedure pursuant to Articles 15 and 17 of the StrSchG 2020, combined with the specific criteria for waste management facilities pursuant to Article 53, applies. The AllgStrSchV 2020 (Articles 67 to 76) contains detailed provisions for the safe handling of radioactive waste and the operating structure of waste management facilities.

The fundamental provisions for radioactive waste management are found in Part 5, Chapter 5 (Articles 141 to 145) of the Act.

Article 141 of the StrSchG 2020 specifies the principles and objectives regarding the management of radioactive waste generated in Austria. Article 142 creates the legal basis for the National Waste Management Programme pursuant to Article 11 of Directive 2011/70/Euratom. In addition to these provisions, the necessary transparency and participation required by the Directive has also been legally anchored in the preparation of the National Waste Management Programme.

The implementation of a Strategic Environmental Assessment (SEA) as defined in and required by Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (Directive 2001/42/EC) has also been legally anchored in Article 142 of the StrSchG 2020. As the National Waste Management Programme covers all stages of radioactive waste management from the generation to final disposal, it provides, in accordance with Article 3 (2) (a) of the SEA Directive, the framework for the future approval of a project as set out in Annex I of Directive 2011/92/EC, as amended by Directive 2014/52/EC, ("Annex I Z 3 lit b/iv: Installations for the exclusive purpose of the final disposal of radioactive waste").

On the basis of the provisions of Article 36c (1) of the StrSchG (old version), the Republic of Austria contracted the Austrian Research Centers GmbH (now: Nuclear Engineering Seibersdorf GmbH), obliging the company to collect, sort, process, condition and store until disposal all radioactive waste generated in Austria. Article 143 StrSchG 2020 authorises the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, provided that agreement thereon is reached with the Federal Minister of Finance, to update the service contracts concluded by the Republic of Austria with Nuclear Engineering Seibersdorf GmbH in accordance with the requirements of implementing the National Waste Management Programme. The Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology shall ensure guarantee of the effective independence of the competent authority for waste management facilities pursuant to Article 153 (1)

no. 1 litera a from undue influence on its regulatory function referred to in Article 6 (2) of Directive 2011/70/Euratom. Article 144 of the StrSchG 2020 transposes Article 14 (3) of Directive 2011/70/Euratom and requires that at least once every ten years, a self-assessment and peer review through an international expert team is conducted concerning the legislative and administrative framework for the management of spent fuel and radioactive waste, the competent authority and the national waste management programme and its implementation. The European Commission is to be informed of the results of this peer review.

Article 145 authorises the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology to establish, by ordinance, provisions on the safe handling of radioactive waste prior to its disposal and for the transfer as radioactive waste.

Articles 146 and 147 contain the regulations for the official authorisation of transboundary shipments which involve Austria, as well as the essential provisions, which have to be considered during the authorisation procedure, for example

- the mandatory notification to the competent authorities of import, export or transit of radioactive waste to, from or through an EU country,
- the obligation that a holder who intends to ship radioactive waste or spent fuel elements must submit a licence application to the competent authorities of the country of origin,
- the obligation that, in the case of imports into the EU, the recipient must submit this application to the competent authorities of the country of destination,
- that the shipment may only take place after the competent authorities of the country of destination and, where appropriate, the country of transit have given their consent to the competent authorities of the country of origin and
- banning the export of radioactive waste to Cotonou countries and to third countries that are unable to safely manage radioactive waste.

These provisions were transferred from the Radioactive Waste Shipment Ordinance 2009 to the StrSchG 2020, as part of the revision of the radiation protection legislation.

Article 153 of the StrSchG 2020 defined the competent authorities for practices pursuant to Article 3 no. 73 of the Act. The regulatory responsibilities regarding radioactive waste management are divided between:

- The Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology is the supervisory authority for waste management facilities, and, since 1 January 2021, also for research reactors and particle accelerators in the field of universities and the research institutes of the Austrian Academy of Sciences (including spent fuel);
- The heads of the Provincial Governments, which are in most cases the supervisory authorities for these and other waste producers.

General Radiation Protection Ordinance 2020

The Radiation Protection Act 2020 envisages that some of its provisions are to be implemented through specific ordinances. The most important one concerning radioactive waste is the General Radiation Protection Ordinance 2020 (AllgStrSchV 2020), Federal Law Gazette II No. 339/2020. This ordinance was decreed on 1 August 2020 as part of the revision of the radiation protection legislation, transposing Directive 2013/59/Euratom. The ordinance replaces the General Radiation Protection Ordinance from 2006, which was amended in 2015 to transpose essential provisions of Directive 2011/70/Euratom into national law.

The General Radiation Protection Ordinance 2020 contains further provisions concerning the protection from dangers arising from exposure to ionising radiation, which are necessary to assure a high level of nuclear safety as well as the safe and responsible management of spent fuel and radioactive waste, taking into account internationally recognised safety standards. The AllgStrSchV 2020 regulates, among others,

- the application of artificial radiation sources in medicine, industry and research,
- practices involving naturally occurring radioactive materials,
- consumer products and type-approved devices,
- protection of aircrew from cosmic radiation,
- safe management of radioactive waste,
- nuclear safety in research reactors, as well as
- emergency precautions for applications of ionising radiation with higher risk.

Regarding radioactive waste, the General Radiation Protection Ordinance 2020 contains, in particular, the following provisions:

According to Article 10, where applicable, the documents to be submitted for the application for the licensing of practice must include information on radioactive waste management concerning the type and expected amount arising per year, the intended management route, as well as a possible temporary storage.

Section 116 sets out provisions for the collection and temporary storage of radioactive waste. Accordingly, licence holders must collect and mark radioactive waste separately, taking into account the acceptance conditions of the waste management facility. Radioactive waste must only be collected in containers designated for this purpose. In addition, radioactive waste can be temporarily stored until it is delivered to a waste management facility. The competent authority may stipulate conditions and requirements for collection and temporary storage.

These provisions do not affect radioactive substances that are discharged and stored temporarily in decay plants for liquid radioactive waste until discharge. Instead, Sections 110 to 115 regarding the release of radioactive materials from regulatory control apply. For all other sources of radioactive waste (e.g. contaminated goods, radioactively contamined sites, radioactive waste from emergency exposure situations) no separate regulations are required, since in such cases the authority has to stipulate the necessary radiation protection measures via administrative decision.

According to Section 125, radioactive waste occurring in Austria must be handed over to Nuclear Engineering Seibersdorf GmbH unless it is shipped abroad in accordance with the Radioactive Waste Shipment Ordinance 2009, Federal Law Gazette II No. 47/2009. The applicable acceptance conditions are published by Nuclear Engineering Seibersdorf GmbH at the beginning of each calendar year on its website nes.at or made available to the company upon request.

Articles 67 to 76 contain provisions for the safe handling of radioactive waste and for the operation of waste management facilities. In detail, the following areas are regulated:

- General provisions for the safe handling of radioactive waste (Section 67);
- Operating structure and operating rules (Section 68);
- The establishment and maintenance of an integrated management system, which has to take in particular account of aspects of radiation protection, quality assurance, occupational safety, health and environmental protection, security and hazard prevention, as well as measures to promote and improve the safety culture (Article 69);
- Safety report, on-site emergency response plan, emergency exercises (Section 70);
- Education and training of staff (Section 71);
- Obligation to provide information to staff and the public about the normal operating conditions of the waste management facility and about events relevant from the point of view of radiation protection (Article 72);
- Decommissioning concept (Section 73);
- Record-keeping and notification obligations (Section 74);
- Electronic database and operating report (Section 75);
- Further use of radioactive materials, disposal as conventional waste (Section 76).

Ordinance on the Shipment of Radioactive Waste 2009

The Ordinance on the Shipment of Radioactive Waste 2009 (RAbf-VV 2009), Federal Law Gazette II No. 47/2009, last amended by Federal Law Gazette II No. 331/2020, implements the regulations of Directive 2006/117/Euratom for the monitoring and control of trans-boundary shipments of radioactive waste and spent fuel. Within the scope of the ordinance are both the shipments within the European Union as well as the shipments where the country of origin and/or the country of destination is a third country. Since NES must only accept radioactive waste generated in Austria, shipments to the Austrian Federal territory are only permitted if the imported waste originates from material previously exported from Austria for treatment. With regard to shipments of radioactive waste to other countries, Article 6, in accordance with the Waste Directive, stipulates the conditions under which an export can be approved for disposal in another country.

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

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management is an international agreement adopted by the member states of the International Atomic Energy Agency (IAEA) in 2001, also adopted by Austria. The long-term objective of the Convention is to establish uniform, internationally recognised safety standards in this field.

4 Inventory of radioactive waste in Austria

In Austria, no spent fuel arises for domestic disposal. Since constitutional law prohibits the construction and operation of nuclear power plants in Austria, only research reactors are considered as sources of spent fuel. The StrSchG 2020 stipulates that the operation of research reactors will only be permitted if the operator has ensured that the manufacturers or suppliers of the fuel elements undertake to take them back.

Austria's only research reactor is operated at the TRIGA Center Atominstitut of the Vienna University of Technology. For this facility, a contract between the Vienna University of Technology, the US Department of Energy and the Euratom Supply Agency provides for the return of the spent fuel back to the supplier (US Department of Energy) after the reactor has been decommissioned (planned for 2025 or later).

Current and future radioactive waste generated in Austria comes and will come from two types of waste producers, namely institutional users (medicine, industry and research) and decommissioning (decontamination and dismantling) of radiation facilities. The amount of waste generated is low when compared to that produced by nuclear power plants. In addition, radioactive waste generated in Austria is limited to the low and intermediate level radioactive waste categories.

From the two waste streams (medicine/industry/research and decommissioning), NES produces, after using extensive treatment steps, about 200 drums (200 litre drums) of conditioned radioactive waste annually, which is stored in the local storage facility.

Waste from Medicine, Industry and Research

The annual amount of radioactive raw material from medicine, industry and research in Austria is around ten to twenty tonnes. The following are examples of producers and origin of the waste:

Medicine

- Medical diagnostics
- Laboratory tests
- Medical and pharmaceutical research
- Radiotherapy

Largely, this waste is combustible material such as protective gloves, syringes, used dressings, medical equipment, etc. Only a small fraction of the waste from medicine is not combustible.

Industry

- Radiation sources from measuring and control devices in industrial plants (for example equipment for level or flow measurements)
- Radiation sources for quality assurance (for example equipment for non-destructive testing of safety-relevant welds such as in district heating pipes)
- Ionisation smoke detectors
- Waste from laboratory activities

Industrial waste mainly consists of sealed radioactive sources, non-combustible waste, such as contaminated parts, but also combustible waste (similar to medicine).

Research

- Basic scientific research and applied research;
- Medical, physical, chemical, biological research, etc.

Most of the radioactive waste from research is combustible (e.g., protective clothing, cleaning material, vials, chemicals). In addition to this, non-combustible waste, such as contaminated equipment or parts of the facility, may occur.

The following Table 1 lists the quantities of radioactive waste (raw material) received by NES from medicine, industry and research:

Table 1: Received radioactive waste 2021-2021

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Mass (t)	22,3	10,5	11,5	107,6	20,7	19,4	22,7	7,9	7,3	7,0

In 2015, an extremely large amount of (largely liquid) waste occurred during the dismantling of an old laboratory building in an Austrian university. Although this waste arose during decommissioning, it is, due to its origin, attributed to the polluter group “Medicine, research and industry”. Between 2016 and 2018, several large industrial facilities were decommissioned. Apart from these decontamination projects, the amount of waste from this group of producers is declining over the past years.

In some branches of industry, residues (for example sludge, dusts, sands) arise which exhibit increased amounts of radioactive material of natural origin. One example is the technique of sandblasting, where sand containing large amounts of thorium may be used. Of course, radiation protection has to be adhered to also for the disposal of these naturally occuring radioactive materials. Mostly, the concentration of the activity is so low that ionising radiation from such materials does not pose a risk and the remains can be disposed like conventional waste. Yet, seldomly the concentration of the activity may exceed the reference values set by law. In this case, the residues have to be disposed as radioactive waste. The total amount of this in Austria is very low and is therefore not indicated separately in the waste statistics.

Companies that only produce very small amounts of residues (max. 15 kilograms) with high activity concentrations per year (e.g. removed deposits in pipes, layers of paint) can apply, in accordance with Section 115 AllgStrSchV 2020, to dispose of these residues as radioactive waste without prior examination as to whether these residues are clearable. The necessary examination (by a relevant certified service) would be complex due to the radioactivity content and therefore more expensive than treatment at Nuclear Engineering Seibersdorf GmbH.

Radioactive waste from application in national defence arises in very small amounts only. Examples include radioactive lamps used in military equipment.

In the IAEA laboratories at Seibersdorf small amounts of radioactive waste – mainly slightly active waste water – arise continuously. A transfer contract between IAEA and NES provides that this waste be treated at NES. For small amounts of radioactive waste, which comprises fissile material, the contract specifies that this material would not be treated at NES, but has to be transferred to other states by IAEA.

Waste from decommissioning

At the Seibersdorf site (founded in the 1950s as the "Austrian Research Association for Atomic Energy") extensive nuclear research was carried out over several decades. Since the end of these activities, there remains a need to dismantle the installations and facilities used at the time and to process the radioactive waste. This consists, for example, of contaminated facility parts, laboratory equipment and building rubble. One of the largest of these projects was the dismantling of the 10-megawatt ASTRA research reactor, which was completed in 2006. A number of other decommissioning projects have still to be carried out by NES at the site and are being carried out successively.

The amount of waste generated during decommissioning varies greatly, as it depends on the number and type of projects being dealt with. On the average, 200 tonnes can be assumed annually, so that approximately 2.000 tonnes will have to be treated until the final completion of the decommissioning projects at Seibersdorf (presumably in 2033). Most of this raw waste consists of potentially contaminated plant components, construction material and the like. First, this material is characterised in terms of contamination. At this point, usually, a large portion of the material exhibits no or only marginal contamination wherefore this material is not classified as radioactive and can be disposed of conventionally. Material, which was determined to be more contaminated, will be specifically treated and decontaminated. As a result, another large portion can be disposed of conventionally. In this way, the volume of remaining radioactive waste is significantly reduced.

Figure 1: Dismantling of the research reactor ASTRA and the spent fuel pool.

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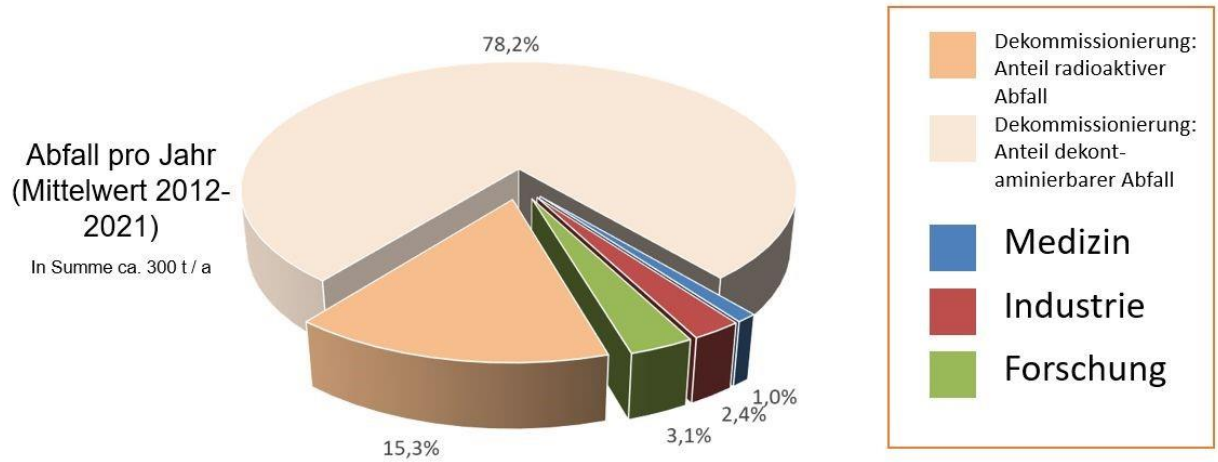
Some radioactive waste will also be generated outside of the Seibersdorf site by, for example, the future decommissioning of the research reactor at the TRIGA Center Atominstitut of the Vienna University of Technology and the management of waste from radioactively contaminated sites.

In the following Figure 2, the radioactive waste is broken down according to the producers. The main share of radioactive waste comes from deconstruction and decommissioning projects.

Figure 2: Occurrence of radioacte waste in the years 2012-2021



Source: nes.at

The radioactive waste from deconstruction and decommissioning projects is sorted in a complex procedure so that a large portion of the original waste can be approved as free of contaminants. This means that the activity is so small that it does not pose any risk and the waste can be disposed of in conventional repositories. In this way, the waste arising from decommissioning projects can be reduced by 80 percent on average.

The remaining radioactive waste from the above-mentioned projects is collected and conditioned at NES together with miscellaneous radioactive waste. In the course of waste conditioning, the highest possible decrease in volume is strived for. This is achieved in several ways; the procedures are described in detail in Chapter 5. Following this complex treatment on average 200 drums (200 litre drums) of conditioned radioactive waste accrue per year and are then transferred to the interim storage facility.

Classification of radioactive waste

According to Article 3 No. 54 of the StrSchG 2020, radioactive waste is “radioactive material for which no further use is foreseen and that is subject to regulatory control as radioactive waste”.

Since no nuclear power plants or other large nuclear facilities are operated in Austria, there is no high-level radioactive waste, but only low and intermediate level radioactive waste, produced in medicine, industry, research and decommissioning of radiation facilities.

The characterisation and classification of radioactive waste at NES

The characterisation and classification of the radioactive waste at NES is based on the recommendation of the EU Commission (Commission Recommendation of 15 September 1999 on a classification system for solid radioactive waste 1999/669/EC, Euratom):

LILW-SL

Low and Intermediate Level Waste – Short Lived; Waste with radionuclides with half-life of less than about 30 years (such as Cs-137 or Sr-90) with a limited concentration of long-lived alpha radionuclides.

According to the recommendation of the EU Commission, the limiting concentration of long-lived radionuclides for the category LILW-SL is 4,000 Bq/g in an individual waste package and 400 Bq/g averaged over the entire waste volume.

LILW-LL

Low and Intermediate Level Waste – Long Lived; Waste with a concentration of long-lived radionuclides exceeding the above limit values for LILW-SL.

Transition radioactive waste

Waste containing radionuclides with half-lives of less than 100 days; such waste is stored until the radioactivity has decayed and the waste can be disposed of as inactive conventional waste after clearance measurement and clearance by the authorities.

Waste Inventory at NES

In the Austrian interim storage facility at NES ("Transferlager"), the following inventory of conditioned radioactive waste is stored as of 31 December 2021:

- LILW-SL: approx. 2.480 m³ with an activity of approx. $4{,}00 \cdot 10^{15}$ Bq (as of 31 December 2021)
- LILW-LL: approx. 52 m³ with an activity of approx. $6{,}11 \cdot 10^{12}$ Bq (as of 31 December 2021)
- Total activity: approx. $4{,}03 \cdot 10^{15}$ Bq (as of 31 December 2021)

According to the most recent calculations of NES, as of 31 December 2021, the activities amount to approx. $4{,}00 \cdot 10^{15}$ Bq for LILW-SL and $6{,}11 \cdot 10^{12}$ Bq for LILW-LL, respectively. These calculations take into account the decay of the radionuclides. The amount of LILW-LL is comparatively low. This waste comes largely from medical and research activities that took place decades ago and have since then been discontinued; it consist mainly of radioactive sources with radium-226. Because of the reconditioning of inhomogenous cemented waste, the volume of waste packages with long-lived waste was reduced from 60 m^3 to 52 m^3. Some of these old sources are currently stored together with their casing in barrels. It can be assumed that using the reconditioning methods, the volume of long-lived waste can be further reduced.

A total of 12.500 drums (mainly 200 litre drums) and ten special containers (type “Konrad” and “Mosaik®”) are located in the interim storage facility.

Table 2 lists the radionuclides with the highest activities in the interim storage. By far the largest contribution to total activity is from the radionuclide tritium (H-3).

Table 2: Radionuclides with the largest contribution to total activity in the interim storage of NES (date of reference: 31 December 2021)

Nuclide	H-3	Ni-63	Cs-137	Am-241[3]	Ag-108m	Sr-90	Ra-226++	C-14	Kr-85
Activity (Bq)	4,0E+15	2,0E+13	2,7E+12	3,9E+12	2,6E+12	1,6E+12	1,3E+12	7,7E+11	7,4E+11

The special containers contain mainly waste from the decommissioning of the Seibersdorf research reactor ASTRA and the operation of the TRIGA research reactor at the Vienna University of Technology.

In the so-called “Konrad” container, a container type originally designed for use in the planned German repository Konrad, mainly larger, bulky parts have been placed.

The so-called “Mosaik” containers are approved radioactive waste containers made of cast iron, which have a high shielding effect due to their large wall thickness. In these, wastes with high dose rate and/or high specific activity (e.g., strongly activated components from the ASTRA reactor, beryllium reflector elements with high tritium content from the ASTRA reactor) have been placed.

Other inventory (outside of the interim storage facility)

On the NES site, radioactive waste, which must be conditioned in the future, is also located in the hot-cell laboratory, outside the interim storage facility. These are of two types: first,

[3] This nuclide is an alpha-emitter and is assigned to LILW-LL waste. The other nuclides are assigned to LILW-SL waste.

enclosed radioactive substances (radiation sources) currently stored in the hot cells for radiation protection and shielding purposes and, secondly, small amounts of fissionable material (nuclear material).

The fissionable materials are mainly residues from previous research projects (such as samples, measurement standards, chemicals, etc.), materials seized by the Republic of Austria (e.g., materials not declared according to transport regulations) and shielding containers made of depleted uranium.

Inventory at the TRIGA Center Atominstitut

Currently, no spen fuel elements are stored in the interim storage at the Atominstitut of the TU Wien.

Estimation of future waste

Estimation of the amount and type of future radioactive waste is, of course, subject to uncertainties, since future developments, new applications of radioactive substances or the replacement of existing applications cannot be conclusively foreseen.

According to Section 4 of the StrSchG 2020, practices may only be licenced or approved, if they are justified in the sense that it can be reasonably assumed that the individual or societal benefit resulting from the practice outweighs the health detriment that it may cause by the exposure related to the practice. Because of this mandatory examination of the justification, it may be assumed that the amount of waste from medicine, industry and research will further decrease. Furthermore, as of today, it seems likely that the amount of waste from decontamination and dismantling activities will decrease significantly in the 2030s. In general, the trend in many areas is to make the use of radioactive substances unnecessary by introducing new methods, whileall users have to implement measures to comply with the principle of waste minimisation.

The following **Fehler! Verweisquelle konnte nicht gefunden werden.** provides an estimate of the amount of radioactive waste by 2045:

Table 3: Estimated amounts of conditioned radioactive waste by 2045 (2021 estimation)

Origin of waste	Number of 200 litre drums
Stock in interim storage 2021	12.500
Reduction by reconditioning[4]	-1.500
Waste from medicine, industry and research by 2045	700
Decommissioning by 2045[5]	5.500
Decommissioning of the research reactor at TRIGA Center Atominstitut	500
Total until 2045	17.200

The amount of waste to be disposed of in Austria is estimated to be around 3.600 m^3 short-lived (LILW-SL) and max. 60 m^3 of long-lived waste (LILW-LL).

The activity of the newly accruing waste is minor compared to the total activity. If the decay of the radionuclides is considered as well, the activity of the inventory will not change significantly in the period up to 2045 compared to the current level.

By conditioning it is possible to reduce the volume of waste while at the same time treating it in a way ensuring safe storage.

At Nuclear Engineering Seibersdorf, storage facilities have been designed in a way that there is sufficient space for the expected future waste.

[4] Since 2012, some of the waste already held in interim storage will be reconditioned so as to achieve a significant volume reduction

[5] Largely dismantling of old installations at the Seibersdorf location

Safety of interim storage

The interim storage of radioactive waste by NES happens under extensive protection against disruptive actions or other third-party impacts. Even worst-case accident scenarios, like a plane crash cannot result in the release of considerable amounts of radioactive substances.

The facilities at NES work at the state-of-the-art of technology and are subject to continuous modernisation.

5 Radioactive waste management

According to Section 15 (1) of the StrSchG 2020, practices pursuant to Section 3 No. 73 leg. cit. require a licence. Within the framework of the licensing procedure, the applicant for a licence has to submit documents, which detail what is to happen to the radioactive waste resulting from the practice.

The competent authority has to include in its administrative decision conditions and requirements with respect to the management and disposal of radioactive waste. According to Section 10 (1) No. 6 of the AllgStrSchV 2020, the documents to be submitted for the application for a licence need to include details on radioactive waste management, where appropriate, specifically regarding

- the type and average amount of waste per year,
- the radionuclides contained and their respective activity concentrations,
- the intended management/disposal route,
- possible temporary storage.

Pursuant to Article 116 (1) of the General Radiation Protection Ordinance 2020, radioactive waste must be segregated, collected and marked by the waste producer, taking into account the acceptance criteria of the waste management facility. The applicable acceptance criteria are published on the website of NES[6]. The acceptance criteria now in force demand the segregation, collection and marking according to the following categories (among others):

- Liquid – combustible
- Liquid – not combustible
- Solid – combustible
- Solid – non-combustible
- Gaseous
- Biogenic waste
- Bulk waste

[6] nes.at/en/products-and-services/disposal-of-radioactive-waste

- Composite waste
- (bulky) sealed radioactive sources declared as radioactive waste
- Decay waste (short-lived radionuclides with a half-life of less than 100 days)
- Clearance measurement of slightly radioactive substances

Management Routes

Depending on the activity and half-life of the radioactive substance, the following disposal methods are currently permissible:

Discharge via air or water pathway

Radioactive substances may be discharged with the wastewater or the exhaust air from facilities licensed under radiation protection law, if the exposure of members of the public does not exceed an effective dose of 0.3 mSv per year due to these discharges (Articles 54 and 55 StrSchG 2020 in conjunction with Article 77 AllgStrSchV 2020).

Clearance

Radioactive waste can be disposed of as inactive waste, recycled or reused when it can be demonstrated that the exposure of members of the public will not exceed 10 µSv per year. The clearance of radioactive material is an administrative act, i.e. the holder of the licence must seek permission from the competent authority. If the application is accepted, the material is cleared and no longer falls under the radiation protection regime (Article 73 StrSchG 2020 in conjunction with Articles 110 to 115 AllgStrSchV 2020).

Decay storage

According to Article 110 (5) of the AllgStrSchV 2020, the clearance of radioactive waste which contains mainly only radionuclides with a half-life of less than 100 days (e.g., from the nuclear medical field) is exempted from the obligation to obtain a licence. The competent authority includes the necessary requirements and conditions for clearance in such cases in the licence for performing the practice, taking into account the provisions of Article 111 AllgStrSchV 2020.

Return of radioactive substances

The return of radioactive substances after their use to the manufacturer or supplier for their local re-use or disposal is a further possibility to minimise the amount of waste. This approach is mandatory for holders of high-activity radioactive sources. Before acquiring the source, they must conclude a take-back agreement with the manufacturer or supplier for the subsequent return of the source (Article 44 (2) No. 2 StrSchG 2020). This is to avoid from the outset the necessity of disposing of the spent/disused radiation source in Austria.

Handover of radioactive waste to NES

Radioactive waste, which cannot be disposed of by the above-mentioned routes or shipped abroad according to the Radioactive Waste Shipment Ordinance 2009, is finally to be handed over to Nuclear Engineering Seibersdorf GmbH in accordance with Article 125 AllgStrSchV 2020.

Further use of radioactive materials, disposal as conventional waste

Pursuant to Article 76 AllgStrSchV 2020, as the licensee of a waste management facility, taking into account the principles of Section 141 (4) StrSchG 2020, NES has to check whether the radioactive material handed over as radioactive waste can be reused or disposed of as conventional waste. If it affirms this possibility, it has to submit an application to the competent authority, which in turn has to determine the safe further use or disposal by administrative decision on a case-by-case basis, taking into account as well the principles mentioned in Article 141 (4).

Waste volume reduction in foreign facilities

The volume of certain types of radioactive waste can be effectively reduced by special methods: for contaminated metal scrap, the process of melt decontamination can be applied, for which installations exist in several European countries. The metal scrap is melted together with slag formers, the bulk of the contamination being enriched in the slag. The molten metal can be recycled as a raw material. The radioactive slag produced is radioactive waste, having no further use and is returned to Austria for disposal. Provisions for this are found in Article 146 of the Radiation Protection Act 2020.

Treatment and interim storage at Nuclear Engineering Seibersdorf

Nuclear Engineering Seibersdorf GmbH has two main tasks, both carried out on behalf of the Republic of Austria:

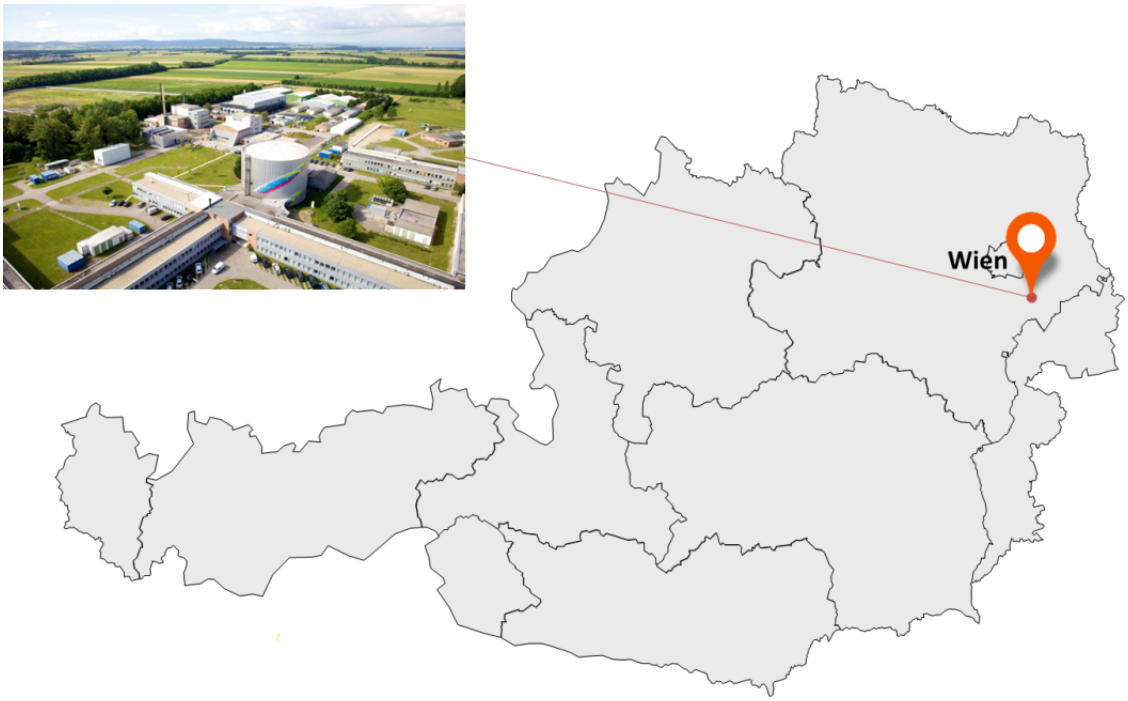
- Treatment of all radioactive waste arising in Austria (from medicine, industry and research) from acceptance and collection, sorting, processing, conditioning and interim storage, and
- decommissioning and decontamination of installations, equipment and materials from 45 years of nuclear research and development activities at the Seibersdorf location.

Conditioning means the conversion of the waste into a chemically and physically stable form and placement into a container (normally 200 litre drums), so that it can be safely stored over longer periods of time and is suitable for the later final disposal. NES uses state-of-the-art methods to bring the radioactive waste into a stable and, above all, safe form, while also achieving the greatest possible volume reduction.

NES has an integrated management system (IMS), as required by Article 69 AllgStrSchV 2020, where, among others, regulations for quality assurance and radiation protection, for occupational and health protection as well as physical protection measures are integrated. The IMS is certified according to ISO 9001:2015 (quality management), ISO 14001:2015 (environmental protection) and ISO 45001:2018 (occupational health and safety). NES also operates a test centre accredited according to ISO 17025.

Every NES employee, who is dedicated to work in radiation areas, receives basic radiation protection training as well as theoretical and practical workplace-related training pursuant to Article 71 and Annex 16 AllgStrSchV 2020. Even after the initial training, regular training is an essential point for all employees at NES. Consequently, it is ensured that the required qualified personnel is available.

Figure 3: Operational site NES at the Seibersdorf location



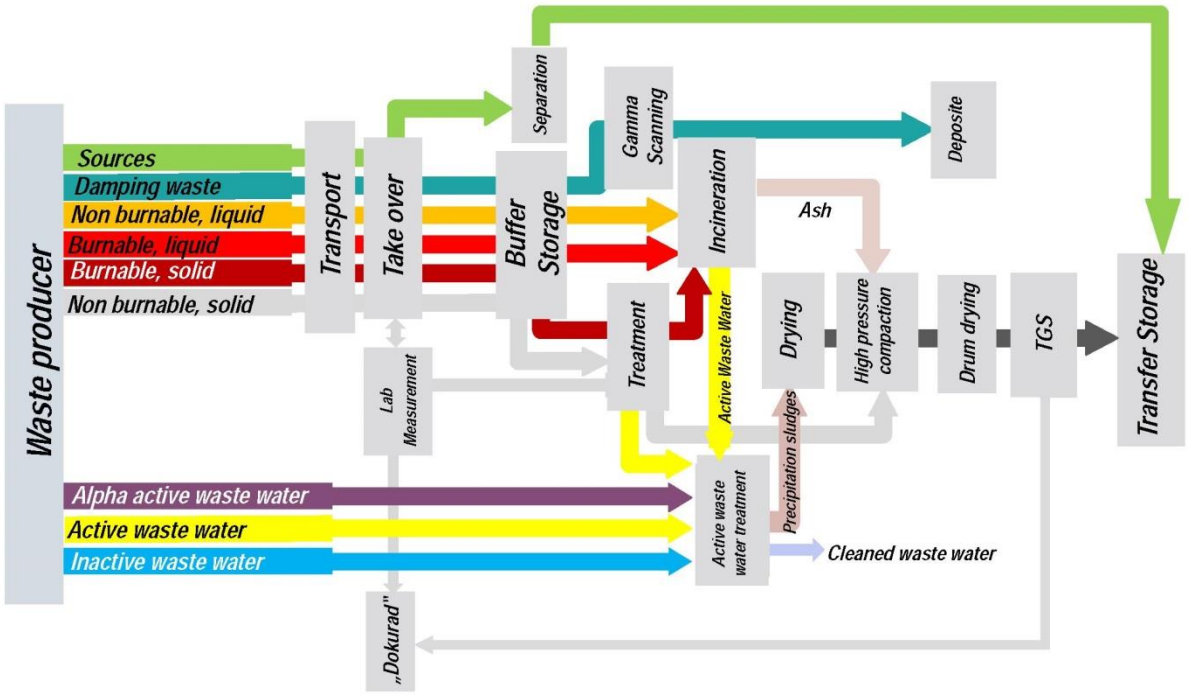
© NES GmbH

The company premises of NES are located about 40 km southeast of Vienna on the site of the local research center. NES systems meet the highest technical standards. Regarding treatment and storage of radioactive waste, the main focus is on optimising material flow, work safety and radiation protection as well as waste volume reduction. Bulky items are treated in the “New Manipulation Centre” of NES, in which state-of-the-art structural and house engineering measures minimise the risk of the release of radioactive material (for example, double door systems or a ventilation system that maintains a graded vacuum in all sections of the building).

Waste treatment

At NES, in compliance with Article 76 of the AllgStrSchV 2020, every effort is being made to reduce the volume of radioactive waste (to be subsequently disposed of in a final repository) as far as possible. All materials and objects are decontaminated as far as technically and economically feasible and reasonable, in order to transfer them again into the conventional material circuit after official clearance and release or to dispose of them as inactive material (e.g., landfill).

Figure 4: Material flow of radioactive waste treatment in NES



In the above figure, the essential management steps are shown, which are executed depending on the type of waste. The following phases can be distinguished:

- Takeover of the waste up to sorting
- Conditioning
- Drying to interim storage

Takeover of the waste up to sorting

Takeover

The transfer of the waste to the facilities at NES takes place in the takeover hall. There, the radioactive waste, which is usually delivered in 100 litre drums, is unloaded from the transport vehicle and initial characterisation (e.g., control measurements on the containers, sampling of liquid waste) of the waste takes place.

Buffer storage

From the takeover building, the waste is transferred to the buffer storage sheds, where it is stored – as far as possible homogenous – for further treatment:

Sorting

The next step in the process is the sorting of the waste. The waste is assigned to one of the subsequent processing steps.

Waste conditioning

Larger, bulky waste such as, for example, contaminated equipment or building components, must be dismantled and reduced to smaller pieces for conditioning. In order to reduce the volume of waste, contaminated items and materials are, to the extent practicable, decontaminated so that they can be cleared for release for recycling or disposal. For this work at NES, two stainless steel containments are designated, in which the material can be dismantled, decontaminated and prepared for further conditioning by personnel wearing externally ventilated protective suits. The radioactive waste generated in these activities will be further treated by the methods listed below.

Depending on the category and type of the waste, the following process steps are possible.

Incineration

In the incineration plant, all combustible solid and liquid radioactive waste is incinerated. The radioactive substances are concentrated in the ash, which is then further conditioned (usually welded in stainless steel cartridges placed into a 200 litre drum).

High pressure compaction

Since volume reduction is one of the main objectives in the conditioning of radioactive waste, non-combustible, compactible waste is compacted within metal cartridges using the high-pressure compactor to form so-called pellets, which are introduced into 200 litre drums.

Cementing

In cases where incinerating or compacting of the waste is not possible, cementing can be carried out to embed the material in a solid matrix. The radioactive waste is homogeneously distributed in the concrete and inserted into a 200 litre drum.

Source processing

Disused sealed radioactive sources, which could not be returned to the manufacturer, are dismantled, documented, sorted according to nuclides and further processed and conditioned according to the radionuclide and its activity.

At the end of the conditioning process, the radioactive waste is in a stable form and enclosed in a container (usually a 200 litre drum).

Drying to interim storage

Drying

As a rule, ready-conditioned waste drums are dried in the dryer before being transferred to the interim storage facility. As a result, the waste is also chemically stabilized.

Drum measuring system

All ready-conditioned waste drums are characterised radiologically using the drum measuring system. The measured values provide important information for future steps in management.

Interim storage

After the characterisation of the drums, they are transferred to the NES air-conditioned interim storage. In order to ensure that the drums can be inspected and accessed at any time, the waste drums are stored horizontally on steel shelves (drum pallets).

Figure 5: Interim storage of the conditioned 200 litre drums

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Documentation of the conditioned radioactive waste

During the conditioning and interim storage of radioactive waste, a complete documentation of the waste and the respective processing steps is essential. The exact knowledge of the contents of the containers is necessary for the later treatment of the waste, for the future final disposal or any subsequent release (after decay of the radioactivity). Likewise, traceability of the conditioned waste back to the incoming raw waste should be strived for.

With the DOKURAD software, NES uses a database in which all necessary information on waste management is stored and documented.

Each incoming and temporary container, as well as every completely conditioned waste drum, receives a unique number and QR code, with which it is mapped in DOKURAD; this means that all information and data can be retrieved at any time in the system. It is therefore possible to reproduce the entire conditioning process from the incoming container up to the finished stored drum and also to trace the path of the waste from the finished drum back to the incoming container and the waste producer.

Final disposal

The entire radioactive waste inventory, which is currently stored at NES, finally has to be disposed of, according to Directive 2011/70/Euratom. A decision on the location and type of the required disposal facility has not yet been made in Austria – as is the case in many other countries around the world. As experience in other countries shows, decisions on the final disposal of radioactive waste are not reached quickly.

In view of the comparatively low levels of waste (around 3.600 m³ of short-lived waste and a maximum of 60 m³ of long-lived waste) and the low risk potential (exclusively low and intermediate level radioactive waste), the current storage of radioactive waste in the interim storage facility at NES is a good starting point to find an optimal and accepted solution for the final disposal for Austria.

To achieve this goal, a decision-making process must be defined. In addition to the clarification of the legal and organizational issues, it is above all necessary to ensure that the entire process is completely transparent. All important decisions must take place with the appropriate involvement of the public and all interested institutions. Accordingly, it is to be understood that a complex multi-stage process will be required. In **Annex I** of this programme, an example roadmap is presented. This is based on the procedures used by some other countries and is intended to be illustrative.

The aim of this roadmap is to determine the type and location of one or more repositories for Austrian waste. Austria will seek cooperation with other European countries to resolve the issue of final disposal. Collaboration is particularly appropriate for those countries in which the situation is similar to that in Austria, i.e., smaller countries without their own nuclear power programme. An exchange of experience, cooperation in international working groups and joint action in some areas – for example coordinated research projects – would bring benefits for all parties.

According to the present state-of-the-art, various types of repositories are used, which are suitable for different types of waste. The IAEA publication NW-G-1.1 "*Policies and Strategies for Radioactive Waste Management*" may be referenced here as an example. A brief analysis of possible disposal options for Austrian waste can be found in **Annex II** of this document. Since Austria does not have to dispose of highly radioactive waste or spent fuel, the technical disposal requirements for Austrian radioactive waste are significantly lower than in countries with nuclear power plants. Therefore, the final repository or repositories to be

defined only have to match the requirements for safe storage of low- and intermediate active waste.

The safe disposal of short-lived radioactive waste, which makes up most of the waste volume, is possible in disposal facilities that, even complying with best world practice, can be constructed comparatively easily. Such disposal facilities already exist in several countries of the world. Austria is striving for the timely establishment of a repository for its short-lived radioactive waste in its own country.

In order to find a suitable solution for the small quantities of long-lived waste, the possibility of cooperation with other countries seems to be an option. An international cooperation for the establishment of a common disposal facility for this waste in a European country may be a feasible alternative to final disposal in Austria. In the international community, regional or international cooperation is now regarded as a suitable option for final disposal and there are corresponding initiatives for a common approach. The advantages and disadvantages of Austria's participation in a joint repository will have to be weighed in a discussion process.

In the event that radioactive waste from Austria is to be disposed in a repository located in another country at some point in the future, clear provisions in Directive 2011/70/Euratom apply: The facility must have obtained an operating licence before transferring the waste, and it has to meet the same standards of safety and transparency provided for in the requirements of the Directive that would apply to a repository in Austria.

The internationally specified safety provisions for the safe transportation of radioactive waste must be observed. Compliance is required with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention).

Austrian Board for Radioactive Waste Management ("Advisory Board", formerly Task force "Disposal")

Targets

For the implementation of The National Waste Management Programme, the Austrian Federal Government has to set up a Task force "Disposal". This body shall address the issues and tasks relating to final disposal in an efficient and transparent manner and make recommendations for further steps. The Task force will consist of ministerial representatives, representatives of the Federal Provinces, experts in the subject matter and stakeholders. The Task force will be coordinated by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology.

The Task force will develop proposals for the final disposal of short- and long-lived waste taking into account technical, economic and social aspects. It will do this through studies and workshops and also in cooperation with foreign institutions and experts. A concept for the comprehensive information and involvement of the public is to be created.

In particular, the task force shall launch the following activities:

- Consultation on changes to the legal framework conditions and the financial framework for the disposal of radioactive waste,
- Consultation over a period with the most important milestones,
- Monitoring of the development of the waste inventory at NES, incl. assessments of the periods of time within which activity values allowing release could be achieved,
- Monitoring of the activities of other countries with a comparable waste inventory,
- Providing information on European and international cooperation concerning radioactive waste,
- Discussion on mode and requirements for the participation and information of the public as well as for ensuring transparency and participation,
- Initiation and monitoring of research and development activities which should lead to an assessment of the feasibility of new technologies and concepts, waste minimization, etc.,
- Development of a conceptual project for the waste disposal facility, but also for any other relevant elements, e.g. transport, supervision etc.,
- Development of criteria for the selection of disposal options, above all in respect of safety aspects,

- Consultation on the requirements to be placed upon the future operator of a disposal facility and ensuring that sufficient numbers of qualified staff are available,
- Consultation on the concept for decommissioning of unneeded facilities at NES,
- Monitoring the implementation and updating of the National Radioactive Waste Management Programme.

The Board has to regularly report to the Federal Government on its activities and submit its recommendations for a decision. In order to ensure sufficient time for the construction and commissioning of the installation(s) for final disposal, the decision on the final disposal of the radioactive waste shall be taken no later than 10-15 years before the end of contract for interim storage in 2045. However, an earlier point in time is envisaged.

Establishment of the Advisory Board

In implementation of the provisions of National Waste Management Programme of 2018, on 10 March 2021, the Austrian Federal Government tasked the Federal Minister for Climate Action to set up the Austrian Board for Radioactive Waste ("Advisory Board"). The Advisory Board develops recommendations for the Austrian Federal Government, which will form the basis for further decisions regarding the final disposal of radioactive waste. The Advisory Board was initially given a mandate limited to three years.

The mandate[7] of the Austrian Board for Radioactive Waste Management includes the following tasks:

- To compile a more detailed inventory of the current and future radioactive waste than is currently available,
- Evaluation of possible options for the final repository of Austrian radioactive waste, including the necessary requirements, strengths, weaknesses, opportunities and risks as well as associated costs,
- Compilation of a participation concept with recommendations on how the population may be informed, involved and included in any decisions,
- Outline of a timetable and milestones for the disposal of the radioactive waste produced in Austria.

Scientists, NGOs, representatives from the federal and state governments and civil society are represented in the Advisory Board. In addition, the Federal Minister for Climate Action nominated six independent experts. The task of the 20 members of the Advisory Board is to work out the basis for decisions and recommendations within the framework of their mandate. The composition of the Board serves to fulfill the tasks of the mandate limited to three years and might be subject to changes in possible future mandates.

[7] entsorgungsbeirat.gv.at/en/themen/about-us/tasks

6 Research and development

Treatment of radioactive waste

To ensure continuous development and optimisation of the management of radioactive waste, NES implements numerous projects dealing with safety, radiation protection or optimal reduction of the volume of radioactive waste. Therefore, despite not being a designated research entity in the strict sense, research and development are an important part of the duties and responsibilities of NES. Several examples of such projects conducted at NES are:

Development of an Ultrafiltration System

In the past, the chemical precipitation process used for the wastewater treatment at the Seibersdorf site resulted in the production of radioactive contaminated sludge, which had to be removed with a filtration device. Because of the necessary addition of a filter aid, a considerable amount of radioactive secondary precipitation was produced in this process. As an alternative, NES has developed a process in which the radioactive contaminated wastewater is subjected to a two-stage filtration process by means of an ultrafiltration system (membrane filtration system), which does not require any filter aid.

Figure 6: Filtration unit of the ultrafiltration system

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The operational experience has shown that with this system the use of chemicals for the precipitation could be drastically reduced, because in general no preparative chemical precipitation is necessary in the wastewater treatment. In this way, the amount of radioactive waste produced during the wastewater treatment could be reduced by a factor of 20.

Development of a Soil Measuring System

In order to minimise the radioactive waste during the ongoing decommissioning and dismantling projects, NES is currently developing and constructing a soil measuring system which can be used to separate slightly contaminated rubble, soil material, etc. into radioactive waste and conventional waste. The system performs an automated activity measurement and separation of the (previously crushed) material, which optimally minimises the amount of radioactive waste.

Figure 7: Soil measuring system (right: material application, left: measurement and separation)

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Final disposal

A number of projects have already been carried out in relation to the disposal of radioactive waste. In addition, in the future, waste management will have to be continually developed and optimised in order to ensure maximum safety. An effective and extensive research and development activity, especially with respect to final disposal, is also needed. In this context, the results of previous studies in Austria as well as of the relevant international references (for example IAEA, NEA/OECD documents) should be taken into account to the extent usable in order to cover the basic questions already addressed by the international community. Participation in conferences and international working groups will also take place. Contributions from other organisations, such as universities and research institutes, as well as relevant foreign institutions are expected, as these institutions have in-depth knowledge in specific areas for the selection and planning of waste disposal facilities. In addition, the research and development activities will also include activities on geological, geotechnical, spatial planning and technical aspects, general safety analysis of the facilities, environmental research, radiation protection, as well as deterministic and probabilistic risk analyses.

7 Transparency and public participation

Transparency plays a key role in the management of spent fuel and radioactive waste. Therefore, the amendment of the Radiation Protection Act in 2015 explicitly enshrined public participation in the national law. All stakeholders concerned are to be given the opportunity to participate effectively in the decision-making process concerning the disposal of the radioactive waste.

Information of the public

Supervisory authority

Public information on radioactive waste in Austria is provided on the homepage of the BMK at strahlenschutz.gv.at (Article 149 (2) StrSchG 2020). This provides information on radioactive waste, including: waste storage at NES, the Ordinance on the Shipment of Radioactive Waste 2009 and the latest national reports to the "Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management", Federal Law Gazette no. 169/2001 which, as a contracting party, Austria must provide periodically.

Nuclear Engineering Seibersdorf

Pursuant to Article 72 AllgStrSchV 2020, NES has to provide information to the public on the management activities carried out in its facilities. In this regard, information can be found at nes.at. On the website, among other things, information about the company's tasks, the organization as well as the products and services offered can be obtained. For radioactive waste generators, the website contains the document „Übernahmebedingungen und Preisliste für die Verarbeitung, Konditionierung und Zwischenlagerung von radioaktiven Abfällen" as well as all information necessary for storage at NES (order form, transport information, etc.).

Information according to the accident information regulation

Pursuant to the provisions of the Hazardous Incident Information Ordinance (Störfallinformations-Verordnung), Federal Law Gazette No. 391/1994, the interim storage facility for radioactive waste is a facility that is subject to information obligations. The information obligation in this respect is implemented by means of publication of a notice at the porter's lodge of the Seibersdorf site and the municipality offices of the surrounding municipalities. The information is also communicated to the competent authorities. The hazardous incident information shall be revised in regular periods of not more than five years.

Multifunctional Information Centre

Pursuant to the radiation protection regulations, the NES premises are declared as a radiation area. Because access to this area is permitted to a limited extent only and only for a certain group of people and in compliance with elaborated formalities, the "Multifunctional Information Center" has been set up outside this secure area. Topics such as the handling of radioactive substances and waste, radiation protection, processing and conditioning processes, interim storage etc. can be brought to a broader range of interested parties (interested groups, stakeholders, decision-makers, emergency personnel, political bodies, international expert groups, etc.). The information centre has been equipped with exhibits from the history of radioactivity and measurement technology, but offers above all a suitable space, in which even larger groups of visitors can be informed by means of lectures, presentations, and information events or similar.

Austrian Board for Radioactive Waste Management

Information both in German and in English on the Advisory Board and its activities are available on the website entsorgungsbeirat.at. This includes information on the members, about meeting and reports of the Board as well as general information regarding radioactive waste and its management in Austria.

Strategic Environmental Assessment

Analogous to the preparation of the National Programme, also any future substantial changes to this Programme require the performance of a Strategic Environmental Assessment (Article 142 (4) and (5) StrSchG 2020), in particular when concrete decisions concerning final disposal are taken. The impact of the National Programme on the environment is

assessed with the participation of the public. The neighbouring States may participate in cross-border consultations within the framework of the Strategic Environmental Assessment.

The present, updated version of the National Programme amends the original version of the Programme with respect to the changes in the radiation protection legislation in 2020 and new data on the inventory from 2021. In this respect, the present update is considered neither a major nor a minor amendment of the National Programme according to Article 142 (4) and (5). Thus, neither a Strategic Environmental Assessment nor public consultations were carried out. Interested parties were given the possibility to state their opinion during the review process of the Radiation Protection Act 2020.

8 Financing

Financing of waste management

Nuclear Engineering Seibersdorf GmbH, which carries out the processing, conditioning and interim storage of radioactive waste, is commissioned by the Republic of Austria to deal with the radioactive waste generated in Austria in accordance with Article 143 of the StrSchG 2020. In June 2003, a contract was concluded between NES, the municipality of Seibersdorf and the BMLFUW (today the BMK), which regulates the tasks of NES and their financing.

Financing by the polluter

The ongoing financing of the management of radioactive waste takes place according to the polluter pays principle. Holders of a licence according to the Radiation Protection Act, owners of radioactive waste from practices with natural radiation sources, as well as authorities, who have seized radioactive sources or to whom orphan radioactive sources have been handed over, must, on the one hand, pay a processing fee for the processing and interim storage and, on the other hand, a precautionary fee ("Vorsorgeentgelt") pursuant to Article 143 of the StrSchG 2020. By express earmarking of the precautionary fee collected the Republic of Austria ensures that the full amount of these funds is available to finance the subsequent final disposal of this waste.

NES has to check the cost estimates of the processing and precautionary fees annually in order to ensure the safe operation of the facility financially. The calculations are to be reported to the BMK (Article 143 (5) last sentence of the StrSchG 2020). These calculations are based on the actual cost of the waste treatment at NES.

Financing by public authorities

Based on the provisions of the StrSchG 2020 in connection with the agreement between NES, the municipality of Seibersdorf and the BMK, the Republic has to bear a significant financial burden for the management of radioactive waste. In concrete terms, the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, in

agreement with the Federal Minister of Finance, is obliged to pay the costs for the establishment and adaptation of treatment plants and storage facilities. In addition, the costs of post-conditioning and reconditioning for the old containers stored at NES are also to be covered.

A contract between NES and the BMK (as the legal successor of the Federal Ministry for Transport, Innovation and Technology) exists for the facilities and radioactive substances, which are the result of past nuclear research activities in Seibersdorf. According to this contract, NES is responsible for the successive remediation of these contaminated sites and the federal government is responsible for the costs.

Financing of final disposal

Precautionary fee

The precautionary fee for final disposal to be paid by the polluters is to be transferred to the Federal Government and used exclusively for the later final disposal of the conditioned radioactive waste. The precautionary fee is determined according to current estimates of the costs of final disposal and the associated preparatory and transport costs.

Financing by public authorities

Based on the stipulations of Article 36c (1) StrSchG 1969, the Republic of Austria concluded an agreement with Austrian Research Centers GmbH (now: Nuclear Engineering Seibersdorf GmbH) in 2003, in which the ARC were obliged to accept, collect, sort, process, condition and store until disposal all radioactive waste generated in Austria. This agreement takes into account the requirement of Art. 4 (1) of Directive 2011/70/Euratom (implemented by Section 141 (1) StrSchG 2020), according to which the ultimate responsibility for the disposal of radioactive waste lies with the Republic of Austria.

In the future, it will no longer be necessary to conclude contracts in this area, because the treatment plant at Nuclear Engineering Seibersdorf GmbH, after having undergone fundamental modernisation, corresponds to the most modern international standards. Therefore, with Article 143 (1) StrSchG 2020, the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, in agreement with the Federal Minister

of Finance, is authorised to update the service contracts concluded by the Republic of Austria with Nuclear Engineering Seibersdorf GmbH in accordance with the requirements resulting from the implementation of the National Waste Management Programme.

Since no final decision has yet been made on the future disposal option, a cost estimation for the disposal facility or facilities is very uncertain. The Republic of Austria has the ultimate responsibility for the final disposal of existing and future radioactive waste and undertakes to ensure the timely availability of sufficient financial resources for the final disposal of the entire inventory.

9 Milestones and time horizon

Modernisation of treatment facilities at NES

Comprehensive modernisation of the facilities at NES has been ongoing since 2009. With this, the treatment and interim storage of radioactive waste is being brought to the state-of-the-art. This project will be completed around 2025.

Reconditioning of waste packages

All older packages with conditioned waste stored at NES, whose contents have not been conditioned according to the current state-of-the-art, are subject to reconditioning in the modernised facilities of NES. The use of new treatment methods, made possible by the modernisation project, will result in a considerable reduction in the volume of the waste. The project is to be completed in the beginning of the 2030s.

Austrian Board for Radioactive Waste Management

The Austrian Board for Radioactive Waste Management was established by the Federal Government in 2021 and consists of ministerial representatives, representatives of the Federal Provinces, experts in the subject matter and stakeholders. The Board is expected to work in an efficient and transparent manner in accordance with the principles of Article 141 StrSchG 2020. In implementation of the National Waste Management Programme, it will deal with issues regarding final disposal. First recommendations to the Federal Governments regarding further steps are expected in the end of 2024.

Interim waste storage at NES

The treatment and interim storage of radioactive waste by NES is secured by a contract between the BMK, NES and the municipality of Seibersdorf until 2045.

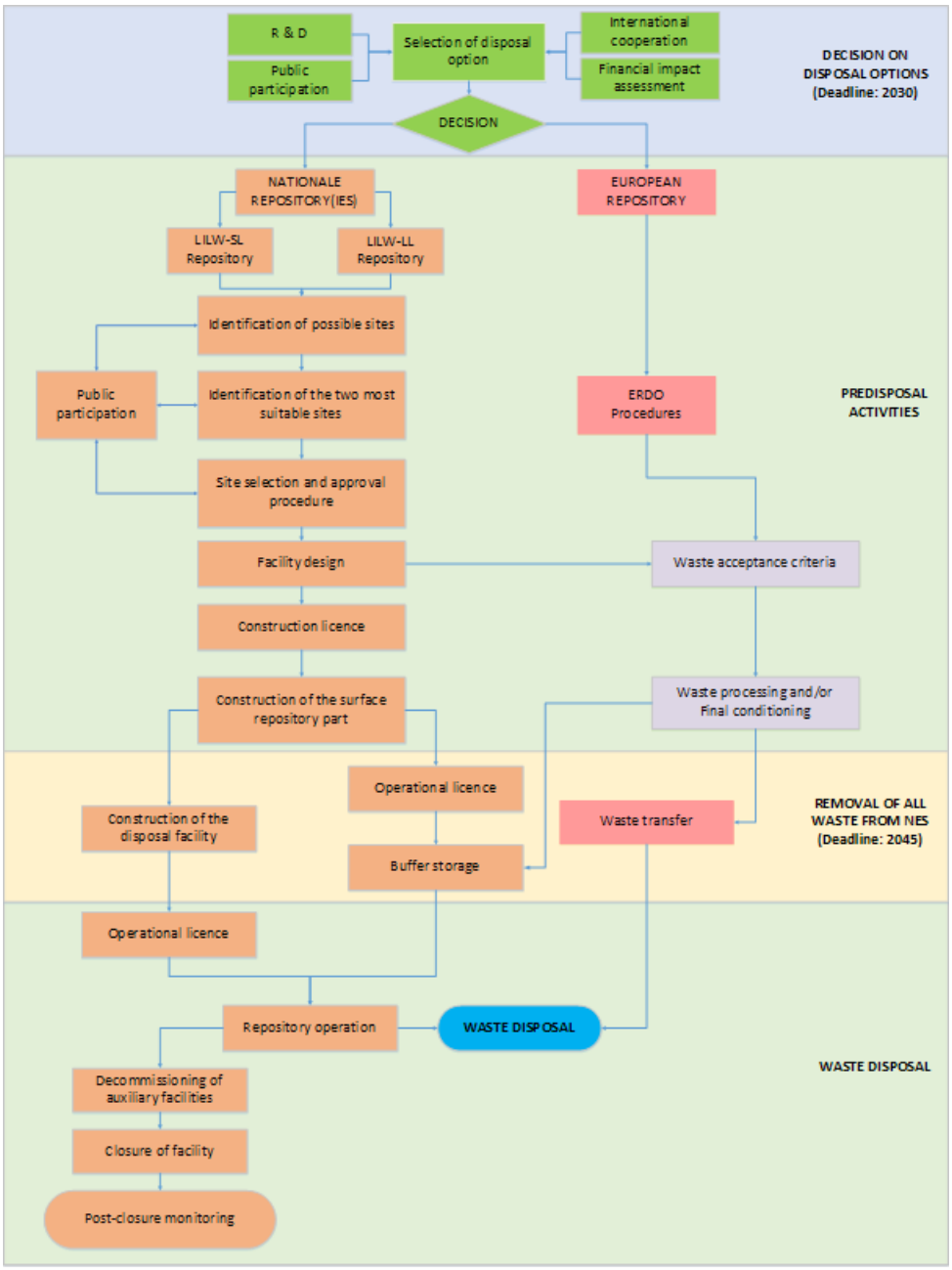
Update and review of the National Waste Management Programme

As experience in other countries shows, a decision on the final disposal of radioactive waste will not be reached quickly. As part of the decision-making process, appropriate adjustments to the legal provisions will have to be made. Similarly, the National Waste Management Programme must also be regularly updated, also in accordance with the provisions of Directive 2011/70/Euratom.

The present, updated version meets the requirements of the Directive for the updating of the National Programme.

Annex I

Figure 8: Illustration of the sequence of steps within the multi stage process for radioactive waste disposal in Austria.



Annex II

The applicability of the possible technical solutions for the disposal of radioactive waste in a repository, as described in the IAEA publication NW-G-1.1 "*Policies and Strategies for Radioactive Waste Management*", was analysed taking into account the Austrian characteristics. The results of the analysis are shown in Table 4. The table indicates the current state of the possible endpoints for the Austrian waste. However, it does not constitute a decision-making basis for a specific type of waste.

Table 4: Summary of potential disposal options for radioactive waste in Austria

RAW classes	**Characteristic of waste**	**Endpoint**				
		Surface trench	**Engineered near surface facility**	**Borehole**	**Surface trench**	**Engineered near surface facility**
LILW-SL with very low activity/LILW-LL with very low activity	-	++	NR	NT	NR	NR
LILW-SL	-	+	++	NT	NR	NR
LILW-LL	-	N	N	+	++	++
Disused Sealed Radioactive Sources	Short-lived nuclides	**+**	**++**	**NR**	**NR**	**NR**
	Long-lived nuclides	**N**	**NR**	**++**	**++**	**++**
	High Activity Sources	**N**	**N**	**++**	**++**	**++**

Legend: + = acceptable solution, ++ = preferable solution, N = not possible for safety reason, NT = not possible für technical reason, NR = possible but not recommended for technical of economic reason

Disposal in a trench-type repository is basically equivalent to the disposal of conventional waste in a conventional landfill. The waste is disposed of in a trench and covered with soil. No additional safety surveillance or radiation monitoring is required. The trench type repository can be recommended from the safety and economy point of view for the disposal of waste with very low activity as well as for the disposal of disused sealed radioactive sources with very low activity. For the disposal of long-lived radioactive waste and disused sealed sources with long-lived radionuclides, this design is not suitable for safety reasons.

An engineered near-surface facility is a system of technically designed trenches or concrete vaults, into which the waste is placed. An engineered cap that minimizes the penetration of surface water is placed over the waste containers. The facility is built on the ground surface or up to several meters below the surface. The facility is subject to surveillance and radiation monitoring until the hazard associated with the waste declines to acceptable levels. A near-surface facility is suitable for the disposal of radioactive waste and disused sealed sources with short-lived radionuclides. The disposal of small quantities of sealed radioactive sources with long-lived radionuclides together with large quantities of short-lived radionuclides is possible under certain safety conditions, but is generally not recommended. Disposal of waste with higher levels of long-lived radionuclides or of sealed sources with high activity is not recommended from the safety point of view for this type of facility.

A borehole disposal facility consists of one or more boreholes with a depth of several tens to a few hundred meters. Borehole facilities are suitable for the disposal of small volumes of long-lived waste, in particular, disused sealed sources (long-lived radionuclides and high activity sources). Disposal of disused sealed sources together with short-lived waste is not recommended for economic reasons.

An intermediate depth disposal facility consists of caves, vaults or silos, which are usually a few tens of meters to a few hundred meters below the surface. Such a facility can also be established by digging an adit into a mountain, where the smallest distance from the surface must be more than 100 metres. A number of abandoned mines have already been converted into disposal facilities of this type worldwide. Deep geological facilities are built several hundred meters below the surface, usually in the form of tunnels, vaults or silos. In these two types of facilities, any kind of waste or disused sealed sources can be disposed of. However, since the construction of these facilities is costly, they are normally recommended for the disposal of large quantities of waste with long-lived radionuclides.

With reference to the radioactive waste disposal strategies recommended by the IAEA, the following provisional result can be obtained for Austria, taking into account the waste inventory by 2045.

Different features have to be considered for the 3.600 m³ of short-lived conditioned radioactive waste and the 60 m³ (or even less) of long-lived waste. The final disposal option will be chosen on the basis of criteria deliberated by the Austrian Board for Radioactive Waste Management.

New findings resulting from the work of the Advisory Board may lead to changes in the preliminary evaluation presented in Table 4

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Abbrevations

AllgStrSchV 2020	General Radiation Protection Ordinance 2020
ARC	Austrian Research Centers
ASTRA	Adapted Swimming Pool-Type Reactor Austria
BMK	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology
BMLFUW	Federal Ministry for Agriculture and Forestry, Environment and Water Management
BMVIT	Federal Ministry for Transport, Innovation and Technology
Bq	Becquerel (Unit of activity – number of decays per second)
DOKURAD	Waste documentation system
ENEF	European Nuclear Energy Forum
IAEA	International Atomic Energy Agency
ISO	International Organization for Standardization
NEA/OECD	Nuclear Energy Agency of the Organization for Economic Cooperation and Development
NES	Nuclear Engineering Seibersdorf GmbH
RAbf-VV 2009	Radioactive Waste Shipment Ordinance 2009
StrSchG 2020	Radiation Protection Act 2020
TRIGA	Training, Research, Isotopes, General Atomics
TU Wien	Vienna University of Technology

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