Ministry of Infrastructure and Water Management

Self-Assessment Report
ARTEMIS mission to the Netherlands
19 – 28 November 2023

Contents

List of symbols and abbreviations

Acronym	Full term	Translation or explanation
ALARA	As Low As Reasonably Achievable	
ALM-study	Asset Liability Management study	
ANVS	Autoriteit Nucleaire Veiligheid en Stralingsbescherming	Authority for Nuclear Safety and Radiation Protection
ARTEMIS	Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation	
Awb	Algemene wet bestuursrecht	General Administrative Act
AVG	Afval Verwerkings Gebouw	Waste processing building
Bbs	Besluit basisveiligheidsnormen stralingsbescherming	Basic Safety Standards for Radiation Protection Decree
Biudrabs	Besluit in-, uit- en doorvoer van radioactieve afvalstoffen en bestraalde splijtstoffen	Radioactive waste and Fissile materials (Import, Export and Transit) Decree
Bkse	Besluit kerninstallaties, splijtstoffen en ertsen	Nuclear Installations, Fissile Materials and Ores Decree
Bvser	Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen	Fissile materials, Ores and Radioactive materials Transport Decree
COG	Container Opslag Gebouw	Container storage building
Conventional waste	Waste substances as intended in the Environmental Protection Act (or non-radioactive waste)	
COVRA	Centrale Organisatie Voor Radioactief Afval	Central Organisation for Radioactive Waste
DGMI	Directorate-general for the Environment and International Affairs	
Directive 2011/70/Euratom	Directive 2011/70/Euratom of the European Council dated 19 July 2011 on the establishment of a community framework for the responsible and safe management of spent fuel and radioactive waste	
DWT	Decontamination and Waste Treatment complex	Facility for decontamination and waste treatment in Petten
EIA	Environmental Impact Assessment	
EU	European Union	
EURAD	European Joint Programme on Radioactive Waste Management	
HABOG	Hoogradioactief AfvalBehandelings- en Opslag Gebouw	High-level waste treatment and storage building
HASS	High Activity Sealed Sources	
HFR	Hoge Flux Reactor	High Flux Reactor (Research Reactor in Petten, tank-in-pool type, 45 MW_{th})
HLW	High-Level Waste	In Dutch: hoogradioactief afval (HRA)

HOR	Hoger Onderwijs Reactor	Higher Education Reactor (research reactor of the Delft University of Technology)
IAEA	International Atomic Energy Agency	
IandWM	(Ministry of) Infrastructure and the Water Management	
IBC	Isoleren, Beheersen, Controleren	Isolate, Manage, Control
ILW	Intermediate-Level waste	
IRRS	Integrated Regulatory Review Service	
Joint Convention (JC)	Joint Convention on the Safety of the Management of Spent Fuel and the Management of Radioactive Waste	
JRC	Joint Research Centre of the European Communities	
Kew	Kernenergiewet	Nuclear Energy Act
LILW	Low- and Intermediate-Level Waste	In Dutch: laag- en middelradioactief afval (LMRA)
LLW	Low-Level Waste	
LOG	Laag- en middelradioactief afval OpslagGebouw	Low- and intermediate-level waste storage building
LTO	Long Term Operation	
MOG	Multifunctioneel OpslagGebouw	Multifunctional storage building
National programme	The national programme for the responsible and safe management of spent fuel and radioactive waste	
NORM	Naturally Occurring Radioactive Material	
NPP	Nuclear Power Plant	
NR	National report for the Council Directive 2011/70/Euratom	
NRG	Nuclear Research and consultancy Group	Licence holder and operator of the HFR
OPERA	OnderzoeksProgramma Eindberging Radioactief Afval	National geological disposal research programme (2011-2017)
PALLAS	Research and medical isotope production reactor	
RB	Regulatory Body	
Rbs	Regeling Basisveiligheidsnormen Stralingsbescherming	Regulation on Basic Safety Standards for Radiation Protection
RID	Reactor Institute Delft	(Operator of the HOR research reactor in Delft)
RIVM	Rijksinstituut voor Volksgezondheid en Milieu	National Institute of Public Health and the Environment
RR	Research Reactor	
Rnvk	Regeling nucleaire veiligheid kerninstallaties	Nuclear Safety Regulation for nuclear installations
RW	Radioactive waste	

SAR	Safety Analysis Report	
SEA	Strategic environmental impact assessment	
SF	Spent Fuel	Fission material that has been irradiated and permanently removed from a reactor core
SHINE	Nuclear installation for the production of medical isotopes	
Sodm	Staatstoezicht op de Mijnen	State Supervision of Mines
SR	Safety Report	
TS	Technical Specifications	
UN	United Nations	
URENCO	Uranium ENrichment Corporation Ltd	
Vbs	ANVS-verordening Basisveiligheidsnormen Stralingsbescherming	Regulation of the Authority for Nuclear Safety and Radiation Protection
VOG and VOG-2	Verarmd uranium Opslag Gebouw	Storage building for depleted uranium
Wm	Wet milieubeheer	Environmental protection act
Woo	Wet open overheid	Act on government information
WSF	Waste Storage Facility	Waste storage building for legacy waste in Petten
WTU	Waste transfer building	Waste Transfer Unitgebouw

Introduction

On 6 February 2019, the State Secretary of Infrastructure and Water Management submitted a request to the IAEA to conduct an international peer review of the Dutch national framework for the safe management of radioactive waste and spent fuel (ARTEMIS). In dialogue with IAEA, it was agreed that the ARTEMIS review would be carried out 'back-to-back' with an IRRS mission. The IRRS mission took place from 4-16 June 2023. Highlights of the mission have been communicated to the Dutch parliament on 3 July 2023[1]. The ARTEMIS mission will be carried out in the period 19-28 November 2023.

The request for this ARTEMIS mission serves the implementation of Article 14.3 of Directive 2011/70/Euratom which states that 'Member States shall periodically, and at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation, and invite international peer review of their national framework, competent regulatory authority and/or national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent fuel and radioactive waste.'

During the upcoming mission, the Dutch framework will be examined for the first time in the manner indicated.

The details of the content and of the execution of the mission were discussed in a Preparatory Meeting with the IAEA on 17 May 2023. What has been agreed, is laid down in the Terms of Reference.

The Ministry of Infrastructure and Water Management, the Authority for Nuclear Safety and Radiation Protection and the waste management organisation COVRA worked together on the preparation of the self-assessment in this report. The questionnaire provided by the IAEA has been answered to the best of their knowledge and ability, as an overlap between the scopes of the themes policy and strategy was noted, and the choices we made are inevitably arbitrary. We mean to have been thorough in answering the questionnaire. Relevant outcomes of the recently carried out IRRS mission have been taken into account in this self-assessment whenever possible.

The outcomes of this peer review will be reported to the European Commission and will be made available to the public where there is no conflict with security and proprietary information.

[1] Parliamentary papers, Session year 2022-2023, 25422, no. 292.

1 National policy and framework

1.1 National policy for the management of the spent fuel and different classes and types of radioactive waste from generation to disposal and the main principles on which the policy is based

Framework
The current policy on the safe management of spent fuel and radioactive waste has been detailed in the National programme for the management of radioactive waste and spent fuel (further: National programme), that was published in 2016 in compliance with Council Directive 2011/70/Euratom. The basis of the national policy on radioactive waste management was originally laid down in a policy statement in 1984[2].

The National programme is the most recent and complete official publication detailing the policy on the management of spent fuel and radioactive waste and it also includes an inventory and a description of the route to disposal. The National programme will be updated at least every ten years, in accordance with Directive 2011/70/Euratom. The next update of the National programme is currently being prepared and is expected to be published in August 2025 (further: National programme 2025).

The policy on radioactive waste is connected to the policy on radiation protection, which protects individuals, society and the environment against the risks of exposure to ionising radiation. Exposure to radiation must be justified, as low as reasonably achievable (ALARA) and must remain within specified thresholds. Anyone using ionising radiation bears prime responsibility for its use. The same principles are applied to the management of radioactive waste.

The policy for radioactive waste is in line with the policy for conventional waste. For example, the policy strives to close raw materials cycles as much as possible, with priority to be given to the most environmentally friendly possible processing methods. In the policy on radioactive waste, the same hierarchy for preferred processing is assumed: prevention, reuse, recycling and finally, safe management of remaining waste substances. Furthermore, the IBC-principle is applied to the management of spent fuel and radioactive waste: isolate, manage and control (*Isoleren, Beheersen, Controleren*).

Policy principles
The principles for the management of radioactive waste are laid down internationally, among others by the International Atomic Energy Agency (IAEA). The Netherlands, together with many other countries, has underwritten these principles by joining the Joint Convention on the Safety of the Management of Spent Fuel and the Management of Radioactive Waste (Joint Convention[3]). Directive 2011/70/Euratom is also based on these principles (Article 4.3):

a) The generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;
b) The interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;
c) Spent fuel and radioactive waste shall be safely managed, including in the long-term with passive safety features;
d) Implementation of measures shall follow a graded approach;
e) The costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;
f) An evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste.

[2] Parliamentary papers, Session year 1983-1984, 18343, no. 1 and 2.
[3] Latest report see https://open.overheid.nl/repository/ronl-f0deb925-00f7-469e-a2e3-bc97e0052d2e/1/pdf/dutch-national-report-for-the-joint-convention-2020.pdf, further: JC 2020.

Since 1984, the management of radioactive waste in the Netherlands has been based on the following principles:

- Minimizing the occurrence of radioactive waste, both in volume as activity.
  Prevention of waste production, reuse and using radioactive decay are successful policy instruments to minimize radioactive waste.
- Safe management of radioactive waste now and in the future.
  Radioactive waste should be transferred as soon as reasonably possible to the Central Organisation for Radioactive Waste (*Centrale Organisatie Voor Radioactief Afval* - COVRA), for long-term centralized interim storage in dedicated buildings followed by geological disposal in 2130. The definitive decision on the disposal method will be taken around 2100.
- No unreasonable burdens on future generations.
  Generations that have profited from a specific application of radioactivity, such as nuclear power or medical isotopes, must bear the burdens for managing the waste produced in those activities.
- Those who produce radioactive waste bear the costs for the management of the waste.
  For all costs involved in the management of the radioactive waste the 'polluter pays' principle applies.

More details are given in the following sections and chapter 3.

Recent policy developments
In the policy paper sent to the House of Representatives on December 9, 2022[4], designated areas of policy developments on the management of radioactive waste are described, as well as which steps are being taken with regard to updating the National programme for 2025.

Moreover, on December 22, 2022[5], the House of Representatives was informed about the planning and general outlines of the National programme for 2025. These outlines are based on the conclusions and recommendations of several studies on the effectiveness of the Dutch policy. More details are given in the following sections and chapters.

1.2 National policy documentation and approval

The Netherlands published its national policy on radioactive waste management in the National programme in 2016.

The draft National programme was made available for consultation for citizens and organizations. The submitted remarks, together with the advice from the Netherlands Commission for Environmental Assessment[6] (*Commissie voor de milieueffectrapportage*) have led to the draft National programme being amended. The amended draft National programme was presented to the Dutch Parliament. After receiving several questions from the House of Representatives, various parts of the National programme were clarified through textual adjustments. Thereafter, the Minister of Infrastructure and Environment adopted the National programme and submitted it to parliament and the European Commission.

The National programme is publicly available in both Dutch (official document[7]) and English (courtesy translation[8]). The national policy has been discussed with parliament through the years; the letters, minutes and reports are stored in the national archive.

In addition, as a member of Euratom, the Netherlands issue a report in a three-year cycle on the progress in implementing the obligations of Directive 2011/70/Euratom to the European Commission. On 17 May 2016, the Minister of Infrastructure and Environment presented the first national report for Directive 2011/70 to the House of Representatives. The most recent report[9] was published in 2021 (further: NR 2021).

The Ministry of Infrastructure and Water management (IandWM, formerly known as Infrastructure and Environment) together with the Authority for Nuclear Safety and Radiation Protection

[4] Parliamentary papers, Session year 2022-2022, 32645, no. 102.
[5] Parliamentary papers, Session year 2022-2023, 25422, no. 286.
[6] https://www.commissiemer.nl/english
[7] https://zoek.officielebekendmakingen.nl/blg-775466.pdf
[8] https://english.autoriteitnvs.nl/documents/report/2016/08/09/the-national-programme-for-the-management-of-radioactive-waste-and-spent-fuel
[9] https://open.overheid.nl/documenten/ronl-0ac91e23-f967-4cd9-95e9-abdf872bbf9c/pdf

(*Autoriteit Nucleaire Veiligheid en* Stralingsbescherming - ANVS), have published both in 2018 and 2022 a Guide for Readers[10] (*Wegwijzer*) which gives an overview of the Dutch policy on nuclear safety and radiation protection. The Guide also outlines how the Netherlands handles the organization and implementation of this policy. This overarching document is intended for professionals working in the field.

1.2.1 Safety objectives, including the importance of avoiding undue burden on future generations

1.2.1.1 Overall Safety Objectives

A gradual approach
The policy, the regulations and supervision follow a gradual approach. This means: the greater the risk, the stricter the regime.

Continuous improvement
Practice, policy, regulations and supervision must be continuously improved in order to comply with developing technologies and knowledge. The Ministerial Decree on nuclear safety of nuclear installations requires continuous improvement of (nuclear) safety and the execution of periodic safety reviews.

COVRA carries out periodic safety reviews as required by the licence:
• Every 5 years an assessment of the activities and accomplishments in the area of safety, waste management and radiation protection is performed against the licence requirements to conclude about eventual shortcomings and possibilities to improve;
• Every 10 years a comprehensive assessment is performed, where the design, operation, procedures and organisation is compared with current/modern (inter)national standards in order to find reasonably achievable improvements.

1.2.1.2 Policy principle: Minimization

According to Article 10.2 of the Decree on Basic Safety Standards for Radiation Protection (Bbs), a licensee in possession of radioactive material is obliged to prevent or minimize the generation of radioactive waste. The licensee is in principle free to choose its measures to achieve this.

Prevention and justification
Authorization is required for the use of radioactive substances (Nuclear Energy Act Article 29). One of the criteria for obtaining a licence is that the requested application is justified. This means that radioactive substances may only be used if the economic, social and other advantages of the ionizing radiation outweigh the potential health damage which can be caused as a result (Bbs Article 3.7). Even if the application is justified, the licence applicant still has the duty to prevent or restrict the production of radioactive waste materials as far as possible (Bbs Article 10.2). Furthermore, the operator is required to ensure that both the dose in the event of exposure and the risk of exposure are kept as low as reasonably achievable (Bbs Article 2.6): the ALARA principle (As Low As Reasonably Achievable).

Reprocessing
On December 9, 2022[11] and February 7, 2023[12], the State Secretary[13] of Infrastructure and Water Management sent policy papers to the House of Representatives on reprocessing. In these letters, the State Secretary expressed a preference for the reprocessing of spent fuel from nuclear power plants. Main argument to support reprocessing is that there is less waste to be managed while the nuclear programme is growing. A study showed that the consequences of reprocessing and direct storage of spent fuel are comparable for non-proliferation, safety and economical aspects while the environmental consequences (specifically when considering the entire fuel cycle) are more favourable for reprocessing. The choice between direct storage or reprocessing of spent fuel (the so-called 'back-end strategy') is nevertheless left to the operator’s judgement.

[10] https://www.autoriteitnvs.nl/documenten/publicatie/2022/08/17/wegwijzer-nationaal-beleid-nucleaire-veiligheid-en-stralingsbescherming-2022
[11] Parliamentary papers, Session year 2022-2022, 32645, no. 102.
[12] Parliamentary papers, Session year 2022–2023, 25422, no. 288.
[13] In the legislation the responsibilities are allocated to the Minister, in practice at this moment the State Secretary bears responsibility for the tasks mentioned in the Nuclear Energy Act and associated legislation.

Currently in the Netherlands, spent fuel from the nuclear power plant (NPP) Borssele is sent for reprocessing to France and, after reprocessing, the radioactive waste generated during this process is returned to the Netherlands. Reprocessing is considered as beneficial with regard to minimizing the use of raw materials and with regard to minimizing the volume of radioactive waste to be stored. Therefore, also less storage capacity is required. By reprocessing spent fuel, the volume (and lifetime) of the high-level radioactive waste (HLW) to be managed is smaller compared to direct storage.

In the case of a new nuclear power plant, the license holder will have to provide a back-end strategy beforehand and evaluate it every ten years. The government should evaluate back-end strategies every twenty years. For now, it is assumed that the NPP Borssele will continue reprocessing its spent fuel when its operation time will be extended, and possibly new nuclear power plants will do the same.

Note that the spent fuel from the research reactors (RR) is not reprocessed but directly stored at COVRA.

Reuse
From the point of view of sustainability, reuse is preferred to disposal (both dumping at landfill and geological disposal). This can be achieved by reusing or separating radioactive components and/or decontaminating radioactively contaminated material.

Radioactive decay: storage on site
Using the property of decay is an effective means of limiting the amount of radioactive waste. It is therefore legally permitted to allow radioactive waste with a half-life of less than 100 days to decay for a maximum of 2 years at the premises of the operator, until it is below the clearance levels (Bbs Article 10.7-4). It can then be managed as conventional waste. This option is regularly used with radionuclides with a short life, for example in hospitals and laboratories.

Radioactive decay: storage at COVRA
Some radioactive waste requires several decades to decay to below the clearance levels. According to current regulations, this waste must be stored at COVRA (Bbs Article 10.6) followed by geological disposal. However, some of this material is potentially valuable, such as metals or rare earth elements, and could be reused. The Government strives for a circular economy and wishes to stimulate the (European) market for renewable raw materials and the reuse of scarce material. This goal includes regulations that allow returning valuable (raw) materials that have decayed below the clearance levels to the raw material cycle, rather than storing these materials at COVRA or in a disposal facility. In a decay storage, materials that need more than two years to decay below the clearance levels can be stored safely. Expansion of decay storage possibilities for these materials at COVRA was defined as an action point in the National programme. For that reason, materials originating from the dismantling of large installations (such as cyclotrons) can now be stored at COVRA for a period of not more than 50 years. These materials can then be reused as raw materials or be recycled.

On 3 April 2023[14], the State Secretary of Infrastructure and Water Management presented two studies to the House of Representatives that were carried out by KPMG, on behalf of the Ministry, into the financial consequences of extending the possibilities for decay storage for respectively the hospital sector and COVRA. The Ministry concluded that extending the period of decay storage on site is not an optimal solution for safe management of radioactive waste. Instead, it prefers further extension of the possibilities for decay storage at COVRA as this has similar benefits compared to decay storage at hospitals or companies, in terms of waste minimization and lower tariffs, while not entailing the disadvantages of a possible higher supervisory burden and amendment of laws and regulations. Moreover, the option for decay storage at COVRA is in line with the policy principle of one central storage of radioactive waste.

Therefore, COVRA has started exploring the possibilities of optimizing its decay storage facilities and will be actively offering this to its customers, initially focusing on radioactive waste from hospitals. COVRA is also exploring whether a lower tariff can be charged for radioactive waste that will decay in a short-term. This could be particularly interesting for hospitals, because a significant part of their radioactive waste decays within eight years. COVRA expects to be able to complete its

[14] Parliamentary papers, Session year 2022-2022, 25422, no. 289.

exploration in the course of 2023 and will inform the Ministry on her findings. Thereafter, the House of Representatives will be informed.

Incineration
In certain cases, it is possible to safely incinerate radioactive waste, whereby the radioactive substances remain behind in the filters and in the ash. For radioactive waste containing certain nuclides above their general clearance level, it is permitted to incinerate the waste in specified incineration installations, thus reducing the waste volume (Regulation of the Authority for Nuclear Safety and Radiation Protection (*ANVS-verordening Basisveiligheidsnormen Stralingsbescherming)* Article 3.18).

1.2.1.3 Policy principle: Safe management now and in the future

The second principle in the policy on the management of radioactive waste is that radioactive waste must be managed safely as long as it represents a risk to man and the environment. In the Netherlands, the chosen option is central storage at COVRA in dedicated buildings above ground, after which geological disposal is envisaged around 2130. Decision-making on geological disposal is planned for around 2100. For more information, see chapter 3.

Safe management now

Central storage and IBC-principle
Radioactive waste is produced at various locations in the Netherlands (for more information, see chapter 4). To achieve the safe management of the radioactive waste, the policy is focused on isolating, managing and controlling (IBC-principle) the waste. For the management of radioactive waste, specialist measures, infrastructure and expertise are essential. In the Netherlands, the decision was taken in 1984 to establish a national waste management organisation, the Central Organisation For Radioactive Waste (COVRA). The central collection, processing and storage of radioactive waste also ensures the fulfilment of other key aspects such as environmental hygiene, cost effectiveness and occupational hygiene.

Radioactive waste must be transported to COVRA as soon as reasonably achievable. COVRA has been authorised for the collection and reception of radioactive waste. The operator transfers all responsibilities for the waste to COVRA, at the moment that the waste is collected by COVRA. As a result, COVRA becomes owner of the radioactive waste. At the COVRA site, the waste is stored aboveground for at least 100 years in specially designed buildings. The special feature of the waste packaging method employed, and these buildings is that in the design of the construction work, account was already taken of a storage period of at least 100 years. During the sixth Review Meeting of the Joint Convention, the upfront design of packages and facilities for long-term safe interim storage (100 –300 years) was identified as an Area of Good Performance for the Netherlands.

There are several reasons to choose for a relatively long period of interim storage among which:
- *Physical*: The aboveground storage period allows cooling of the waste and the final volume of the waste for disposal is reduced through radioactive decay.
- *Financial*: The aboveground storage period is used to acquire the necessary financial resources, also by a return on investment.
- *Economical*: Because of the economy of scale all radioactive waste (i.e., high-, medium- and low-level radioactive waste) will be placed in one disposal facility.
- *Technological*: The aboveground storage period gives time to conduct research, to gather knowledge and to learn from experiences in other countries.
- *Societal*: Society might choose other management options in the future, depending on the insights and possibilities at that time.

For these reasons a sound underpinned decision on the management of radioactive waste can be made in the future without placing unreasonable burdens on future generations. For more information, see chapter 3.

To facilitate the safe management of radioactive waste, it is essential that the people dealing with the waste are sufficiently qualified. This subject is further elaborated in chapter 8.

Safe management in the future

Geological disposal
Because there are no guarantees in the future that society will be able to maintain the same level of active waste management, passive management is needed for the long term. Passive safety by geological disposal is one means of guaranteeing safety over a very long period. See chapter 6 for more information.

Period and method of retrievability
Retrievability has been included as a precondition in the policy for the management of radioactive waste[15]. This means that the possibility for retrieving waste (packages) must be included in the design of a facility, such that the retrievability of the waste (via the existing shaft) must be possible during the use of the disposal facility. Research in the past has shown that it is possible to create a retrievable geological disposal facility in the Netherlands in clay and salt, for a period of one hundred through to several hundreds of years. At the point in time when a disposal facility is to be created – in the Netherlands around 2130 – society will be able to impose demands on the retrievability of the disposed material. Until the disposal facility is fully closed, it will be possible to reconsider whether the disposal facility should be kept open or closed. Following closure of the disposal facility, the waste will no longer be retrievable via the original shafts and galleries.

Monitoring and knowledge management
Monitoring and knowledge management are relevant at different moments in the process of creating a disposal facility. There are many international developments in these fields, and a great deal of progress is expected, because the first disposal facilities for high-level radioactive waste are now being commissioned. Up to date knowledge on developments around disposal is acquired through national research, cooperating in international research and participating in international working groups.

Dual track approach
To achieve disposal, both a national and an international route are being followed: a ‘dual track approach’. The dual track approach makes it possible to respond appropriately to possible international initiatives regarding management of radioactive waste. The costs of a national disposal facility will be relatively high for a country with a small nuclear programme; cooperation with other countries may reduce these costs due to the economy of scale.

International collaboration
The ERDO Association was established on 7 January 2021 in Vlissingen, the Netherlands and continues the work of the European Repository Development Organization Working Group (ERDO-wg). As a relatively small, self-financed body, the ERDO Association can concentrate resources and manage projects effectively on modest budgets with efficient timescales. The ERDO Association is an association of national radioactive waste management organizations from Denmark, Slovenia, Croatia, Italy, Norway and Belgium (the Ministry of climate and environment of Poland is an observer) with a mission to work together to address the common challenges in managing their radioactive wastes. The Netherlands is one of the cofounders and COVRA is chair and secretary of the ERDO Association.

For European countries with only small amounts of waste to manage, constructing their own disposal solutions is a major challenge. Article XI of the Joint Convention states that countries can under certain circumstances fulfil this responsibility by sharing a disposal facility and Directive 2011/70/Euratom also acknowledges this option. The founding feasibility studies for sharing disposal solutions in Europe were carried out in the European Commission SAPIERR projects that involved organizations from numerous European countries. This led to the establishment of the ERDO-wg in 2009. Shared solutions have been researched over the last 20 years and much of the corresponding knowledge base lies within the ERDO Association. Both the fundamental concepts and the practical aspects of multinational waste management solutions have been researched and discussed by the IAEA, often with central involvement of ERDO Association members.

[15] Parliamentary Papers, Session year 1992-1993, 23163, no. 1.

1.2.1.4 Policy principle: No unreasonable burdens for future generations

Roadmap
For the National programme 2025 a roadmap to disposal will be developed. This roadmap will include the necessary steps for several paths such as research, participation, decision-making processes, developments of legislative framework and knowledge management. With each update of the National programme, the roadmap will be updated. The roadmap is a mean to make progress towards disposal and take responsibility towards future generations. See chapter 3 for more information.

Retrievability and reversibility
The third principle in the policy on the management radioactive waste policy is that no unreasonable burdens may be imposed on future generations. Generations that have profited from a specific application of ionising radiation, such as nuclear power or medical isotopes, must themselves bear the burdens for managing the waste produced in those activities. To minimize the burden for the management of waste in the future, a passively safe management method is needed. Future generations should have sufficient knowledge and financial resources (see chapter 5 and chapter 7) to establish, operate and close a disposal facility. The period of retrievability offers the possibility of retrieving waste from the disposal facility if new techniques for waste processing or management become available. A reversible process for decision-making on disposal also allows future generations flexibility on decisions taken in the past.

(JC 2020, page 101)
For several decades, retrievability has been included as a precondition in the policy for the management of radioactive waste in a geological disposal facility. This means that the possibility for retrieving waste (packages) must be included in the design of a facility, such that the retrievability of the waste (via the existing shaft) must be possible during the use of the disposal facility. Research in the past has shown that it is possible to create a retrievable geological disposal facility in clay and salt, for a period of one hundred through to several hundreds of years.

The period of retrievability offers future generations the possibility of retrieving waste from the disposal facility if new techniques for waste processing or management become available. The reversible structuring of the process for (definitive) disposal will also relieve future generations from the burden of decisions taken in the past.

The main reasons for introducing the concept of retrievability were derived from considerations of sustainable development. Arising of waste should therefore be prevented or limited. If prevention is not possible, the reuse and/or recycling of this waste is the preferred option. By disposing of the waste in a retrievable way, future generations are given a choice to change the management option for the waste. This could include the application of more sustainable management options if such technologies become available. At the same time, the emplacement of the waste in the deep underground would ensure a safe situation in case of negligence or social disruption.

While retrievability of the waste allows future generations to make their own choices, this is dependent on the technical ability and preparedness of the society to keep the facility accessible during a long period for inspection and monitoring. It also entails a greater risk of exposure to radiation and requires a long-term organisational effort involving maintenance, data management, monitoring and supervision. In particular in the case of geological disposal, retrievability may make the construction and operation more complex which implies additional costs.

There might be some conflict between the requirement of retrievability and the requirement to prepare technical provisions for closing a disposal facility. While retrievability demands accessibility of the waste in a geological disposal facility for a prolonged period – until adequate assurance has been obtained that there are no adverse effects associated with geological disposal, or that no more advanced processing methods for the waste have become available – safety requires that the geological disposal facility is closed as soon as all the waste is emplaced, in order to create an effective barrier from the biosphere. In practice the feasibility of keeping a geological disposal facility accessible for retrieval purposes is restricted to a maximum of a couple of hundred years, depending on the type of host rock. While borehole convergence due to plastic deformation of the host rock is rather limited for granite, repositories in salt and clay, without any supportive measures of the galleries, tend to close around the emplaced waste. Basically, in safety studies this plastic behaviour of salt and clay has been advocated as a safety asset because of an enhancement of the containment function of the geological disposal facility and a facilitation of the heat dissipation to the rock formation. Consequently, the retrieval period should be limited to a realistic length of time. In consultation with society, it will be important to assess the optimum period of retrievability. Under all circumstances, radioactive waste must be retrievable during the operational phase of the disposal facility through to its closure. In the Netherlands only salt and clay are available as possible host rock for a geological disposal facility.

1.2.1.5 Policy principle: Waste management costs for producers

The fourth principle in the policy on the management radioactive waste is 'the polluter pays' principle: waste producers pay for all costs of the management of the radioactive waste. COVRA includes all estimated costs for processing, storage and disposal in its charges, on the basis of the state of the art at that time. With the implementation of Directive 2011/70/Euratom, the obligation has been introduced to set off the research costs into disposal in the charges imposed by COVRA. For more information on costs estimates and financing of radioactive waste management see chapter 7.

1.3 Policy and any relevant requirements relating to the export/import of spent fuel and/or radioactive waste

1.3.1 Investigation of conditions for import and export

The national waste policy is designed for waste produced in the Netherlands. The current storage capacity at COVRA has been dimensioned for the expected volume of Dutch radioactive waste.

In parallel to the efforts aimed at international cooperation around management of radioactive waste, the possibility and desirability of imposing conditions on the import and export of radioactive waste substances for storage and/or disposal in the Netherlands will be investigated. The investigation of these conditions is an action point in the National programme.

1.3.2 Intergovernmental agreements

The Netherlands has entered into an agreement with France concerning the reprocessing of spent fuel originating from the Netherlands. In 1979, the Dutch and French governments signed an agreement in which the possible return to the Netherlands of spent fuel originating from the NPP Borssele following reprocessing is organised.[16] The Netherlands agreed to implement no statutory measures or draw up regulations which prevent COGEMA (now Orano, the organisation responsible for reprocessing of the spent fuel) from returning the radioactive waste produced during reprocessing to the Netherlands.

Because of the extension of the operating period for the NPP Borssele until at the latest the end of 2033, it was necessary to establish a new agreement between the Netherlands and France for the importing of spent fuel[17] into France. In the agreement, it is determined that the spent fuel from the NPP Borssele can be reprocessed at Orano. This spent fuel must have been imported into France between the moment at which this agreement became effective, and at the very latest 31 December 2049 (in connection with the dismantling). The Netherlands has accepted the obligation to take back the waste that is produced during reprocessing. The last return delivery of radioactive waste must have taken place at the latest by 31 December 2052.

1.3.3 Disused sealed sources

With respect to disused sources the regulation and policy give priority to the reuse of the source. When this is not possible, the preferred alternative is to return the disused source to the supplier. Classifying the disused source as radioactive waste, by transferring it to a waste storage facility, is considered to be the less preferred alternative. The licence holder is allowed to store radioactive waste onto its premises for the period of 2 years after cessation of use. Within this period, the radioactive waste must be transferred to COVRA.

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[16] Correspondence between the Government of the Kingdom of the Netherlands and the Government of the French Republic relating to an agreement in respect of the possible return delivery of the radioactive waste remaining following the reprocessing of irradiated reactor fuel, Paris, 29 May 1979.
[17] Agreement between the Government of the Kingdom of the Netherlands and the Government of the French Republic concerning the reprocessing in France of Dutch irradiated fuel elements, The Hague, 20 April 2012.

Sources, as any other radioactive waste, are destined for disposal in the geological disposal facility in due time. Regular inspections by the official inspection services ensure that individual sources can be tracked during their whole useful life by following the chain of records.

1.4 Scope of governmental, legal and regulatory framework for safety

1.4.1 Demarcation

The National programme covers all fissile materials and radioactive waste substances to which the Nuclear Energy Act (*Kernenergie wet* - Kew) applies, and for which no reuse is planned.

This includes:
- Radioactive waste produced in the Netherlands as a consequence of licensed actions and activities involving radioactivity (as intended in the Bbs);
- Spent fuel used in the Netherlands (as intended in the Bkse);
- Radioactive reprocessing waste;
- Orphan sources;
- Radioactive waste from the dismantling of Dutch nuclear reactors, cyclotrons and particle accelerators;
- Radioactive waste from possible future remediation of sites with radioactive contamination or of companies using naturally occurring radioactive materials (NORM).

The National programme does not cover:
- Radioactive waste materials (possibly) originating abroad;
- Depleted uranium and other residue from the enrichment of natural uranium, unless identified as radioactive waste;
- NORM-waste subject to compulsory reporting that is reused or disposed at designated landfills as very low-level radioactive waste. Herewith the scope of the National programme becomes equivalent to the scope of the Joint Convention report, in which the Netherlands reports internationally on radioactive waste. NORM-waste will be covered in the National programme 2025.
- Radioactive waste in the Netherlands Caribbean territories. The Nuclear Energy Act and the Euratom treaty do not apply in those territories.
- Spent fuel from the NPP Borssele which has been transferred to France for reprocessing, as long as it is at the reprocessing plant or in the cooling down phase before being transported back to the Netherlands.
- Waste originating from military or defence programmes, unless this waste has been transferred permanently to and managed within civilian programmes.

1.5 Allocation of responsibilities for safety and implementation of activities, noting the interdependencies

Ministry of IandWM – Directorate-general for the Environment and International Affairs
The State Secretary of Infrastructure and Water Management (IandWM) is accountable for nuclear safety, security and radiation protection, including policies concerning management of waste and their implementation. This responsibility is delegated to the Directorate-general for the Environment and International Affairs (DGMI). The director general for the Environment and International Affairs is therefore responsible for policy development with regard to nuclear safety, security and radiation protection and for the relevant national legislation, i.e., Nuclear Energy Act and Ministerial Decrees and regulations.

The State Secretary of Infrastructure and Water Management bears responsibility for the ANVS.

Ministry of Finance
The Minister of Finance is sole shareholder of COVRA and is responsible for the investment mandate on the funding for waste management. For more information, see chapter 7.

Regulatory body
The Regulatory Body (RB) ANVS is the authority designated by the government as having legal authority for conducting the regulatory processes, including issuing authorizations, supervision and enforcement, and thereby regulating nuclear safety, security and safeguards, radiation protection, radioactive waste management and transport safety. The regulatory tasks related to the management of radioactive waste and spent fuel are in the scope of the ANVS. The tasks and

responsibilities of the ANVS have been discussed during the IRRS mission in June 2023. For more information, see the IRRS self-assessment.

COVRA
COVRA is the national waste management organisation which has the task to manage the Dutch radioactive waste, now and in the future. Since 2002, 100% of the shares in COVRA are held by the State and this guarantees a system of long-term institutional control.

Licensee
The licensee bears prime responsibility for safe management of radioactive waste.

1.6 Provisions for human and financial resources, including responsibilities for these matters

Financial resources are addressed in chapter 7, human resources are addressed in chapter 8.

1.7 Responsibilities for R&D

The Ministry of Infrastructure and Water Management is responsible for research supporting the development of policies regarding radioactive waste management. The ANVS is responsible for research relating to its formal duties. COVRA is responsible for the development and implementation of the strategy and the technical solutions in line with the national policy and thus also for the plans and time schedules for R&D.

1.8 The decision-making process and mechanisms for taking account of social and economic aspects

The purpose of participation in the decision-making process on disposal is that around the year 2100 or as much earlier as necessary, a broadly supported choice will be made in the Netherlands on the future method of managing radioactive waste. Participation is above all also important for establishing mutual trust, building bridges and being open to the ideas of others such as citizens, governments, social organisations, scientists and other stakeholders. For a subject such as radioactive waste and disposal, this is essential. Furthermore, imposing a decision has proven to be relatively unsuccessful. Good cooperation and harmonisation between national and local governments is essential in order to arrive at a constructive decision-making process. See further in 1.8.2 on the research on participation by the Rathenau Institute.

1.8.1 Consultation

More information on the legal framework regarding consultation is given in chapter 2.

With respect to granting licences for the management of radioactive waste, there are several different consultation moments. During these consultation moments, everyone will be given an opportunity to present his or her opinion. In addition, the public is actively consulted in the case of policy or legislative changes.

The National programme was also made available for public consultation. In addition, the draft programme was submitted to the House of Representatives and Senate for political discussion.

1.8.2 Decision-making process, research Rathenau Institute

In the National programme, the establishment of a consultation group on the management of radioactive waste and spent fuel (Disposal Advisory Platform) was announced. To further define the mission of this consultation group, a number of interviews with national stakeholders (researchers, local and national government, waste producers and NGO's) were conducted. Lessons learned by countries with experience on public participation were also collected during interviews. The main conclusion of this research was that there is support for the establishment of such a consultation group in the Netherlands, but stakeholders agreed that this consultation group should have a more active role than solely acting as a sounding board. Therefore, instead of establishing one consultation group, it was decided to start a project in which a variety of stakeholders can participate.

From July 2019 till July 2024, the Rathenau Institute will lead this project called 'Toekomst Radioactief Afval'[18] (English translation: 'Future of Radioactive Waste'). This project has the following mission: organize a participative process to deliberate on a possible societal decision-making process on disposal of radioactive waste and spent fuel ('participation on participation') and advise relevant stakeholders on the results. The project consists of both the interaction of the dialogue with citizens, stakeholders and experts as well as research activities. The results and experiences will be consolidated in an advice to the State Secretary of Infrastructure and Water Management.

1.8.3 Communication practice of COVRA

Transparency and communication are an integrated part of the operations of the radioactive waste management organisation COVRA. Over the past decades, there has been a growing social awareness of the need for transparency and openness, and the dialogue with stakeholders in decision-making processes throughout the life cycle of radioactive waste facilities. Dialogue processes can enhance public awareness, trust and understanding and consist of interactions between waste management organizations, local municipalities, regulatory bodies, members of the public and environmental and civil society organisations.

In the Netherlands with a policy on long-term storage, COVRA has to maintain a dialogue with the local community and other stakeholders for over a century. Maintaining a long-term dialogue around an operational waste facility, is different than during a siting process. To create opportunities for dialogue, people need to notice you: you have to show yourself, standout, be proud of what you do, show that radioactive waste management can be done in not only a safe, effective and efficient manner but also with beauty. This is why COVRA's communication became not only factually and objectively, but also based on emotion.

Looking for opportunities to communicate requires creativity, thinking outside the box and sometimes even outside the nuclear field. In particular art is able create opportunities as it can connect divergent worlds. Using art you can reach the non-technical part of the population, which is by far the majority. COVRA uses its buildings as canvasses to tell stories about radioactive waste and the long-term involved in the management of it. It aims to bring the work done inside closer to the people and shows that safe can be beautiful. An important element in the dialogue with stakeholders is inviting people to the facility. Site visits are an effective way to facilitate the dialogue about radioactive waste as visitors can form an opinion on the storage based on their own experience. After the tour visitors generally take a more positive attitude towards COVRA. Social media and other online communication tools are also great opportunities for building relationships with stakeholders.

For more information on the communication practice of COVRA, see annex 2 of the JC report 2020.

1.9 Due account of waste minimization and graded approach

The Bbs (Article 10.1), states that the National programme should include the implementation of the policy principle regarding the minimization of radioactive waste. Further elaboration on this policy principle is given earlier in chapter 1.

The policy on management of radioactive waste follows a graded approach. Also, the implementation of the policy at COVRA follows a graded approach, COVRA has dedicated buildings for high-level waste, low- and intermediate-level waste and NORM-waste. For more information on the waste classification system, see chapter 4 and for more information on the storage buildings at COVRA, see chapter 5.

1.10 Measures to ensure that the policy covers all waste streams, including legacy and orphaned waste at all stages of the process

To ensure that policies and legislation covers all waste streams, the Ministry of IandWM asked the Institute for Public Health and the Environment (*Rijksinstituut voor Volksgezondheid en Milieu* - RIVM) to perform a complete study of all waste streams in the Netherlands. The report of this study has been published in 2022[19]. For more information, see chapter 4.

[18] https://www.rathenau.nl/nl/dossier-advies-besluitvormingsproces-toekomst-radioactief-afval
[19] https://www.rivm.nl/publicaties/radioactieve-rest-en-afvalstromen-in-nederland-inventarisatie

2 Legal, regulatory and organizational framework

2.1 Arrangements for safe management of RW and SNF in the legislation

2.1.1 All types of radioactive waste and spent fuel from all producers in the Netherlands

General legislation, for example legislation for the protection of the environment and general legislation on the granting of licences or the availability of government information for the public apply to nuclear safety and radiation protection as well.

Nuclear Energy Act (Kernenergiewet - Kew)
The basis of the legislation in the Netherlands governing nuclear activities and radiation protection, including radioactive waste management, is contained in the Nuclear Energy Act. The Nuclear Energy Act is a framework law, which sets out the basic rules on the application of nuclear technology and materials, makes provision for radiation protection, designates the competent authorities and outlines their responsibilities. More detailed legislation is provided by associated Government Decrees, Ministerial and ANVS-Regulations.

Operation of a nuclear facility can only be conducted in accordance with a license issued under the Nuclear Energy Act. The licenses for nuclear installations also include general aspects of the environment and the possible impact on the environment. With regard to nuclear facilities, the purpose of the Nuclear Energy Act, according to its section 15b, is to serve the following interests:
- The protection of people, animals, plants and property;
- The security of the State;
- The security and safeguarding of nuclear material;
- The liability for damage or injury caused to third parties;
- The compliance with international obligations.

A number of Governmental Decrees under the Nuclear Energy Act have been issued and these continue to be updated in the light of ongoing developments. Important Decrees in relation to radioactive waste and spent fuel are:
- The Nuclear Installations, Fissile Materials and Ores Decree (*Besluit kerninstallaties, splijtstoffen en ertsen* - Bkse);
- The Basic Safety Standards for Radiation Protection Decree (*Besluit basisveiligheidsnormen stralingsbescherming* - Bbs);
- The Fissile materials, Ores and Radioactive materials Transport Decree (*Besluit Vervoer splijtstoffen ertsen en radioactieve stoffen* - Bvser);
- Radioactive waste and Fissile materials (Import, Export and Transit) Decree (*Besluit in-, uit- en doorvoer van radioactieve afvalstoffen en bestraalde splijtstoffen* - Biudrabs);
- The Radioactively contaminated Scrap metal Detection Decree (*Besluit detectie radioactief schroot*).

Amendments in the Nuclear Energy Act need parliamentary approval by vote. Draft Governmental Decrees are offered to parliament to give an opportunity for examination, input and debate, whereas Ministerial Regulations or ANVS-Regulations are not submitted to parliament for input or vote. Ministerial Regulations can be issued by the responsible Ministers on the basis of the relevant Decree. See the figure below for the hierarchical structure of the Dutch legal framework. In addition to the levels shown in the figure, there are international conventions and other legal instruments related to nuclear safety and radiation protection that also apply.

The Nuclear Energy Act regulates all types of spent fuel and radioactive waste from all producers in the Netherlands, including radioactive waste of natural origin (NORM-waste).

The Nuclear Energy Act (Kew) forms the basis for the legislation on nuclear safety and radiation protection.

Governmental Decrees and Ministerial Regulations contain additional regulation.

ANVS-Regulations give additional rules for certain topics.

Guidelines are safety requirements that are not binding unless referred to in the license.

Various industrial codes and standards are part of the licensing base.

Figure 2.1: Simplified representation of the hierarchy of the Dutch legal framework.

Figure 2.2: Schematic overview of national legislation for activities with ionizing radiation.

Nuclear Installations, Fissile Materials and Ores Decree (Bkse)
The Bkse is mainly concerned with issues of nuclear safety and security and sets out additional regulations in relation to nuclear facilities and fissile materials in a number of areas, including the license application for the construction, commissioning and operation of a facility for the storage of fissile materials, including spent fuel, and associated requirements.

The Bkse furthermore includes legislation on decommissioning and financial provisions for the costs of decommissioning of nuclear installations. It requires the license holder to have and periodically (every five years) update a decommissioning plan during the lifetime of the facility and submit it to the authorities for its evaluation and decision of approval of the ANVS.

Based on the Nuclear Energy Act and the Bkse, license holders of a nuclear installation must have a decommissioning plan approved by the ANVS. The Bkse specifies the minimum requirements on the content of the decommissioning plan. The decommissioning plan sets out safety conditions for all the activities carried out during the decommissioning phase, and it provides the basis for the financial provisions for the decommissioning costs. The decommissioning plan must be updated at least once every five years.

Based on the 'polluter pays' principle, it is important that the costs arising from the decommissioning and dismantling are covered. Therefore, license holders of a nuclear installation with a nuclear reactor are also required to have a financial security approved by the State Secretary of Infrastructure and Water Management and the Minister of Finance for the costs of decommissioning and dismantling, which must also be updated at least once every five years.

The Bkse stipulates further that the relevant sections of the Bbs and the underlying regulations about the protection against ionizing radiation also apply to fissile materials, including spent fuel.

The Basic Safety Standards for Radiation Protection Decree (Bbs)
The Bbs regulates radiation protection and contains requirements with regard to the management of radioactive waste. Radioactive material for which no further use is foreseen, can be classified as radioactive waste (Bbs Article 10.7). For the disposal of radioactive waste, a license is required (Nuclear Energy Act Articles 15 and 29). However, an authorized user of radioactive material is allowed to remove the radioactive material from the site without a license, in a limited number of ways (Bbs Article 10.6):

- If the (activity) concentration is below the general clearance levels, as applicable;
- In the case of sealed sources, if return of the source to the manufacturer or supplier of the source is agreed and contracted;
- In case of NORM, there are some possibilities to enable reuse of these materials; by transfer to another individual or legal person for use, reuse or recycling of this radioactive material or for collection and pre-treatment of radioactive waste, provided that this person holds a valid license for this material;
- By transfer to a recognised waste management organisation. COVRA is the only recognized organisation for the collection, treatment and storage of radioactive waste;
- By transfer to another designated organisation (landfills) for the collection of radioactive waste;
- In the case of specific clearance, other options than a transfer to COVRA are possible when the material is below specific clearance levels and the exposure of workers and the public is limited by additional measures or by permitting, for example, only one specific application (conditional clearance).

Licensees are required to deliver their radioactive waste (excluding waste that can be disposed at a landfill) or fissile materials for which no further use is foreseen or spent fuel which is not destined for reprocessing, to COVRA. The underlying philosophy is that, because of the relatively small amounts of waste to be managed, only a centralised approach can ensure an adequate level of professionalism in the management of the waste. Therefore, most requirements are established in the license of COVRA and only a few generic rules exist for spent fuel and radioactive waste management facilities.

Fissile materials, Ores and Radioactive materials Transport Decree (Bvser)
The Bvser deals with the import, export and domestic transport of fissile materials, ores and radioactive substances, including radioactive waste and spent fuel, by means of a reporting and licensing system.

Radioactive waste and Fissile materials (Import, Export and Transit) Decree (Biudrabs)
The import, export and transit of radioactive waste and spent fuel is regulated by the Biudrabs. This Decree is the implementation of Council Directive 2006/117/Euratom and is aimed to control shipments of waste between EU Member States and between EU Member States and countries outside the EU.

Disused sealed sources
All import, manufacturing, storage, use, export and disposal of radioactive sources with a radioactivity content in excess of the clearance limits, specified in Annex I of the Euratom Basic

Safety Standards[20] and implemented in the Bvser, the Bbs and subordinate regulation, must be licenced. A licence will only be granted if a qualified expert is available who is knowledgeable with respect to the hazards of ionizing radiation. Persons are considered qualified to use a radioactive source if they have completed a radiation protection course at a level in accordance with the hazard of the source and successfully passed an exam. Transport of disused sealed sources usually does not require a licence but is subject to notification of the ANVS.

Council Directive 2003/122/Euratom aims to further restrict exposure of the population to ionizing radiation from high activity sealed sources (HASS), including orphan sources. This Directive requires that the possession and use of each high activity sealed source is licenced, that it is uniquely identified with a number embossed or stamped on the source and that countries keep a registry of all licence holders and sources. It further provides for financial arrangements to ensure that the costs for management of disused sources are covered by the licence holder. In cases where no owner can be identified, the State will cover the costs. The provisions of this Directive are fully implemented in the Bbs and subordinate regulation. After Council Directive 2013/59/Euratom was implemented (February 2018), the transport of HASS is subject to licensing.

In Articles 22 and 33 of the Nuclear Energy Act a mechanism is put in place in which recovered orphan sources, for example lost sources, should be notified to the mayor of the municipality or the city where the sources are found. Subsequently one of the competent inspection services is alerted, which is authorized to impound such source and have it transferred to one of three appointed institutes, which are equipped to store the source. However, most orphan sources are found during routine radiation monitoring of scrap material with portal monitors at scrap yards. Operators working with large volumes of scrap or highly active sources have statutory obligations for securing the management of these radioactive sources. The competent authorities, the ANVS, the Netherlands Labour Authority and the Dutch State Supervision of Mines (SodM) inspect on compliance with legislation and regulations regarding sealed sources. Their scope covers safety and security aspects.

The Environmental Protection Act (Wet milieubeheer - Wm)
The Wm states that under certain conditions (depending on size and nature of modifications), an independent Commission for Environmental Assessments must be established and in these cases, it should be consulted when it is decided that an Environmental Impact Assessment (EIA) needs to be submitted. The dedicated organisation for this procedure, is called the Netherlands Commission for Environmental Assessment (*Commissie voor de milieueffectrapportage* - Cmer). The types of activities for which such assessments are required are specified in the Decree on environmental impact assessment. The Cmer can be asked to advise on the requirements of all EIAs conducted in the Netherlands, including those related to nuclear facilities. Participation is also compulsory in the procedures with an environmental impact report. The environmental impact report procedure can include meetings where the licence holder, the authority (ANVS) and the public participate. The public can present its views on proposed decisions, and the competent body will respond in its decisions. There are opportunities for individual citizens to appeal, if they disagree with a decision.

General Administrative Act (Algemene wet bestuursrecht - Awb)
The Awb is the law that governs the activities of administrative agencies of government and the interaction of the public in the procedures (i.e., objections and appeals). The Awb applies to virtually all procedures in administrative law, including the Nuclear Energy Act. It thus also details the general procedures for the oversight and the enforcement and related to the latter the possible sanctions. The Awb also provides for procedures regarding publication of information of draft decisions, like those needed to award a licence. These need to be published in the Dutch Government Gazette (*Staatscourant*), and in some cases the national and/or local press.

The Awb has a short and an extensive preparation procedure. The Nuclear Energy Act specifies which procedure applies to which decision. In the case of an extensive procedure, the ANVS makes a draft decision. Under the General Administrative Act, documents provided with an application for a licence are to be made available for participation by the public. Everyone is free to lodge written or oral opinions on the draft decision. All views made to the draft version of the decision are taken into account in the final version. Everyone who has expressed views to the draft decision (or cannot reasonably be accused of not having expressed a view) or any stakeholder is free to appeal to the Council of State (the highest administrative court in the Netherlands) against the decision

[20] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of health of workers and the general public against the dangers of ionizing radiation, Official Journal of the European Communities, 1996, 39 (L159) 1-114.

by which the licence is eventually granted, amended or withdrawn. All new acts and governmental decrees are published on the internet (www.officielebekendmakingen.nl). This website includes the publications of the Official Journal (*Staatsblad*), the Official Gazette and all publications of the parliament. In the case of a short procedure, there is only a final decision. Any stakeholder is free to appeal to object to the ANVS and afterwards to the Council of State.

In drawing up regulations, public participation is effectively indirectly achieved via parliament.

With regards to the management of spent fuel and radioactive waste, via the procedures, the public is able to participate in the decision-making processes involving licensing for installations in which spent fuel and/or radioactive waste are managed.

Open Government Act (Wet open overheid - Woo)
The Woo regulates the right of citizens to obtain governmental documents and public information from the government[21].

2.1.2 International conventions and legal instruments related to the management of radioactive waste and spent fuel

The Netherlands is party to many other Treaties and Conventions related to the management of spent fuel and radioactive waste and has implemented the obligations and requirements under these legal instruments in the Nuclear Energy Act and in associated Decrees and regulations. The Netherlands, as a Member State of the European Union, is required to implement Euratom Directives that are established in collaboration with the other Member States in its own national system of legislation. Directive 2011/70/Euratom of the European Council dated 19 July 2011 on the establishment of a community framework for the responsible and safe management of spent fuel and radioactive waste was implemented in the Bbs and in the Bkse.

Nuclear safety
- The Netherlands is party to the Convention on Nuclear Safety, the CNS.
- EU-legislation: the Netherlands has implemented Council Directive 2014/87/Euratom of 8 July 2014 amending Council Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations. The safety objectives of the Directive cover those of the Convention on Nuclear Safety and are in some regards more specific and have a larger scope.
- The legislation also prescribes that:
    - License holders should give sufficient priority to nuclear safety systems;
    - License holders must provide adequate human and financial resources to meet the obligations on the nuclear safety of a nuclear installation;
    - All parties, including the license holder, are required to provide a mechanism for educating and training their staff responsible for the safety of nuclear installations to meet the expertise and competence in the field of nuclear safety to be maintained and developed.
- The transposition of the amended Nuclear Safety Directive in Dutch legislation was completed in 2017 and resulted in a Ministerial Regulation on Nuclear Safety.

Radiation protection
- The Netherlands has implemented Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. This Directive has been fully implemented in the Bbs.

Spent fuel and radioactive waste management
- The Netherlands is party to the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive waste management.
- EU-legislation: the Netherlands has implemented Directive 2011/70/Euratom of 19 July 2011 'establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste'. Directive 2011/70/Euratom has been fully implemented in the Bbs and in the Bkse.
- Based on this EU-Directive the Netherlands has drafted the required 'National programme for the management of radioactive waste and spent fuel'.

[21] For instance, see https://business.gov.nl/regulation/freedom-of-information/

Physical protection

- The Netherlands is party to the Convention on Physical Protection of Nuclear Material and Nuclear Facilities. In addition, the Netherlands has also expressed its support for the following 'Codes of Conduct':
  - 'Code of Conduct on the Safety and Security of Radioactive Sources' (published 2004, IAEA);
  - 'Code of Conduct on the Safety of Research Reactors' (published 2004, IAEA).

Non-proliferation and safeguards

- The Netherlands is party to the 'Treaty on the Non-Proliferation of Nuclear Weapons', the non-proliferation treaty of the United Nations (UN). Related to this are the guidelines from the 'Nuclear Suppliers Group' that lay down restrictions on the transfer of sensitive nuclear techniques such as enrichment and reprocessing.
- The Netherlands is party to the safeguards agreement between the IAEA, Euratom and Euratom's non-nuclear weapon Member States and has in force the Additional Protocol and the Comprehensive Safeguards Agreement. In addition, the Netherlands is affiliated to the 'Proliferation Security Initiative', based on Resolution 1540 of the UN Security Council for the Non-proliferation of Weapons of Mass Destruction.

2.1.3 Transboundary movement

The Netherlands, as a member state of the European Union, has implemented Directive 2006/117/Euratom[22] in the Biudrabs. This directive sets out similar requirements as the ones specified in paragraphs (i)-(v) of Article 27 of the Joint Convention. Under these regulations, imports and exports of radioactive waste require a licence to be issued by the ANVS. Licence applications for a transboundary shipment of radioactive waste should be made to the ANVS using the standard document laid down in Directive 2006/117/Euratom.

A licence is required in order to transport, import, export, be in possession of or dispose of fissile materials and ores. This is specified in Section 15, sub a of the Nuclear Energy Act. The licensing requirements apply to each specific activity mentioned here. Under Article 29 of the same Act, a licence is required in a number of cases (identified in the Bbs for the preparation, transport, possession, import or disposal of radioactive material, including radioactive waste.

Spent fuel destined for reprocessing is not considered as radioactive waste. However, with a view to the quantities and high radioactivity levels, these shipments are also subject to the provisions of Directive 2006/117/Euratom and need an import and export licence.

In addition to that, for transport inside the Netherlands, depending on the material, a transport licence or transport notification is required based on the Nuclear Energy Act. The transport shall be in compliance with the international transport regulations covering aspects such as transport safety, radiation protection, package design approval certificates and physical protection measures. Paragraph 2 of Article 27 of the Joint Convention derives from the Antarctic treaty to which the Netherlands is a party.

Concerning paragraph 3 of Article 27 of the Joint Convention, the Netherlands has implemented the international agreements on the transport of radioactive materials for the different modes of transport as released by ICAO (air transport), IMO (sea transport), ADR (road transport), RID (rail transport) and ADNR (transport over inland waterways). The provisions in these agreements[23] are not affected by the Joint Convention.

2.1.4 Provisions in your legislation to ensure the establishment and maintenance of the necessary competences and skills

The Nuclear Energy Act requires that an application for a licence for a nuclear facility shall contain an estimate of the total number of employees plus details of their tasks and responsibilities and,

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[22] Directive 2006/117/Euratom of the Council of the European Communities of 20 November 2006 on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community.

[23] International Civil Aviation Organisation (ICAO), Technical Instructions; International Maritime Organisation (IMO), International Maritime Dangerous Goods Code; Accord Europeen relatif au Transport de Marchandises Dangereuses (RID); Réglement International concernant le Transport des Marchandises Dangereuses par Chemins de Fer; Réglement pour le Transport des Matières Dangereuses sur le Rhin (ADNR).

where applicable, their qualifications. This includes supervisory staff. The licence holder has to submit its education and training plan for information and approval by the Regulatory Body. These requirements apply also to COVRA.

2.1.5 Provisions in your legislation to allow the RD&D required to support the technical solutions and maintenance of skills

See chapter 7 and 8.

2.1.6 Financing arrangements to ensure availability of funds for safe and timely management of radioactive waste and spent fuel

See chapter 7.

2.2 How responsibilities are assigned and how this is documented

2.2.1 Preparing the strategy, programme and updating where necessary

In Bbs Article 10.1 and Bkse Article 40a, the State Secretary of IandWM is made responsible for preparing and publishing a National programme. Updates are carried out according to Directive 2011/70/Euratom.

2.2.2 Review and approval of the National programme

The National programme is presented to the parliament for approval.

2.2.3 Implementation of the various activities in the National programme/Provisions to manage interdependencies between the steps

A framework for decision-making and implementation has been put into place in the beginning of 2023. The Ministries of Economic Affairs and Climate Policy, Health, Welfare and Sports, Finance, Infrastructure and Water Management are participating in this framework. The ANVS has a consulting role.

2.2.4 Monitoring progress with implementation

Monitoring the progress with the implementation of the various activities in the National Programme goes through reports to parliament and the European Commission. Updates on progress with implementation are sent to parliament twice a year or more often if relevant.

2.2.5 Regulatory supervision of spent fuel and radioactive waste management

The ANVS supervises all regulations concerning radiation protection and nuclear safety, including radioactive waste and spent fuel. See IRRS self-assessment for more information.

2.2.6 Transfer & delegation of responsibilities (waste or spent fuel ownership at various steps, provisions in the event of non-availability of the responsible organization)

See IRRS self-assessment for more information.

2.2.7 Responsibilities of competent bodies during the post-closure period and, if applicable, foreseen transfer or ending of responsibilities

The post closure period for a disposal facility is not yet addressed in legislation or policies. The State has ultimate responsibility for safe management of the waste. This is not limited to the interim storage period.

2.2.8 Planning and delivery of the required RD&D

The National programme sets the framework and timeline for RD&D.

2.2.9 Planning and delivery of the required education and training

See IRRS self-assessment for more information.

2.3 Regulatory provisions and implementation

See IRRS self-assessment for more information.

3 Strategy

3.1 Implementation plan for the national strategy

The national strategy is quite straightforward:

- All radioactive waste and spent fuel that has been labelled as waste must be brought to COVRA as soon as possible and be stored there until a long term solution is available;
- NORM-waste with activity concentrations up to 10 times clearance levels or waste under specific clearance may be disposed of at designated landfills;
- Legacy waste that was stored at the Nuclear Research Group (NRG) in Petten is being transferred to COVRA.

Safe management of radioactive waste and spent fuel
The principle behind the policy on radioactive waste is that radioactive waste must be managed safely as long as it represents a risk to man and the environment. In the Netherlands, the chosen option is central interim storage for a period of at least 100 years in dedicated storage facilities and buildings, after which disposal is envisaged. This disposal facility should be operational by around 2130. The rationale behind a period of at least 100 years is that this period is necessary in order to save sufficient waste and sufficient money to create a disposal facility.

Safe management now: storage
Radioactive waste is produced at various locations in society. The Netherlands has a limited volume of high-level radioactive waste. To achieve the safe management of the radioactive waste, the policy is focused on isolating, managing and controlling (IBC-principle). For the management of radioactive waste, specific measures, infrastructure and expertise are essential. In the Netherlands, the decision was taken in 1984 to entrust the allocation of this policy to a single specially established organisation (COVRA). The central collection, processing and storage of radioactive waste also ensures the fulfilment of other key aspects such as environmental hygiene, cost effectiveness and occupational hygiene.

Radioactive waste must be transported to COVRA as soon as reasonably achievable. COVRA has been authorized for the collection and reception of radioactive waste. All responsibilities for the waste are transferred from the operator to COVRA, when the waste is being transferred to COVRA. As a result, COVRA becomes owner of the radioactive waste.

At the COVRA site, the waste is stored aboveground for at least 100 years in specifically designed buildings. Already in the design of these buildings and in the specific features of the waste packaging account was taken with a period of at least 100 years. This storage method is unique in the world. The period of aboveground storage for at least 100 years offers the following advantages:

- Over the period of 100 years, the volume of radioactive waste that has to be disposed of can grow, as a result of which operating costs per unit of waste could be reduced, in addition to which new technical advances could take place for the most efficient and cheapest method possible of disposing of the waste.
- The period of 100 years can also be used for allowing money placed in specific provisions to accumulate. The aim is to use this money to cover the costs for the long-term storage and the preparation, construction, operation and closure of the disposal facility.
- Within the period of 100 years, part of the radioactive waste will decay to below the release threshold. As a result, this part of the waste need no longer be placed in the disposal and may possibly be suitable for reuse.
- During the period of aboveground storage, the heat-producing waste will cool to a temperature at which it is easier to handle and to dispose of.
- Since no choice has yet been made for a location for the disposal facility, this period can be used to make a selection of a suitable location in consultation with society.
- There is more time to learn from experience acquired abroad in building and operating disposal facilities.
- There is more time to carry out research into the best management method for the long term.
- In the future, international (for example regional disposal in Europe) or new technical solutions could become available (such as partition and transmutation whereby long-lived radionuclides are separated and converted into shorter-lived radionuclides).
- Future generations will be given an opportunity to choose a long-term management method on the basis of their own understanding, with the least possible burden.

Following the period of aboveground storage of radioactive waste at COVRA, geological disposal for HLW, low- and intermediate-level waste (further: LILW) and NORM-waste is planned. The table below provides an overview of the interim and definitive management methods for the various categories of radioactive waste. Radioactive waste which following storage at COVRA remains classified as radioactive waste, will be placed in one disposal facility. If the radioactive waste has decayed to below the release thresholds, it can be released for reuse or processed as conventional waste. This applies to two thirds of the LILW stored at COVRA.

Category radioactive waste	**Interim management**	**Long-term management**
HLW	Storage at COVRA	Geological disposal[24]
LILW	Storage at COVRA	
NORM, subject to licensing	Storage at COVRA	
NORM, subject to notification (i.e.: up to 10x the general clearance level)	-	Designated landfill
Radioactive waste with $T_{1/2} < 100$ days decaying below clearance levels in 2 years	-	Reuse or reprocessing as conventional waste
Radioactive waste decaying below clearance levels in 50 years	Storage at COVRA	
Radioactive waste below clearance levels	-	
When applicable: radioactive waste between general and specific clearance levels	As specified in the requirements for the specific clearance	As specified in the requirements for the specific clearance

Table 3.1 Overview of management routes.

Safe management in the future: disposal
Responsibility for radioactive waste does not end following the period of aboveground storage. HLW and long-lived LILW must be managed for many thousands of years before the radiation levels have fallen to such an extent that they no longer represent radiation risks. Aboveground storage is a temporary solution that offers no alternative for disposal. There is no guarantee that the chain of active management necessary for aboveground storage will or can be maintained over such a long period. Passive safety is one means of guaranteeing safety over a longer period. This passive safety is achieved by means of geological disposal.

For that reason, also by international consensus, geological disposal is viewed as the only safe means of managing long-lived radioactive waste for the long term. In the case of disposal, it must be demonstrated that the population is sufficiently protected against the effects of exposure to radiation, now and in the future, in all stages of waste management. This extends to include the quality of the groundwater and the drinking water extracted therefrom.

The earth is made up of different layers or strata. Some of these layers deep underground have been stable for millions of years. There is international consensus that stable geological layers are suitable for the disposal of radioactive waste. In the Netherlands, certain clay layers and rock salt layers/domes are in principle suitable for geological disposal. A feature of these layers is that they are self-healing; should empty spaces or cracks in the geological layer occur during the excavation of the disposal site, these will disappear due to the plasticity of the layer.

The radioactive waste will be carefully placed in excavated galleries, taking account of the volume of heat and radiation still being released by the waste. Following the placement of the waste, the galleries will be backfilled in phases, so that the geological layer becomes a compact unit (closure of the disposal facility). Following closure of the disposal facility, it will be considered passively safe. This means that future generations are no longer required to manage or maintain the disposal facility. Humans will be protected by placing a series of (both natural and artificial) barriers (‘defence in depth’) between the radioactive waste and the human environment: enclosure, delay and isolation.

The packaging of the waste is an artificial barrier that ensures that the waste is enclosed. The packaging materials will be designed in such a way that they enclose the waste for the first few

[24] Radioactive waste that has decayed till below exemption levels at the time of disposal will be treated as conventional waste.

thousand years. Over this time, the heat-producing waste will cool down, and the remaining waste will decay, resulting in an even lower radiation burden. At the point in time when the packaging degrades, the clay or salt layer will ensure that the radionuclides move towards the surface at a delayed rate. Radioactive decay means that most radionuclides will not even reach the surface. In addition, the depth of the geological disposal forms the final barrier: isolation from the human environment. In this way, people and animals cannot access the disposal facility, and the depth also protects against human penetration. International research has shown that methods are available for adequately determining the long-term safety of geological disposal. Since that time, these methods have been improved by further development. The safety case, in which the evidence for safety is considered in its entirety, is an example of the further development of these measures. Knowledge of the underground environment is combined internationally, in order to gain a greater understanding of the behaviour of that environment and of the processes and issues which could disrupt the safe disposal of radioactive waste, and how this might happen.

For more information on the strategy of COVRA for achieving the goals and requirements set out in the national policy for the safe management of spent fuel and radioactive waste, see chapter 5.

3.1.1 Overview of management plans for all the SF & RW streams/types management steps, from generation to disposal

See chapter 5.

3.1.2 Key drivers for implementation (e.g. programme priorities, timing, safety aspects, public and political interest, RD&D needs)

Storage capactity
Needs for extention of specific facilities at COVRA are under responsibility of COVRA. COVRA provided the waste inventory together with a prognosis of waste volumes until 2050 and an estimation of waste volumes until 2130. This includes scenarios with a possible LTO (Long Term Operation) of 10 years of the NPP Borssele and the building of two new NPPs, a new research and medical isotope production reactor (PALLAS) and a new nuclear installation for the production of medical isotopes (SHINE). See chapter 4 and the inventory by COVRA for more information.

Roadmap
For the National programme 2025 a roadmap[25] to disposal will be developed. Designing and implementing such a roadmap was put forward during the evaluation of the Dutch policy for the management of radioactive waste and spent fuel. The parliament has been informed that a roadmap will be designed and that the roadmap will become part of the National programme 2025. In this way, the roadmap will be updated periodically. This roadmap will include the necessary steps for several paths such as research, participation, decision-making processes, developments of legislative framework and knowledge management. The roadmap is a mean to make progress towards disposal and take responsibility towards future generations. The roadmapwill include timelines for the development of necessary knowledge, the decisions that must be taken and the parties involved, the necessary developments in legislation and regulations and the organization of participation and consultation. The roadmap will also include the dual track approach, and a milestone for the decision on whether to choose for a national or an international solution.

New technologies
The possible extention of the nuclear programme and building of new facilities for medical isotopes do not change the fundamentals of the Dutch policies for radioactieve waste and spent fuel. However, building new facilities implies that more waste will be produced than was earlier anticipated in the inventory of 2130. The Dutch governement will improve communication and dialogue with its citizens in order to assure confidence in existing policies and its possible developments, as increased interest in nuclear energy also means an increased interest in how radioactive waste (HLW mainly) is dealt with. A website has been launched to provide more information (www.overkernenergie.nl). Plans for communication and participation are being put together at the time of writing this self-assessment.

[25] Parliamentary papers, Session year 2022-2023, 32645, no. 102.

3.1.3 Main milestones and timeframes for achievement

(NR 2021, page 74)
The most important milestones and their timetable appear in the National programme in paragraphs 7.1 and 7.2. These include:

- Defining criteria for the start of the first environmental impact report: the potential environmental effects of disposal must be considered in the decision-making, and this will take place in the future in the form of an environmental impact report. The definition of criteria is planned for 2030.
- Reporting on the implementation of the National programme; a national report must be submitted in a three-yearly cycle to the European Commission.
- The National programme is updated at least every ten years; the first version of the programme was submitted to the Commission in 2016. The next update will be sent to the European Commission and the Dutch parliament in 2025.
- Drawing up a waste inventory: the latest inventory was published in 2022. According to the requirement of Directive 2011/70/Euratom, a new inventory is presented every 3 years.
- Establishing a Disposal Advisory Platform: the Rathenau Institute will present an advice on a participative decision-making process in 2024.
- Closure of the NPP Borssele: closure of the only nuclear power plant still operational in the Netherlands is planned for 2033. However, a LTO of 10 years is considered.
- Reception of last waste from reprocessing of spent fuel in the Netherlands is agreed at the latest in 2052. This is related to the actual life time of the NPP Borssele.
- End of period of aboveground storage at COVRA: the buildings at COVRA are suitable for safe storage of the radioactive waste for the next 100 years, and due to periodic maintenance the lifecycle of these buildings can certainly be extended to 300 years. Geological disposal is envisaged in 2130. Around 2100, a decision will be taken on the follow-up process.

3.1.4 Key performance indicators to monitor progress

(National programme, page 44)
Performance indicators are indicators of the progress of the National programme. Reports are issued in the three-yearly reporting cycle on the National programme, in respect of the following performance indicators:
Financing – Amount available for disposal is sufficient for preparation, construction, operation and closure of the disposal facility;
Status action points – Timely implementation of the action points from the action list;
COVRA capacity – Volume of space available is sufficient for the expected volume of Dutch radioactive waste. In the last inventory, this aspect has been adressed with particular attention because of the new build plans (NPPs and facilities for the production of medical isotopes).
The National Institute for Public Health and the environment is asked to work on a proposal for KPIs. The project is foreseen to be starting in 2024.

3.1.5 Ways and means for managing in the event of programme delays, changes or unavailability of services

The main way to manage programme delays goes through interaction with the Dutch parliament. International commitments, such as reports to the European Commission or the IAEA are adressed in letters to parliament. In this way, international commitments are also commitments to our national parliament. All commitments to the parliament are registered and follow up of (inter)national commitments is kept up even when elections have taken place. See an example in Parliamentary papers, Session year 2022-2023, 32645, no. 102.

One important instrument in managing the National programme is still to be designed and implemented: the roadmap to disposal. See 3.1.2 for more information.

3.1.6 Provisions for public consultations and participation in the decision-making

See chapter 2 for information on the regulatory framework on consultation and participation in the decision-making.

The Rathenau Institute is preparing an advice on decision-making when it concerns the geological disposal facility. The advice will be published in 2024. This is a voluntary activity. See chapter 1 for more information.

At this moment, participation issues related to radioactive waste and spent fuel are also discussed in the context of the possible LTO for the NPP Borssele and the possible new build of NPPs.

A strategic environmental impact assessment (SEA) is being performed for the National programme.

Procedures concerning the SEA and licensing are subject to consultation.

3.1.7 Process for development, review, approval and update (when last)

Developments are driven by political decisions (such as the coalition agreement), (inter)national developments and the international commitments, such as conclusions of peer reviews.

3.2 Progress made with its implementation

The status of the action points/milestones as mentioned in chapter 7.1.1 of the National programme is given in the table below.

The transfer of legacy radioactive waste from Petten to COVRA.	In progress (see chapter 5).
Release thresholds for materials, buildings and sites.	Accomplished. The completion and publication of a guide for the release of materials, buildings and sites following dismantling of a nuclear installation was finalised by 31 December 2017. In addition, the National Institute for Public Health and the Environment has published an advise on standards for the clearance of sites. The Ministry of IandWM is currently working on the implementation of that advise.
Decay storage.	Accomplished. Current practice: licence holders may store their radioactive material for 2 years at their own site. COVRA used to offer the possibility to store materials at their facilities for 25 years to decay below the clearance levels, without being reprocessed, but has extended this period to 50 years. During decay storage, materials can decay to below the release threshold, and then be safely released for reuse or discharged to a conventional waste processor. In addition extension of decay storage possibilities is being investigated by COVRA (see chapter 1).
Imposing rules on import and export, storage and disposal of radioactive waste from abroad.	Policy in progress. Research has been done by the National Institute of Public Health and the Environment on secondary waste and on regulation of imports of NORM-residues in surrounding countries.
Financial aspects in the decommissioning plan of a facility.	Modification of legislation for nuclear facilities is nearly completed. Certain licence holders of non-nuclear facilities are obliged to submit a decommissioning plan which contains a description of the required financial provisions. An inadequate decommissioning plan is one of the grounds for not granting a licence. The decision which licence holders are obliged to submit a decommissioning plan is based on the nature and size of the radiological risks involved (graded approach). The obligation for financial assurance for decommissioning of major non-nuclear facilities is in a more preliminary phase and currently being investigated.
Investigating the consequences of new European basic standards on the volume of radioactive waste.	Accomplished. The Bbs was implemented in February 2018. A report on streams of radioactive waste has been published in October 2022. Amounts of waste per industrial sector have been updated.
Environmental impact assessment of disposal.	On schedule, planned to be finalised at the end of 2030.

	A process has started to set up a strategic environmental impact study for the new National programme. The Report should be ready by the end of 2024.
Reporting on implementation of the National programme.	Every three years reports to the European Commission are drafted and published.
Updating the National programme on radioactive waste.	The first update of the NP is planned for 2025.
Drawing up a waste inventory.	Accomplished. See chapter 4.
Appointing a consultation group.	In progress, see chapter 1 on research by Rathenau Institute.
Analysis of online debate.	A broader participation plan has been established.

Table 3.2: Status of the action points/milestones.

3.3 Recent modifications since earlier plans and why

In a letter to parliament (9 December 2022[26]), the government declared to favour reprocessing of spent fuel from NPPs rather than direct storage of spent fuel at COVRA without reprocessing it. Driving force behind this policy accentuation is the intent of the government in the coalition agreement of December 2021 to support the LTO of the NPP Borssele and support the build of two new NPPs. Main argument to support reprocessing is that there is less waste to be managed while the nuclear programme is growing.

On 21 March 2022[27], a new assessment framework to allow acceptance of alternative packages of reprocessing fuel has been sent to parliament. The assessment framework came into force in January 2023. There is still work to be done to complete the implementation of this assessment framework. Driving force behind this new policy was a request of the NPP Borssele to allow more flexibility in the packages of reprocessing waste returning to the Netherlands.

[26] Parliamentary papers, Session year 2022-2023, 32645, no. 102.
[27] Parliamentary papers, Session year 2021-2022, 25422, no. 282.

4 Inventory of spent fuel and radioactive waste

4.1 Description of the waste classification system in the Netherlands

The regulatory framework in the Netherlands defines when a radioactive material is radioactive waste and distinguishes several categories of radioactive waste: waste containing fissile material or ore, radioactive waste, waste for which specific clearance is applicable, short-lived waste and exempt waste.

(Bbs Article 10.7.1)
The Authority or the organization may designate a radioactive substance as radioactive waste if the Authority or the organization foresees no use of this substance and no recycling of it as a product or material and the substance is not discharged.
Een radioactieve stof kan door de Autoriteit of de ondernemer als radioactieve afvalstof worden aangemerkt, indien voor deze stof geen gebruik of product- of materiaalhergebruik is voorzien door de Autoriteit of door de ondernemer en er geen sprake is van lozing van de stof.

The rationale used in defining the waste classification system is that for operational purposes (radiation protection, security, non-proliferation, etc.), the Dutch classification of radioactive waste is based on practical criteria both derived from the need to limit exposures during the long-term interim storage period and from requirements set by the disposal route (JC 2020, page 17). This waste classification system has been implemented and further detailed by COVRA.

Note that there is no specific waste category for sources, these are classified as radioactive waste (unless they contain fissile material or ore).

4.1.1 Waste categories in the regulatory framework

The regulatory framework in the Netherlands distinguishes between several radioactive waste categories.

4.1.1.1 Waste containing fissile material or ore

Waste containing fissile material or ore is defined in the Bkse.

(Bkse Article 1)
Waste containing fissile material or ore: fissile material or ore which is designated as such pursuant to Article 19 of this Decree in conjunction with Article 10.7 (1) and (2) of the Bbs, and which is not discharged.
Splijtstof of erts bevattende afvalstof: splijtstof die, of erts dat krachtens artikel 19 van dit besluit in samenhang met artikel 10.7, eerste en tweede lid, van het Besluit basisveiligheidsnormen stralingsbescherming als zodanig is aangemerkt en niet wordt geloosd.

Fissile material is defined in the Nuclear Energy Act and further specified in the Bkse.

(Nuclear Energy Act Article 1.1.b)
Fissile materials: materials containing uranium, plutonium, thorium or other elements provided for by Order in Council in percentages also provided for therein.
Splijtstoffen: stoffen, welke ten minste een bij algemene maatregel van bestuur te bepalen percentage uranium, plutonium, thorium of andere daarbij aangewezen elementen bevatten.

(Bkse Article 1a)
The percentages of uranium, plutonium or thorium present in fissile materials as referred to in section 1 (1) (b) of the Act are one tenth, one tenth and three respectively, calculated by weight.
Het in artikel 1, eerste lid, onder b, van de wet bedoelde percentage van in splijtstoffen aanwezig uranium, plutonium of thorium is onderscheidenlijk een tiende, een tiende en drie, gerekend naar het gewicht.

Ore is defined in the Nuclear Energy Act.

(Nuclear Energy Act Article 1.1.c)
Ores: ores which, when calculated by weight, contain at least one tenth of a per cent of uranium or three per cent of thorium and which are used for their fissile or fertile properties.

Ertsen: ertsen die naar gewicht gerekend ten minste een tiende procent uranium of drie procent thorium bevatten en waarmee handelingen worden verricht wegens hun splijt- of kweekeigenschappen.

4.1.1.2 Radioactive waste

Radioactive waste is defined in the Bbs.

(Bbs Annex 1)
Radioactive waste: radioactive material in gaseous, liquid or solid form designated as radioactive waste pursuant to Article 10.7.
Radioactieve afvalstof: radioactief materiaal in gasvormige, vloeibare of vaste staat die krachtens artikel 10.7 als radioactieve afvalstof wordt aangemerkt.

This category of waste also contains NORM-waste as well as radioactive sources.

NORM-waste
NORM-waste with an activity concentration of more than 10 times the general clearance levels and when specific clearance is not applicable is stored at COVRA until disposal in the geological disposal facility.

NORM-waste between 1-10 times the general clearance levels or when specific clearance for disposal is applicable, can be disposed of at designated landfills.

(Waste (landfill ban) Decree (*Besluit stortplaatsen en stortverboden afvalstoffen)* Article 11k.2)
This Decree, with the exception of subsection 1, is equally applicable to radioactive waste originating from activities with natural sources in which the activity concentration of the radionuclides in the natural sources concerned is equal to or higher than the respective clearance level specified in or pursuant to section 3.20 or 3.21 of the Decree on Basic Safety Standards for Radiation Protection and is lower than 10 times this level.
Dit besluit is, met uitzondering van paragraaf 1, van overeenkomstige toepassing op radioactieve afvalstoffen afkomstig van handelingen met natuurlijke bronnen waarvan de activiteitsconcentratie van de radionucliden in de betrokken natuurlijke bronnen gelijk is aan of hoger is dan de desbetreffende bij of krachtens artikel 3.20 of 3.21 van het Besluit basisveiligheidsnormen stralingsbescherming vastgestelde vrijgavewaarde en lager is dan tien maal deze waarde.

If there is no increased risk for man and the environment, NORM-waste may be mixed with other materials for reuse. However, mixing is not allowed if its sole purpose is to reduce the activity concentration (the amount of radioactivity per gram of material).

(Bbs Article 10.7.5)
It is not permitted to mix radioactive waste in order to bring the activity concentration of the waste below the respective clearance levels set in accordance with Subsection 3.3.2, as a result of which practices with such radioactive waste no longer fall under the licensing or registration obligation.
Het is verboden radioactieve afvalstoffen te mengen met het doel de activiteitsconcentratie van de stoffen beneden de desbetreffende ingevolge paragraaf 3.3.2 vastgestelde vrijgavewaarden te brengen, als gevolg waarvan handelingen met deze radioactieve afvalstoffen niet meer onder de vergunningplicht of registratieplicht vallen.

(Bbs, Article 10.7.6)
The prohibition specified in paragraph 5 does not apply with regard to radioactive waste originating in practices with naturally occurring radionuclides if the organization has demonstrated to the satisfaction of the Authority that mixing causes no greater hazard, detriment or nuisance than if such radioactive waste substances were not mixed.
Het in het vijfde lid gestelde verbod geldt niet ten aanzien van radioactieve afvalstoffen afkomstig van handelingen met van nature voorkomende radionucliden, indien door de ondernemer ten genoegen van de Autoriteit wordt aangetoond dat het mengen geen groter gevaar, schade of hinder veroorzaakt dan in het geval deze radioactieve afvalstoffen niet zouden worden gemengd.

4.1.1.3 Specific clearance for waste above the clearance levels

(NR 2021, page 16)
Specific clearance can be established by ANVS for specific use in which materials exceed the general clearance levels, provided that the cleared materials meet the general (exemption and) clearance criteria. Specific clearance may be authorised for specific materials or specific pathways and additional measures or requirements may apply in order to limit the exposure and the public. Since the introduction of the Bbs in 2018, specific clearance values have been established for several cases.

(JC 2020, page 16)
Examples of specific clearance levels set by ANVS-regulation are:
• Lamps and lamp starters containing Kr-85;
• Wet sludge from oil and gas production and geothermal application;
• Clearance of liquids by incineration;
• ~120 nuclides in material containing very low levels of activity that pose a very limited risk;
• Emission to air and (surface)water for K-40.
An example of specific clearance by authorisation, is the specific clearance of several waste streams resulting from the decommissioning of a phosphor producing facility. Under specific conditions, these waste streams can be disposed of in a designated landfill.

(Bbs Article 3.21)
1 Unless detrimental to the interests of radiation protection, in derogation of Article 3.20 (1) or (4) specific clearance levels and associated rules may be set in a decision or ANVS-regulation for specific radioactive materials designated therein, for radioactive materials originating from specific types of practices designated therein or for materials belonging to a specific category designated therein.
2 In the application of paragraph 1, the general criteria included in Appendix 3, section A, part 3, and the provisions of and pursuant to chapter 10 are taken into account and factors relevant to radiation protection are taken into consideration in the assessment of the desirability of the clearance. The rules set pursuant to Article 3.17 (8) apply.
1 Bij beschikking of verordening van de Autoriteit kunnen, indien het belang van de stralingsbescherming zich daar niet tegen verzet, in afwijking van artikel 3.20, eerste of vierde lid, voor daarbij aangewezen specifieke radioactieve materialen, voor radioactieve materialen afkomstig van daarbij aangewezen specifieke soorten handelingen of voor materialen behorend tot een daarbij aangewezen specifieke categorie, specifieke vrijgavewaarden en daarmee verbonden regels worden vastgesteld.
2 Bij de toepassing van het eerste lid worden de algemene criteria, opgenomen in bijlage 3, onderdeel A, onderdeel 3, en het bepaalde bij en krachtens hoofdstuk 10 in acht genomen en worden bij de beoordeling van de wenselijkheid van de vrijgave de met het oog op stralingsbescherming relevante factoren in aanmerking genomen. De krachtens artikel 3.17, achtste lid, gestelde regels zijn van toepassing.

4.1.1.4 Short-lived waste

Radioactive waste with a half-life of less than 100 days may be stored with the producer for a maximum of 2 years in a suitable facility, subject to inspection. If after this period, the waste has decayed to below the release threshold, it can be managed as conventional waste.

(Bbs Article 10.7.4)
The obligation specified in paragraph 3 does not apply if the radioactive waste has a physical half-life of less than 100 days and is stored for a maximum of two years in an appropriate area with a view to physical decay into waste with a practice concentration not exceeding the value referred to in Article 10.6, paragraph 1.
De in het derde lid gestelde verplichting geldt niet indien de radioactieve afvalstoffen een fysische halveringstijd hebben van minder dan 100 dagen en maximaal twee jaar worden opgeslagen in een daartoe geschikte ruimte met het oog op fysisch verval tot afvalstoffen met een activiteitsconcentratie van niet meer dan de in artikel 10.6, eerste lid, bedoelde waarde.

4.1.1.5 Exempt waste

Exempt waste is radioactive waste with activity concentrations below the exemption levels. This waste has such low radioactivity levels that it can safely be disposed of or processed as conventional waste. Exempt waste is defined in the Bbs Articles 3.20.1 and 10.6.1.

(Bbs Article 3.20.1)
Division 3.2 does not apply to practices with radioactive materials intended for removal, recycling, reuse or incineration:
a. in which the activity concentration of the radionuclides in the radioactive substance concerned does not exceed:
- 1°. the respective clearance level for artificial radionuclides included in Appendix 3, section B, table A, part 1, or
- 2°. the respective clearance level for naturally occurring radionuclides included in Appendix 3, section B, table A, part 2, or

b. in which the activity concentration of the radionuclides in the radioactive substance concerned does not exceed the respective clearance level set pursuant to paragraph 4 or Article 3.21.
Afdeling 3.2 is niet van toepassing op handelingen met radioactieve materialen bestemd voor verwijdering, recycling, hergegbruik of verbranding:
a. waarvan de activiteitsconcentratie van de radionucliden in de betrokken radioactieve stof niet hoger is dan:
- *1°. de desbetreffende in bijlage 3, onderdeel B, tabel A, deel 1 opgenomen vrijgavewaarde voor kunstmatige radionucliden, of*
- *2°. de desbetreffende in bijlage 3, onderdeel B, tabel A, deel 2 opgenomen vrijgavewaarde voor van nature voorkomende radionucliden, of*

b. waarvan de activiteitsconcentratie van de radionucliden in de betrokken radioactieve stof niet hoger is dan de desbetreffende krachtens het vierde lid of artikel 3.21 vastgestelde vrijgavewaarde

(Bbs Article 10.6.1)
A prohibition as referred to in Article 3.5 in conjunction with Article 3.8 (4)(b) on unlicensed disposing of radioactive substances for product or material recycling or as radioactive waste does not apply if the activity concentration of that substance or as a waste is lower than the respective clearance level set in or pursuant to Article 3.20 or 3.21.
Een verbod als bedoeld in artikel 3.5 in samenhang met artikel 3.8, vierde lid, onder b, om zich zonder vergunning te ontdoen van radioactieve stoffen voor product- of materiaalhergebruik of als radioactieve afvalstof, is niet van toepassing indien de activiteitsconcentratie van die stof of afvalstof lager is dan de desbetreffende bij of krachtens artikel 3.20 of 3.21 vastgestelde vrijgavewaarde.

(Bbs Article 10.7.2)
A waste substance is not designated as radioactive waste if the activity concentration of such waste is lower than the respective clearance level set in or pursuant to Article 3.20 or 3.21 and Article 10.6 (1) applies.
Een afvalstof wordt niet als radioactieve afvalstof aangemerkt, indien de activiteitsconcentratie van die afvalstof lager is dan de desbetreffende bij of krachtens artikel 3.20 of 3.21 vastgestelde vrijgavewaarde en artikel 10.6, eerste lid, van toepassing is.

4.1.2 The implementation of the waste classification system at COVRA

During the licencing procedure COVRA has to submit a Safety Report (SR) and Technical Specifications (TS). The ANVS reviews these documents during the licensing procedures. Upon approval, these documents become part of the licence. In the COVRA case they set, amongst others, requirements for waste classification.

(SR COVRA 2014 paragraph 2.2.3)
The radioactive waste offered is divided into the category low- and medium-level radioactive waste (LILW) and the category high-level radioactive waste (HLW). The distinction between LILW and HLW is based on the requirements regarding radiation protection needed for transporting and processing the (packaged) waste.
Het aangeboden radioactief afval wordt onderverdeeld in de categorie laag- en middelradioactief afval (LMRA) en de categorie hoogradioactief afval (HRA). Het onderscheid tussen LMRA en HRA is

gebaseerd op het stralingshygiënisch kunnen transporteren en behandelen van het (verpakte) afval.

(TS COVRA paragraph 3.1)
In the total supply of radioactive waste, a distinction can be made between the following waste streams:
- Radioactive waste generated in the Netherlands during activities with radioactive substances carried out by a company or institution that has a permit under the Nuclear Energy Act.
- High-level radioactive waste from institutions such as the Joint Research Centre in Petten (JRC), the Reactor Institute Delft (RID) and the Nuclear Research Group in Petten (NRG).
- High-level radioactive waste from irradiated fuel elements from Dutch nuclear reactors that have been reprocessed abroad.
- Low- and medium-level radioactive waste from companies and institutions which, in their production processes, are confronted with a certain degree of concentration of the radioactive substances which are naturally occurring in the raw materials processed by those companies.
- Low-level radioactive waste originating, among others, from the oil and gas industry with low natural radioactivity
- Depleted uranium as U3O8 from the uranium enrichment industry.
In het totale aanbod van radioactief afval kan een onderscheid gemaakt worden in de volgende afvalstromen:
- Radioactief afval dat in Nederland ontstaat bij werkzaamheden met radioactieve stoffen uitgevoerd door een bedrijf of instelling die daar een vergunning krachtens de KEW voor heeft.
- Hoogradioactief afval afkomstig van instellingen als het Gemeenschappelijk Centrum van Onderzoek te Petten (GCO), het Reactor Instituut Delft (RID) en de Nucleair Research Group te Petten (NRG).
- Hoogradioactief afval afkomstig van in het buitenland opgewerkte bestraalde splijtstofelementen uit Nederlandse kernreactoren.
- Laag- en middelradioactief afval van bedrijven en instellingen die in hun bedrijfsprocessen geconfronteerd worden met een zekere mate van concentrering van de radioactieve stoffen die van nature in de door die bedrijven verwerkte grondstoffen voorkomen.
- Laagradioactief afval ondermeer afkomstig van de olie- en gasindustrie met een geringe natuurlijke radioactiviteit.
- Verarmd uranium als U3O8 afkomstig van de uraniumverrijkende industrie.

Unless specific clearance applies, all radioactive waste in the Netherlands (including NORM-waste above 10 times the general clearance levels) is treated and stored at COVRA and will be disposed of in one geological disposal facility around 2130. COVRA is responsible for the general strategy for the management of this radioactive waste and the alignment thereof with the national policy on waste management.

(COVRA license 2015 B.1)
COVRA is responsible for the general strategy for managing radioactive waste and spent nuclear fuel, taking into account the mutual dependences between each stage of the radioactive waste and spent nuclear fuel, from production to disposal. The strategy must be consistent with general national radioactive waste policies.
COVRA is verantwoordelijk voor de algemene strategie voor het beheer van het radioactief afval en verbruikte splijtstof, rekening houdend met de onderlinge afhankelijkheid tussen alle stadia van het radioactief afval en verbruikte splijtstof, van productie tot en met berging.

COVRA explains the implementation and further details of the waste classification system in *Het oranje boekje*. The waste classification system used at COVRA is also described in the National programme on the management of radioactive waste and spent fuel (National programme, chapter 3).

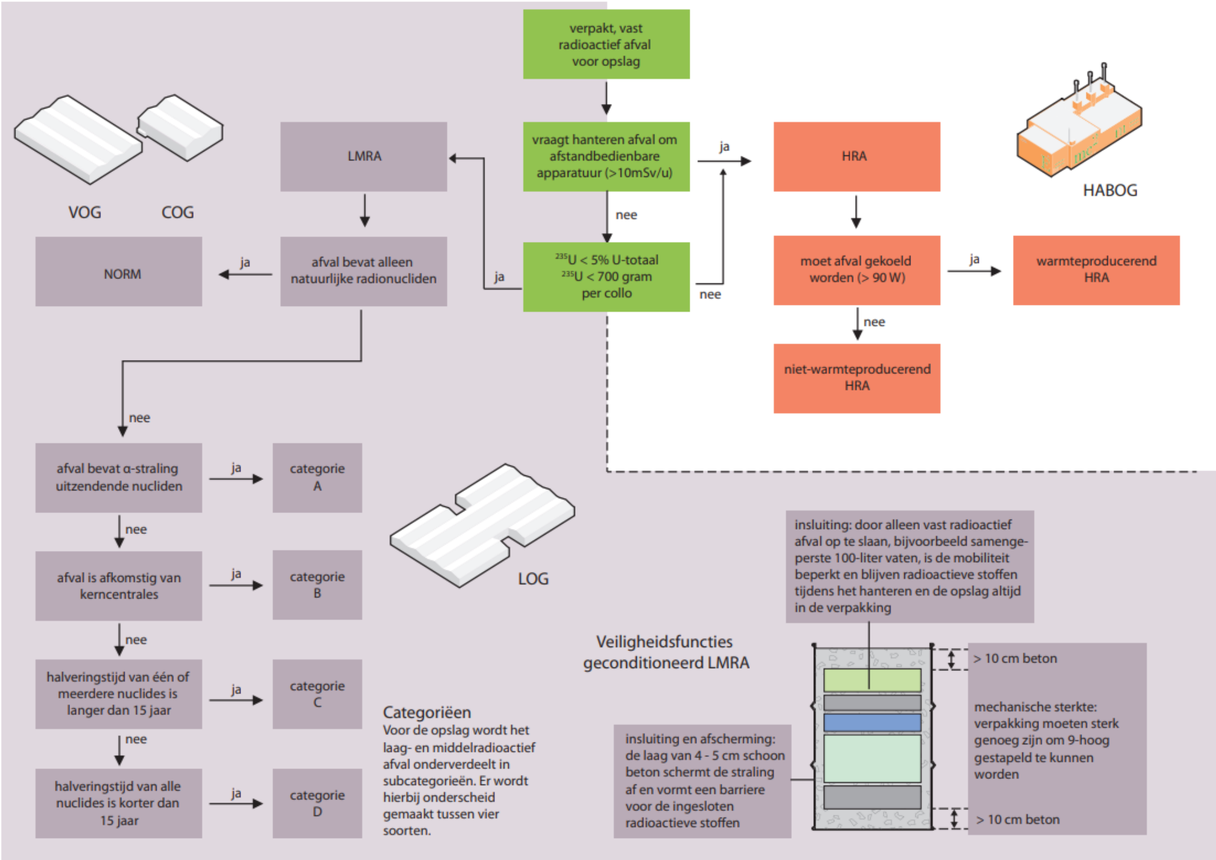

Figure 4.1: Figure from The Orange Booklet COVRA (Het Oranje Boekje) with further details on waste classification at COVRA.

4.1.2.1 High-level radioactive waste (HLW)

HLW is radioactive waste that, because of its high radiation level, must be processed with remotely controlled facilities and must be stored behind thick concrete walls in special containers. Part of the HLW produces heat and must therefore be cooled. HLW consists of waste from the reprocessing of spent fuel elements from nuclear power plants and from the fuel elements used as fuel in research reactors. In addition, HLW is also generated in medical isotope production. Decommissioning of nuclear facilities or management of legacy waste can also generate HLW.

All HLW is stored in a dedicated storage building at COVRA (HABOG, *Hoogradioactief AfvalBehandelings- en Opslag Gebouw*, high-level waste treatment and storage building.) in which heat-generating and non-heat-generating HLW are stored in separate compartments (JC 2020, page 28).

4.1.2.2 Low-level and intermediate-level radioactive waste (LILW) including NORM-waste

LILW is all the other waste at COVRA. Among other, LILW consists of consumables (gloves, clothing, hypodermic needles, laboratory glassware, etc.), calibration and irradiation sources, ionization detectors (smoke detectors) and replaced parts in nuclear facilities (tubes, pumps, filters, etc.). LILW consists of both long-lived and short-lived waste.

A distinction is made between four types of LILW:

- A-waste: waste containing radionuclides emitting alpha radiation. Alpha-containing waste is often long-lived.
- B-waste: waste originating from a nuclear power plant. Much of the radioactivity of this waste decreases relatively quickly. B-waste contains a lot of Cobalt-60, a radioactive substance with a half-life of about five years, but it also contains Cs-137 with a half-life of about 30 years.
- C waste: waste containing radionuclides with a half-life longer than fifteen years.
- D-waste: waste containing radionuclides with a half-life less than fifteen years. Most of this waste decays within a period of one hundred years.

LILW is stored in a dedicated building at COVRA (LOG, *Laag- en middelradioactief Opslag Gebouw*, low- and intermediate-level waste storage building). COVRA is planning to build another building for the storage of LILW (MOG, *Multifuntioneel Opslag Gebouw*, multifunctional storage building).

NORM-waste
A special category within LILW at COVRA constitutes of NORM-waste above 10 times the general clearance levels. NORM-waste arises, among others, when radioactive substances that occur naturally in, for example, industrial ores (such as phosphate ores) are concentrated in the waste during processing. Other examples of industries that produce NORM-waste are the pigment industry, steel industry, zircon industry, oil and gas industry. This is often long-lived waste.
There are dedicated buildings at COVRA for the storage of NORM-waste. The calcined product resulting from the production of phosphor in a dry/high temperature process is stored in the COG (*Container OpslagGebouw*, storage building for containers, which is also the building where bulk material that is slightly activated or contaminated and decays below the exemption limit within a period of 50 years is stored for decay storage). Depleted uranium is stored in VOG and VOG-2 (*Verarmd uranium OpslagGebouw*, storage building for depleted uranium).

4.1.3 How the waste classification system relates to the IAEA safety Series GSG-1 and explanation of possible differences from the IAEA classification

The four categories of radioactive waste (exempt waste, short lived waste, LILW and HLW) in use at COVRA are based on activity and half-life. The LILW category includes NORM-waste. The HLW category contains both heat generating waste and non-heat generating waste.
The radioactive waste categories at COVRA roughly follows the IAEA classification in GSG-1, the IAEA categories high-level waste and intermediate level waste broadly compares to the Dutch category *hoog radioactief afval* and the IAEA categories low-level waste and very low-level waste broadly compares to the Dutch category *laag- en middelradioactief afval* (JC 2020, page 30, figure 3).

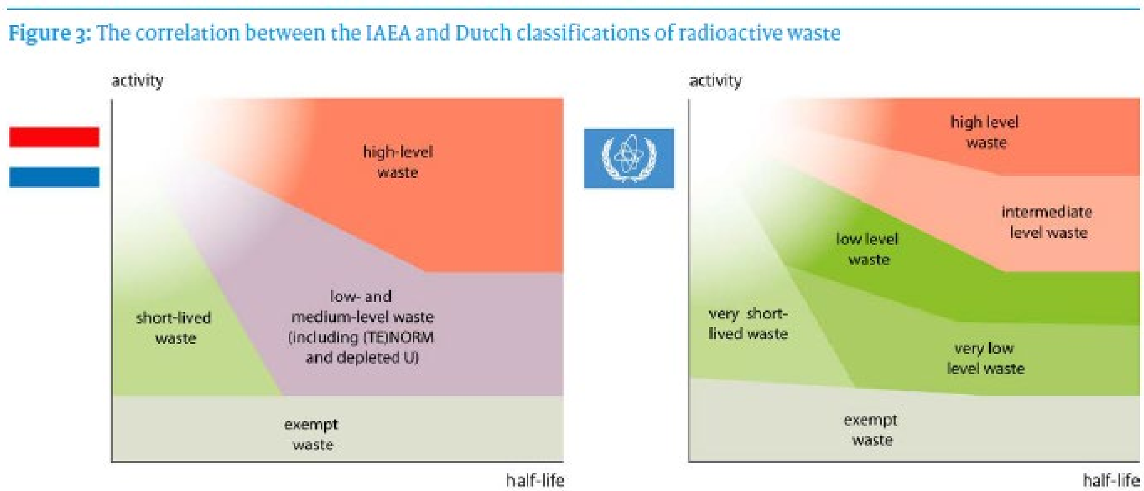

Figure 4.2: Figure from JC 2020 with the IAEA classification (right) and the waste classification system used in the Netherlands (left).

All categories of waste stored at COVRA will be disposed of in one geological disposal facility in the future (due to the small amounts of radioactive waste, no separate disposal facilities for LILW and HLW are envisaged) (National programme, page 32, 4.5.3).

4.1.4 Historical changes in the system and expected future developments, where relevant

During the implementation of the Euratom Basic Safety Standards in 2018, the concept of specific clearance has been added to the regulatory framework (*Staatsblad* 2017, 404). There are no future developments foreseen on the classification system expected at this moment.

(*Staatsblad* 2017, 404)
The Decree gives the Minister of IandM (now: IandWM) the authority to set additional exemption and clearance values for radionuclides that are not included in Tables A and B. These can be laid down by ministerial regulation. It is important here that the exemption and clearance values are not standards, but technical limits of the control system derived from the standards (dose limits) included in the Decree. The Decree also gives the Authority the power to set a higher or lower value for the total activity or activity concentration by decision or regulation for specific actions, in deviation from the values laid down in Annex 3 of the Decree. Criteria from part A, sub 3 of that appendix must be applied.
Het besluit biedt de minister van IenM de bevoegdheid om additioneel vrijstellings- en vrijgavewaarden vast te stellen voor radionucliden die niet in de tabellen A en B zijn opgenomen. Deze kunnen bij ministeriële regeling worden vastgesteld. Van belang is daarbij dat het bij de vrijstellings- en vrijgavewaarden niet gaat om normen, maar om van de in het besluit opgenomen normen (dosislimieten) afgeleide technische begrenzingen van het controlestelsel. Ook geeft het besluit aan de Autoriteit de bevoegdheid om bij beschikking of verordening voor specifieke handelingen een hogere dan wel lagere waarde voor de totale activiteit of activiteitsconcentratie vast te stellen, in afwijking van de waarden vastgelegd in bijlage 3 van het besluit. Hierbij moeten criteria uit onderdeel A, sub 3 van die bijlage worden toegepast.

4.2 Organizations involved in developing and maintaining the national inventory

The Ministry is responsible for the implementation of Directive 2011/70/Euratom which includes the obligation to report on the inventory including future prospects in the National programme and national report and is therefore responsible for timely updates of the inventory (Bbs Article 10.1 and Decree on nuclear installations, fuels and ores Article 40a). The Ministry has asked COVRA and RIVM to develop the national inventory together.

The national inventory will be updated together with each update of the National programme. The government announced the improvement of the monitoring for all radioactive waste in the Netherlands[28].

4.2.1 How the information is collected, including frequency, and how that is enforced

Current inventory at COVRA
The administration of COVRA is updated on a day-to-day basis (COVRA license 2015 B.8). In the reports to the European Commission and the Joint Convention, actual amounts of radioactive waste stored at COVRA at that moment are reported.

National inventory
The Netherlands have presented 2 full inventories also including forecasts till 2130, the first one was published in 2013 and the second one in 2022.

The inventory distinguishes between three types of waste:
- High-level waste (HLW)
- Low- and intermediate-level waste (LILW)
- Waste consisting of radioactive materials from natural origin (NORM with activity concentration of more than 10 times the threshold of the Bbs.)

For more information on the inventory, see 4.6.1, for information on enforcement see 4.2.3.

4.2.2 The frequency of updating the national inventory and the process of evaluation

The national inventory at COVRA is updated every 3 years in the context of reporting to the European Commission and the Joint Convention.

[28] Parliamentary papers, Session year 2022–2023, 25422, no. 286.

More extensive national inventories also containing forecasts till disposal have been released in 2013 and 2022. With every update of the National programme, an update of the more extensive national inventory will be made.

4.2.3 How the quality of the information is ensured

The Ministry of IandWM, COVRA and RIVM took part in the update of the national inventory in 2022. In the future, ANVS will be asked to join the project.

The Ministry of IandWM initiated the study on waste streams.

COVRA's licence makes registration of waste compulsory. The information is used for the inventory. Once a Nuclear Energy Act license is issued, the licensee has the responsibility to comply with the licence and licence requirements (Nuclear Energy Act Article 76a). The compliance of the license holders with these requirements can be subject to inspection and enforcement by the regulator (Economic Offences Act Article 1a and Nuclear Energy Act Article 3.3).

4.2.4 How the completeness of the information is ensured (different waste producers and streams, legacy waste)

Licensees are all registered at the ANVS. The license database has been used to produce a list of producers of waste. This list includes the licensee of legacy waste.

The study on waste streams has been done on the base of information on waste in the licenses.

The Ministry of IandWM is currently working on a more systematic monitoring of waste streams, which could include registration and reporting obligations for licensees.

4.2.5 What information about the national inventory is publicly available

Reports to the European Commission and the Joint convention, as well as both inventories of 2013 and 2022 have been published on the internet by the government. COVRA has also published both national inventories on the website. The study on waste streams is publicly available at the sites of the government and RIVM.

4.3 Information recorded in the national inventory

Please refer to the inventory in the ARM for the information recorded in the national inventory.

4.4 If relevant, how waste and spent fuel imported from another country and waste and spent fuel exported to another country are accounted for in the inventory (including processing and disposal)

There is no import of radioactive waste or spent fuel from another country.

4.5 Categories of radioactive material not included in inventory, e.g., mining waste, sources not declared as waste, NORM etc.

The following categories of radioactive material are not included in the national inventory:

- Radioactive waste that has been disposed of at the designated landfills;
- Radioactive waste that has a half-life less than one hundred days and is stored at the manufacturer;
- Waste originating from military or defence programmes, unless this waste has been transferred permanently to and managed within civilian programmes

The Caribbean Netherlands falls, in line the National programme, outside the scope of the inventory. The Nuclear Energy Act and the Euratom Treaty do not apply there.

4.6 Estimation of future waste arisings in the National Inventory

4.6.1 The basis for estimating future waste arisings (e.g., established or planned nuclear programme, operational life time, time horizons)

The radioactive waste production and amounts stored at the producers is estimated on the basis of interviews and administration of COVRA. The interviews have been carried out with selected companies from the sectors mentioned above. The administration of COVRA is updated on a day-to-day basis (COVRA license 2015 B.8).

Ten sectors have been defined in which licensees are distributed: nuclear, medical isotopes, medical care, education and research, oil and gas, scrap metals, industry general, NORM, smoke detectors and other.

The final HLW inventory to be disposed of is drawn up on the basis of production data from the producer, the waste already stored at COVRA and expected amounts from decommissioning (as reported in the decommissioning plans). The spent fuel of the HFR and the HOR are stored at COVRA without reprocessing while the nuclear power plant's spent fuel is reprocessed and the reprocessing waste is stored at COVRA. We also assume the following: the HFR will be shut down in 2030, the NPP Borssele will shut down in 2033, the NPP of Dodewaard will be decommissioned before 2045 (shut down in 1997 and currently in safe enclosure), the HOR and Urenco in Almelo will shut down in 2050.

The predicted quantities of LILW and NORM-waste are calculated by extrapolation to 2130 of the current production, to which expected quantities of decommissioning waste and waste stored on location are added. We assume hereby that processing routes remain the same until 2130. The current annual production of radioactive waste is averaged over the period 2018-2020.

The NORM-waste described in this report only concerns the NORM-waste that is stored at COVRA and therefore not the NORM-waste that is dumped at the designated landfills. Future waste arisings for disposal at landfills are not available.

(Specifically) released material is not classified as radioactive waste.

In the 2022 inventory, various alternative scenarios have been elaborated with regard to an estimate of the amount of HLW, LILW and NORM-waste up to and including 2130.

The following principles have been used for these scenarios:

- In 2030, the HFR will be directly succeeded by the PALLAS reactor. The PALLAS reactor is a one-to-one replacement of the HFR with a lifespan of 70 years.
- A scenario has been worked out with an additional lifetime extension of the NPP Borssele from 10 years to 2044.
- In 2035 and 2040, the NPP Borssele (485 MW) is expected to be succeeded by two new nuclear power plants, each with an assumed capacity of 1600 MW and a lifespan of 80 years. The scenario assumes the current method of storage in which the fuel elements are reprocessed. It is assumed that the quantities of waste are proportional to capacity.
- The American company SHINE intends to build a new installation in the Netherlands for the production of medical isotopes. It is assumed that SHINE will start its activities from 2030 for 30 years. The amount of radioactive waste is based on data from the similar production site in America.

4.6.2 Waste from decommissioning and dismantling

Waste from decommissioning and dismantling of nuclear installations is included in the inventory.

4.6.3 Responsibilities for estimating future waste arisings

The waste management organisations (COVRA and landfills) are responsible for ensuring enough capacity within the limits of their license. For COVRA, the regularly updated inventory shows the expected future arisings of radioactive waste and the types of waste in 2030, 2050 and 2130. The capacity of the storage and disposal facilities can be monitored according to these expectations.

5 Concepts, plans and technical solutions for spent fuel and radioactive waste

5.1 Pre-disposal management plans and activities covering processing, storage and radioactive waste conditioning for disposal

5.1.1 The main existing and foreseen radioactive waste processing facilities in the country

5.1.1.1 The main existing and foreseen radioactive waste processing facilities in the country

The main existing waste processing facilities in the Netherlands are specified in the table below.

Category radioactive waste (NL)	**Location of processing facility**	**Processes**	**Reference/ more information**
HLW	HABOG, COVRA	Repacking of SF from RR	JC 2020, page 86, table 1, 3, annex 1
LILW	AVG, COVRA	For various types of processing at AVG see below (*1)	JC 2020, page 100
LILW	NPP Borssele	Conditioning installation	JC 2020, page 28
HLW + LILW	Facility for Decontamination and Waste Treatment (DWT, including the WSF and WTU), Petten	Treatment of liquid waste, sorting and repackaging of legacy waste, packaging of waste in transport containers	JC 2020, page 98
NORM-waste	Landfills	Treatment of certain kinds of NORM-waste	

Table 5.1: Existing radioactive waste processing facilities in the Netherlands.

(*1) Processing of LILW at COVRA (AVG)
Processing of LILW occurs in a special building, the waste processing building (AVG). Drums of waste collected from licensees from all over the country are sorted with respect to type and/or processing method to be applied.

The main purpose of processing the radioactive waste is to contain the waste so that no radioactive substances can be released into the environment. In addition, the final packaging of the waste ensures that the external radiation level is acceptable and that the waste can be stored in the appropriate buildings. Also processing of radioactive waste reduces the volume to be stored.

Most of the volume of radioactive waste collected by COVRA is compactable solid waste. Its volume is reduced by compacting the waste container with a 1500 tonnes super compactor. The compacted containers are transferred to larger containers and immobilised with concrete. The conditioned waste is transferred to the storage building.

Used sealed radioactive sources that cannot be returned to the supplier are mixed with cement and stored in containers. Other radioactive waste consisting of large sized components is first pre-compressed or shredded or cut to fit the compacting drums. Again, conditioning for long-term interim storage is done with cement grout and concrete.

The two incinerators and the installation for the treatment of vials containing scintillation liquid in the AVG have been permanently taken out of operation. The waste that was processed here is now stored pending the availability of a new furnace. COVRA is investigating the plasma technology as the new incineration technology. COVRA intends to submit a license application end 2023-early 2024, with the final investment decision foreseen in 2024, the start of construction at the end of 2025 and commissioning at the beginning of 2028.

The foreseen radioactive waste processing facilities in the Netherlands are specified in the table below.

Category radioactive waste (NL)	Location of processing facility	Processes
LILW	COVRA	Planned installation (2028): plasma oven for incineration of radioactive waste
LILW, legacy waste	MOG	Planned storage facility (2025): repackaging and storage building for part of the (intermediate-level) legacy waste and decommissioning waste

Table 5.2: Foreseen radioactive waste processing facilities in the Netherlands.

5.1.2 The main existing and foreseen radioactive waste storage facilities in the country and the corresponding periods of storage with the view of disposal and pre-disposal management facilities that still need to be developed and implemented

The existing radioactive waste storage facilities in the Netherlands and the corresponding periods of storage with the view of disposal are specified in the tables below and see further in this chapter for more information on the storage facilities.

Category radioactive waste (NL)	Location	Expected lifetime facility	Interim management	Long-term management	Reference/ more information
HLW	HABOG, COVRA	In operation since 2003, end of operation planned for 2160	Long-term dry storage of heat-generating and non-heat generating waste in canisters in vaults	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1
HLW	Fuel storage pool of the NPP Borssele, Borssele	NPP in operation since 1973, end of operation NPP planned for 2033	Temporary storage of spent fuel before shipment to France for reprocessing	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1
HLW	Fuel storage pool of the RR HFR, Petten	RR in operation since 1961, end of operation planned for around 2030	Temporary storage of spent fuel before shipment to COVRA	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1
HLW	WSF, Petten (*1)	In operation since around 1960, end of operation planned for 2027	Temporary dry storage of legacy SF samples from HFR irradiation experiments in drums in concrete-lined vaults before shipment to COVRA	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1

HLW	Fuel storage pool of the RR HOR, Delft	RR in operation since 1963, end of operation foreseen around 2050	Temporary storage of spent fuel before shipment to COVRA	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1
LILW	LOG, COVRA	In operation since 1991, end of operation foreseen in 2160	Long-term dry storage in conditioned form in drums and containers (cemented waste packages (200 litre or 1000 litre))	Geological disposal facility is foreseen around 2130	JC 2020, table 1, 4, annex 1
LILW	WSF, Petten	In operation since around 1960, end of operation planned for 2027	Temporary dry storage of unconditioned waste in drums	Geological disposal facility is foreseen around 2130	JC 2020, table 1, 4, annex 1
NORM, subject to licensing: calcinate	COG, COVRA	In operation since 2000, end of operation foreseen in 2160	Long-term dry storage in unconditioned form in 20-ft containers	Geological disposal facility is foreseen around 2130	JC 2020, table 1, 4, annex 1
NORM, subject to licensing: depleted uranium (U_3O_8)	VOG and VOG-2, COVRA	VOG in operation since 2004, VOG-2 since 2017, end of operation both buildings foreseen in 2160	Long-term dry storage in unconditioned form in DV70 containers to allow for potential reuse	Geological disposal facility is foreseen around 2130	JC 2020, table 1, 4, annex 1
Radioactive waste with $T_{1/2}$<100 days decaying below clearance levels in 2 years	Managed at location of waste producer as specified in license		Temporary storage to allow for potential reuse or reprocessing as conventional waste	N.A.	JC 2020, table 1
Radioactive waste decaying below clearance levels in 50 years	COG, COVRA	In operation since 2000, end of operation foreseen in 2160	Temporary storage to allow for potential reuse or reprocessing as conventional waste	N.A.	JC 2020, table 1
Radioactive waste below clearance levels	N.A.		N.A.	N.A.	JC 2020, table 1
When applicable: radioactive waste between general and specific clearance levels	As specified in the requirements for the specific clearance		As specified in the requirements for the specific clearance	As specified in the requirements for the specific clearance	JC 2020, table 1

*Table 5.3: Existing radioactive waste storage facilities in the country and the corresponding periods of storage with the view of disposal and pre-disposal management facilities that still need to be developed and implemented. (*1, see text on legacy waste below for more information.)*

Note: All radioactive waste stored at COVRA that has decayed till below exemption levels at the time of disposal will be treated as conventional waste.

The foreseen storage facilities in the Netherlands and the corresponding periods of storage with the view of disposal are specified in the tables below.

Category radioactive waste (NL)	**Location**	**Expected lifetime**	**Interim management**	**Long-term management**
LILW, legacy waste	MOG, COVRA	Planned building: 2025, end of operation foreseen in 2160	Long-term dry storage in containers	Geological disposal facility is foreseen around 2130

Table 5.4: Foreseen radioactive waste storage facilities in the country and the corresponding periods of storage with the view of disposal and pre-disposal management facilities that still need to be developed and implemented.

Legacy waste at Research Location Petten
Originally the Dutch radioactive waste storage facility was located at the Research Location Petten. The Waste Storage Facility (WSF) was originally intended as a storage facility until the geological disposal became available. Dutch policy for radioactive waste changed with the establishment of the Central Organization for Radioactive Waste (COVRA) in 1982 and the policy statement on radioactive waste of 1984: all radioactive waste generated in the Netherlands must be collected, processed and stored by COVRA. As a result, all waste stored in the WSF had to be transferred to COVRA as soon as COVRA was able to receive it. The waste from the WSF could not simply be sent to COVRA. The transport to and the processing and storage at COVRA set requirements in terms of characterization and packaging that the WSF waste did not meet.

In the 1990s, about 1,500 drums of low- and intermediate-level radioactive waste were transported to COVRA after was shown that these drums met the requirements of COVRA. This was only a part of the legacy waste in the WSF. NRG still had about 1,600 drums of legacy waste and about 100 drums with fissile material containing waste in the WSF in 2016. Transport and storage of the remaining barrels was technically complex, resulting in a sharp increase in costs and a halt in the transfer of waste to COVRA. The complexity was due to the fact that the requirements for characterization and packaging are determined by the chosen waste processing route, but a waste processing route can only be chosen based on characterization of the waste. A solution for the remaining part of the legacy waste therefore had to lie in an integrated chain approach: close cooperation between NRG and COVRA so that knowledge about the waste is combined with knowledge about possible disposal routes.

In 2018, the Dutch administration carried out an investigation on the effectiveness and efficiency of these plans and concluded that the chain of waste management from NRG to COVRA should be optimized and that the project planning and budget was not realistic. A mediator was appointed by the government to boost the cooperation between NRG and COVRA and to seek for chain optimization. Furthermore, the government provided extra budget as a loan to NRG to cover the increased costs of the legacy waste project. The cooperation between COVRA and NRG has been intensified between 2018-2020. At the Research Location Petten the sorting and repackaging of the waste has been prioritized. This has resulted in a better integrated, more detailed project planning and a steadier transfer of waste from Petten to COVRA.

Based on a four-step procedure, action plans were drawn up for the characterisation, separation and packaging of the various types of waste. A distinction was made between low-level radioactive waste (LLW) and two categories of intermediate-level radioactive waste (ILW-L and ILW-H) based on dose rate. A second distinction was made between alpha emitter and fissile material containing waste and non-alpha emitter containing waste.

Currently all non-alpha emitter containing WSF drums have been sorted and repackaged. The LLW-fraction that is formed in the process has been transferred to COVRA, this is about 70 percent of the waste from these drums. The ILW-fractions of this waste are packaged and stored in the WSF to await transfer to COVRA.

The plans for the transfer to COVRA are worked out in detail. For this COVRA obtained a licence to build a new building (multifunctional storage building). Furthermore, an installation was built at the NRG site to transfer inserts with ILW-waste from ILW-drums into transport containers. The new building at the COVRA site is meant to be operational approximately in 2025 and will also be used for future decommissioning waste. The project is in the construction phase.

Next to the legacy waste drums there are other waste streams at NRG that did not yet have a waste management route to COVRA. These streams, together with the legacy waste drums from the WSF, are part of the Radioactive Waste management programme of NRG which aims at developing a waste management route for all the waste streams. Every few years a plan is developed that describes to the ANVS in which way NRG plans to do this. This plan contains a brief description of the routes without details, technological developments, financial plans and timetables. In the most recent plan, approved by the Regulatory Body in 2022, it is planned by NRG that all legacy waste from the WSF in Petten will have been removed in January 2027. NRG has to submit an updated plan for approval before 1 July 2025.

One of the waste streams consisted of resins and all stored resins have been transferred to COVRA before the end of 2020. The transfer of the resins to COVRA has become a normal, operational route. This route can also be used by other nuclear facilities.

For the alpha emitter containing WSF drums the process for sorting and repackaging is developed and the necessary changes to current and building of new equipment and installations is in process. Part of the unirradiated fissile materials is expected to be transported in November 2023, for other unirradiated fissile materials (with higher enrichment) the process is still in development. This is also the case for caesium filters, sodium, beryllium and irradiated fissionable material.

Based on a four-step procedure, action plans were drawn up for the characterisation, separation and packaging of the various types of waste. A distinction was made between low-level radioactive waste (LLW) and two categories of intermediate-level radioactive waste (ILW-L and ILW-H) based on dose rate.

- Legacy low-level radioactive waste: After characterization, seventy percent of the waste can be disposed of as low-level radioactive waste via COVRA's existing waste processing routes. Of the 1,647 barrels (as of April 2021), 886 have already been transported to COVRA as LLW and stored in the low- and intermediate-level waste storage building (LOG).
- Legacy intermediate-level radioactive waste: Unlike the LLW, the ILW does not fit into existing COVRA routes. Before it could be stored at COVRA, it had to be processed. The plan was to do that in Belgium, COVRA had no capacity for this. After processing, the waste would be stored at COVRA: the ILW-L in the LOG and the ILW-H in the HABOG. Processing in various steps and countries was complex and, particularly in coordination across the entire chain, had bottlenecks and risks, which put pressure on the feasibility of the route. In the periodic consultations between the mediator, NRG and COVRA, a simpler alternative to the route via Belgium was sought. A new storage building at COVRA would offer a feasible solution for the remaining thirty percent of the legacy waste. COVRA is planning to extend the storage capacity for intermediate-level waste by realizing a new waste storage building, the so-called multifunctional storage building. The new building is meant to be operational in 2025. The building is designed to accommodate different waste streams, including intermediate legacy waste from the Research Location Petten, as well as the expected future decommissioning waste from the current nuclear installations. The project is in the construction phase.

The current process for opening a waste management route is that NRG develops a starting document, which contains information about the type of waste and describes how NRG is going to characterize the waste. This starting document is sent to COVRA, which puts the information next to the requirements for the different buildings and tries to find a building that is most suitable for storing the waste, where the waste fits into the building envelope and which transport container/method would be best suitable. Then NRG makes a plan of approach, in which they write down in detail what they are going to do. If COVRA agrees with this plan a new route is opened.

Currently all WSF drums have been sorted and repacked. The LLW-fraction that is formed in the process is has been transferred to COVRA. For the ILW-fractions, plans for the transfer to COVRA are worked out in detail. Furthermore, before the end of 2020 all stored resins from the HFR were transferred to COVRA. The transfer of the resins to COVRA has become a normal, operational route.

In the most recent plan, approved by the Regulatory Body in 2019, it is planned by NRG that all legacy waste from the WSF in Petten will have been removed before the end of 2026. NRG has to submit an updated plan for approval before 1 July 2022.

5.1.3 Pre-disposal management facilities that still need to be developed and implemented (if applicable)

There are no pre-disposal management facilities that still need to be developed and implemented other than the foreseen facilities mentioned in tables above.

5.1.4 The compatibility, in terms of safety, of each step in predisposal management with the other steps (including disposal)

By having one central waste management organisation (COVRA) for the collection, conditioning, storage and disposal of radioactive waste and spent fuel, the interdependencies between the different steps are taken into account.

(National programme, page 52)
Because COVRA is responsible for various different elements of the waste management chain, right at the beginning of the waste management chain, account can be taken of the requirements imposed on the storage and disposal of radioactive waste.

Transferral of the radioactive waste to COVRA includes transferral of the property and liabilities. The fact that COVRA takes full title of the waste is reflected in the Transfer document and laid down in the General Conditions of COVRA (*Algemene voorwaarden COVRA* 2022 Article 9).

The license of COVRA (2015) states: B.1 COVRA is responsible for the general strategy for managing radioactive waste and spent nuclear fuel, taking into account the mutual dependences between each stage of the radioactive waste and spent nuclear fuel, from production to disposal. The strategy must be consistent with general national radioactive waste policies.

The process for defining waste acceptance criteria for storage and disposal, and for defining the capacity of storage and disposal facilities
COVRA is responsible for the processing and storage of radioactive waste generated in the Netherlands. This responsibility encompasses the entire radioactive waste management chain; from transport, processing, to storage and eventual disposal. Requirements are set for the different steps arise from legislation and regulations, the permit and the company's own policy. The requirements set by COVRA for radioactive waste within the waste management chain form an integral set. For example, the requirements imposed on waste when it is accepted pre-sort the way in which the waste is processed; the waste must be delivered in such a way that it can be processed as efficiently and effectively as possible. COVRA's Requirement Management System will be used for the derivation and management of the criteria and specifications for new waste. It will provide insight into what requirements are set for the waste and packaging for each processing or storage building, and what considerations underlie these. COVRA requirements management system is important, not only for compliance with the requirements, but also for the completeness and mutual consistency of (existing and new) required properties.

In June 2023 the license of COVRA was amended due to the planned realisation of the MOG.

(COVRA license 2015, amended in 2023 with B.2)
If COVRA wishes to change the waste specifications it uses when assessing the acceptability of the radioactive waste offered to it, COVRA must submit the proposed change to the ANVS for approval in advance.
Indien COVRA de afvalspecificaties die ze hanteert bij de beoordeling van de aanvaardbaarheid van de haar geboden radioactieve afvalstoffen wil wijzigen, dient COVRA de voorgenomen wijziging vooraf aan de ANVS ter goedkeuring voor te leggen.

(COVRA license 2015, amended in 2023 with B.2A)
COVRA must draw up acceptance criteria for the reception, processing and storage of radioactive waste in the MOG for the purpose of verifying that the storage of packaged and unpackaged radioactive waste remains within the limits set in the safety analysis. These acceptance criteria and amendments thereto are submitted to the ANVS for review. COVRA must draw up these acceptance criteria with a view to safety during operations, in possible accident situations and long-term storage.
COVRA dient acceptatiecriteria op te stellen voor de ontvangst, verwerking en opslag van radioactief afval in het MOG ten behoeve van de verificatie dat de opslag van verpakt en onverpakt radioactief afval binnen de in de veiligheidsanalyse gestelde grenzen blijven. Deze acceptatiecriteria en wijzigingen daaraan worden ter beoordeling voorgelegd aan de ANVS. Deze acceptatiecriteria dient COVRA op te stellen met het oog op de veiligheid tijdens bedrijfsvoering, in mogelijke ongevalssituaties en de lange termijn opslag.

The ANVS will investigate whether a similar condition can be set for the other storage buildings at COVRA. Setting requirements for waste acceptance criteria will ensure that the waste accepted by COVRA fits within the specifications necessary for safe management of the waste on the short and long term.

(National programme, page 56)
Not only the passing on of knowledge to future generations is important. Equally, it is now already important to have knowledge of the design of a future disposal facility that will be used for the acceptance of radioactive waste, for making choices in processing and storage and securing funding in the long term. Because COVRA is responsible for both storage and disposal, these aspects are already taken into account.

(JC 2020, page 68/69)
With regard to the acceptance criteria for vitrified waste it is worth to mention that the specifications were drawn by the reprocessing facilities and approved by the operators of the NPP's and the RB. These specifications were used – among other things – as input for design and licensing of COVRA's HLW facility. These specifications include guaranteed parameters for contamination and radiation levels, heat load and chemical composition. Before shipment from the reprocessing site to COVRA, all relevant data and product files are provided and checked, compliance with transport regulation is assured, and the canisters are witnessed by COVRA and the NPP operator. Upon arrival at the COVRA site a second check is performed.

(Summary report IRRS)
COVRA has set conditions for acceptance of the waste according to the requirements for transport [GSR Part 5 requirement 9, Technical Conditions 2023 as published on the website of COVRA], classification [GSR Part 5 requirement 9, safety report 2.2.3], processing [GSR Part 5 requirement 10, safety report 6.1.2 (low- and intermediate-level waste, further: LILW) and 8.1.2 (high-level waste, further: HLW)] and storing the waste [GSR Part 5 requirement 11, safety report 7.1 (LILW), 8.1.3 (HLW)]. The ANVS reviews and approves these criteria during the licensing procedures or according to license conditions. When for instance COVRA changes their waste specifications, they need consent from the Regulatory Body [GSR requirement 12, COVRA license 2015 B.2]. The ANVS requires that waste accepted by COVRA for processing and storage must conform to the specifications as set in the safety report [GSR Part 5 requirement 12, Bkse Article 8.d and licence 2015 B.13]. During the Joint Convention Review Meeting in 2022, a suggestion was made to COVRA to implement the results of the research programme on disposal into the to be developed waste acceptance criteria.

(Draft report IRRS mission 2023)
Two recommendations have been made by the IRRS team on waste acceptance criteria:
1. (R17) The ANVS should further develop regulations and guides to be consistent with current IAEA safety standards. In this context, the IRRS report mentions the following areas for improvement and clarification of the legal framework:

- the interdependencies between the steps in predisposal management of radioactive waste and the impacts on the anticipated disposal option,
- the requirements on processing of RAW that ensure there is appropriate consideration of the RAW characteristics and of the demands imposed by the different steps in its management (this has been identified in the ARM and is part of the Action Plan),
- the requirements that ensure storage conditions take into account of the planned storage periods; the use of passive safety features; prevention of the waste containment degradation

and; provisions for radioactive waste inspection, monitoring, retrievability and preservation (this been identified in the ARM and is part of the Action Plan),
- specific requirements for location and design of predisposal facilities,
- conditions for the procedures for the operation of predisposal waste management facilities and their documentation, incl. their maintenance.

2. (R21) The ANVS should develop regulatory requirements on Waste Acceptance Criteria. The safety case should be identified as the main source of criteria for accepting radioactive waste packages and unpacked radioactive waste for processing, storage and disposal.

The process for defining the capacity of storage and disposal facilities
There is no process in the Netherlands to define the capacity of storage and disposal facilities. The waste management organisations (COVRA and landfills) are responsible for ensuring enough capacity within the limits of their license. For COVRA, the regularly updated inventory shows the expected future arisings of radioactive waste and the types of waste in 2030, 2050 and 2130. The capacity of the storage and disposal facilities can be monitored according to these expectations.

The way radioactive waste that returns from pre-disposal activities in a foreign country is taken into account
When applicable, waste that returns from pre-disposal activities (such as processing) in a foreign country must, upon return to the Netherlands, be managed according to the national policy.

5.1.5 Interim Waste Storage Facilities at COVRA[29]

COVRA has a site of about 25 ha at the industrial area Vlissingen-Oost. Long-term interim storage was taken into account in the design of the facilities, installations and packages. The available site offers enough space for the waste expected to be produced in the Netherlands in the next hundred years up to disposal. A layout of the COVRA facilities as present today, is given in the figure below.

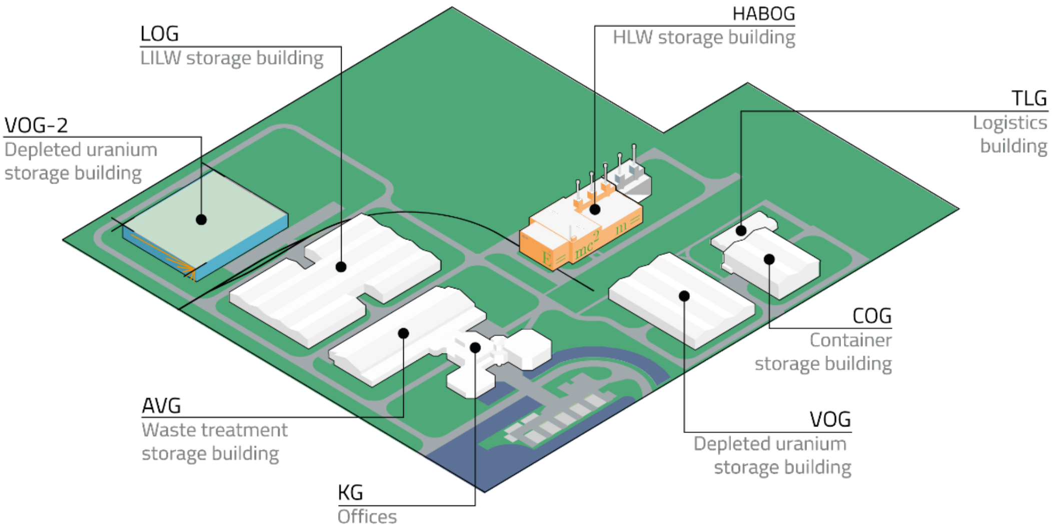

Figure 5.1: Layout of the COVRA facilities.

Buildings
All storage facilities are modular buildings. Since all wastes will be stored for a period of at least 100 years, this has to be taken into account in the design of the storage buildings.

The storage building for low- and intermediate-level waste (LOG) is H-shaped and consists of a central reception bay surrounded by four storage modules. Each storage module presents a storage capacity for ten to fifteen years of waste production at the present rate. In total 16 storage modules for low- and intermediate-level waste can be constructed which represents at least some 160 years of waste production.

[29] JC 2020, Annex 1.

There is a storage building for 20-ft containers, including decay storage (for a maximum of 50 years) and NORM[30]-waste (COG), which can be modularly extended to triple its current size in the future.

The storage building for depleted uranium is the VOG. A second building for the storage of depleted uranium (VOG-2) has been constructed to accommodate the generation of the depleted uranium from 2017 on.

The storage building for high-level waste (HABOG) is currently being extended. This is necessary because of the Long Term Operation of the NPP Borssele.

Low- and intermediate-level waste in the LOG
LILW is treated to produce a waste package that is expected to last for at least 100 years and that can be handled after that period. The package should therefore:
- Provide a uniform and stable containment;
- Avoid possible spreading of radionuclides into the environment;
- Lower the radiation dose of handling to acceptable levels;
- Make identification possible to know the content;
- Allow simple repair and monitoring;
- Reduce the volume of the waste;
- Be acceptable for disposal.

For the low- and intermediate-level waste the desired package that meets the above criteria is a cemented waste package. The size of the resulting package is standardised and limited in size in order to ease later handling. Generally, packages with a final volume of 200 litre or 1000 litre are produced. The 200 litre package is a galvanised steel drum with inside a layer of five centimetre of clean, uncontaminated concrete, embedding the waste. The 1000 litre packages are full concrete packages wherein a cemented waste form is present. In each package there is at least as much cement as waste volume. 200 litre packages with higher dose rate can be placed in removable concrete shielding containers of the same size as the 1000 litre containers.

Figure 5.2 (left): The storage of low- and intermediate-level waste in the LOG.
Figure 5.3 (right): The storage of 20-ft containers in the COG.

The conditioned waste packages are stored in a dedicated storage building (LOG). Simplicity, but robustness was leading in the design phase. The storage building is constructed from prefabricated

[30] Naturally Occurring Radioactive Material, NORM.

concrete elements. The outer shell, roof and walls, can be replaced while keeping the waste indoors. Technical provisions inside the modules are minimal: only supply of electricity and light. Both can easily be replaced. All other technical provisions are placed in the reception area. With mobile equipment the air humidity in the storage building is kept around 60%. Waste packages are stacked inside with forklift trucks. Waste packages are placed five rows thick and nine positions high, leaving open inspection corridors. In a group of five rows of packages, higher dose rate packages are placed in the middle to reduce dose to the workers and the environment. The exact position of each individual package is administrated. All containers must be free of outside contamination according to normal transport requirements. As a result, contamination is not present inside the building. Nor fire detection or firefighting equipment is present in the storage modules since burnable materials are almost absent. Floor drainage has been judged to be useless and weakening the structure. The floor has upstanding edges that prevent water entering the building.

Decay storage and NORM-waste in the COG
The NORM-waste stored in the COG is a calcined product resulting from the production of phosphor in a dry/high temperature process. It is a stable product that does not need further conditioning to assure safe storage. Polonium-, lead- and bismuth-210, relatively short lived but highly radiotoxic nuclides, are concentrated in this waste. Radiation levels from these alpha-emitting radionuclides are very low at the outside of a package.

There are forms of radioactive waste that require several tens of years to decay to below the release threshold values. Some of this material is potentially valuable, such as metals or rare earth elements, which could be reused. Decay storage makes it possible to return valuable (raw) materials that are no longer radioactive to the raw material cycle. Bulk material that is slightly activated or contaminated and decays below the exemption limit within a period of 50 years is eligible for decay storage in COG as well.

Economics played an important role in the implementation of the storage solution. The waste for decay storage and the calcinate are stored in a 20-ft container. Where needed these containers can be tailored to the characteristics of the waste stored. The container for calcinate has three filling positions in the roof of the container that can be closed with a sealed lid and a polyethylene bag that serves as a liner. The inside and outside of the container is preserved with high quality paint. The 20-ft containers can be filled with up to 30 tonnes of material. These containers are stacked four high in the container storage building. Inspection corridors are kept open, as well as an opening to retrieve the containers firstly stored.

The container storage building is a galvanised steel construction frame with steel insulation panels. High quality criteria were set for the construction and materials in order to meet 150 years lifetime with minimum maintenance. This building also, can be modularly expanded. Again, technical provisions inside the building are minimal. Per storage module an overhead crane is present. The very low radiation doses in the facility allow all maintenance inside. With mobile equipment the air humidity in the storage building is kept around 60%. As all containers must be free of outside contamination according to normal transport requirements, no contamination is present inside the building.

Depleted uranium in the VOG
Depleted uranium from enrichment activities, is stored in a similar way as calcinate: storage of unconditioned material in larger containers, in this case storage of U_3O_8 in DV70 containers in the VOG. For depleted U_3O_8 the argument to wait for decay to clearance levels is not applicable. The argument not to embed the material in a cement matrix is the potential value of the material as a future resource. If reuse does not take place in the future and the decision is taken to dispose of the material, this can be done according to then applicable standards. Funds for this treatment and for disposal are set aside in the capital growth fund in the same way as is done for all other waste stored at COVRA.

The storage building is a simple concrete construction with insulation panels. A concrete structure is used, because some shielding is required. The building can be expanded modularly and per storage module an overhead crane is present. For maintenance the overhead crane can be brought to a central reception area that is shielded from the storage module. The same philosophy is followed in this storage building as in the other storage buildings: technical provisions inside the building are minimal. With mobile equipment the air humidity in the storage building is kept around 50%. As all containers must be free of outside contamination according to normal transport requirements, no contamination is present inside the building.

High-level waste in the HABOG
Vitrified waste and compacted hulls and end caps are and will be returned to the Netherlands after reprocessing of spent fuel. The research reactors as well as the molybdenum production facility in the Netherlands produce spent fuel and other high-level waste. A packaging and storage facility is in operation for high-level waste. This facility, called HABOG by its acronym, is a modular vault with a passive cooling system. Heat-generating waste is stored in vertical wells, filled with a noble gas in order to prevent corrosion during the long-term interim storage period. Air convection brings cold air in that cools the wells at the outside and is discharged as warmer air via the ventilation stacks. Contamination of the air is not possible.

The choice for this system that has no mechanical components is a direct result of the choice for long-term interim storage. The design of the concrete structure was based on a lifetime of at least 100 years. The facility has further been designed such that all events with a chance of occurrence of 10^{-6} per year are taken into account and do not create any radiological risk to the outside world. There is spare capacity available to empty each storage module to allow for human inspection or repair. Also repacking is possible within the facility, including space to store the larger over packs. spent fuel from research reactors are packaged into stainless steel canisters compatible with the storage wells. These canisters are welded tight and filled with helium to check the weld and to create a non-corrosive environment for the waste. All waste packages stored are free of contamination on the outside. In the storage areas no mechanical or electrical equipment is present. Maintenance, repair or even replacement can be done in a radiation-free environment.

See Figure below for the appearance of HABOG before the current ongoing extension.

Figure 5.4: HABOG before current extension.

The extension of the HABOG is in progress. Currently, approximately 110 m^3 of high-level radioactive waste is stored in the HABOG. The extension will offer 50 m^3 extra storage capacity for heat-producing high-level radioactive waste. See Figure below for photos of the construction of the extended HABOG.

Figure 5.5: Construction on the extension of HABOG.
A. heavy reinforcement in the concrete floor on which the wells are placed.
B. Pouring concrete for 1,7 m outer walls.
C. with the emplacement of the ventilation shafts the construction reaches its highest point.

5.2 Disposal management plans and activities

5.2.1 The existing solutions or plans for disposal of all waste types covering siting & design, construction, operation, closure and post-closure control of a disposal facility or facilities

The main existing solutions or plans for disposal of all waste types in the Netherlands are specified in the table below.

Category radioactive waste (NL)	**Location**	**Long-term management**	**Reference/ more information**
NORM, LILW, HLW	COVRA	Geological disposal is foreseen around 2130	JC 2020, table 1, 3, annex 1
NORM, subject to notification (i.e.: up to 10x the general clearance level) and when specific clearance is applicable	Afvalzorg B.V. (locations Nauerna, Zeeasterweg and Wieringermeer) and Mineralz B.V. (location Maasvlakte)	Radioactive waste to be disposed of at a landfill must be transported to the landfill as soon as reasonably possible	JC 2020, table 1, 4

Table 5.5: Existing solutions for disposal of all waste types.

5.2.2 The schedule for development and implementation of the national disposal facilit(y)(ies) (see also 'Milestones')

The current timeline for the development and implementation of the geological disposal facility is described in the OPERA safety case (see Figure below).

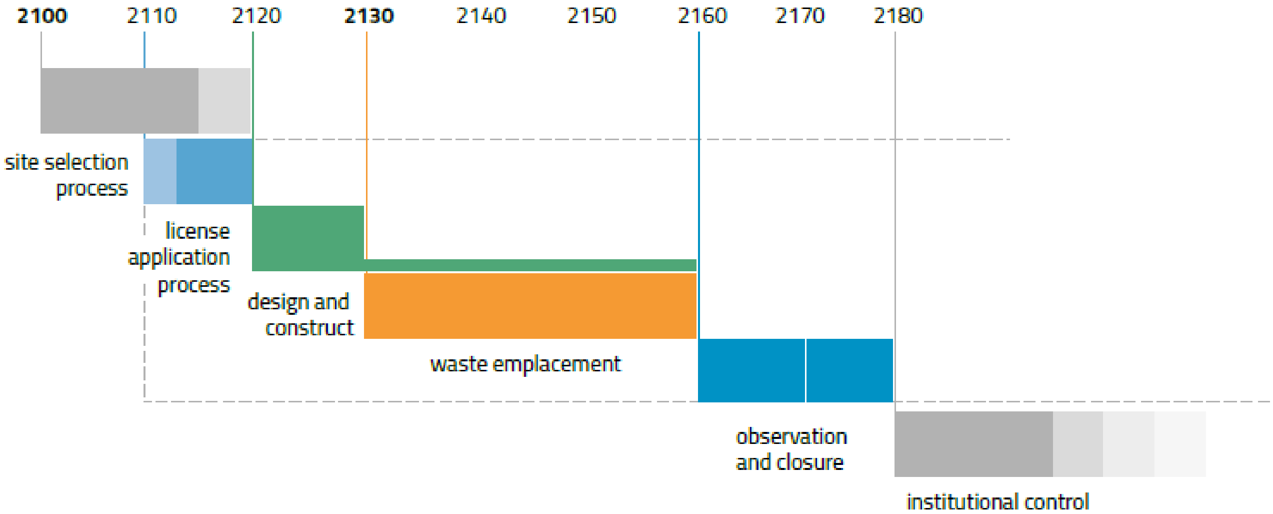

Figure 5.6: Timeline of the disposal facility.

5.2.3 The current status of disposal development for all the waste categories in the national inventory including any future waste arisings

As decision-making on disposal is envisaged around the year 2100, no definitive choice has been made for a design or location of the disposal facility.

The Netherlands is involved in research on the long-term management of spent fuel and radioactive waste for decades already. Results from the research programmes have been used as input for the policy development on the management of spent fuel and radioactive waste.

5.2.4 Plans for disposal in another country (if any)

At this moment, there are no plans for disposal of radioactive waste and/or spent fuel which has been produced in the Netherlands in another country.

(JC 2020, page 24: Dual track approach)
To achieve disposal, both a national and an international line are being followed: a 'dual track approach'. Within this strategy, a national route towards disposal will be elaborated. At the same time, the possibility of international collaboration will not be excluded. The dual track approach makes it possible to respond appropriately to possible international initiatives regarding management of radioactive waste.

5.2.5 The measures in place or foreseen to ensure safe closure of the disposal facility

There are no measures in place or foreseen to ensure safe closure of the disposal facility as the design and the location of the facility are not chosen yet.

5.2.6 The concepts or plans for the post-closure period of disposal facilities (existing and/or planned), including monitoring, institutional controls and long-term knowledge preservation

5.2.6.1 The current status of development of post-closure measures or plans

There are no concrete plans for the development of post-closure measures at this moment as there are no plans yet for the construction of a geological disposal facility.

Monitoring
(National programme, page 55, E.1.1)
During the lifecycle (realisation, operation and phased closure) of the disposal facility, monitoring provides information on the basis of which (in part) the decisions can be taken within the project. In other words, monitoring contributes to the confidence in the disposal facility, both for the operator, the public and the regulatory and supervisory authorities.

(National programme, page 56, E.1.3)
In the post-operational phase: following the closure of the disposal facility, there will probably be (1) a period of indirect monitoring, followed by (2) a period in which no further monitoring is carried out. According to international thinking, we must strive towards extending the period of indirect supervision as long as possible.

Institutional controls
(JC 2020, page 68, 22 (iii))
The national research programme on geological disposal 'OPERA' (see section B of the present report) addresses the issue of institutional controls and makes proposals on the types of institutional control necessary, taking into account the prolonged retrievability of the waste from the geological disposal facility. In OPERA an underground observation phase of ten years is included to facilitate eventual retrieval of waste packages before closure.

Long term knowledge preservation
(NR 2021, page 75, 12.1.e)
The importance to preserve knowledge is fully recognized. In the National programme it is said (in paragraph 4.3.4) that 'monitoring and knowledge assurance are relevant at different moments of the process of creating a disposal facility. There are many international developments in these fields, and a great deal of progress is expected, because the first disposal facilities for high-level radioactive waste have not yet been commissioned. It is important that the Netherlands remains up to date on these developments. This is achieved in the Netherlands through research, tying in with international studies and consultation groups in which the knowledge and results are shared.'

(JC 2020, page 109, Section K)
Maintenance of knowledge of the properties of the waste and the disposal facility(ies) is necessary to inform future generations of what will be located in geological disposal facilities, where and why. In (international) research programmes into disposal, much attention is focused on how this information can continue to be transferred for the very long-term. Because the decision has been taken in the Netherlands to store radioactive waste on the surface till 2130, this also allows time to learn from experiences abroad.

5.2.6.2 The provisions for the release of disposal facilities from institutional control (if applicable)

There are no provisions for the release of the geological disposal facility from institutional control yet.

5.3 R&D envisaged to support these solutions

5.3.1 The responsibilities for establishing the plans and time schedules for R&D in relation to the development and implementation of the technical solutions in line with the National Strategy

The Ministry of Infrastructure and Water Management is responsible for the national policy on the management of radioactive waste and spent fuel. The national policy provides the framework for the R&D activities on pre-disposal and disposal.

COVRA is responsible for the development and implementation of the strategy and the technical solutions in line with the national policy and thus also for the plans and time schedules for R&D.

5.3.2 The roles and responsibilities of different actors involved in the R&D activities (licence holders, waste management agency, regulatory bodies, research organizations, universities and others)

Besides the Ministry of Infrastructure and Water Management and COVRA (see 5.3.A) other actors involved in R&D activities are:

- The ANVS has several tasks among which the granting of licenses, supervising and enforcing compliance and undertaking research in support of the implementation of its tasks. The ANVS

has the responsibility to assess the safety case accompanying the license application for a new waste management route and should have and/or acquire the knowledge to do so.
- SCK.CEN is a technical support organisation from Belgium. ANVS has a framework contract with SCK·CEN for consultancy in the area radiation protection which includes research related to waste management.
- RIVM is a governmental supporting organisation which provides scientific support to several ministries as well as the ANVS. Through financing of COVRA, NRG also participates in EURAD (European Joint Programme on Radioactive Waste Management).
- NRG in Petten and Arnhem provides consultancy & educational services to government and industry. The company has implemented 'Chinese Wall' procedures to protect the interests of its various clients and avoid conflicts of interest. NRG currently has framework contracts with the ANVS for consultancy in the area's radiation protection and nuclear safety and support in licensing of applications of ionising radiation. Through financing of COVRA, NRG also participates in EURAD.
- The Technical University in Delft has several academic projects on geological disposal. Through financing of COVRA, the Technical University in Delft also participates in EURAD.
- The Utrecht University has several academic projects on geological disposal. Through financing of COVRA, the Utrecht University also participates in EURAD.
- TNO institute is an independent research institute. Through financing of COVRA, the geosciences branch also participates in EURAD.
- BGS, the UK geological survey, studies clay properties. Through financing of COVRA, BGS also participates in EURAD.

Note that the licensees do not have any role or responsibility for R&D into waste management after transfer of the waste to COVRA as the responsibility for the waste transfers to COVRA upon payment of the tariffs.

Societal research
See chapter 1 for the research being performed by the Rathenau Institute on the decision-making process around disposal.

5.3.2.1 Joint R&D activities on bilateral or multilateral level (if applicable)

The Netherlands participates in several joint research activities. Examples are:
- The joint research programme of the European Commission (EURAD);
- Research performed in various international working groups such as the ERDO Association;
- Collaboration with Belgium in the research programme on geological disposal.

5.3.3 The identification of R&D needs and priorities

In 2020 COVRA published a detailed technical research plan for the period of 2020-2025 as part of a long-term research programme for geological disposal of radioactive waste. This programme uses the roadmap for future R&D developed in the OPERA safety case, thereby using a structured process to select research activities to be carried out over the coming years.

5.3.4 Financing of the R&D activities

(National programme, page 31)
The fourth principle in the policy on radioactive waste is that in respect of all costs involved in the management of the radioactive waste, 'the polluter pays' principle will apply. This principle will be fulfilled by the fact that COVRA will include in its charges all estimated costs for processing, storage and disposal, on the basis of the state of the art at that time. In the implementation of the Directive, the obligation has been introduced to set off the research costs into disposal, in the charges imposed by COVRA.

5.3.5 The review of R&D activities and the way they are approved

The research programme at COVRA is reviewed by an International Advisory Board consisting of international experts in fields crucial for the geological disposal of radioactive waste. The goal of the International Advisory Board is to assure the quality of the research programme and its outputs, assure its international embedment and its linking with adjacent initiatives in the Netherlands and abroad, and to strengthen the research programme based on input from international experts.

5.3.6 The evaluation of R&D progress in regard to National Strategy implementation

At this moment there is no formal review structure of the R&D activities at COVRA by the Ministry and/or the ANVS. The Ministry and the ANVS are informed on the results of the R&D activities during annual research meetings.

5.3.7 Research programmes

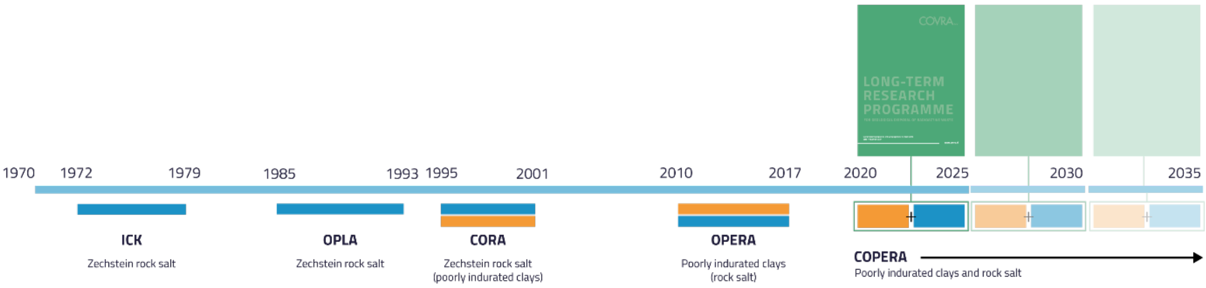

Figure 5.7: Overview of previous research programmes (From 'Overall research programme and work programme for 2020-2025', November 2022, published on COVRA.nl).

OPERA
In 2017 the national research programme on geological disposal OPERA (*OnderzoeksProgramma Eindberging Radioactief Afval*, English translation: research programme disposal radioactive waste) was concluded. COVRA coordinated the 10-million-euro research program, which started in 2011. The costs of the programme were divided between the nuclear industry and the government. Various organisations have been contracted to perform parts of the research programme.

In OPERA, an initial safety case, the first in a series of safety cases, for the geological disposal of radioactive waste and spent fuel in Boom Clay has been developed. The initial safety case gives good indications that a stable and robust disposal of all current and expected Dutch radioactive waste at 500 meters depth in Boom Clay may be possible in the Netherlands, although several uncertainties remain and should be clarified in the following safety cases. The safety case also contains a roadmap for future research. A separate, complementary report of the OPERA Advisory Group deals with the societal issues of geological disposal, including stakeholder engagement and conditions for the long-term decision-making process on disposal.

OPERA focused on the Boom Clay, still salt formations and other clay formations are also viable options for geological disposal. Salt as host formation has been explored in the past in the Netherlands and a limited update study has been carried out in OPERA. Much of the information and many of the approaches developed in OPERA are directly transferrable for an evaluation of these other formations (e.g., work on waste types, inventories, packaging, overlying geological formations and safety assessment modelling).

A separate, complementary report of the OPERA Advisory Group deals with the societal issues of geological disposal, including stakeholder engagement and conditions for the long-term decision-making process on disposal.

For more details on previous research programmes, see JC 2020, Annex 4.

COPERA
In 2020 COVRA published a detailed research plan[31] for the period of 2020-2025 as part of a long-term research programme for geological disposal of radioactive waste (COPERA). This programme uses the roadmap developed in the OPERA safety case, thereby using a structured process to select research activities to be carried out over the coming years.

[31] https://www.covra.nl/app/uploads/2020/11/2020-LTRProgramme-email.pdf

6 Safety demonstration of radioactive waste and spent fuel management activities and facilities

6.1 Current status of safety cases for the facilities needed (existing and planned) for the safe management, at all stages, of all SF and radioactive waste in the Netherlands

6.1.1 Current status of the safety case for the predisposal facility: COVRA (currently operational)

Due to the policy choice for central collection and storage of radioactive waste, there is one predisposal facility in the Netherlands: COVRA. During a licensing procedure COVRA has to submit a Safety Report (SR) and Technical Specifications (TS). These documents become part of the license. A licensing procedure is started when COVRA builds a new building for a type of waste that cannot be stored in the existing buildings. In the license of COVRA, COVRA is obliged to operate the facility in accordance with the SR.

(COVRA license 2015 B.13)
The facility must be organized and operated in accordance with the Safety Report.
De inrichting dient te zijn ingericht en te worden bedreven in overeenstemming met het Veiligheidsrapport.)

6.1.2 Current status of the safety case for landfills (currently operational)

There are three landfills which are dedicated to the management of hazardous waste in the Netherlands, a fourth one is closed due to having reached the maximum capacity. These landfills are allowed to accept NORM up to 10 times the general clearance levels. These materials are regulated under the framework of the Nuclear Energy Act. Depending on the activity concentration of the material licensing and registration by the ANVS might apply to activities involving these materials. Waste that has been cleared from regulatory control under the framework of the Nuclear Energy Act through a specific clearance process may also be managed by those landfills. These materials are further regulated as conventional waste under the framework of the Wm.

During the IRRS mission in June 2023 discussions were held whether the landfill should be classified as a landfill for hazardous waste or a landfill for radioactive waste. At this moment, there is disposal of radioactive waste on the landfill which can lead to the conclusion that the landfill should be classified as a landfill for radioactive waste. However, as the radiological risk is very low, an investigation will start to evaluate whether NORM-waste up to 10 times the general clearance levels to be disposed on the landfill could be defined as conventional waste. Then the landfill can be legally classified as a landfill for hazardous waste, which is how the Netherlands considers the landfills at this moment.

A landfill needs a license or registration from the ANVS for performing specific activities with radioactive materials and radioactive waste. These licensing and registration procedures are generic procedures and regulated in the Nuclear Energy Act and associated Decrees. For more information on these procedures see the IRRS self-assessment.

The province is the regulatory authority for the landfill and is responsible for the supervision of the landfill, also after closure. These licensing and supervising responsibilities are not regulated by the Nuclear Energy Act but are regulated under the regulatory framework for environmental protection.

History

- Since 2004, NORM-waste is defined in Dutch regulations.
- A decision in 2005 (*Aanwijzing inrichtingen voor storten van gevaarlijke afvalstoffen als instelling voor ontvangst van radioactieve afvalstoffen*) allowed disposal of NORM-waste lower than 10 times the clearance level at a landfill for disposal of hazardous waste. A study showed that disposal of this very low-level waste on landfills for hazardous waste does not lead to significant risk from radiation protection point of view.
- Since 2007 the Decree on landfills and bans on dumping waste (*Besluit stortplaatsen en stortverboden afvalstoffen*) also applies for the disposal of very low level radioactive NORM-waste. This Decree sets requirements (amongst others) on:
  - The requirements that the competent authority has to set for a hazardous waste landfill;
  - The type of waste that is allowed on the landfill;

- Waste acceptance criteria;
- Requirements on sampling.

Regulatory framework - Environmental Acts (province is competent authority)
Environmental legislation sets strict requirements for the method of processing and disposal and for the way in which the substances are prevented from spreading to the environment. For landfills, environmental licenses are granted by the provinces on the basis of the Environmental Act in conjunction with the Environmental Protection Act. Examples are the provincial licenses for Mineralz and Afvalzorg.

The licensing process takes the following into account:
- The existing state of the environment;
- The consequences for the environment;
- The reasonably expected developments;
- Opinions and advice submitted;
- The protective measures to be taken;
- Monitoring measures.

Environmental legislation sets emission limit values, both in general regulations and in license conditions. Emission limit values shall be set (among others) for substances which may cause adverse effects to the environment. There are also regulations for the protection of soil and groundwater.

In an environmental license requirements are set:
- To protect soil and groundwater;
- To ensure (by regular monitoring and recording) that measures are taken to prevent emissions into soil and groundwater. These measures are based on a systematic evaluation of the risk of adverse effects on the environment;
- To prevent the generation of waste and wastewater and, insofar as this is not possible, the efficient management and monitoring of waste and waste water.

An environmental impact report has to be drawn up for the construction license of a landfill.

For landfills that have closed or will close the aftercare regulation of the Environmental Act applies. Based on a license, these locations have been equipped with a system of soil protection facilities. Aftercare assessment frameworks and calculation models are drawn up for this purpose by the provinces. A dedicated aftercare fund, financed by the landfill operator, is in place to pay for perpetual monitoring and maintenance by the province after closure.

6.1.3 Current status of the safety case for the deep geological disposal facility (foreseen in 2130)

An initial safety case for deep geological disposal in Boom clay has been published in 2018[32].

COVRA has started a new research programme in 2020 in which the initial safety case for disposal in Boom clay will be complemented as well as an initial safety case for geological disposal in rock salt will be developed. The results are expected to be published in 2030. The generic (non-site specific) safety cases for disposal in poorly indurated clay and rock salt will develop to site specific safety cases when policy decisions on disposal method and location have been made.

(COVRA detailed research plan, page 21)
During the thirty years of the long-term research programme, no siting for a GDF is foreseen in the Netherlands. During this period, every ten years generic (non-site specific) safety cases will be produced.)

[32] Parliamentary papers, Session year 2017–2018, 25422, no. 217.

6.2 Process in place for developing and maintaining a safety case and/or supporting safety assessments

6.2.1 The way this process of developing and maintaining a safety case and/or supporting safety assessments] is adapted to the different phases in the lifetime of a facility (siting &design, construction, operation, decommissioning or closure, post closure)

The Nuclear Energy Act stipulates in Article 15, sub b that a license must be obtained for construction, commissioning, operating, modifying or decommissioning a nuclear facility. During the regulatory assessment the Regulatory Body reviews and assesses the documentation submitted by the applicant as obliged by Bkse Article 8. This includes the EIA Report and Safety Report with underlying safety analyses submitted within the context of a license renewal or modification request, proposals for design changes, changes to Technical Specifications, etc.

COVRA is obliged by the license to (COVRA license 2015 B.7) keep the data on the facility as well as the data on the background and the basis for the conclusions in the Safety Report available at all times. If COVRA wishes to change the way, nature, or scale in or on which this is done, if must be agreed beforehand with the director of the ANVS.
COVRA moet voortdurend gegevens van de inrichting alsmede gegevens omtrent de achtergrond en de basis waarop de conclusies van het Veiligheidsrapport berusten, beschikbaar houden. Mocht COVRA de wijze, aard en/of omvang ervan, waarop dit geschiedt willen wijzigen, dient dit vooraf te zijn afgestemd met de directeur ANVS.

The ANVS is tasked by law (Nuclear Energy Act Article 3) to verify through the regulatory functions (authorization, review and assessment, inspection and enforcement) compliance with the requirements.

6.2.2 The role of the implementor and regulator at the various stages of the process

For more information on the role of the implementor and regulator at the various stages of the process, see the IRRS self-assessment report.

The Nuclear Energy Act (Articles 15 and 29) forbids practices with radioactive materials, including radioactive waste and spent fuel, without a licence.

A disposal facility (excluding a landfill for NORM-waste) is a nuclear facility with a license obligation (Nuclear Energy Act Article 15.b, as the length of 'storage' is not defined in the regulatory framework this is also applicable for disposal ('indefinite storage')). Also due to the Nuclear Energy Act (Article 15.a and 29) a license is obliged for handling or disposing of spent fuel, ores and radioactive materials therefore also a license for constructing, operating and closing a disposal facility is obliged.

The prospective licensee has to present a safety case which shall be assessed by the Regulatory Body (Bkse Article 8.1.d, *veiligheidsrapport* as specified in Bkse Article 6.1.h). Similar requirements exist for the:
- Operation of a nuclear facility for the storage of spent fuel: Bkse Article 8.2;
- Modification of a nuclear facility for the storage of spent fuel: Bkse Article 11.1.c;
- Decommission of a nuclear facility for the storage of spent fuel: Bkse Article 10.2.

The licensee of a nuclear facility has to make sure that the safety of the facility is investigated and verified continually and systematically improved (Nuclear Safety Regulation for nuclear installations (*Regeling nucleaire veiligheid kerninstallaties* – Rnvk) Article 11).

Once the license is issued, the licensee has the responsibility to comply with the licence and licence requirements (Nuclear Energy Act Article 76a). The compliance of the license holders with these requirements can be subject to inspection and enforcement by the regulator (Economic Offences Act Article 1a and Nuclear Energy Act Article 3.3).

A license application for a nuclear installation will be denied if it does not comply with the dose limits and safety limits set in Bkse Article 18.

6.2.3 The process for review and update of the safety case

A safety report is submitted during the license application and reviewed by the Regulatory Body. Modifications influencing the safety of the facility require an update of the safety report. There are requirements for periodic reviews of the safety of the facility.

Bkse Article 11 obliges a license holder when applying for a license due to a modification of the facility and when the modification has an influence on the safety study to supplement the safety report: if the application relates to a facility as referred to in Article 6, 7 or 8 and the proposed change concerns one or more data as mentioned in the safety report or risk analysis referred to in Article 6 (h) submitted with a view to obtaining the licence referred to at (a): a relevant addition to said data.
indien de aanvraag betrekking heeft op een inrichting als bedoeld in artikel 6, 7 of 8 en de voorgenomen wijziging van invloed is op een of meer gegevens als vermeld in het ter verkrijging van de onder a bedoelde vergunning overgelegde veiligheidsrapport of de risicoanalyse, bedoeld in artikel 6, onder h, een desbetreffende aanvulling hiervan.

This is also a requirement in the license of COVRA.

(COVRA license 2015 A.2)
After the realization of changes and before commissioning the altered facility, COVRA must demonstrate, in order to obtain a declaration of no objection from the director of the ANVS, that the entirety of the changes that have been made are in compliance with the Safety Report and the key principles applied therein.
Na het realiseren van wijzigingen en voorafgaand aan het in bedrijf stellen van de gewijzigde inrichting, dient COVRA, ter verkrijging van een verklaring van geen bezwaar van de directeur ANVS, aan te tonen dat het geheel van de gerealiseerde wijzigingen voldoet aan hetgeen gesteld is in het Veiligheidsrapport en de daarbij gehanteerde uitgangspunten.

Rnvk obliges a license holder to continuously improve the nuclear safety of the facility and to systematically evaluate the nuclear safety (Article 11) as well as implement measures from these evaluations (Article 12).

There are several evaluation requirements in the license of COVRA (COVRA license 2015, section C):
C.30. COVRA must periodically evaluate the maintenance, test, and inspection programmes in order to learn lessons from them, for the purpose of continually improving the maintenance, test, and inspection programmes.

C.31. COVRA must analyse its own operational experiences (including malfunctions) and information obtained from operational experiences (including malfunctions) at other organizations that process and store radioactive waste and, to the extent that it applies to the safety of the facility, to learn lessons in the form of modifications to systems, components, procedures and organization.

C.32. COVRA must periodically evaluate the technical, organizational, personnel, and administrative resources relating to safety and radiation protection and take measures to remedy any shortcomings, unless the taking of measures cannot reasonably be required.
Every five years, the resources must be assessed in the light of the key principles underlying the current license. The next evaluation will cover the period from 2014 to 2018.
More detailed evaluations must be carried out every ten years, as meant in the Council Directive 2009/71/Euratom on nuclear safety (Government Gazette 2011, no. 12517), Article 2, fourth paragraph, with the key principles themselves also assessed in the light of new developments regarding safety and radiation protection. The next ten-yearly evaluation shall cover the period from 2009 to 2018 and must be completed in 2019.

C.33. The results of the evaluations referred to in requirement C.32 must be submitted to the director of the ANVS within one year of the final evaluation year. Any proposed changes resulting from the evaluations previously mentioned must be sent beforehand to the director of the ANVS, for his/her approval.

C.34. If it is concluded from analyses, studies, and evaluations, as referred to in the foregoing requirements C.31, C.32, C.33, or elsewhere, that measures should be taken to improve safety, they should be taken as soon as reasonably possible. If, pursuant to the terms of the Nuclear Energy Act, a license is required for the purpose of carrying out these measures, COVRA must apply for the license as soon as reasonably possible before the measures are taken.

C.35. Every five years, COVRA must compare the data concerning the amount and composition of the waste received in the foregoing period with the previous estimates for this data. A description must also be given of how the operations were adapted to the waste being submitted and how operations are expected to be adapted in the next five years. Reports on this matter must be submitted to the Minister of Economic Affairs and a copy of the reports must be sent to the director of the ANVS.

C.30. COVRA dient periodiek de onderhouds-, test- en inspectieprogramma's te evalueren om daar uit lering te trekken met als doel het continu verbeteren van de onderhouds-, test- en inspectieprogramma's.

C.31. COVRA is verplicht de eigen bedrijfservaringen (inclusief storingen) en de verkregen informatie over bedrijfservaringen (inclusief storingen) bij andere organisaties voor de verwerking en de opslag van radioactief afval te analyseren en voor zover van toepassing op de veiligheid van de inrichting daaruit lering te trekken in de zin van aanpassingen in systemen, componenten, procedures en/of organisatie.

C.32. Periodiek dient COVRA de eigen technische, organisatorische, personele en administratieve voorzieningen te evalueren met betrekking tot de veiligheid en de stralingsbescherming en maatregelen te treffen om eventuele tekortkomingen ongedaan te maken, tenzij het treffen van maatregelen redelijkerwijs niet kan worden gevergd.
Elke vijf jaar dienen de voorzieningen beoordeeld te worden in het licht van de uitgangspunten die ten grondslag liggen aan de van kracht zijnde vergunning. De eerstvolgende evaluatie betreft de periode van 2014 tot en met 2018.
Elke tien jaar dienen meer omvangrijke evaluaties te worden uitgevoerd, zoals bedoeld in de Ministeriële regeling implementatie richtlijn nr. 2009/71/Euratom inzake nucleaire veiligheid (Stcrt. 2011, nr. 12517), artikel 2, vierde lid, waarbij ook de uitgangspunten zelf worden vergeleken met nieuwe ontwikkelingen inzake veiligheid en stralingsbescherming. De eerstvolgende tienjaarlijkse evaluatie betreft de periode 2009 tot en met 2018 en dient in 2019 afgerond te zijn.

C.33. De resultaten van de in voorschrift C.32 genoemde evaluaties dienen een jaar na het laatst geëvalueerde jaar ingediend te zijn bij de directeur ANVS. Voorgestelde maatregelen naar aanleiding van eerdergenoemde evaluaties dienen vooraf ter goedkeuring aan de directeur ANVS te worden voorgelegd.

C.34. Indien uit analyses, studies en evaluaties zoals bedoeld in de voorgaande voorschriften C.31, C.32, C.33 of anderszins, de conclusie wordt getrokken dat het gewenst is om maatregelen te treffen ter verhoging van de veiligheid dienen deze zo spoedig als redelijkerwijs mogelijk te worden getroffen. Indien voor de uitvoering van die maatregelen een vergunning op grond van de Kernenergiewet is vereist, dient COVRA deze vergunning zo spoedig als redelijkerwijs mogelijk en voorafgaand aan de wijzigingen, aan te vragen.

C.35. Iedere vijf jaar dient COVRA de gegevens over de in de voorgaande periode ontvangen hoeveelheden afval en de samenstelling daarvan te vergelijken met de eerder opgestelde ramingen over die gegevens. Tevens dient te worden aangegeven hoe de bedrijfsvoering op het afval aanbod werd afgestemd en hoe die afstemming in de volgende vijf jaar naar verwachting zal plaatsvinden. Rapportage hierover dient te worden aangeboden aan de Minister van Economische Zaken en een afschrift hiervan dient aan de directeur van de ANVS te worden gezonden.

6.2.4 The way safety demonstration is taken into account in the licensing process

The Nuclear Energy Act (Articles 15 and 29) forbid practices with radioactive materials, including radioactive waste and spent fuel, without a license.

Before a license application is submitted the RB sets up an assessment framework (*toetsingskader*) based on national and international (e.g., IAEA) regulations. The license application and underlying documents (e.g., safety evaluations, calculations, etc.) have to comply to this assessment framework (see ANVS procedure *reguliere voorbereidingsprocedure*).

The General Administrative Law Act sets out the procedure for obtaining a license, and also stipulates in Article 3:2 that the RB must exercise due diligence (*zorgvuldigheidsbeginsel*) before issuing a license and in Article 4.5 that a license application can be rejected if submitted data and documents are insufficient for the assessment of the license application or the preparation of the license.

During the license application procedure for the construction of a nuclear facility, the prospective licensee has to present a safety case which shall be assessed by the Regulatory Body (Bkse Article 8.1.d, *veiligheidsrapport* as specified in Bkse Article 6.1.h). Similar requirements exist for the:

- Operation of a nuclear facility: Bkse Article 8.2;
- Modification of a nuclear facility: Bkse Article 11.1.c;
- Decommission of a nuclear facility: Bkse Article 10.2.

A license application for a nuclear installation will be denied if it does not comply with the dose limits and safety limits set in Bkse Article 18.

(JC 2020, page 92)
A license for a spent fuel management facility is only granted if the applicant complies with the national requirements and, more in general, with international (IAEA) established safety goals, codes and guides, as well as with the international state of the art. The applicable parts of the IAEA Safety Standards (Safety Fundamentals, Safety Requirements and Safety Guides) must be covered or incorporated in the Safety Report (SR), which is submitted to the RB as part of the license application. A typical example is compliance with the requirements addressing the site-specific external hazards, such as military aircraft crashes, external flooding, seismic events and gas cloud explosions.

The license holder drafts and submits to the RB the Safety Analysis Report (SAR) and supporting topical reports. In these reports detailed descriptions of the facility are presented as well as an in-depth analysis of the way in which the facility meets the requirements and the international state of the art.

After construction and commissioning of the spent fuel management facility the license holder submits the updated SAR with a description of the as-built facility and the results of the commissioning to the RB for approval before start of the routine operation. Since full compliance is expected with the Safety Report, no formal update of the safety assessment or environmental assessment is foreseen and there will be no need for revision of the Safety Report, which is the basis of the license. However, all the results of the commissioning programme are incorporated in a full update of the detailed SAR.

Once the license is issued, the licensee has the responsibility to comply with the license and license requirements (Nuclear Energy Act Article 76a). The compliance of the license holders with these requirements can be subject to inspection and enforcement by the regulator (Economic Offences Act Article 1a and Nuclear Energy Act Article 3.3).

The licensee of a nuclear installation has to make sure that the safety of the facility is investigated and verified continually and systematically (Rnvk Article 11).

6.2.5 The consideration of operational safety (the normal operating conditions, anticipated operational occurrences and design basis accidents and mitigation of consequences should such an accident occur) and long-term safety (for disposal) in the safety case

Safety of the design of the predisposal waste management facility under both normal and accident conditions and for their decommissioning is assessed during the license application against the general requirements in Article 15b, sub-1, of the Nuclear Energy Act for the protection of humans, plants, animals and goods.

A safety assessment for the operation of a spent fuel management facility is made by the operator of the facility as part of the application for a license to operate the facility or to modify the facility (Bkse Article 8) or for decommissioning (Bkse Article 10). The technical specifications and the assumptions underlying the postulated accident scenarios are laid down in a Safety Analysis Report. It is the responsibility of the operator to demonstrate to the Regulatory Body that the situation as built is in accordance with the technical specifications and that the safety requirements can be met.

6.2.6 The way a graded approach is applied to safety demonstrations

(JC 2020, page 23)
The policy (on radioactive waste management) allows for the use of a graded approach, the greater the risk, the stricter the regime. For example, the requirements imposed on activities involving spent fuel and HLW are stricter than for activities involving other radioactive substances.

For the management of radioactive waste at COVRA, different buildings are available for different categories of waste. This makes it possible to assess the safety of each building according to the waste stored in that building.

6.2.7 If applicable, improvements envisaged or planned in your processes for future safety demonstrations

A roadmap to disposal will be developed and included in the National programme 2025. In each update of the National programme, the roadmap will be updated too. Safety demonstrations will be addressed in the roadmap. See chapter 3 for more information on the roadmap.

7 Cost estimates and financing of radioactive waste and spent fuel management

7.1 Responsible entity for the National Strategy cost assessment and how frequently this assessment is updated

The State Secretary is responsible for the chapters of the State Budget (*Staatsbegroting*) concerning the development and upkeeping of the regulatory framework and policies associated with nuclear safety and radiation protection.

For the ANVS, the Nuclear Energy Act stipulates that the Ministry of Infrastructure and Water Management will allocate sufficient financial resources for the ANVS to carry out its duties. Under current regulation the costs of the Regulatory Body for oversight and licencing are partially covered by licensees. Applicants and licensees pay for licensing activities and the licensees of nuclear installations pay an annual fee for oversight.

7.2 Responsible entity for financing the different components of the national strategy activities

In general licence holders hold prime responsibility for the safe management of spent fuel and radioactive waste generated by them and therefore bear the costs that arise from the associated management. That means that the costs for on-site management are for the waste producer. However, as soon as radioactive waste is being transported to COVRA, and the associated tariff is paid, responsibility for safe management as well as the follow-up costs, is transferred to COVRA.

7.2.1 COVRA
Since 2002, the Dutch State has been a 100% shareholder of COVRA. The Ministry of Finance represents the State as the shareholder of COVRA. COVRA is an independent N.V. (*Naamloze Vennootschap*, Limited Liability Company) that publishes its annual report every year (see www.covra.nl) containing annual accounts with an audit report by an independent accountant.

7.2.2 'The polluter pays'
A starting point in the policy for radioactive waste is that all costs of radioactive waste management are based on the principle that 'the polluter pays'. COVRA charges the costs of radioactive waste management to suppliers of waste by tariffs that the company sets within the framework of the Nuclear Energy Act and underlying legislation.

COVRA determines the tariffs based on their estimation of costs of radioactive waste management, including the cost assessment for disposal and research: the established rate, serves to cover the costs arising from the services over the entire management cycle (from transport, processing, interim storage, research to disposal as well as programme management, concept development, siting & design, licensing, construction, operation, decommissioning/closure, long term monitoring and surveillance, regulatory costs, etc. of the interim storage and of the future disposal) on the basis of the current insights.

COVRA takes over the legal ownership and thus the responsibility for the radioactive waste. After transfer to COVRA, no waste management responsibilities and financial obligations remain with the operators (final discharge). In doing so, COVRA mitigates the risk that could arise from a possible future bankruptcy of waste producers.

For standard waste there is a price list that can be viewed on the COVRA website.

Where non-standard waste is produced, arrangements between COVRA and the producers are laid down in private law agreements. Part of these agreements concerns the price that providers must pay for the processing, interim storage and disposal of their radioactive waste and spent fuel. This procedure is in line with the principles of Directive 2011/70/Euratom, that those who created the radioactive waste and spent fuel must bear the costs of its management, including the costs of research into safe storage and disposal methods.

The costs for public participation in relation with disposal are a responsibility of the government.

7.2.3 Decommissioning costs
There has been a general understanding that the 'polluter pays principle' applies to all stages of the management of radioactive waste. Based on legislation and regulations, license holders of a nuclear installation must have a decommissioning plan for the installation approved by the ANVS. The decommissioning plan must be updated at least once every five years.

In addition, operators of a nuclear installation with a nuclear reactor and Urenco are also obliged to have a financial guarantee approved by the State Secretary of Infrastructure and Water Management and the Minister of Finance for the costs of decommissioning, which must also be updated at least once every five years. The Bkse contains provisions for the execution of decommissioning and financial assurance. The Government is in the process of taking over the shares of the NPP Dodewaard[33].

7.2.4 Non-nuclear activities
Pursuant to Bbs Article 10.8.1, an entrepreneur (of a category designated by ministerial regulation) must provide which provisions have been made regarding the termination of use and the disposal of the radioactive source, including financial provisions. Pursuant to Bbs Article 3.7.f, a license application is refused if no or an inadequate termination plan as referred to in Article 10.8 is appended to the application. This also applies if the termination plan does not provide sufficient understanding into the financial provisions made for the termination.

Based on a draft termination plan and a cost estimate, financial provisions shall be established to justify how an entrepreneur is able to bear the future financial burden to pay for the termination of its activity. Taking into account the graded approach, a cost estimate and provision for the termination of a simple operation can be more confined than that for the termination of an extensive (set of) operations and/or activities in comprehensive facilities. If no, or an inadequate, termination plan is submitted, then this is a ground for refusal by the competent authority when an entrepreneur is applying for a license.

7.2.5 High Active Sealed Sources (HASS)
The High Active Sealed Sources Directive has been implemented in the Dutch regulations in the Bbs. The Directive is aimed at preventing unregulated sources. It has also al system of financial assurance for safe disposal of a high-activity source. Bbs Article 4.15 states that the entrepreneur, who holds the source, provides for financial security to cover the costs regarding the safe disposal of a discarded high-activity source in the event:

- He goes bankrupt or otherwise terminates its business activities, or;
- The person with whom an agreement was concluded to retrieve the discarded high-activity source is no longer able to recover it.

7.2.6 Financial provision for maintenance and aftercare of landfills
Producers of NORM-waste who need to dispose of them to the designated landfill, are required to pay a certain fee to the Province in which the landfill is located. This fee is to cover the costs of operating the landfill and the costs of monitoring the landfill after it has been closed. The Province is required to monitor the landfill.

7.3 Arrangements for securing adequate and timely finances for implementing the different components of the National Strategy activities

7.3.1 Cost estimate for the disposal
In summary, the strategy of COVRA to obtain required assets for disposal is based on the 'polluter pays' principle. The tariffs charged by COVRA cover the costs of research, collection, processing, storage and disposal. The tariffs are reviewed annually, and the standard tariffs are set annually. The income to cover expected future expenses, including disposal, is invested based on an investment mandate imposed by the shareholder, the Minister of Finance. The aim is to cover all anticipated costs.

Within OPERA, the expected waste inventory in 2130 has been further detailed and a cost estimate has been made for its geological disposal in Boom clay. This indicative cost estimate for geological disposal in Boom clay amounts to €2.27 billion (real term 2022, discounted to 2130). This cost estimate is used for the determination of (contractual) tariffs. This cost estimate has been drawn up based on the Belgian model of ONDRAF/NIRAS and reviewed by an external agency.

[33] Parliamentary Papers, Session year 2022-2023, 28165, no. 392.

Part of the uncertainty in the cost estimate is caused by the technology required (salt or clay and the depth at which the disposal facility will be constructed) depending on this. The initial safety case from OPERA will be further elaborated in the coming decades. The cost estimate will also be periodically updated. International experiences are taken into account in these estimates.

Assuming 15-20 years for site selection and 7-10 years for the permit application process, the operation of the geological disposal facility is planned to start in 2130. The entire process up to and including inspection after closure will take many decades. The cost estimate for the disposal includes the license application, the design and construction of the above and below ground facilities, the placement of the waste and the closure of the facility. A ten-year observation phase is included (retrievability). The development of the design of the disposal and the process of choosing a location are not included in the cost estimate but are included in the provision for the disposal facility.

The estimate of the disposal costs is based on the best available knowledge of the costs of building, operating and closing a disposal facility. The uncertainty margins are calculated according to the EPRI method (EPRI stands for Electric Power Research Institute), a method that is used internationally for estimating the costs of nuclear facilities, among other things. The cost estimate is a conservative estimate and has been used as a target for further calculations. The cost estimate and associated system has been checked by an external expert party.

7.3.2 Unforeseen increases in costs

There are three ways to ensure that assets are sufficient to cover the long-term costs of radioactive waste management:

(1) The cost estimate for disposal takes into account margins of uncertainty. These percentages are calculated per expense item and are based on international standards. Subsequently, the financial impact can be calculated by determining how high the provision for the disposal facility should be at the end of a year, so that this provision, after additions and withdrawals, will be around €0 at the end of the operational phase of the disposal facility at around 2180. On the way there, it must be checked annually whether the provision is high enough at the end of a year and therefore sufficient for future expenditure. The applied estimation system and the completeness of the included cost items of the disposal facility have been reviewed by an external agency.

(2) In order to cover the long-term costs of radioactive waste management, the proceeds from the management of liquid assets are important.

(3) Any unforeseen costs will have to be absorbed with additional revenues from tariffs, optimization of the operation and with possible additional revenues from the management of the financial resources.

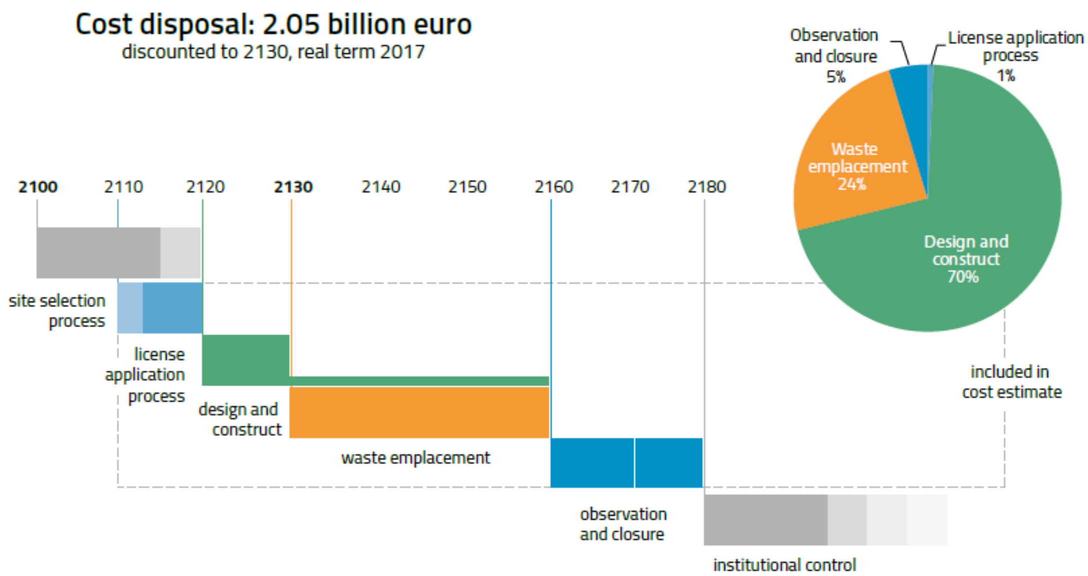

Figure 7.1: Source: OPERA safety case, 2017.

7.3.3 COVRA tariffs for waste management

COVRA annually has about three hundred customers with standard waste. Five of those customers also supply specific, non-standard waste. COVRA distinguishes between two categories of waste streams:

1. Standard waste

Standard waste is understood to mean the waste that is described as such in the Technical Conditions of COVRA. The tariffs applied by COVRA for standard waste streams as well as for the packaging costs and services, and the General and Technical Conditions, are published annually by COVRA on its website. These tariffs apply to all suppliers who produce standard waste, so also to customers who also supply specific waste.

2. Non-standard waste (also known as specific waste)

This concerns unique waste streams that require specific treatment and/or storage facilities. For the handling and storage of these types of waste streams, which require specific, unique processing and/or storage facilities, specified contracts have been drawn up with a number of suppliers. These contracts also cover the costs of construction, management and maintenance of these specific storage facilities. The specific storage facilities are built on the COVRA site on behalf of these large customers, invoiced and not capitalized on COVRA's balance sheet. An example concerns (the expansion of) the HABOG and the new building for depleted uranium (VOG-2). A large part of the risk (the construction risk) has thus also been removed from COVRA. The arrangements between COVRA and the producers are laid down in private law agreements. Part of these agreements concerns the price that providers must pay for the processing, interim storage and disposal of their radioactive waste and spent fuel. This procedure is in line with the principles of Directive 2011/70/Euratom, that those who created the radioactive waste and spent fuel must bear the costs of its management, including the costs of research into safe storage and disposal methods.

7.3.4 Cost model

The same cost model is used for all waste streams (standard and non-standard waste). The 2017 cost price calculation model was evaluated by KPMG in 2021/2022. There were areas for improvement especially concerning the simplification of the system. In 2022, a new cost price calculation model was drawn up in which these points for improvement were incorporated. The model has been approved by the Supervisory Board and will be assessed by KPMG in 2023. This may lead to a further improvement of the model. The new cost price calculation model includes the total costs of radioactive waste management (such as storage costs, processing costs, transport costs, operating costs, additions to facilities, research and including the provision for disposal). Because multiple waste streams use the same assets, the cost of these assets must be divided among the various waste streams. In the allocation of costs, a distinction is made between direct costs (costs that can be allocated entirely to a specific waste stream) and indirect costs (costs that are incurred by several waste streams and can therefore not be traced back to a single waste stream). The cost prices are calculated annually, and the model is periodically recalibrated so that the cost prices reflect the current expected costs for standard waste streams. If new waste streams are offered to COVRA, the distribution of costs is updated using the model described above.

The starting point for setting the tariffs is that the same rates are charged to all customers for equal waste streams. The rates for standard and non-standard waste are adjusted annually. Only non-standard waste arrangements are laid down in long-term contracts in which a long-term indexation mechanism has been agreed. These rate increases are based, among other things, on general wage and material developments, as determined by Statistics Netherlands (CBS). As specific installations and storage facilities for this waste also apply, different risks and deadlines apply.

At the moment, a small number of waste streams have negative margins. This is due to a changed supply of waste streams and changed treatment options. The rates for these waste streams are gradually increased until the desired margin is reached. The rates of waste streams with negative margins have increased by 17.5% in 2023. For waste flows with positive margins, there was a standard increase of 2% (inflation correction). The rates for standard waste and the rationale on the structure of the tariffs are published annually on the COVRA website (www.covra.nl). Any future adjustments, for example due to changes in waste supply or the introduction of new management equipment, will be reassessed yearly. The entire system is reviewed periodically with an evaluation of the tariffs, also taking into account the return on investment.

7.3.5 Determination of COVRA tariffs
The tariffs are determined on the basis of a number of basic principles. A starting point of this is, among other things, the implementation of the 'polluter pays' principle. There is no direct or indirect government contribution. All waste management costs are included in the tariffs. In Bkse Article 30g and Bbs Article 10.10 is stipulated that to determine the tariffs of radioactive waste management, these must be set by COVRA in a transparent, objective and non-discriminatory manner. The ANVS is tasked with the oversight on these requirements for the tariffs. In 2021/2022 the oversight on the tariffs was evaluated by KPMG, in the same report that the cost model was evaluated. KPMG advised the ANVS to specify these requirements to aid the oversight and create more clarity. In August 2023 a concept policy rule was published by the ANVS for public participation. After the reactions from the public and/or COVRA are received the ANVS will adopt and apply the policy rule when conducting oversight on these requirements.

The current actuarial rate of interest used to discount future obligations is 2.3%. The provisions are accrued annually with this real yield of 2.3% + 2% assumed inflation (4.3% total). The interest rate with which the future obligations are discounted is periodically evaluated and adjusted if necessary. The Minister of Finance is sole shareholder of COVRA and is responsible for the investment mandate on the funding for waste management.

7.3.6 Financial provisions at COVRA
Since 1994, the financial provisions that COVRA has for long-term above-ground management on the one hand and disposal on the other hand have been extensively reviewed every five years. An extensive evaluation and update of the financial provisions takes place every year, including an extensive check of the parameters for acceptability by the independent external auditor. If there are signals that parameters need to be adjusted, this is signalled by COVRA to the evaluation and audit by the external auditor.

Unexpected increases in the costs of above-ground management or disposal are taken into account for the relevant facility. The adequacy of the provision is guaranteed by any additional endowments to this provision. The extra costs are then, if necessary, converted into the cost price of the standard waste (and into the new tariffs) and into non-standard waste, under the condition that this does not apply to current contracts, but only to new contracts to be concluded.

COVRA has developed an investment strategy in order to meet its long-term obligations. This strategy is partly based on an asset liability management study (ALM-study), as is customary for pension and guarantee funds in the Netherlands. The conclusion of the ALM-study is that the chosen strategy will enable COVRA to meet its long-term obligations.

On 28 October 2018, the Minister of Finance broadened the investment framework and approved an amended investment charter. Investments should be made according to a clear, framed prudential investment framework. The investment charter has been established on the basis of expert advice. The long-term liabilities (the provisions at COVRA on the balance sheet) are matched with various investment strategies so that the assets (shares, bonds, etc.) are deployed against the best possible return and risk ratio. The investment framework is tested on the basis of the results of the ALM-study. An evaluation of this ALM-study takes place every five years so that COVRA can continue to pursue its investment strategy as effectively as possible. However, there are no investment guarantees for the future, as is known. COVRA settles with waste suppliers against final discharge, minimizing the risk of non-collectability of future costs. The investment risk lies entirely with COVRA.

COVRA's annual reports contain the annual accounts and can be consulted on the COVRA website (www.covra.nl/nl/downloads).

7.3.7 Costs of disposal and research programme on disposal
When COVRA was established, it was decided to form a provision for the costs of disposal (and a comparable provision for long-term interim storage), which is built up through annual additions from COVRA's tariffs and interest. This should cover the costs of long-term storage and disposal. Part of the revenue from standard waste and part of the revenue from non-standard waste are allocated to the provisions. Capital growth is an important part of COVRA's financial management. The funds that COVRA has received are invested in accordance with the investment statute adopted by the Minister of Finance and COVRA must generate an annual average return of 4.3% (2% calculated inflation and 2.3% discount rate) in order to achieve the target capital in 2130.

The investment strategy contributes to the financing of the disposal facility. The current size of the provision for disposal and the annual additions to it, are based, among other things, on an estimate of the costs for disposal and the discount rate used (plus inflation). The estimate of the costs of disposal is periodically evaluated in a research programme.

The annual endowments to the provisions are part of the (in)direct costs in COVRA's cost price calculation model. The item 'other indirect costs' includes both the allocations for the final storage facility and the allocations to the operating facilities for above-ground management. The indirect costs are allocated to the various waste streams based on the calculation method explained above. The allocations for disposal are therefore an integral part of the cost prices of the various waste streams and the cost prices of standard waste. The amounts and agreements stated in the contracts apply to non-standard waste.

7.3.8 Supervision on tariffs COVRA

In addition to the technical aspects of nuclear safety and radiation protection, the ANVS's supervision of COVRA also includes compliance with the requirements of Bkse Article 30g and Bbs Article 10.10. In view of this responsibility, the ANVS's supervisory task explicitly does not include the investigation into and the estimation of the costs of radioactive waste management and disposal. These are accepted as fixed for the purposes of ANVS supervision of the tariffs.

The Ministry of IWM is responsible for the governance of COVRA as a state company. As mentioned before the ANVS has published a concept policy rule in August 2023 that provides further explanation and interpretation from the ANVS of the requirements on the tariffs set in Bkse Article 30g and Bbs Article 10.10.

7.3.9 Costs of legacy waste

A volume of legacy radioactive waste that predates the establishment of COVRA in Nieuwdorp is still present at the research location in Petten. A project is ongoing to transfer the legacy waste to COVRA.

The costs for this transfer are for the account of the owner of the waste, NRG. These costs include adapting installations to make them suitable for repackaging the waste for transport, transport to third parties and treatment of the waste at third parties, transport to COVRA and the costs charged by COVRA for the storage and disposal of the waste. To cover the increasing cost estimates of the legacy waste project over the last 20 years, caused by new insights, new regulations and technical challenges, the Ministry of Economic Affairs and Climate Policy provided several times extra budget as a loan to NRG.

8 Capacity building for radioactive waste and spent fuel management - expertise, training and skills

8.1 Arrangements in place to obtain, maintain and further develop the necessary expertise and skills to cover the needs of the National programme

In 2019, the Advisory Board of the ANVS presented an advice on the possible ways to guarantee the adequate education and scientific knowledge in the Netherlands. As a response to this advice, the ANVS appointed an independent committee, the so-called 'Van der Zande Commission'. From June 2019 to January 2020, the committee explored the support and conditions within the sector, knowledge institutions and within the government on how to maintain and further develop the required knowledge structure for nuclear safety and radiation applications within the Netherlands.

Following the discussions with stakeholders, the Commission made the following four main recommendations:
- Draw up a knowledge and innovation agenda for nuclear technology and radiation from the government;
- Establish a national platform for Nuclear Technology and Radiation and from the platform initiate three impulse programs in the field of awareness, research and education;
- Establish a Human Resources Observatory for Nuclear Technology and Radiation;
- Strengthen horizontal interdepartmental coordination at (high) official level.

These recommendations relate to the Ministry of Infrastructure and Water Management and the ANVS, but also to other ministries and the sector.

The recommendations were followed-up by the establishment of an interdepartmental working group at the end of 2020. Within this working group, the ANVS, the Ministry of Economic Affairs and Climate Policy, the Ministry of Infrastructure and Water Management, the Ministry of Social Affairs and Employment, the Ministry of Health, Welfare and Sport and the Ministry of Education, Culture and Science take part. The working group was to investigate the challenges related to guaranteeing the required knowledge structure within the Netherlands in the long-term, as well as to identify concrete solutions to these challenges. In the analysis, the (future) supply and demand of expertise, the inflow and outflow into training and employment, and the size of the relevant labour force are discussed.

During the 7th Review Meeting of the Joint Convention, which was held from 27 June-8 July 2022, the Netherlands presented its national report. The maintenance and development of the adequate knowledge structure was identified as a challenge for the Netherlands. A first step in the implementation of this challenge has been taken by the establishment of this interdepartmental working group.

Its recommendations[34] were presented in a report sent on 29 June 2023 to the House of Representatives:
- Invest in nuclear education at all levels, in order to familiarize a large group of students with nuclear technology;
- Increase scientific expertise by establishing professorships, including a chair in the field of radiation protection;
- Stimulate cooperation between the existing organizations that offer radiation protection courses;
- Investigate solutions to make sure a shortage of labour will not hamper the government's nuclear ambitions.

In this report, presented to the House of Representatives, the interdepartmental working group stresses that the background to the challenges addressed in the Van der Zande advice has changed dramatically in just a few years. As a result of the government's ambitions to add more nuclear power to the energy mix, as well as the plans for two new production facilities for medical isotopes (PALLAS and SHINE), the Dutch nuclear sector is a growing. On the one hand, this leads to an even larger challenge concerning the required knowledge base, especially considering the broader workforce needed to build new nuclear power plants in a very tight labour market. On the other hand, the new developments also create momentum for all parties involved in the nuclear

[34] Parliamentary papers, Session year 2022-2023, 32645, no. 118.

field to invest in the knowledge base, and an incentive for students and professionals to enter the field.
Another important development was the announcement (issued simultaneously with the report's publication) by the government that 'Nuclear Energy' will be part of the so-called Top sector Energy, meaning that an integrated knowledge and innovation agenda will be created for the nuclear sector. Incorporation in the Top sector Energy formalizes cooperation of public and private actors in the field and will serve as a vehicle for combined public and private investments in the knowledge base for nuclear technology.

Currently, a revision of the interdepartmental governance structure is being worked on, in which various ministries participate. Within this revised governance structure, a separate working group will be set up devoted to the maintenance and development of the knowledge structure within nuclear technology and radiation applications. Through this structure, follow-up will be given to the recommendations of the interdepartmental working group which were presented in June 2023.

Additionally, in 2021, an amendment[35] was adopted within the House of Representatives to allocate 5 million euros within the budget of the Ministry of Economic Affairs and Climate Policy to strengthen the knowledge structure and to encourage innovation in the fields of nuclear technology and radiation protection. This one-off €5 million offers the opportunity to boost the knowledge structure within the Netherlands.

As part of the university curriculum, the Ministry of Education, Culture & Science partially finances courses on nuclear technology and radiation protection. At present there are no university chairs in the field of radiation protection.

The Government also (partially) finances research and consultancy institutes (NRG, RIVM) to develop and maintain knowledge on relevant nuclear safety and radiation protection subjects.

8.2 Requirements on the regulatory authority to ensure that arrangements for education and training are adequate

The Nuclear Energy Act states in Article 9 that the minister of Infrastructure and Water Management has to allocate sufficient financial resources available to the ANVS for the performance of its duties. And according to Nuclear Energy Act Article 10, the minister has to assure that sufficient and qualified personnel is available to the Authority for the performance of its duties.

Next to this, Rnvk Article 18 states that the ANVS is required to educate their staff to be adequately prepared to perform their duties.

The Governance Board of the Ministry of IandWM has decided for all entities, including ANVS, to develop a forward-looking Strategic Personnel Plan. The Strategic Personnel Plan is linked to the strategic knowledge and competence needs of ANVS. The Strategic Personnel Plan will be updated periodically and if needed depending on real or potential external developments and is used also to support the regular budget discussions with the Ministry.

8.2.1 Qualified staff at the ANVS

ANVS is currently developing a strategic personnel plan, which will be the basis of their personal planning. One of its focal points is how to assure that sufficiently qualified employees remain available. It also considers the long-term requirements and the expected changes in knowledge that will be caused by future developments (e.g., new NPP's, decommissioning projects and work regarding the geological storage facility). More structured personal development plans are also being developed, along with the required training opportunities. More information on this topic can be found in the responses to question 3.2 and 8 (and its subsidiary questions) in IRRS module 1 'Responsibilities and Functions of the Government'.

The expertise of the ANVS spans disciplines in areas like radiation protection, nuclear safety, waste safety, transport safety, conventional safety, risk assessment, security and safeguards, emergency preparedness and response, legal and licensing aspects. Recently it has been decided that the ANVS needed more expertise for a number of financial topics. Other disciplines that needed further development were decommissioning, knowledge management and public communication.

[35] Parliamentary papers, Session year 2021-2022, 35925-XIII, no. 14.

Therefore, ANVS has contracted staff with the necessary expertise in these areas. When needed, knowledgeable consultants are contracted for support.

The ANVS provides tailor-made training for its staff. Experts have to keep up to date with developments in their discipline. Apart from the general courses, training dedicated to the technical disciplines in the areas of nuclear safety, radiation protection and emergency preparedness and response is provided. This includes international workshops, but also conferences and visits to other regulatory bodies. In addition, information exchange takes place through the international networks of OECD/NEA, IAEA, EU et cetera. To be mentioned are the contributions to HERCA, WENRA, ENSREG, TRANSSC, RASSC, WASSC, NUSSC, EPRSC, NEA/CNRA, NEA/CSNI and several of its Working Groups. Furthermore, there is a policy to participate in several IAEA missions annually, like in IRRS, ARTEMIS, IPPAS, EPREV, INSARR. It is considered to be worthwhile to have staff positioned at IAEA, NEA or EU; however, this has not yet materialised.

All ANVS staff follow trainings for their work and maintain training plans that are assessed at least annually with their team leader. In addition to formal education courses, the ANVS utilizes informal, voluntary learning opportunities, including presentations and workshops. The ANVS is also conducting a competence gap analysis, through an employee knowledge survey, to assess the organization's education and development capabilities.

Staff requiring specific expertise, such as inspectors, receive the specific training required and participate in a mentoring program with more experienced staff before completing work on their own. In addition, they are provided with the training and information required to safely complete their tasks in the various work environments that they may encounter. The inspector qualification process includes instruction for all the procedures necessary to complete inspections and practical experience in the field, combined with the evaluation by a senior inspector. Inspectors also receive training on a comprehensive range of potential workplace hazards that they may encounter, both general (such as chemicals and physical hazards) as well as specific hazards related to the physical locations where they may conduct their inspections. Through this training program, the ANVS fulfils its duty of care to these workers and ensures their ongoing safety through education.

8.2.2 Requirements on education programs
The quality of the education and training of the Radiation Protection Officers and Radiation Protection Experts is guaranteed by only accepting education/training given by registered educational institutions. The requirement on these institutions is detailed in the Regulation on Basic Safety Standards for Radiation Protection (*Regeling Basisveiligheidsnormen Stralingsbescherming* – Rbs) 5.4 application for accreditation as a training institution in the area of radiation protection (*Kwaliteitsborging erkende instellingen*).

8.3 Requirements on a holder of radioactive material or radioactive waste or a license holder to ensure that arrangements for education and training are adequate

To handle radioactive waste or spent fuel an authorization (e.g., a license or registration) is required and the organization has to ensure that a practice is carried out by or under the supervision of a radiation protection officer. Therefore, part of the authorization requirement is that the applicant has to show that the employees have the proper training to supervise the practice. The risk and complexity associated with the work determines the required supervision and the requested level of training and education (Bbs).

For low risk work a Radiation Protection Officer (RPO) (*Toezichthoudend Medewerker Stralingsbescherming*, TMS) is sufficient. For medium/high risk work a Radiation Protection Expert (RPE-CD-level) (*Coördinerend Deskundige*, CD) is required, and for complex situations a Radiation Protection Expert (RPE-ACD-level) (*Algemeen Coördinerend Deskundige*, ACD) is required. There are registration requirements for both types of radiation protection experts to ensure that they demonstrably continue to meet the requirements set for their knowledge, skills and professional competence. When assessing the first registration applications for radiation protection experts, the ANVS checks whether they have received the correct recognized training. For the renewal of the registration, required every 5 years, ANVS checks whether they have demonstrably worked in the field of radiation protection, and they have followed sufficient relevant further training/education. They are only authorized to perform the duties of a radiation protection expert if they are included in the register of the ANVS.

No registration is required for the radiation protection officer. However, they are obliged to maintain their skills and expertise by gaining work experience and regularly following further training.

ANVS has established and applies an Oversight and Enforcement strategy (*Toezicht en Interventie Strategie*, TIS-2023). A check on the requirements on education can be part of an inspection and when the requirements are not met, the ANVS can act accordingly.

8.3.1 Assessing the licensees staff level of education and training
Judging the level of education and training of the licensee's staff is part of the assessment of a licence application. This is described in *Vergunningenbeleid ANVS 2019 - Op weg naar een gedeeld beeld*. A licence application will be refused when the staff of the license does not have the required extend and level of expertise. This is related to the risk and complexity of the activities.

8.3.2 Qualified staff at COVRA
The Nuclear Energy Act requires that an application for a licence for a nuclear facility shall contain an estimate of the total number of employees plus details of their tasks and responsibilities and, where applicable, their qualifications. This includes supervisory staff. The licensee has to submit its education and training plan for the Regulatory Body's information and approval. These requirements apply also to the COVRA waste and spent fuel management facilities.

COVRA has implemented a Personnel Qualification Plan (as part of a more generic quality management system) in which clear guidelines have been formulated on the subject of attracting and developing (new) employees. In addition to the Personnel Qualification Plan, COVRA has an education plan and education matrix which contains the requisite level of expertise, and in which the requirements for training and education are laid down. A training plan ensures that an adequate number of staff, with relevant expertise and appropriately trained is always available. Any major organizational changes, e.g., at management level, must be reported to the Regulatory Body. Together with the job descriptions, which detail the responsibilities and authority interfaces, the Personnel Qualification Plan and the education plan constitute the building blocks to ensure qualified staff.

September 2023