Outlines of the Dutch policy for radiation protection and nuclear safety

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0. Foreword

Radiation protection, nuclear safety and the management of radioactive waste and spent fuel: over the past decades, consecutive cabinets developed a policy on these issues. This policy was laid down in a large number of documents, including Letters to Parliament, policy documents, licences and generally binding regulations. Policies and documents have also been drawn up for the response to radiological incidents, the transport of radioactive materials, the security of nuclear facilities and radioactive sources, and safeguards. Government policy is laid down in legislation and in various licence conditions. A number of supervisory bodies are responsible for ensuring compliance with the legislation and enforcing them where necessary.

An important part of this legislation has been in place since the 1960s. Around this period, nuclear energy was introduced in the Netherlands. The policy has been undergoing continuous development ever since. Where necessary it has been modified to meet the requirements of the state-of-the-art. The modifications are largely based on internationally accepted recommendations and principles. However, an umbrella-document was lacking in which the policy is integrally presented and which describes how the policy conforms with the Fundamental Safety Principles[1]developed by the International Atomic Energy Agency (IAEA). The IAEA has recommended that such a policy document should be drawn up and adopted and promulgated by the government[22].

The present memorandum was written with a view to the IRRS mission (Integrated Regulatory Review Service) of the IAEA, which is to review the Dutch policy and legislation in November 2014. This document contains a summary of the main features of the existing policy. This means that no new policy is formulated here.

The Fundamental Safety Principles and the IRRS mission do not encompass all aspects of the policy. The security of nuclear facilities and radioactive sources and safeguards are excluded. This memorandum therefore focuses on safety policy, and less on security and safeguards. For the sake of completeness these topics are discussed in brief in Chapter 4 of this document.

This document was laid down by the Minister of Economic Affairs, also on behalf of the Minister of Social Affairs and Employment and the Minister of Health, Welfare and Sport. It is intended for all parties who perform practices or work activities using ionizing radiation and/or who wish to know more about the relevant policy and legislation in the Netherlands.

Contents

1. Introduction

Exposure to ionizing radiation[3] entails risks for humans and the environment. These risks need to be assessed with a view to safety and managed where this is deemed necessary. Practices and work activities involving radioactive and fissionable materials, ores and devices that emit ionizing radiation are therefore bound by strict rules. Of course, these rules also apply to the construction, commissioning, operation and decommissioning of nuclear facilities[4]. The aim is the protection of humans and the environment against the risks of exposure to ionizing radiation – today and in the future.

This document describes the main features of the strategy and the policy that has been developed for this purpose, as well as the most important regulations. It also describes how the development of the strategy and the policy is in line with internationally accepted principles. The document only contains a summary of the current situation; no new policy is formulated.

<u>Guide for readers</u>

Chapter 2 describes what aim is pursued by the Dutch strategy and policy relating to radiation protection and nuclear safety. The different components of this policy are also explained. Chapter 3 describes the manner in which the policy harmonizes with the internationally accepted *Fundamental Safety Principles* of the International Atomic Energy Agency (IAEA). Chapter 4 briefly discusses the security and safeguards policies. Chapter 5 covers communication, public access to documents and transparency and Chapter 6 describes the competent authority for radiation protection and nuclear safety. Finally, Chapter 7 discusses the legal framework.

Appendix 1 provides an overview of the applications and sources of ionizing radiation that exist in the Netherlands. Appendix 2 provides an overview of the most important international obligations. Appendix 3 explains the terms used and provides references to relevant legislation and literature.

Ionizing radiation in the Netherlands

Ionizing radiation is radiation that is sufficiently energetic to remove an electron from an atom and to ionize it. Ionizing radiation is applied in the Netherlands in a wide range of applications. Well-known examples are applications in the nuclear industry and in the medical sector. Ionizing radiation is also used in scientific and other research and there are various industrial applications. A less well known fact relating to ionizing radiation is that it can ‘unintentionally’ be a side effect of certain industrial processes, such as in the ore-processing industry. There is also a chance of exposure to ionizing radiation due to the presence of natural radioactivity in building materials and in the soil.
Appendix 1 of this document provides an extensive description of the main applications of ionizing radiation in the Netherlands.

2. Dutch radiation protection and nuclear safety strategy and policy

2.1 Aims of the Dutch radiation protection and nuclear safety strategy

The Dutch government has a radiation protection and nuclear safety strategy. This strategy aims to achieve the following key objectives:

The protection of humans and the environment against the risks of radiation, now and in the future.

The party that applies the ionizing radiation has primary responsibility for this protection. The relevant government and semi-government bodies also have responsibilities to this end. The government has four strategic objectives for achieving this protection:

1. *Radiation protection:* Exposure to radiation stemming from practices or work activities must be justified, it must be as low as reasonably achievable, and it must remain below the prescribed levels.
2. *Nuclear safety:* Nuclear facilities must comply with safety requirements in accordance with the state-of-the-art and safety must be subject to continuous improvement.
3. *Security and safeguards:* The measures pertaining to security and safeguards must be up to date, proportional and realistic.
4. *Competent authority:* The competent authority for radiation protection and nuclear safety (see Chapter 6) must meet international requirements in terms of expertise, transparency and independence, and it must subject its working methods to continuous improvement.

By optimizing its methods, an independent authority can continue to improve the way humans and the environment are protected and thus also build trust.

This strategy is illustrated in the figure below.

2.2 Elements of the radiation protection and nuclear safety strategy

The government deploys various instruments in order to achieve and safeguard the above-mentioned strategic objectives. These instruments include policies, legislation, licences, supervision and enforcement. Other important aspects of the strategy are transparency, a graded approach and continuous (further) improvement of safety. These elements are briefly described below:

A radiation protection and nuclear safety policy
The government's strategy is based on a policy for the protection of humans and the environment against ionizing radiation, nuclear safety and management of radioactive waste and spent fuel. This policy applies equally to the transport of radioactive materials, fuels and ores, the response to radiation incidents, nuclear safeguards and the security of radioactive sources and nuclear facilities. The policy is further referred to in this document simply as the "radiation protection and nuclear safety policy".

This radiation protection and nuclear safety policy is the result of a process of continuous development over several decades. A number of important choices were made at an early stage, based on the national situation. These choices continue to influence the current policy. The Dutch policy is and will continue to be developed in a dialogue with the stakeholders and the industry. The roles and responsibilities of the government and the business community are carefully monitored.

The policy distinguishes between protection against risks resulting from incidents (*safety*) and risks that are the result of deliberate interference (*security*). The safety policy is based largely on the ten Fundamental Safety Principles. These principles have been formulated by the IAEA and are internationally accepted. Chapter 3 describes how these principles are put into practice. The development of policy with respect to the security of nuclear facilities, radioactive sources and fissile materials and safeguards also follow the IAEA recommendations and Fundamentals as much as possible[5]. The starting points for applying these to the Dutch context are 'proportionality' and 'realism'. The security and safeguards policy is briefly described in Chapter 4.

This document focuses on safety and not security.

Continuous improvement
To cater to a constantly changing environment, evolving technology and progressive insights, it must continuously be investigated where improvements can be made with regard to practice, policy, legislation and regulation. The aim is to ensure the safety and protection of humans and the environment as effectively and efficiently as possible, while conforming to the state-of-the-art. To this end, the policy makers expressly look to the example of similar situations and facilities in other countries.

The aim of continuous improvement was set down in the licence conditions of the nuclear facilities many years ago. Recently, this aspect was explicitly included in European[6] and national[7] legislation. Under this legislation, the licensed operators of nuclear facilities are required to continuously, systematically and verifiably examine and assess the nuclear safety of their facilities. The licensees are required to report to the Minister of Economic Affairs periodically and when requested.

If and when the examinations and assessments require it, the licensee must take all measures (within reasonable bounds) to improve the nuclear safety of the facility. The licensee's compliance with these conditions is subject to supervision. If any necessary improvement requires the licence conditions to be amended, then the licensee must submit an application for this amendment without delay. The licensing authority may also amend the rules ex officio if necessary.

In addition, the licence may itself prescribe certain obligations with regard to the investigation and evaluation of nuclear safety. For example, the operating license for Borssele nuclear power plant contains a condition to analyse and evaluate technical, organizational, staffing and administrative factors that affect nuclear safety and radiation protection. These evaluations must be performed every two and every ten years. The two-yearly evaluation is less far-reaching than the ten-yearly evaluation. The conditions in the legislation and licences are also subject to continuous improvement on the basis of evaluations and peer reviews.

A graded approach
A graded approach is taken towards the development and design of the radiation protection and nuclear safety policy, the relevant legislation and the supervision thereof. This means that, among others, the degree of risk of exposure to ionizing radiation, the potential effects on the environment in the event of a serious accident, and the complexity of the nuclear facilities themselves are taken into account. In other words: the greater the risk, the stricter the regime.

Depending on the risk, the graded approach is expressed in the legislation in the application of three concepts: exemptions, notification requirements and licence conditions. Furthermore, the requirements in the Nuclear Energy Act and the underlying safety regulations are more extensive for activities involving fissile materials and nuclear facilities than for activities involving radioactive materials, for example. An example of the graded approach in supervision is that a complex facility such as Borssele nuclear power plant is subject to more intensive supervision than, for example, the COVRA (Central Organization for Radioactive Waste).

Tailor-made licences alongside legislation
As is clear from the description in Appendix 1, the Netherlands has sustained a small but at the same time very diverse nuclear sector for several decades now. For this reason, it was decided from the start not to draw up extensive general legislation for each individual facility. Instead, a great many conditions and restrictions were laid down in tailor-made licences for each facility

within a framework set down in the relevant legislation and regulations. Because there are only a limited number of nuclear facilities, this is deemed to be more practical and more effective than drawing up extensive general legislation for every type of facility. This means that, in comparison with other countries, in practice a relatively large number of nuclear safety issues are regulated in the licence conditions, rather than in generally binding legislation. This approach does not impede adequate enforcement of the legislation.

Goal-oriented conditions preferred to means-based conditions
It is also common practice to work with goal-oriented conditions rather than means-based conditions whenever possible. This allows both the licensee and the licensing authority leeway to create made-to-measure solutions to ensure that safety is safeguarded as efficiently as possible and can be constantly improved. In addition, this approach also prevents licensees - who have primary responsibility for operational safety - from limiting their safety precautions to the implementation of specific prescribed measures only. The supervisory body closely monitors how and by which means the licensee chooses to meet the goal-oriented conditions.

The polluter pays
The principle that 'the polluter pays' is applied with regard to the responsibility for the social and other costs of practices or work activities with ionizing radiation. This means, for example, that the costs of managing radioactive waste are for the account of the party that generates it. To safeguard this part of the policy, the Nuclear Energy Act includes a requirement for the licensees of nuclear reactors to provide financial security for the costs of safe shutdown and decommissioning of the relevant facility[8]. In addition, certain supervision and licensing costs are charged in part to the nuclear sector[9].

Communication and transparency policy
The government actively provides information on policies, licensing, supervision and enforcement. It does so with the aim of informing society in general, and the involved parties and stakeholders in particular, of developments, findings, any applicable health and other risks, et cetera. Another aim is to guarantee the quality of the decision-making process. The legislation also provides opportunities for public participation in decision-making. The communication and transparency policy is explained in detail in Chapter 5.

A competent authority for radiation protection and nuclear safety
In the Netherlands, various branches of government are jointly responsible for policy, legislation and licensing where it concerns radiation protection and nuclear safety. They also have the responsibility and authority to monitor compliance and enforce this where necessary. Together they form the so-called competent authority or regulatory body. This is elaborated further in Chapter 6.

A legal framework
By setting down the policy in legislation, a longer-term commitment to this policy is ensured. The legal foundation of the policy for radiation protection and nuclear safety is specifically reflected in the Nuclear Energy Act and the legislation and licences based on it. The Nuclear Energy Act is an integrated law on radiation protection and nuclear safety. It covers the protection of various interests involving humans, the environment, working conditions, patient protection, public health and the security of sources and facilities. In addition, licences for nuclear facilities issued under the Nuclear Energy Act also regulate other, 'conventional' environmental aspects.

A number of other acts are relevant in addition to the Nuclear Energy Act. These acts cover issues such as liability in case of accidents at nuclear facilities. They also cover more general matters such as transparency, the powers of supervisory bodies, public access, public participation and legal protection. The legal framework is elaborated further in Chapter 7.

International orientation
The Dutch input at the international level focuses on active participation in activities and initiatives aimed at improving radiation protection and nuclear safety worldwide. The Netherlands is not suited to playing a pioneering role here. This has to do with the small size of the Dutch nuclear programme and the limited human and financial resources available. However, the Netherlands is taking due responsibility wherever possible. The available knowledge and experience are deployed in order to make an active contribution. International cooperation has clearly intensified in recent years.

European and international guidelines are followed in the development and design of the radiation protection and nuclear safety policy, the relevant legislation and the regulation thereof. The requirements regarding radiation protection, nuclear safety and radioactive waste management under the Euratom Treaty and its directives have also been applied in Dutch legislation. A number of international treaties have also been ratified by the Netherlands.

In addition to these requirements, the Netherlands also abides by various internationally accepted principles, recommendations, practices and agreements drawn up under the flag of the IAEA and the WENRA[10], on a voluntary basis and wherever possible. In places, national conditions have required a specific approach. An example is the choice for made-to-measure licences rather than general legislation for the nuclear sector (as described above), and the distribution of powers among ministers (as described in Chapter 6).

In order to ensure that radiation protection and nuclear safety measures remain state-of-the-art, both the government and the nuclear sector participate in international peer reviews. During peer reviews, the practice, policies, legislation and/or supervision are compared with international standards (often IAEA standards) by foreign colleagues. An example is the peer review of the so-called stress test analyses of the European nuclear facilities and the ensuing national action plans. The stress test analyses were performed following the accident in Fukushima. In addition, the Dutch policy on nuclear safety and the management of radioactive waste and spent fuel is also periodically reviewed by other countries. This is done within the framework of the Convention on Nuclear Safety or the Joint Convention Treaty, respectively.

Periodic international reviews of the legislation and government organization are required by European legislation. Finally, peer review missions are regularly invited to inspect the Dutch nuclear facilities, among other things as part of the supervision strategy. Examples include the OSART mission[11], the IPSART mission[12] and the SALTO mission[13].

Another important initiative towards learning from international experiences is the participation in international reporting systems. These systems are used to systematically collect and analyse data on malfunctions, abnormal events, et cetera. The Netherlands takes part in the Incident Reporting System (IRS) of the IAEA/NEA*, the Incident Reporting System for Research Reactors (IRSRR), the Fuel Incident Notification and Analysis System (FINAS, for nuclear fuels) and the European Clearing House on Operational Experience Feedback organization*[14]*.* The information on international experiences thus obtained can be used by the licensees and the government to improve safety.

The policy and legislation for the transport of radioactive and fissile materials and ores is almost entirely based on international agreements. This is due the fact that much of this transport crosses national borders.

Appendix 2 describes the most important international agreements and partnerships.

3. Explanation of the ten *Fundamental safety principles*

The development and implementation of a policy for radiation protection and nuclear safety is a national matter. But the Netherlands is also aware that it operates in an international context. The potential cross-border effects of certain incidents involving ionizing radiation is one important reason for international cooperation. The same applies to the necessary exchange of experiences in the area of radiation protection and nuclear safety.

The IAEA has formulated ten fundamental safety principles in support of this international cooperation. Governments can base their policy on these principles. The international conventions and European directives in the area of radiation protection and nuclear safety are also based on these principles. The IAEA has elaborated on these principles in its Safety Requirements and Safety Guides[15]. These safety guides are used, among others, as standards against which government policies on more specific issues are assessed by means of peer reviews and other instruments.

Fundamental principle 1: Responsibility for safety

The party that performs practices or work activities involving the use of ionizing radiation or nuclear facilities is responsible for safety. This responsibility is a de facto outcome of the system of prohibitions and licences on the basis of the Nuclear Energy Act, as well as the requirements in the legislation based on this act. A large number of applications using ionizing radiation as well as the operation of nuclear facilities are prohibited without a licence. In these cases, the responsibility lies with the licensee. So the licensee of a nuclear facility has primary responsibility for the nuclear safety - and security - of its facility, as well as for radiation protection in and around this facility.

In the case of medical applications, the final responsibility for radiation protection lies with the Boards of Directors of the relevant healthcare institutions. The responsibility for safety cannot simply be transferred to another party, since the permission of the Minister of Economic Affairs[16] is required for the transfer of licences based on the Nuclear Energy Act. In the case of low-risk applications where a notification suffices (and therefore no licensee exists), the relevant organization is responsible for safety. An example of this is the use of X-ray scanners by dentists.

In connection with this responsibility for safety, the organization or licensee must ensure among other things that both the effective or equivalent doses absorbed by individuals as a result of an activity and the number of exposed persons are kept as low as reasonably achievable[17]. The organization is further required to record the allocation of powers and responsibilities with regard to radiation protection within the organization in writing[18].

Additional legal provisions apply to nuclear facilities. The licensee must design and implement the organization’s management systems such that sufficient priority is given to nuclear safety[19]. The licensee is also responsible for ensuring that adequate human and financial resources are available so that activities can be executed in a safe manner[20]. The conditions of the licences for various nuclear facilities also include Nuclear Safety Rules (NSRs), which cover aspects as the licensee’s responsibility for operational safety.
The “*Dutch Safety Requirements*” that are currently being developed for new nuclear reactors contain new requirements based on the latest international insights.

Fundamental principle 2: Role of government

The role of the government in radiation protection and nuclear safety focuses on the realization and safeguarding of the aforementioned key objective and strategic objectives. Policies and legislation are developed and implemented to this end. This involves tasks such as the granting of licences, the establishment and maintenance of a crisis response organization, the registration of radiation protection experts and radiation physicians, et cetera. The licensee's compliance with the legal requirements and licence conditions is also subject to supervision. If necessary, compliance can be enforced.

The government is responsible for the establishment of a robust competent authority (or regulatory body) that performs these tasks (see also Chapter 6). It is also the government's responsibility to conclude international agreements and conventions in the area of radiation protection and nuclear safety policy(or parts thereof).

In accordance with the previously mentioned graded approach, the government's role is mainly determined by the nature and extent of the nuclear sector and the applications involving ionizing radiation in the Netherlands. Furthermore, the presence of nuclear and non-nuclear facilities in neighbouring countries also plays a role, as do international obligations and recommendations. All in all, these responsibilities are intended to cover a relatively broad policy area with a number of very diverse specializations and competencies.

Because both the government and the licensees must have access to sufficient qualified personnel, it is important that sufficient and detailed knowledge of radiation protection and nuclear safety is available. The availability of this knowledge must also be guaranteed in the future. The wide spectrum of nuclear applications and applications involving ionizing radiation in the Netherlands also means that knowledge of a wide range of speciality fields is required. The government has a responsibility here too. This involves facilitating such things as high quality training programmes, sufficient academically qualified trainers and an infrastructure for responding to societal concerns about radiation protection and nuclear safety.

A point of concern is that the continuity of the knowledge held by various scientific institutions, and also in the nuclear sector, is at risk due to the ageing of the population[21]. A decline in expertise and scientific research could lead to a shortage of skilled trainers and training opportunities.

The Netherlands leans heavily on the expertise and training programmes available in its neighbouring countries. where it specifically concerns the development and maintenance of knowledge on nuclear safety. The government has consciously chosen to purchase knowledge on certain areas of expertise from abroad.

Among other things, the government stimulates research by means of a research grant to the National Institute for Public Health and the Environment (RIVM) for strategic radiation protection research. It also provides a research grant to the Nuclear Research and consultancy Group (NRG) for nuclear and radiation protection research and it co-finances the OPERA research programme[22] on the final storage of radioactive waste. A Chair at TU Delft is also funded under the OPERA programme. The Dutch government also participates in OECD research aimed at supporting the regulation of nuclear safety, albeit at a limited scale.

The government also plays a role in facilitating dosimetry services (i.e. the measurement of radiation doses) and worker dose registration. To this end, NRG and Philips have been designated as dosimetry service providers by the Minister of Social Affairs and Employment. These companies provide the legally prescribed radiation dosimetry service for approximately 30,000 workers in the industrial and healthcare sectors and about 15,000 workers in the aviation sector. For the dose registration of workers in the nuclear sector, the so-called National Dose Registration and Information System (NDRIS) has been developed to this end. This system has been in use since 1989. It enables the storage of data over a period of several decades after exposure. NDRIS was commissioned by the Minister of Social Affairs and Employment and is currently maintained by NRG.

Fundamental principle 3: Leadership and management for safety
Safety is a priority in the development of policies and legislation, in licensing, and in the supervision and enforcement of radiation protection and nuclear safety matters. Of course this also applies to working practice. Safety must therefore be of central importance not only to the government, but to organizations and licensees as well. Branches of government and other organizations must thus demonstrate the highest level of leadership in all matters that concern safety. It is the responsibility of the highest level of an organization to ensure that safety is promulgated in all the activities of that organization. An instrument that can be used to achieve this is the management system. Such a system can be implemented to determine the extent to which the objectives are being realized and safeguarded by:

- collecting and describing all the safety requirements for the management in a coherent manner;
- describing the scheduled and systematic actions and the requisite means needed to provide sufficient confidence that all these requirements are met;
- ensuring that the safety requirements are assessed in conjunction with requirements on health, the environment, security, quality assurance, finance, et cetera;
- reinforcing a safety culture on the shop floor.

In practice, a safety culture concerns matters such as competency, knowledge and staffing management, as well as values such as openness, transparency, independence and integrity. Because of the knowledge-intensive character of radiation protection and nuclear safety, the knowledge management aspect requires special attention. Alongside appropriate safety behaviour, an inquisitive attitude and willingness to learn are also important.

Organizations operating nuclear facilities are required to establish a Radiation Protection Unit. This requirement also applies to organizations and locations where practices are performed involving more than 100 radioactive sources. A Radiation Protection Unit is responsible for, among other things, drawing up and implementing the organization's radiation protection policy, granting internal permissions and the internal regulation of compliance[23]. These organizations' management systems also set down the procedures and distribution of responsibilities. Organizations operating nuclear reactors are additionally required to establish internal and/or external Reactor Safety Committees, which provide independent advice to the management of the organization on safety matters.

Fundamental principle 4: Justification of facilities and activities
To ensure that the benefits of applications that involve ionizing radiation outweigh the risks of exposure to ionizing radiation, the requirement of justification applies[24]. A licence applicant must demonstrate that the desired application is justified. This involves assessing whether the economic, social and other benefits of that activity outweigh the damage to health that it could cause.

The net benefit of the social - and sometimes also the economic - advantages and disadvantages is sometimes difficult to quantify. To simplify the process of justification for both the government and the relevant organization, lists of justified practices (and work activities) or categories (the 'positive list') and unjustified practices (and work activities) or categories (the 'negative list') are published[25]. The positive list contains existing practices (and work activities) that have already been licensed or notified (in accordance with the notification requirement) on the basis of the Nuclear Energy Act. The negative list includes, among others, the addition of radioactive materials to foodstuffs, toys and cosmetics.

If new data become available that lead to a different conclusion with respect to the justification of certain practices (or work activities) in the negative list, then these data may be included in a licence application to demonstrate that the practice or work activity is justified, so that it can be registered by the Minister of Economic Affairs.

Fundamental principle 5: Optimization of protection against ionizing radiation
The policy focuses on optimizing the protective measures against ionizing radiation. To this end, it has been determined that the exposure to ionizing radiation caused by the organization's use of a certain application must be kept as "As Low As Reasonably Achievable". This is also known as the ALARA principle[26]. This can be achieved by striving for the optimum combination of the lowest possible dose and the fewest possible social and economic disadvantages in the planning phase of a practice or work activity.
Optimization of potential exposure does not only entail that the effect must be as low as reasonably achievable, but also that the risk of exposure is kept as low as reasonably achievable. The costs of necessary investments are also taken into consideration. The ALARA requirement is a general duty of care that applies to all parties, even if no notification requirement or licence condition applies.

Part of the licensing process involves a prior assessment of whether the organization has sufficiently met this requirement. Model licenses have been drawn up for many common applications of ionizing radiation containing rules that ensure adequate implementation of the ALARA principle. If necessary, specific measures can be prescribed and recorded in the licence conditions. The competent authority responsible for supervision and enforcement determines whether the organization complies with the general optimization requirement and the specific conditions as set out in the licence. Further instructions are provided if necessary.

Fundamental principle 6: Limitation of risks to individuals
Dose limits have been set in order to reduce the exposure risks for individuals. These dose limits are included in the policy and/or legislation. Each situation should also be analysed separately in order to determine to what extent further optimization is possible within the framework of the ALARA principle. The most important dose limits are described below:

- A limit of 1 mSv per year applies for members of the public regarding the effective dose resulting from the "normal operation" of facilities, practices and work activities. This applies to all anthropogenic[27] sources[28]. For an individual source (i.e. the combination of practices and work activities performed under the responsibility of an organization at a location), a dose limit of 0.1 mSv per year applies for members of the public outside the location[29].
- The dose limit for radiological workers is 20 mSv per year[30], where a distinction is made between workers with a high likelihood of being exposed to an annual dose of 30% or more of this limit (A-workers) and workers with a very low likelihood of this happening (B-workers)[31]. The employer is required to monitor the radiation dose for both A-workers and B-workers.
- No limits have been established for the exposure of patients to ionizing radiation.
- Special limits have been set for the operation of nuclear facilities concerning the likelihood (frequency) of design basis accidents resulting in an effective dose for a member of the public outside the location[32]. These are accidents that have been taken into account in the design of the facilities and the safety measures.
- Additional risk limits have been laid down for accidents in nuclear reactors which have not been taken into account during the design phase (beyond-design basis accidents). These limits apply to exposure risks for members of the public. Licence applications for nuclear facilities that exceed these limits are denied[33]. The limit for the individual mortality risk (acute and delayed death) has been set at 10^{-6} per year. In addition, a limit has been set for the group risk, to protect against social disruption[34].

Fundamental principle 7: Protection of present and future generations
The protection against the risks of exposure to ionizing radiation does not end with the current generation. Because some radioactive materials and radioactive waste continue to pose an exposure risk over a very long period of time, the protection of future generations is also relevant.

It is therefore important to limit discharges of radioactivity into the environment as much as reasonably possible. This helps to ensure that exposure to ionizing radiation produced by radioactive materials present in the soil, water and air is prevented as much as possible, both now and in the future. This is one of the reasons why discharges of radioactive materials into the soil are prohibited (with the exception of a limited number of specific mining activities). Discharges into the air and water are subject to licensing[35].

The levels of radioactivity in the environment are frequently measured by, among others, the RIVM. The results of these measurements are reported annually in accordance with European agreements. In addition, various European and other standards are applied for radioactivity in foodstuffs and water.

The Netherlands currently adheres to the principle that the combined measures for the protection of both individuals and the population as a whole against the harmful effects of ionizing radiation is also deemed to be sufficient to protect plant and animal life against these effects.

The protection of future generations against ionizing radiation also plays a role in the decommissioning of facilities and the management of radioactive waste. With regard to the decommissioning of nuclear facilities, it has been laid down by law that this must be started as soon as reasonably achievable after shut down. In addition, the decommissioning of the facility must also be completed as soon as reasonably achievable[36]. The legislation also obliges licensees of nuclear reactors to furnish a financial security approved by the Minister of Economic Affairs and the Minister of Finance for the costs of decommissioning.[37]

A policy for the management of radioactive waste (and spent fuel that is considered radioactive waste) was adopted in 1984[38]. This policy is based on four main points:

1. Minimization of generation of waste. The organization is required to prevent the generation of radioactive waste as much as reasonably achievable[39]. Recycling options must also be considered to this end. If the activity has decreased below the clearance levels, radioactive material can be released from supervisory control and reused or managed as conventional waste. The justification requirement described above contributes to the goal of minimization.
2. Safety. Radioactive waste must be safely managed as long as it poses a risk to humans and the environment. The Netherlands has opted for centralized storage in buildings for a period of at least 100 years, followed by passively safe geological disposal. The Central Organization for Radioactive Waste (COVRA) has been established to manage all Dutch radioactive waste. Geological disposal is currently regarded as the only safe option for the management of radioactive waste over the very long term. Any kind of storage (including long term storage) of radioactive waste will always be a temporary solution and is not considered as an acceptable alternative to disposal[40].
3. The polluter pays. In principle, all the costs for radioactive waste management are borne by the parties responsible for the generation of the waste. This includes all costs incurred by the COVRA for collection, conditioning, storage and disposal. These costs are charged to the waste generators through the COVRA's fees.
4. The burden of radioactive waste must not be passed on to future generations. In this context, among other things, a disposal fund has been established, to which waste suppliers contribute via a surcharge to the COVRA's fees. In addition, the feasibility of a disposal location is being studied in, among others, the radioactive waste disposal research programme, OPERA.

Recently, new European legislation[41] came into force which requires member states - thus including the Netherlands - to draw up a national programme for the management of their spent fuel and radioactive waste. The national programme must contain, among other things, concrete plans for the management of the waste for the very long term, including milestones and dates, as well as a financial substantiation. Some of the key components of this programme were recently presented in a Letter to Parliament[42]. This letter states, among other things, that the Dutch policy is generally adequate, but that it can be accentuated: the policy allows for the possibility of cooperation with other countries to create a multinational solution for disposal (a so-called dual strategy). If necessary, the period of 100 years must be flexible.

Finally, there is also an intervention requirement. This requirement concerns the remediation measures required to prevent or reduce exposure to ionizing radiation as a result of an accident or practices or work activities that have taken place in the past[43]. This requirement likewise makes an important contribution to the protection of both current and future generations.

Fundamental principle 8: Prevention of accidents

The potential exposure and risks are analysed for conformance with ALARA requirements (see fundamental principle 5) during the licensing phase. Measures are also taken to reduce risks and prevent exposure to ionizing radiation. During the decision-making process on a licence application, the submitted documents on safety and other matters are evaluated and tested against the exposure and risk conditions by the licensing authority.

Many licences require a fire prevention, fire detection and fire control plan to be drawn up and implemented. Many organizations have established a company fire department[44]. The organization must consult the company fire department and the local fire department before drawing up such a fire control plan.

For nuclear facilities, the concept of defence in depth must be applied in the design criteria. This entails implementing various overlapping strategies or measures (defensive levels) in the design, ensuring that the failure of a single system can only affect one single defensive level. The defence-in-depth concept is defined in NVR-NS-R-1, 'Safety Requirements for Nuclear Power Plant Design'. The defence-in-depth concept is further developed to encompass the latest insights in the 'Dutch Safety Requirements' (see fundamental principle 1).

Furthermore, the objective of preventing accidents is also advanced by means of continuous reflection on opportunities to further enhance safety.

Fundamental principle 9: Emergency preparedness and response

The organization's preparations for an effective response to radiation accidents (in the Netherlands or abroad) is a statutory responsibility of both the national and the regional government. This responsibility is dependent on the nature and size of the facility where the accident takes place. A distinction is made between category A and category B facilities.

A radiation accident involving a category A facility is a crisis with consequences that might transcend the region. National security may potentially be challenged. For 'A' facilities (nuclear reactors), the national government is responsible for the preparation of the off-site response to accidents. The primary responsibility lies with the Minister of Economic Affairs in the first place. Other ministers may also share some of the responsibility insofar as the matter concerns their specific policy areas[45]. The regional government is responsible for its own operational preparation in the region concerned

A radiation accident involving a category B facility normally has only local consequences. For category B facilities (plants for uranium enrichment, processing and storage of radioactive waste and transports of fissile materials, ores or radioactive materials), the regional government is responsible for the preparation and response to emergencies . The administration of the relevant security region has primary responsibility here.

The response to emergency situations at 'A' facilities is described in the National Nuclear Emergency Plan (NPK) and the National Nuclear Emergency Response Plan which is based on the NPK. The regional response to emergencies at 'A' facilities is described in the regional emergency response plans. The regional response to emergencies at 'B' facilities is described in the Radiological Handbook for Emergency Services.. The measures that have to be taken in such an emergency with an 'A' or a 'B' facility are based on the recommendations of an interdepartmental advisory team (the Nuclear Planning and Advice Unit - EPAn).

In the event of a radiation accident or a radiological emergency, the undertaking that operates the relevant facility must take all appropriate measures to limit the impact of the emergency without delay. This requirement is laid down in legislation[46] and in licence conditions. The undertaking shall notify the mayor of the municipality in case of an accident or emergency situation. The mayor then informs the Minister of Economic Affairs. The licence stipulates that the organization must also warn the Inspectorate of the Environment and Transport (ILT).

In the event of a radiation accident at an 'A' facility, the ministers can determine which measures they can take within their policy areas to minimize or neutralize the effects thereof as much as possible. The Minister of Economic Affairs and any other ministers it may concern coordinate the measures. The ministers immediately provide the affected population with information on what they are required to do and what measures have been taken, and continually update this information.

If there is also a national crisis (current or impending), then the general crisis procedure is activated via the National Crisis Centre, in accordance with the Institutional Decree of the Ministerial Crisis Management Committee and the National Handbook on Decision-Making in Crisis Situations. In this case the Ministerial Crisis Management Committee is responsible for decision-making. This committee is chaired by the Minister of Security and Justice, or the Prime Minister if he so wishes.

In the event of a radiation accident involving a 'B' facility, the mayor may exercise his general powers to maintain public order and safety. The mayor can issue orders and generally binding rules in order to respond to the accident[47]. In addition, the mayor is responsible for coordinating the response itself[48]. Depending on the scale of the accident, the chairperson of the safety region concerned may be delegated the responsibility.

If the effects of a radiation accident involving a category B facility spread (or threaten to spread) beyond the local area, the Minister for Economic Affairs may decide to respond to the accident as if it were an accident involving an 'A' facility[49]. In the event of an accident involving an 'A' facility, in accordance with the by-laws, the chairperson of the security region can set out rules or take measures to minimize or neutralize the effects of the accident as much as possible. The chairperson will cancel these rules and measures in as soon as a relevant minister announces corresponding rules or measures for his policy area[50].

Fundamental principle 10: Protective actions to reduce existing or unregulated radiation risks must be justified and optimized

A protective action (intervention) may be required in connection with prolonged exposure to ionizing radiation or an unregulated situation. An intervention involves the reduction or elimination of certain undesirable aftermath effects as a result of a past event. This event may be an accident, or an application that was deemed acceptable in the past but not any longer. The dose reduction aimed at with the intervention must be sufficient to justify the adverse social consequences and the costs thereof[51]. Interventions are also governed by an optimization requirement, although this solely concerns the limiting of health risks.

An example of unregulated exposure to ionizing radiation in the Netherlands is the presence of radon and thoron in dwellings. From a radiological point of view, the radioactive isotopes Rn-220 ("thoron") and Rn-222 ("radon" of the noble gas radon), as well as their progeny, are relevant. These nuclides are generated as a result of radioactive decay of radionuclides of natural origin, which are present in soil and in building materials. The RIVM has been investigating the exposure of the public due to these radio-isotopes since the 1980s.
Agreements were made with the construction industry in the past on the exposure to ionizing radiation due to building materials. Exposure to ionizing radiation as a result of radon and thoron in homes is currently the subject of a new RIVM study. The conclusions of this study are expected in early 2015. The necessity of a policy and any possible measures will be determined on the basis of this exposure information and the accompanying risk assessment.

Another example relevant for the Netherlands in this context is the problem of so-called 'orphan sources'. In the first half of the 20th century, ionizing radiation applications were generally not subject to the same strict safety and regulatory framework that applies today. Certain radioactive sources were no longer traceable after the relevant activities ceased. An example of this is the luminous paint containing radium that was used in clocks and watches, some of which devices are still in use.

Radioactive sources may unintentionally be imported from countries where regulation is less stringent or even absent. An example would be a consignment of scrap. There is a risk that such orphan sources will lead to the exposure of individuals to ionizing radiation without this being noticed. In some cases this may even lead to significant doses. To limit these risks, major scrap companies are required to install detectors that can detect ionizing radiation at the entrance to their premises[52].
Some of these companies have a licence to possess radioactive scrap under the Nuclear Energy Act. They are required to employ staff who have been trained to work safely with ionizing radiation. In addition, these companies must provide financial security for the eventual removal of the sources from their premises. Such sources must be managed in accordance with the ALARA, optimization and dose limit principles. As soon as a radioactive orphan source is detected, this must be reported to the mayor of the municipality in which it is located. The mayor subsequently informs the Minister of Economic Affairs[53]. The Radiation Incident Hotline of the Inspectorate of the Environment and Transport (ILT) can also be notified.

In addition to these rules for scrap companies, there are also rules and provisions in place for securing and safely managing detected unauthorized radioactive materials. These cases are subject to the same notification requirements. If necessary, the materials can then be removed in a controlled manner.

4. Nuclear security and safeguards policy

The policy on the security of nuclear facilities, radioactive sources and fissile materials as well as the policy on safeguards are essential parts of the system in place to protect the population against the risks of exposure to ionizing radiation. Because these topics fall outside the context of the forthcoming IRRS mission (as explained in the foreword), this document only briefly addresses the manner and extent to which the Netherlands has established and implemented nuclear security measures and nuclear safeguards.

Security of nuclear facilities, radioactive sources and fissile materials
The Netherlands strives to secure its nuclear facilities, radioactive sources and fissile materials against unauthorized influence by means of goal-oriented conditions as much as possible. The competent authority has drawn up so-called Design Basis Threats that serve as the basis for this security. These Design Basis Threats apply to both the physical security infrastructure and cybersecurity. They describe the scenarios against which the organizations must protect themselves. The organizations then choose the most effective and efficient security measures for their situation. They submit the proposed measures to the competent authority for approval. Transports of radioactive sources and fissile materials are also governed by this policy.

In 2012, the Netherlands was the first European country to complete the full *International Physical Protection Advisory Service (IPPAS)* cycle of the IAEA, including a follow-up mission. During this peer review, the security of both the Dutch nuclear facilities and the Dutch government organizations were examined. It was concluded that the Netherlands has drawn up and implemented an effective nuclear security policy. The sections of the IPPAS report that are available to the public can be found on the government's website.

Safeguards
The concept of safeguards can be described as 'monitoring activities aimed at countering the distribution of fissile materials and ores that contain a certain amount of fissile material'. This is a system of monitoring activities set down in international agreements and performed by the IAEA and Euratom. The aim is to monitor compliance with the international agreements on the peaceful use of nuclear energy. These agreements have been set down in the Non-Proliferation Treaty.

For the Netherlands this entails, among other things, inspections in and around nuclear facilities, a nuclear accounting system and verification of the quantities of nuclear materials in a country. The involvement of the Inspectorate of the Environment and Transport in nuclear safeguards affairs entails supervision of the international inspections, accreditation of these inspections and the inspectors concerned, and regulatory activities with regard to correct implementation of the agreements made. The ILT is also the point of contact for Euratom, the IAEA and the licensees in the Netherlands.

The interests of safety and security may conflict. From a policy point of view they are equal, and both require licensees to comply with the respective legislation. Possible conflicts between safety and security must be elaborated and solved at the site or object level. The licensee must elaborate the most effective configuration for its site or object, applying compensatory measures where necessary for safety or security issues to ensure compliance with safety and security legislation. Of course, it is also important that information on security must be treated confidentially.

5. Communication and transparency policy

Information on government policy and the risks of ionizing radiation is publicized via www.rijksoverheid.nl and the RIVM's website. Alongside general information on ionizing radiation and its effects, there is also more specific information available on these websites, such as on the risk of exposure to radon from the soil and from building materials and how this can be prevented, and on radiation protection in case of a nuclear accident.
The RIVM's website also publishes the measurement data of the National Radioactivity Monitoring Network. The network permanently monitors the radiation level at various locations in the Netherlands in order to be able to detect major radiation accidents in good time and monitor the extent and development of such accidents. The appropriate measures for the protection of the public can be based on these monitoring activities.

These websites also publish information on how the government monitors radiation exposure in the Netherlands. As this memorandum demonstrates, the legislation and regulations stipulate limits on the exposure to radioactivity, the requirement to have a licence or to notify for applications involving radiation, and the enforcement of compliance. Increasingly, data, policies, decisions, findings, analyses, et cetera are being actively published on government websites. This includes information on, for example, responding to incidents and malfunctions reported at nuclear facilities. Where necessary, reports in English are translated or a Dutch summary is provided.

If a radiation incident occurs, then an intensified communication protocol is applied, because communication is an important instrument for limiting risks. By informing people of the situation they will be more able to cooperate with the measures that are taken, which helps limit the risks.

Decisions and decrees on radiation protection and nuclear safety are prepared and sanctioned as transparently as possible. The importance of public access and transparency is always balanced against the importance of securing nuclear facilities and radioactive sources on the one hand and the risks of disseminating 'dual-use' [54] knowledge, information and technology on the other.

The rules for public access are set out in the Government Information (Public Access) Act. Anyone may request that information held by a government body be made available on the grounds of this act. Such a request may only be turned down by the relevant government body on the basis of the grounds for refusal laid down in this act. Examples of grounds for refusal are reasons of privacy or national security. Finally the judge may decide whether or not information has to be made public.

To ensure transparent decision-making the policy for the preparation of legislation and decrees is relevant. Parliament's involvement in the establishment of acts and administrative orders is laid down in a public preparatory procedure. When acts and royal decrees enter into force that set out generally binding rules (including administrative orders), this is published in the Bulletin of Acts and Decrees.
Draft regulations and decisions are not normally discussed with the House of Representatives. However, it is accepted practice to provide representatives of the relevant sectors with an opportunity to review the draft regulations and respond to them. There are also various opportunities for participation in decisions with legal effects. An example would be a decision to grant a licence. The General Administrative Law Act describes the procedures for the preparation of such decisions. This entails, among other things, that the draft decision must be announced and published in a local newspaper, the Government Gazette and a regional newspaper. This also applies to the definitive decision.

Hearings on location are also regularly organised in addition to these mandatory communications. During such hearings, the licence applicant and the licensor provide explanations on the relevant initiative to a broad audience. The draft decision and the definitive decision are also made available for inspection for all citizens at local town halls near the sites. These documents can also be inspected at the Ministry of Economic Affairs. All relevant documents are also published on www.rijksoverheid.nl.

In some cases, private and public institutions and organisations (for example, local action groups, NGOs or municipalities) are asked to provide information on the initiative in question separately.

In general the results of supervisory activities are published in the form of reports containing the findings, the instruments used and the conclusions with regard to compliance with the licence. The reports are available to the wider public via websites.

6. A competent authority for nuclear safety and radiation protection

As indicated earlier, the Dutch licensing authority for radiation protection and nuclear safety presently includes several ministers, each of whom has his own responsibilities and powers. These responsibilities and powers are distributed as follows:

- The Minister of Economic Affairs is politically responsible for the environmental aspects of radiation protection, nuclear safety, radioactive waste and spent fuel management, radiation incident response, the transport of radioactive and fissile materials, the security of facilities and radioactive sources and safeguards. This Minister is also responsible for the implementation of and compliance with the Nuclear Energy Act, which means he is primarily accountable to Parliament while they are responsible for 'legislative maintenance'[55]. The Minister of Economic Affairs is also responsible for radiation safety on or in facilities in the oil and gas extraction and mining industries and for product and food safety.
- The Minister of Infrastructure and Environment is responsible for the general environmental policy and legislation, including policy and legislation on Environmental Impact Assessments (EIA), soil, surface water and drinking water;
- The Minister of Social Affairs and Employment (SAE) is responsible for the policy on the protection of workers against the risks of ionizing radiation. This includes policy development, national and international legislation, and regulations and standards.
- The Minister of Health, Welfare and Sport is responsible for healthcare and the protection of patients against the risks of ionizing radiation.
- The Minister of Security and Justice is responsible for the system of disaster and crisis management and is therefore involved in all steps, from prevention to the aftermath. If a disaster or crisis has to be escalated to the national level, the Ministerial Crisis Management Committee must be involved, chaired by the Minister of Security and Justice, or the Prime Minister if he so wishes.
- The Minister of Defence is responsible for military radiation applications, including applications governed by a secrecy requirement.
- The Minister of Finance is responsible for insurance and liability issues, including those related to liability for accidents involving nuclear facilities.
- The Minister of Foreign Affairs coordinates the relevant foreign policy, particularly where it concerns non-proliferation and nuclear issues, and Euratom and IAEA concerns.

With regard to the responsibility of the Minister of Economic Affairs for the Nuclear Energy Act and the responsibilities allocated to him in this context, the Minister also fulfils many coordinating roles in the execution of legal tasks. The coordination between the various organizations with responsibilities regarding the response to an incident involving a nuclear facility or radiological source is described in the National Nuclear Emergency Plan (see also fundamental principle 9). This plan is managed by the ILT. The National Nuclear Emergency Plan fits within the context of the National Handbook on Decision-Making in Crisis Situations.

The supervision of compliance with and enforcement of the various policy areas is the sole responsibility of the various ministers. The supervision and enforcement of the Nuclear Energy Act are the primary responsibility of the Minister of Economic Affairs. The relevant powers have been mandated to the Inspector-General of the Environment and Transport (ILT) of the Ministry of Infrastructure and Environment[56] . The ILT's transport domains for, among other things, shipping and aviation are also involved in the supervision of compliance with this act.

The Department of Nuclear Safety, Security and Safeguards (KFD) is a branch of the ILT. The KFD is the most important supervisory body in the field of radiation and nuclear safety in the Netherlands. The KFD monitors compliance with policies and legislation in the field of radiation protection and nuclear safety by means of proactive and reactive checks (inspections, audits, document checks) and safety assessments. They also make use of the expertise and capacity of the RIVM and foreign technical support organizations for their regulatory activities[57].

Other supervisory bodies have been designated alongside the ILT[58]. For example, the Inspectorate of the Ministry of Social Affairs and Employment (SAE Inspectorate) is responsible for monitoring and supervising employers and workers’ compliance with legislation and regulations that affect working conditions, including radiation protection. This does not extend to the supervision of radiation protection in nuclear facilities, however, which is a KFD responsibility.

The Public Health Service monitors and supervises medical radiation applications in hospitals, dental practices, et cetera. Euratom and IAEA inspectors may monitor compliance with a number of provisions of the Non-Proliferation Treaty in the Netherlands.

The various supervisory bodies can employ administrative enforcement instruments in case of violations. If several supervisory bodies are empowered to regulate a facility or activity, then they will harmonize their supervision activities where useful.

The necessary financial and human resources for policy-making, implementation, supervision and enforcement are made available by the various ministries. These resources are fixed in the State Budget for a period of several years.

In practice, the so-called competent authority (or regulatory body) is formed by the responsible policy directorates of the various ministries together with the Radiation Protection Team of the Netherlands Enterprise Agency (RVO) and the above-mentioned supervisory bodies.

January 2014 the Council of Ministers decided to establish a new independent authority for nuclear safety and radiation protection (ANVS), an outcome of the implementation of the Vos/Leegte motion[59]. The ANVS will be an independent administrative body and a branch of the Ministry of Infrastructure and Environment. Its purpose is to combine the fragmented and scarce knowledge and expertise in the field of nuclear safety and radiation protection in one single authority. The Minister for Economic Affairs will prepare the necessary legislation to ratify this body and the Minister of Infrastructure and the Environment will prepare an ‘organization decree’ to this end. The ANVS will focus on the development of technical and other legislation, safety requirements, licensing, supervision and information provision. The ANVS will also be co-responsible for the preparation of the response to potential incidents involving the release of radiation.

7. Legal framework

The legal foundation of the policy for radiation protection and nuclear safety is formed by the Nuclear Energy Act and the legislation based on it, together with the licences and relevant licence conditions. All these documents can be found via www.overheid.nl.

Typical for the Nuclear Energy Act is that it exclusively regulates all applications and aspects of radiation are covered exclusively. This includes the radiation aspects of worker protection, environmental protection and patient protection, nuclear safety, the transport of radioactive and fissile materials, radioactive waste management, radiation incident response, security and safeguards*.* The licences for nuclear facilities also contain conditions with regard to conventional environmental aspects. The designation of powers with regard to the regulatory activities is fixed in mandates and a regulation under the Nuclear Energy Act.

A number of important aspects that are not directly related to nuclear safety are governed by more general policy documents and legislation. For example, the liability for the damages resulting from accidents at nuclear facilities is regulated in the Nuclear Accidents (Liability) Act ("Wako"). In addition, certain cases relating to penalties for violations of Nuclear Energy Act requirements are referred to the Economic Offences Act. General procedural matters relating to, for example, licence applications on the basis of the Nuclear Energy Act are regulated in the General Administrative Law Act ("Awb"). The Awb also regulates public participation and general matters concerning supervision. Finally, the Environmental Impact Assessment Decree regulates in which cases an EIA requirement or EIA review requirement applies.

Appendix 1: Ionizing radiation in the Netherlands

Ionizing radiation is (consciously) applied in the Netherlands in a wide range of applications. These can be divided into 1) nuclear applications, for which activities involving fissile materials take place or nuclear chain reactions are sustained, and 2) all other applications of ionizing radiation. Ionizing radiation can also 'unintentionally' play a role as a side effect of certain industrial processes. Examples are the presence of natural radioactivity in the ore-processing industry and emissions of radioactivity into the air and surface water. Furthermore, every year a large number of transports of fissile materials, ores and radioactive materials take place.

Below is an overview of the most common applications of ionizing radiation in the Netherlands. The average dose in the Netherlands and radioactivity in the environment are also loosely described, both to serve as an example and for the sake of completeness.

<u>1.1 The nuclear sector in the Netherlands</u>

The Netherlands has a small but diverse nuclear sector. This currently consists of the following facilities:

- An operational nuclear power plant in Borssele (pressurized water reactor, 485 MWe[60], commissioned in 1973), which is operated by N.V. EPZ. The Nuclear Energy Act stipulates that this plant may be operated until 31 December 2033, after which it will be decommissioned immediately. The operator of the nuclear power plant has concluded contracts with a foreign party for the reprocessing of all spent fuel, the return of reprocessing waste and the sale of all fissile materials recovered during reprocessing. In 2013, a licence for the use of MOX fuel[61] in the plant was granted irrevocably. The first fresh MOX fuel is expected in 2014. Finally, in 2013 a licence was issued for an extension of the design lifetime to the end of 2033 (known as a Long Term Operation licence).
- A non-operational nuclear power plant in Dodewaard (boiling water reactor, 60 MWe, put into operation in 1969, shut down in 1997), which was operated by B.V. GKN and which was brought into a state of safe enclosure for a 40-year period in 2005. The licence stipulates that dismantling of the plant is to be started in 2045. All the spent fuel from this plant has by now been removed and reprocessed, and the reprocessing waste has been transferred to the COVRA. The fissile materials recovered during reprocessing have been sold to third parties.
- An operational High Flux Reactor (HFR) (tank-in-pool type, max. 45 MWth[62], put into operation in 1961) at the Petten research centre. This research reactor is owned by the Joint Research Centre of the European Commission and operated by the licensee, NRG. This reactor supplies 70% of the European demand for medical radioisotopes and 30% of the global demand.
- In addition to the HFR, NRG also operates various other nuclear facilities at the Petten research centre. These include a Low Flux research reactor (LFR) (Argonaut type, 30 kWth, put into operation in 1960, shut down in 2010, decommissioning in preparation). There are also various laboratories and facilities on this location where practices are performed with radioactive materials and fissile materials. A certain amount of 'historical' radioactive waste is also present at the Petten research centre, which is being prepared for removal to the COVRA. This material is securely managed under the conditions of a Nuclear Energy Act licence and, as with the other facilities, is under supervision by the regulatory body.
- An operational Higher Education Reactor in Delft (open pool type research reactor, 2 MWth, put into operation in 1963). The licensee is Delft University of Technology (TU Delft). The reactor serves as a neutron and positron source for research and education purposes.
- An operational central storage facility for radioactive waste and spent fuel in Vlissingen (the COVRA). Over the past decades, a number of specially designed storage facilities for various types of radioactive waste have been built and commissioned.

- An operational uranium enrichment facility in Almelo (commissioned in 1973, licensed capacity 6200 tSW[63] per year, corresponding to about 10% of the global demand for low-enriched uranium).
- Each year, some hundreds of transports of irradiated or fresh nuclear fuels or fissionable materials-containing materials take place in the Netherlands. These transports are subject to licence conditions[64]. The transports are governed by international regulations for the transport of hazardous substances, subject to transport licences which can include far-reaching requirements.
- The company Enrichment Technologies Nederland (ETNL), based in in Almelo, develops centrifuge enrichment technology and is a global supplier of centrifuges to the enrichment plants of Urenco and Areva. ETNL is not a nuclear facility as meant in the Nuclear Energy Act and therefore does not operate under a licence on the basis of this act. However, this technology does fall under the Non-Proliferation Treaty and a number of other treaties for the protection of such knowledge and technology. Knowledge and information about this technology must therefore be treated as confidential[65]. This is one of the reasons why the company voluntarily applies the security standards for nuclear facilities in the Nuclear Plants and Fissile Materials (Protection) Regulation.

1.2 Applications of ionizing radiation outside the nuclear sector

In addition to the above-mentioned applications in the nuclear sector, ionizing radiation is also applied or present on a wide range of locations in the Netherlands. Important examples are:

- Practices with devices that can emit ionizing radiation in medical and veterinary settings. This concerns a total of some tens of thousands of devices which are used for therapy and diagnosis.
- The production and preparation of medical radioisotopes using cyclotrons[66] and a limited number of hot cells[67] in various settings. These radioisotopes are used for therapy and diagnosis.
- Practices involving radioactive materials for the purpose of diagnosis and therapy in medical and veterinary settings.
- Practices involving devices for the purpose of scientific research, such as the use of particle accelerators in fundamental research.
- Practices involving the use of radioactive sources in industry, for example for non-destructive testing for product treatment purposes, and research institutes.
- In the Netherlands, some thousands of transports of radioactive materials take place every year. Depending on the type and quantity of radioactive material that is transported, and depending on whether a national border is crossed, a distinction is made between transports subject to a notification requirement[68] and transports subject to a licence condition[69,70] The vast majority of transports are subject to a notification requirement. Transport notifications and licences can both be issued for several transports during a given period. As with transport of fissile materials, transport of radioactive materials is governed by international regulations for the transport of hazardous substances, involving transport licences which can entail far-reaching requirements.
- Various commodities and consumer products contain radioactive materials. Examples are luminescent sources and lamps containing thorium.

1.3 Other situations in which ionizing radiation is relevant

In addition to the applications described above, there are various other conceivable situations in which ionizing radiation produced as a side effect of a standard business process could pose a risk to workers or members of the public. A licence condition or notification requirement often applies to such situations. Important examples are:

- The intentional or unintentional possession of radioactive scrap in the scrap industry. Some companies have a Nuclear Energy Act licence which entitles them to perform certain practices with radioactive scrap if it is detected. Other companies have chosen to outsource such activities to specialized companies.

- Work activities involving natural radioactive sources, often in the ore-processing industry. Large quantities of raw materials that contain low concentrations of natural radioactive materials are handled in the ore-processing industry. This can result in significant quantities of residual material with an increased concentration of natural radioactivity. Exposure risks may also arise during processing and/or natural radioactivity may be discharged into the air and surface water. Examples of the ore-processing industry include the oil and gas industry, fossil power generation, the transhipment of raw materials and the production of elemental phosphorus.
- Natural radioactivity is also relevant in various everyday situations. An example would be thoron and radon, which is released from the soil and from some building materials. The RIVM is engaged in an extensive investigation into the extent and risks.
- Various institutions and nuclear facilities discharge radioactivity into the air or surface water. This mainly concerns hospitals that provide iodine therapy and research institutes with laboratories. A licence is required if these discharges[71] exceed certain limits. Discharges into the soil are not permitted.
- A number of situations are known to exist in the Netherlands where there is an increased level of ionizing radiation as a result of past activities. This typically concerns the processing or occurrence of materials that contain significant amounts of natural radioactivity, of which this was not known at the time and/or for which no legislation existed then. An important example of this is slag wool, which has been used as an insulation material in power plants and which contains natural radioactivity. Depending on the nature and extent of the risks, a major clean-up of buildings and facilities may be required, involving dismantling, radioactive waste conditioning and removal, or soil remediation. Depending on the radioactivity concentration, in certain cases a licence may be issued on the basis of the Nuclear Energy Act.
- A number of nuclear facilities and non-nuclear facilities are situated in Germany and Belgium, near the Dutch border. They include nuclear power plants, a storage facility for radioactive waste and an enrichment plant.
- The amount of radioactivity in the Dutch environment is very low, but still measurable. The Dutch soil contains relatively little natural radioactivity in comparison to other countries. Furthermore, there is an amount of measurable artificial radioactivity as a result of discharges into the air and surface water from hospitals and local and foreign nuclear facilities, and fallout[72] from nuclear testing. On behalf of the Minister of Economic Affairs, the RIVM reports annually to the European Commission on radioactivity levels in the environment, in line with a Euratom Treaty requirement.

1.4 Support organizations

A number of organizations provide support services to the licensing authority.

- The RIVM functions as a knowledge centre for the Dutch government for scientific and societal issues related to hazards and risks to humans and the environment that involve ionizing radiation and radioactive materials. In this context, the RIVM provides various support services, including research for policy support and support for the supervision, and response to radiation incidents.
- NRG provides support services in the area of radiation protection and nuclear safety. In addition, NRG performs a number of legal tasks in the area of radiation protection (see fundamental principle 2).
- Contracts have been concluded with the German Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), an independent, non-profit organization specialized in radiation protection and nuclear safety which works for various governments, for support in policy development and the performance of supervisory activities.

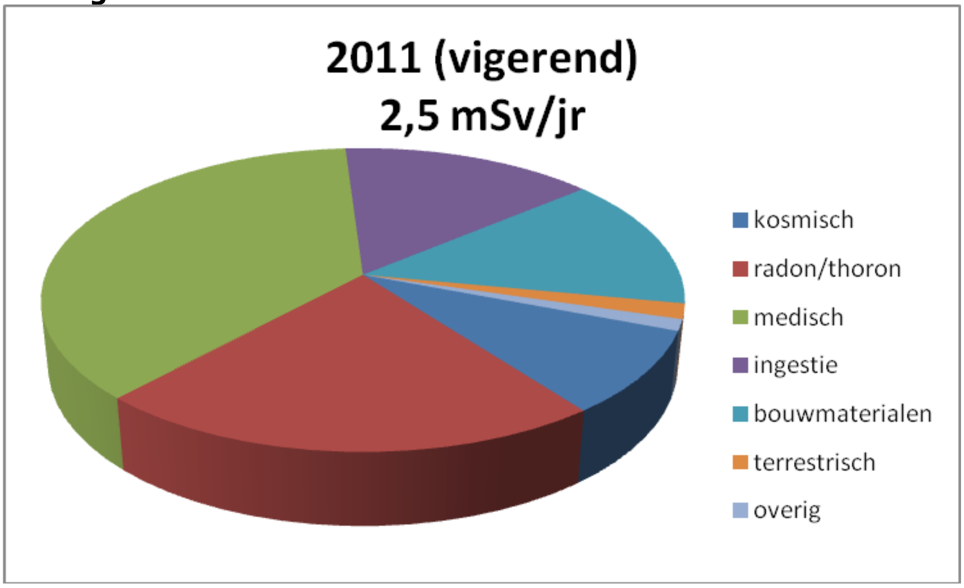
1.5 Key developments in the future

- Options are currently being studied to replace the HFR with a new research reactor (named Pallas). This replacement is currently scheduled for 2023. A separate foundation has been established that is responsible for all the preparatory work. The Dutch government and the Province of Noord-Holland have together provided a loan of €80 million to finance the design, tendering and licensing of Pallas. An important precondition for this financing is the development of a solid business plan and the procurement of private financing for the construction and operation of Pallas.
- The COVRA submitted an application for a licence amendment in late 2013 to be able to expand the capacity of the HABOG storage facility in connection with the storage of Borssele nuclear power plant’s reprocessing waste, which will be produced after 2015.
- TU Delft has launched a project to upgrade its research reactor and continue to develop a so-called ‘cold neutron’ source. In addition, the university wishes to expand its nuclear activities to the production of medical radioisotopes. The project has been named OYSTER (Optimized Yield - for Science, Technology & Education - of Radiation) and is jointly funded by the University (€74 million) and the national government (€38 million).
- A number of initiatives for the establishment of facilities for proton therapy are currently in preparation or under consideration. This type of therapy involves irradiating tumours with protons rather than with high-energy gamma radiation.
- Several years ago, initiatives were taken with the aim of establishing a new nuclear power plant in the Netherlands. For various reasons, however, these initiatives have not yet led to an application for a licence.

1.6 Average annual dose in the Netherlands

The figure below displays the average radiation dose in the Netherlands as calculated by the RIVM for the year 2011. More recent data are not yet available for all of the dose contributions. On average, a person in the Netherlands receives an effective dose of about 2.5 mSv[73] in one year. It is important to note that this is an annual dose that is averaged over the entire Dutch population, which means that the radiation dose may be higher or lower at the individual level. For medical applications, the figure only displays the doses received during diagnostic examinations. The doses used in medical therapy (i.e. radiation therapy for cancer) are not included in the average radiation dose, because these doses are intended to inflict lethal damage to cancer tissue. These high doses are also very unevenly distributed over the population.

Average radiation dose received in the Netherlands



source: RIVM

The RIVM anticipates that the calculated average dose will prove to be higher in the near future, because the dose from the inhalation of radon and thoron (and their daughters) in dwellings probably contributes more to the average radiation dose than calculated thus far. There are two reasons for this: firstly, new scientific insights resulting from research by the International Commission on Radiological Protection (ICRP) suggest that exposure to radon and thoron (and their daughters) is more hazardous than previously thought; and secondly, preliminary research by the RIVM suggests that the amount of thoron (and thoron daughters) indoors is higher than thought thus far. With regard to the first reason, the ICRP reports that, according to new insights, the radon/thoron contribution is at least twice as high. A large national survey of approximately 3000 dwellings is intended to provide more clarity about the concentrations of thoron (and thoron daughters) in the Netherlands. The results are expected in early 2015. Thanks to favourable soil conditions, the contribution of radon (and radon daughters) to the radiation dose in the Netherlands is relatively low in comparison with the surrounding countries.

Appendix 2: Most relevant international agreements and consultations

With regard to the radiation protection and nuclear safety policy described in this document, the Dutch Government has ratified the following international agreements and, where necessary, implemented them in legislation:

- The Euratom Treaty and the implemented directives and regulations based thereon
- *The Convention on Nuclear Safety*
- *The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*
- *The Convention on Early Notification of a Nuclear accident*
- *The Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency*
- *The Non-Proliferation Treaty*
- *The Convention on Physical Protection of Nuclear Material and Nuclear Facilities*
- *The Paris Convention on Third Party Liability in the Field of Nuclear Energy*
- *The Brussels Convention Supplementary to the Paris Convention*
- *The Oslo and Paris Conventions for the protection of the marine environment of the north-east Atlantic ('OSPAR')*
- The Convention on public access to information, public participation in decision-making and public access to justice in environmental matters ('Aarhus Convention')

International agreements on the transport of radioactive and fissile materials and ores are set down in:

- *The International Civil Aviation Organization*
- *The International Maritime Dangerous Goods Code (IMDG)*
- *Accord européen relatif au transport international des marchandises Dangereuses par Route* (ADR)
- *Règlement concernant le transport international ferroviaire des marchandises dangereuses* (RID)
- *Accord européen relatif au transport international des marchandises Dangereuses par voies de Navigation intérieures* (ADN)

In addition, the recommendations in the following non-binding IAEA Codes of Conduct have been applied in the development of legislation, insofar as these are not already incorporated in European directives:

- The Code of conduct on the safety and the security of radioactive sources
- *The Code of conduct on the safety of research reactors*

Representatives of the Dutch Government actively participate in various formal and informal international partnerships, including:

- *The European Nuclear Safety Regulators Group (ENSREG):* A consultation between the heads of the competent authorities for nuclear safety and/or radiation protection of EU member states
- *The European Nuclear Security Regulators Association (ENSRA):* A consultation between the heads of the competent authorities for the security of radioactive and fissile materials and nuclear facilities of EU member states and Switzerland
- *The Heads of the European Radiological protection Competent Authorities (HERCA):* A consultation between the heads of the competent authorities for radiation protection of the EU member states

- *The Western European Nuclear Safety Regulators' Association (WENRA):* A consultation between the heads of the competent authorities for nuclear safety of EU member states with a nuclear energy programme
- The Nuclear Energy Agency (NEA), an agency of the Organisation for Economic Co-operation and Development (OECD)
- *The World Institute for Nuclear Security (WINS)*
- Various IAEA consultations on nuclear security, such as the Nuclear Security Guidance Committee, as well as various working groups

Last but not least, the third Nuclear Security Summit held in The Hague in 2014 is an example of the Netherlands' international engagement.

Appendix 3: Definitions and references

[1] IAEA: *Fundamental Safety Principles*, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).

[2] IAEA: *Governmental, Legal and Regulatory Framework for Safety General Safety Requirements Part 1*, IAEA, Vienna (2010).

[3] Ionizing radiation: Ionizing radiation is radiation that is sufficiently energetic to remove an electron from an atom and so ionize it.

[4] Nuclear facility: A facility where nuclear energy can or used to be released, where fissile materials can be produced, modified or processed, or where fissile materials can be stored.

[5] *IAEA: "Objective and Essential Elements of a State's Nuclear Security Regime", Nuclear Security Series, No. 20.*

[6] Directive 2009/71/Euratom on nuclear safety, Article 6.

[7] Regulation on the implementation of Directive 2009/71/Euratom on nuclear safety, Article 3.

[8] Nuclear Energy Act, Section 15f.

[9] Nuclear Energy Act Payments Decree.

[10] Western European Nuclear Regulators Association: a consultative body formed by the heads of the competent authorities of European countries with a nuclear programme.

[11] *Operational Safety Review Team.*

[12] *International Probabilistic Safety Assessment Review Team.*

[13] *Safety Aspects of Long Term Operation of Water Moderated Reactors.*

[14] Nuclear Energy Agency, an agency of the Organisation for Economic Cooperation and Development (OECD).

[15] The most important publications of the IAEA can be found at www-ns.iaea.org/standards/documents/general.asp.

[16] Nuclear Energy Act, Section 70.

[17] Radiation Protection Decree, Section 5.

[18] Radiation Protection Decree, Section 9, and Nuclear Facilities, Fissile Materials and Ores Decree, Section 19.

[19] Regulations on the implementation of Directive 2009/71/Euratom on nuclear safety, Article 5.

[20] Regulations on the implementation of Directive 2009/71/Euratom on nuclear safety, Article 7.

[21] House of Representatives, 2012-2013 Session, 32645, No. 52.

[22] Final Storage of Radioactive Waste research programme, in the period 2011-2015.

[23] Radiation Protection Implementing Regulations of the Ministry of Economic Affairs, Section 2.2.

[24] Radiation Protection Decree, Section 4.

[25] Justification of Uses of Ionizing Radiation (Publication) Regulation.

[26] Radiation Protection Decree, Section 5 (among others).

[27] Anthropogenic source: radioactive source caused by human activity.

[28] Radiation Protection Decree, Section 6.

[29] Radiation Protection Decree, Section 48.

[30] Radiation Protection Decree, Section 77.

[31] Radiation Protection Decree, Section 79.

[32] Nuclear Facilities, Fissile Materials and Ores Decree, Section 18 (2).

[33] Nuclear Facilities, Fissile Materials and Ores Decree, Section 18 (3).

[34] A probability of 10^{-5} times per year that a group of at least 10 persons outside the applicable facility will be direct fatalities of a non-design basis accident, or a probability of n^2 times smaller for n times more direct fatalities.

[35] Radiation Protection Decree, Section 35.

[36] Nuclear Facilities, Fissile Materials and Ores Decree, Section 30.

[37] Nuclear Energy Act, Section 15f.

[38] Parliamentary Documents II, 1983/84, 18 343, Nos 1-2.

[39] This is also set down in the Radiation Protection Decree, Section 36.

[40] Directive 2011/70/Euratom, Recital 21.

[41] Directive 2011/70/Euratom.

[42] Parliamentary Documents II, 2012/13, 25 422, No. 105.

[43] Nuclear Energy Act, Section 38 (f). In addition, the Radiation Protection Decree, Section 112, places further conditions on this requirement, including an assessment framework in which environmental and other interests can be included.

[44] On the basis of the Board of the security region's decision (see Section 31 (1) of the Security Regions Act).

[45] Nuclear Energy Act, Section 40 (1).

[46] Radiation Protection Decree, Section 116.

[47] Nuclear Energy Act, Section 49c.

[48] Nuclear Energy Act, Section 40 (2).

[49] Nuclear Energy Act, Section 42 (1).

[50] Nuclear Energy Act, Section 49b.

[51] Radiation Protection Decree, Section 112.

[52] Radioactively Contaminated Scrap Metal (Detection) Decree, Section 3.

[53] Nuclear Energy Act, Section 33.

[54]54 Technology, knowledge or goods that have both civilian and military applications

[55] Decree of 11 November 2010, No. 10.003075, concerning departmental reorganization regarding energy and the Dutch Emissions Authority (Government Gazette 2010, 8531)

[56] Decree of the Inspector General for the Environment and Transport of 14 December 2011, No. IENM/IVW-2011/15058, on the establishment of the organization and the granting of a mandate, proxy and authorization of the Inspectorate of the Environment and Transport, 2012 (Organization and mandate decree of the Inspectorate of the Environment and Transport, 2012), Decree of the Minister of Economic Affairs, Agriculture and Innovation of 17 February 2012, No. WJZ / 12019399, on rules for granting a mandate, proxy and authorization to the Inspector General of the Environment and Transport on enforcement of the Nuclear Energy Act (Mandate, proxy and authorization decree of the Inspector General of the Environment and Transport on enforcement of the Nuclear Energy Act), Decree of the Inspector General of the Environment and Transport of 23 February 2012, No. IenM/ILT-2012/4980, concerning the granting of a sub-mandate, proxy and authorization for the Inspector General of the Environment and Transport on enforcement of the Nuclear Energy Act (Sub-mandate, proxy and authorization decree of the Inspector General of the Environment and Transport on enforcement of the Nuclear Energy Act).

[57] Technical Support Organization: a branch of government or a private company that supports the competent authority in the area of policy research, policy development and/or regulatory activities.

[58] Appointment of Inspectors and Fulfilment of Duties (Nuclear Energy Act) Decree 2013 (Decree of the Minister of Economic Affairs of 29 November 2013, No. WJZ/13175315 on the appointment of Inspectors and Fulfilment of Duties in accordance with the Nuclear Energy Act, 2013).

[59] House of Representatives, 2012-2013 Session, 32 645, No. 48.

[60] MWe: Megawatt electrical.

[61] MOX fuel: nuclear fuel consisting of both uranium and plutonium oxide.

[62] MWth: Megawatt thermal.

[63] tSW: (ton Separative Work) is the unit that is used for the degree of separation of uranium isotopes by an enrichment plant. The capacity of an enrichment plant can be expressed in tSW/year.

[64] Nuclear Energy Act, Section 15 (a).

[65] Nuclear Energy Act (Confidentiality) Decree.

[66] Cyclotron: A circular particle accelerator, generally used for scientific research or for the production of medical radioisotopes.

[67] Hot cell: Insulated space in which, among other things, radioactive materials (including highly radioactive materials) and/or fissile materials can be modified or examined, and which provides protection against the ionizing radiation produced by these materials and prevents the dispersion of radioactivity.

[68] Fissile Materials, Ores and Radioactive Substances (Transport) Decree, Section 4c.

[69] Fissile Materials, Ores and Radioactive Substances (Transport) Decree, Section 5.

[70] Radioactive Waste and Spent Fuel (Import, Export and Transit) Decree, Section 3.

[71] Radiation Protection Decree, Section 35.

[72] Fallout: Radioactive precipitation or dust in the atmosphere following a nuclear explosion, or on the earth’s surface if the dust settles.

[73] Sv: Sievert [J/kg] is the unit for the equivalent or effective dose of ionizing radiation to which a person is exposed. 1 mSv is 0.001 Sv.